Tribute to Michel Gambin on the 70th anniversary of the Ménard Pressuremeter

Hommage à Michel Gambin à l'occasion des 70 ans du Pressiomètre Ménard

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ABSTRACT

Hired by Michel Gambin in 1978, a few weeks after Louis Ménard's death, I worked with "Mike" for several years as a boss at the Ménard Group, then for many years with him when he was successively Technical Director at Solétanche, then technical advisor to Apagéo, a company he helped create with a former Ménard employee responsible for the rental and sale of pressuremeter "suitcases".

I have the difficult task of trying to retrace, for those of you who knew him, as well as for the younger generations dealing with pressuremeters, the geotechnical career of Michel Gambin, who devoted his entire professional life and a large part of his retirement to the promotion and development of the Pressuremeter, and all the geotechnical disciplines related to or generated by this exceptional ground investigation tool, in particular the monitoring and understanding of soil improvement mechanisms during the control of this improvement by pressuremeter campaigns before and after improvement;

Keywords: ISP8; September 2025; Ménard Pressuremeter; Michel (Mike) P. Gambin; Louis Ménard; Dynamic Consolidation; Soil improvement; Non-linear elasticity.

RÉSUMÉ

Embauché par Michel Gambin en 1978 quelques semaines après le décès de Louis Ménard, j'ai travaillé pendant quelques années avec "Mike" comme patron dans le Groupe Ménard, puis de longues années avec lui lorsqu'il a été successivement Directeur Technique chez Solétanche, puis conseiller technique d'Apagéo, société qu'il avait contribué à créer avec Robert Robin, ancien salarié de Ménard chargé de la location et vente des "valises" pressiométriques.

J'ai la lourde tâche de tenter de retracer, pour ceux d'entre vous qui l'ont connu, ainsi que pour les jeunes générations amenées à utiliser et développer le pressiomètre, le parcours géotechnique de Michel Gambin, qui a consacré toute sa vie professionnelle et une grande partie de sa retraite à la promotion et au développement du pressiomètre, et à toutes les disciplines géotechniques liées ou générées par cet outil exceptionnel d'investigation des sols, en particulier le suivi et la compréhension des mécanismes d'amélioration des sols lors du contrôle de cette amélioration par des campagnes pressiométriques avant et après amélioration.

Mots-clés : ISP8 ; Septembre 2025 ; Pressiomètre Ménard ; Michel (Mike) P. Gambin ; Louis Ménard ; Consolidation dynamique ; Amélioration des sols ; Élasticité non linéaire.

1. Michel Gambin, 60 Years of Geotechnics without taking eyes off the Pressuremeter

I wanted to talk about almost 50 years of collaboration with Michel Gambin. I realized that in fact it boils down to 40 years, the last published title in his bibliography updated after his death (Apagéo 2024) dating from 2018. It is more accurate to speak of Michel Gambin's 62 years of geotechnical work since his student final dissertation, and 60 years of pressuremetry since his arrival alongside Louis Ménard.

As a preamble, I must also say that it is a great honour for me to give this Lecture at the ISP8 Symposium, because I was fortunate to have Michel Gambin as my boss for 4 years in the Ménard Group, then as a mentor for 43 years until his death in 2024; this fruitful collaboration has also made me very modest about my ability to retrace his long geotechnical career (ICP 2024). I think that geotechnicians of my generation who collaborated with Michel Gambin as much as I did, such as Jean-Pierre Magnan or Roger Frank, would have been more legitimate. One only must refer to the "Reminiscences" published in the ISSMGE Bulletin, in which the latter brings Michel Gambin to give details on his career of which I did not know everything (Frank & Gambin 2009a), and which I will quote throughout this tribute. I also apologize in advance for being led to develop rather the work that I had the pleasure of doing with Michel Gambin, compared to that which he did with other geotechnicians, and which are in practice much more important for the calculation of foundations and structures in the ground.

1.1. 1978, a crucial year

The death of Louis Ménard on January 15, 1978, marked the end of an exceptional partnership for Michel Gambin, lasting exactly 20 years since the inventor of the pressuremeter called upon him to develop the device and the pressuremetric method (Gambin 2005a). A faithful "right-hand man" during these twenty years, Michel Gambin considered throughout his life that Louis Ménard's genius surpassed all his collaborators, and that his death at such a young age gave them all the obligation to develop his inventions by referring to what the master would have done, and which can often be found in his writings, although rare.

From the moment he was deprived of Louis Ménard's support, Michel Gambin devoted all his energy to continuing his work. During these 20 years, 27 issues of the journal Sols-Soils were published, largely devoted to the development of pressuremetric themes by various researchers. In issue 28, Michel Gambin published a tribute to Louis Ménard by their professor Jean Kérisel (Kérisel 1979), and in the same issue, an article on the calculation of foundations using the pressuremeter modulus and ultimate pressure (Gambin 1979), a way of emphasizing that the pressuremeter did not die with its inventor.

Michel Gambin hired me at Etudes Pressiométriques Louis Ménard in April 1978, so I never knew "the great Louis," but I was immediately struck by the energy of the Ménard employees, whose daily work was entirely motivated by the desire to continue the work of their late boss, as if he were still there. I have also always been impressed, as if it were not necessarily a coincidence, by the fact that it was also in 1978 that two reference works appeared almost simultaneously, as a necessary tribute to Louis Ménard, in English "The Pressuremeter and Foundation Engineering" (Baguelin et al. 1978) and in French "Les essais in situ en mécanique des sols" (Cassan 1978) with large practical and theoretical parts on the Pressuremeter.

As a young geologist whose experience was primarily in qualitative geological surveys of road layouts, I felt compelled to make up for my shortcomings in pressuremetry as quickly as possible if I wanted to live up to the reputation of the Ménard companies. Since the edition was only printed at the time, these two works are the most bookmarked books in my library, competing with the Sols-Soils collection, of which Michel Gambin gave a copy to study with each new one, as well as the complete collection of Ménard notices "D series", which Michel Gambin also ensured were constantly updated, and the reissue printed in a very modern way for the time on a professional-level internal printing press. When Michel Gambin circulated a document or publication internally, for the attention of a colleague, with the handwritten note "talk to me about it", the recipient knew that it was in his interest to think about his opinion, and not to forget to make an appointment with him. Michel had a phenomenal memory and did not forget a single detail.

1.2. Before 1958.

I knew little about the childhood and adolescence of Michel Gambin, born on December 2, 1930 in Paris. He only once mentioned to me the gloomy atmosphere of the 1940s in Paris, where he completed his primary and secondary education at the Lycée Janson de Sailly. His eldest son Christophe has given me some information since his death: Michel had a sister Françoise, two years his junior, who died in 2015. Their father Auguste Gambin was captain of quartermasters at the Ministry of War; he died in 1932. Their mother Marie-Lucie raised them alone, at 11 rue Magdebourg (Paris, 16th) under the restrictions of the war and the Liberation, with the difficulties of taking on the studies of a boy who had the ambition to do preparatory classes after the baccalaureate, then the entrance exam to the Ecole Nationale des Ponts et Chaussées. For his family, "Papa Michel" was his familiar name, both for his three children and his grandchildren. Michel himself seemed uninterested in researching his ancestors, even though he often inquired about the origins of mine, often talking to me about his wife Marie-Thèrèse's distant cousins with one of my classmates in Franche-Comté. I remember showing him that people named Gambin, in France, live in the department of Ainbut there are many more in Italy, in the province of Veneto, and in Spain, in the province of Murcia.

Michel Gambin graduated from the ENPC in the class of 1954. He met Louis Ménard, from the following year's class, and like him, he kept in touch with Professor Jean Kérisel. Then he spent a year in the United States at Harvard, Graduate School of Arts and Sciences, where he studied under K. Terzaghi and A. Casagrande, and in the same city of Cambridge (Massachusetts), under D. Taylor and T. Lambe at MIT. He always reminded me that he made a lot of progress with the teaching of David Taylor, perhaps even more than with that of Karl Terzaghi, whose English he had difficulty understanding. Aware of the good fortune of having known these founding fathers of geotechnics, he returned from the USA with an edition of "Soil Mechanics in Engineering Practice" (Terzaghi & Peck 1948), "seventh printing, February 1954," a book he bequeathed to me, with many underlined and annotated pages, as well as his Harvard & MIT lecture notes, copied in his characteristically beautiful, almost calligraphic handwriting.

Michel (Gambin 2005b) talks about his 18 months of military service in 1956-1957, in the Military Engineering Corps, from which he graduated as a lieutenant. Then in 1958, he began collaborating with Ménard, who had returned from the University of Illinois with his PhD (Ménard 1957) on the Pressuremeter and its prototype. Ménard had already founded his company and had to do his military service, while having already started selling his Pressuremeter to the design offices that were his first companions, such as Sopéna, Sobésol and Fondasol, as well as to the LRPC (French Regional Laboratories of Bridges and Roads). The two men, perfectly trained in the already classical soil mechanics, would soon move away from it to innovate and create their own concepts for the Pressuremeter.

2. 1958-2024, the career of Michel Gambin, 66 years in 6 stages

2.1. 1958-1978, 20 years with Louis Ménard

Figure 1. Michel Gambin and Louis Ménard, 1960s, probably Saulx-les-Chartreux (France)

From the 20 years of collaboration between Louis Ménard and Michel Gambin (Fig. 1), we have the testimony of an intense and sustained activity to create, develop, and impose on their contemporaries the irreplaceable role of the Pressuremeter (Fig. 2) in the recognition of the geomechanical properties of soils and rocks. As early as August 1957, a few months after his thesis, Louis Ménard did not hesitate to go alone to the IVth ICSMFE, Congress of the International Society in London, where he presented his prototype, and intervened orally in several communications to say that he knew how to measure the modulus in situ, and to promise to return with proofs to the 5th Congress.

From the very beginning, they formed a small group of enthusiasts around Louis, the undisputed boss, today we would call a "dream team", with an elder, the engineer Henri Pompon, who developed the first calculations for applying their measurements to the bearing capacity of foundations, and young people of their age: Jean Rousseau, whose academic background included a thesis on granular soils, and who created a geotechnical design office within the company La Béarnaise, from which he would later break away to create Soletco; Maurice Cassan, graduating from ESTP, working at the company Paul Clausse, which quickly became Fondasol (Fig. 3); Professor Albert Van Wambecke, from the Royal Military Academy of Brussels was soon added, who would always remain a very close friend of Michel Gambin. Louis Ménard, always imperative, very quickly decided them to abandon at least temporarily the search for theoretical relationships between the expansion of a cylindrical cavity and the intrinsic characteristics of the soil, cohesion and friction angle, yet judged then universally indispensable to the determination of foundations according to the teaching of Karl Terzaghi.

In a few years, between 1958 and 1961, their pragmatic approach, free from classical parameters, was perfected: they invented and emphasized the concept of ultimate pressure as a parameter that could characterize any type of soil, laid the foundations for simple relationships between ultimate pressure and bearing force and friction, established the importance of the shear modulus in understanding settlement, and distinguished between the spherical and deviatoric components of settlement. To avoid overly confusing engineers familiar with Young's modulus, the pressuremeter shear modulus was defined over the pseudo-elastic range of the test and expressed with a single Poisson's ratio, as the compression modulus.

Their research was based on full-scale foundation tests that Ménard conducted on the construction site of his premises and workshops in Saulx-les-Chartreux, in the sands of Fontainebleau, which he named, not without a certain ambition, the "Paris Geotechnical Studies Center." The validation of the hypotheses made on the direct relationship of the limit pressure with the breaking stress, and the use of the pressuremeter module for the prediction of settlement, aims to arrive, as they retained from the teaching of Terzaghi, at a practical dimensioning based on an acceptable differential settlement, before having all the theoretical justifications (Gambin 1995).

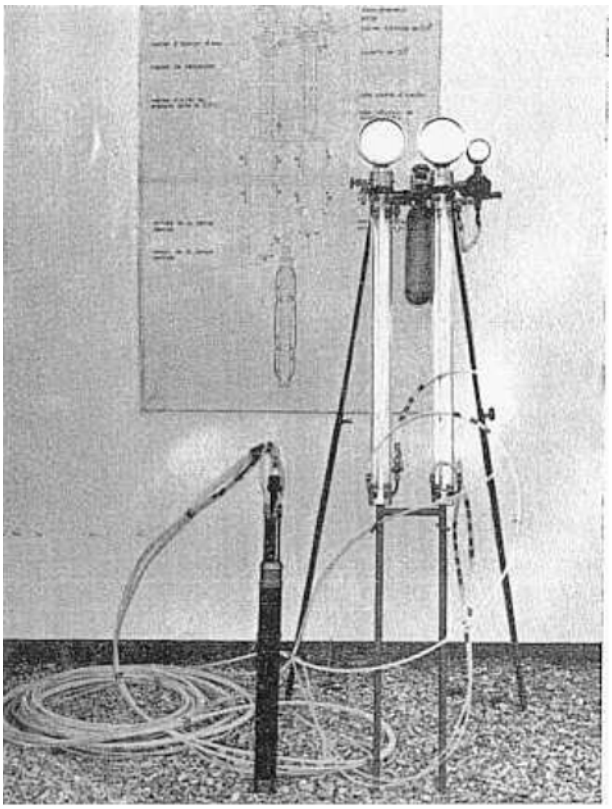

Fig. 1 Type de pressiomètre.
Type of pressiometer.

Figure 2. The Pressuremeter (Ménard 1961). This is type D with 2 volumeters, for the central cell and the guard cells. M. Gambin says that he had never known the types A, B "made in USA", type C was with a quasi-spherical measuring cell probe. They will be replaced after 1962 by type F, long used in the LPC, then type G with a probe with nested cells still in use today (Leblanc 1982)

The objective was to aim for an acceptable differential settlement under admissible stress, which would be the best compromise based on the soil profile, established statistically with a regular distribution every 1m of depth of pressuremeter tests in several boreholes adapted to the geometry of the project.

Their work does not, however, fail to take into account the theoretical study of the pressuremeter curve, which Louis Ménard initiated in his thesis, which they also approach through the results of other contemporary works which were already interested in Ménard's invention quite early on: (Gibson & Anderson 1961), (Ladanyi 1961), (Greenland 1964), (Meigh & Greenland 1965), (Salençon 1966), (Dixon & Jones 1968) (Higgins 1969), or older ones, which can adapt to radial stress (Bishop & al. 1945) (Skempton, Yassin, Gibson 1953) (Rowe 1962)).

Figure 3. In a group photo in 2001, Michel Gambin, Maurice Cassan, Jean Rousseau, with Marie-Laure Carrière, the only lawyer as member of the CFMS. Henri Pompon, Louis Ménard, Albert Van Wambecke are no longer there. No photos from the sixties of the entire team

Michel Gambin, from these pioneering years, applied himself to methodically cataloguing everything that was written about the pressuremeter or that could be useful to it (Ménard Y. notices series, Bibliography on the pressuremeter). The practical needs of pressuremeter design gave rise very early to:

- the concept of the rheological coefficient α (alpha) (Ménard & Rousseau 1962), introduced to account for the nonlinearity of the pseudo-elastic phase of the test, a fundamental notion that still provides elements for thought today (Baguelin et al. 1978, Cassan 1978, Schmitt 1995, 1998, Briaud 2013, Gambin & Baud 2013), see below §3.2,
- the concept of relative depth and critical depth (Ménard 1963, Gambin 1979), see §3.3, which goes hand in hand with
- the concept of the bearing coefficient k for shallow foundations or the tip of deep foundations, for which charts are established according to the terrain categories. The bearing coefficient, predicted by Ménard in the manuscript of his first patent (Gambin 2005), will only be formalized under this name in the article which summarizes his pressuremetric method, the Ménard D60 brochure probably prepared by M. Gambin (Centre d'Etudes Géotechniques Ménard 1967 1st edition), updated and systematically distributed to users, in several languages, and also published in Sols-Soils with the master's signature (Ménard 1975).

The density of these works, at the same time as that of the Laboratories of the Bridges and Roads, users of pressuremeters throughout the French territory, which consolidate through use and through their research the practical and theoretical bases of the pressuremeter, can hardly be summed up in a few sentences. To be convinced of this, one must consult the list of articles by Ménard and Gambin, the titles of the journal Sols-Soils which were the subject of a catalogue in 1968, the list of notices Ménard D (methods), M (materials) and Y (bibliography), as well as the archives of these years of the Bulletin de Liaison des Laboratoires des Ponts et Chaussées.

All these publications of the Ménard group were permanently distributed to the users "Pressuremeter concessionaires", including from 1962 the company Eurasol founded in Luxembourg by Ménard and which kept the archives, sometimes yellowed, but more complete than those of Ménard, dispersed after 1982. As soon as possible after this Symposium, an article (Heintz et al. 2026) will attempt an exhaustive summary.

Louis Ménard had established his first company in Paris, on Avenue de la Motte-Picquet. In the early 1960s, he acquired a building plot at the Rocher de Saulx, in Saulx-les-Chartreux (91), where he built offices, adjoining his personal house, and workshops. During successive expansions, his buildings were used for full-scale testing of foundations and wells, based on Fontainebleau sands (Rupelian, formerly Stampian). He also found beds of highly resistant Fontainebleau sandstone there for the first high-pressure tests. A short distance away, on land belonging to the Satujo company, a rubber producer that was one of Ménard's first shareholders, one can also find the green clays of Sannoisian.

The technique of carrying out drilling and pressuremeter tests was, in a way, nationalized in 1971 by the LCPC (Central Laboratory of Bridges and Roads) operating procedure, and in 1972 by the publication of the thick Fond 72 file managed by LCPC and SETRA (Highway Route Study Service), in which the dimensioning of foundations by pressuremeter was established as a proven and reliable practice. This reference document for public contracts remained in force for a long time before being replaced by “fascicle 62 title V of the CCTG” in 1993, which became the bible of geotechnicians for shallow and deep foundations, before being replaced by the Eurocodes.

Figure 4. Michel Gambin et Louis Ménard in front of the premises of Saulx-les-Chartreux, early sixties

2.2. 1978-1982, Ménard without Louis

After the death of the founder, the companies of the group founded by Ménard maintained a sustained activity, in France and abroad, both in design offices (EPLM) and in dynamic consolidation works (TLM), and his widow Françoise Ménard tried to ensure management, but quickly could not cope with the complexity of the triple activity of the group of companies, where Ménard had hired many employees in geotechnical design offices and pressuremeter surveys, in special foundations company, and in mechanical construction for drills and pressuremeters, but also the compacting gigamachine specially built by Ménard for Nice airport, a major project in progress at the time of his death. Little by little, the projects, although important, no longer ensured the payroll which stifled the cash flow, and their placement under the supervision of Intrafor-Cofor in 1982, resulted in a drastic reduction in the number of employees. A large part of the acquired knowledge, archives, monitoring of manuals and instructions, manufacture of pressuremeters and drilling rigs and compaction cranes, disappeared. The Intrafor company, owned by Lyonnaise des Eaux, was itself sold few years later, most of the former Ménard employees dispersed by creating entities corresponding to their specialties. The Apagéo company created in 1984 took over the Ménard equipment license a few years later, while the soil improvement works separated from Intrafor under the name Ménard Soltraitement, then simply Ménard, today one of the branches of the Vinci group.

In April 1982, the French Petroleum Institute and the LCPC organized a "Symposium on the Pressuremeter and its Marine Applications," during which several papers were presented on the PAF, the LCPC self-drilling pressuremeter, the IFP's self-drilling marine probe designed for offshore reconnaissance, and papers from colleagues from the Ménard group (Gambin 1982, Leblanc 1982).

The year 1982 was a turning point in Michel Gambin's career, as he was forced to close Ménard Inc. in the USA. Upon his return to France, he joined Solétanche, where he remained until his retirement in 1992.

2.3. 1982-1992, the Solétanche years

Michel Gambin's 10 years in the Solétanche company, which had supported Ménard since the beginning, as evidenced by most of the back covers of Sols-Soils, were more directly devoted to internal advice on dynamic consolidation projects and soil improvement in general.

M. Gambin had long supported Louis Ménard's move towards soil improvement work. Louis Ménard's first writing on the subject (Ménard 1970) was on the very first dynamic compaction project attempted and successful in Mandelieu-La Napoule, where Michel Gambin had closely monitored the project and its pressuremeter control throughout the compaction.

At the same time, he began a fairly intensive teaching activity, first through internal training at Solétanche, then through his involvement in various forms of teaching, at the Pierre-et-Marie Curie University (Jussieu) and the CNAM, at Ponts Formations, and occasionally at other institutions.

This training activity somewhat slowed down his publications on pressuremetry. A second symposium, so ISP2, organized in 1986 by Professor Jean-Louis Briaud at Texas A&M University (USA) with the same title as the first, was followed by a third, this time titled ISP3 "Pressuremeters" in 1990, organized by the British Geotechnical Society at the University of Oxford (UK), where he pronounced the introductive keynote (Gambin 1990).

Figure 5. Michel Gambin on a dynamic consolidation site, circa 1990.

He also devoted a lot of time to an important synthesis, with other "old hands" of the pressuremeter (Amar, Clarke, Orr & Gambin 1991) on “The application of Pressuremeter test results to foundation Design in Europe”, which he then often used as a reference.

2.4. 1992-2005, retirement, act I

Professional retirement did not stop Michel Gambin's need for activity, which was expressed within the CFMSG, of which he was vice-president from 1998 to 2002. As can be seen in his production of articles, it was, on the contrary, a period of great activity for him (Fig. 14), to which we will return: writing the French Geotechnique newsletter, publications alone or most often in collaboration on both the pressuremeter and foundations as well as on soil improvement, at an average rate of 4 to 5 articles per year, including those of the ISP4 Symposium in 1995 in Sherbrooke. The publication of booklet 62 (MELT 1993), which reorganized the design of foundations by integrating the advances made by the

LPC network on shallow foundations and especially deep foundations (Bustamante & Gianeselli 1981, Frank 1974, Frank & Zhao 1982), prompted him to revise the Ménard D60 notice, which he intended to remain a teaching document for pressuremeter methods (Gambin 1998).

It was also a time of memories, with the article "Karl Terzaghi, my teacher" (Gambin 1995), which he was to deliver in Istanbul. For this purpose, he reread and began to annotate Terzaghi's writings again (Fig. 6)

He speaks of this by saying that it is necessary to constantly, as Terzaghi taught and practiced, seek to rigorously express the bases of soil mechanics, but in the field put them aside in favour of the pragmatism of observing the behaviour of the grounds, which the pressuremeter allows, and its practical application to dimensioning. This eternal debate, which does not only concern our profession, between theory and practice in geotechnics will lead him to the article "Elementary study of a myth" (Gambin 2003) where he no longer hesitates to defend the qualifier of "semi-empirical" given to Ménard's methods, and to claim that it is an approach as indispensable as a purely theoretical approach.

Figure 6. Another conference, in Tehran, 1993. Michel Gambin, between Pierre Delage and Victor de Mello.

He will be keen to repeat the same idea in English (Gambin 2008), then it will be the common thread of his Coulomb conference (Gambin 2010), see §3.7.

Figure 7. Michel Gambin à la tribune de Solscope (2001, Futuroscope, Poitiers, France)

2.5. 2005-2018, retirement, act II

The year 2005 was also an exceptional year for Michel Gambin. Along with other colleagues, we pointed out to him that 2005 would be the 50th anniversary of Ménard's invention, and that we could organize a small celebration. He immediately thought that it was too little, and summoned us to Jean-Pierre Magnan's office at the LCPC, telling us that the latter, who had just organized and edited a series of important conferences (PARAM 2002, FONDSUP 2003, ASEP-GI 2004), was the right man for the job to create a Symposium on the Pressuremeter, ISP5. With JP Magnan, and like him, M. Gambin devoted considerable energy to mobilizing authors from all countries, and the Symposium was a memorable success, with, in addition to a Ménard Lecture (Baker 2005), 5 major conferences and a large number of communications, more than 162, numerous national reports on the development of the pressuremeter in their country. A deep foundation calculation exercise had been posted before the Symposium, received 12 detailed responses, the subject of as many articles, and a summary comparing forecasts with results (Reiffsteck 2005). Finally, a verbatim report of the lively and passionate debates in the ENPC at Marne-la-Vallée (Fig. 8).

Figure 8. Pressio 2005, at the podium: J.-P. Magnan, M. Gambin, R. Frank. Ecole des Ponts, Paris-Tech

The sum of contributions will lead Presses des Ponts to plan 2 volumes for the proceedings (below fig. 9).

Figure 9. ISP5 Proceedings, both two volumes

At the same time, Michel Gambin obtained from the European Commission for Standardization the formation of a working group (WG5) on expansion tests in drilling, of which he naturally took the chair. Its goal is to broaden the scope of the pressuremeter French standard NF P94-110(-1), in which he had already participated in 1991 and 2000, which he considered too French and restrictive for practice outside France. Here too, he called upon his correspondents in Europe to form a fairly large group, representing around ten European countries, which will successfully complete before 2009 the breakdown of pressuremeter practices into 5 standards, the first being obviously EN-ISO24476-4 "Ménard Pressuremeter Test", one of the rare cases where the international normative system allows giving the standard the name of the inventor.

During these years, when he was still responsible for four annual issues of the Lettre de la Géotechnique, he sometimes reminded us that, even though he still seemed alert, he had been receiving constant treatment for a blood disorder for years, and that he was beginning to feel the weight of age.

This did not prevent him from enthusiastically accepting the CFMS's offer to deliver the 8th Coulomb Conference, an annual event he had helped establish a few years earlier. This provided an opportunity to summarize his vision of the evolution of theories in soil mechanics, their life, and their abandonment according to their applicability: "Theories and their evolution in the face of reality in geotechnics" (Gambin 2010), with a somewhat mischievous subtitle "Part 1: Superficial Foundations", a subject on which he recalled the contributions of Louis Ménard, based on the experimental method (see §3.7). Having himself contributed, more than L. Ménard, practical methods for deep foundations, he seriously considered one day adding a second part to his presentation. After recalling the large number of theoretical approaches to failure, mainly between 1930 and 1960, he extensively cites Terzaghi's recommendations to never rely on theoretical formulas to resolve practical cases of soil-structure interactions, but to adapt to the observed reaction of the soil in full scale to modify the proposed design: this is the observational method, advocated as early as 1945.

A few years later, when announcing the 18th International Congress of Soil Mechanics in Paris for 2013, he emphasized that this was 52 years after the 5th Congress in Paris in 1961 and one of the major founding publications for the pressuremeter (Ménard 1961). He requested a parallel session for the Pressuremeter, which would be ISP6, and for this purpose he called for a series of communications in a few months, which would total 40, much fewer than ISP5-2005. This conference would also be the occasion for the Ménard Lecture "The Pressuremeter test. Expanding its use" (Briaud 2013).

Believing that he had not been able to get enough researchers to speak about the pressuremeter during this session, he pushed for the organization of an ISP7 Symposium, for which he asked Serge Varaksin and Wissem Frikha to organize it in Hammamet (Tunisia), in 2015, sixty years of pressuremeters. Already too tired to travel by plane, he did not make the trip, and addressed the participants by videoconference. 45 papers were presented. At the end of the Symposium, the participants decided to create a permanent organization for the management of questions relating to the pressuremeter and the planning of future Symposia, creation of ICP, International Committee on Pressuremeter, of which Michel Gambin was named Honorary President.

Figure 10. Jean-Pierre Baud, Robert Heintz, Michel Gambin and Clive Dalton. Paris 2013

2.6. 2018-2024, retirement, act III

From 2018, he was then 88 years old, Michel Gambin, who had already told his correspondents on gambin@magic.fr that he was stopping his geotechnical activities, stopped writing for geotechnics, but asked Apagéo and me to keep him informed of developments for the pressuremeter, and he followed the news of the ISSMGE and CFMS sites. He nevertheless still worked a lot, collaborating as he promised to his wife Marie-Thérèse, in the writing of a work undertaken several years ago, on "The planisphere of Ptolemy", which his family would publish after his death (Gambin 2011, Gambin-Dejean & Gambin 2026).

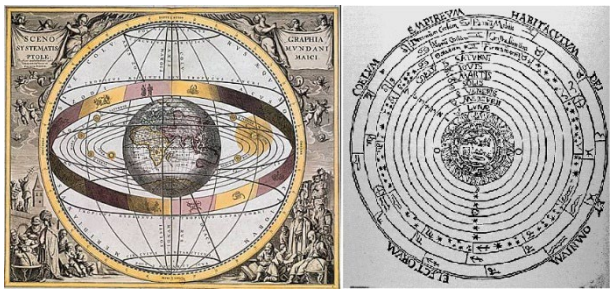

Figure 11. Two representations of Ptolemy's geocentric system

3. Main technical and scientific contributions due to Michel Gambin

Michel Gambin was interested in everything, read extensively while taking notes, and had an impressive memory for everything he had seen or read even once. He most often filed it in an annotated photocopy.

How many times, when I submitted to him an idea that I thought was new or at least relevant to our problem, did I receive the response, "This has already been addressed by such-and-such an author, on such-and-such

a date, and I'll give you the reference today." His internal search engine, long before the computer era, was based on concepts more than words.

I will attempt to group his main areas of interest into a few themes, apologizing in advance for being neither exhaustive nor objective, influenced by the avenues he suggested to me, I would sometimes say imposed on me, throughout the part of his career I was fortunate enough to experience at his side. Some of his co-authors present here, and others who passed away too soon, will not hold it against me.

3.1. Nonlinear elasticity

3.1.1. Pressuremeter curve shapes

This is one of the very first observations that Ménard and Gambin drew from the experience repeated in all terrains for each pressuremeter test. The shape of the pressuremeter curve, homologous whatever the terrain, gave them "a hard time" from the start. Ménard had drawn in his thesis, and repeated in his first writings, the ideal shape of a pressuremeter curve starting "from zero deformation" with a tangent at the origin corresponding to a very steep reaction, a reaction degrading more or less quickly, often very quickly, sometimes more slowly, towards the appearance of large deformations and the notion of progressive rupture. While Ménard was developing his concept of small non-linear deformations read by the pressuremeter (Ménard 1961, Ménard and Rousseau 1962), Michel Gambin, more concerned with giving guidelines for interpreting the test to the first users, established the principle that the first stages of the test in a preliminary drilling being necessarily affected by a minimum "reworking", it was necessary for the calculation of a module to determine a pseudo-elastic range between a point where good contact with the wall is observed, this will be "P_{0M}" and the point where the growth of creep leads to designating by P_F the end of this range.

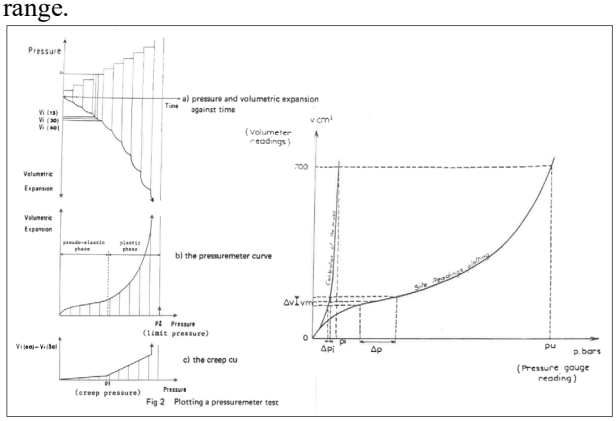

Fig 2 Plotting a pressuremeter test

Figure 12. The classic pressuremeter test (Ménard 1975) considers decompression before the testl

Throughout his life he would reprimand anyone speaking of the elastic part or phase of the test, forcing them to keep in mind and semantically this sub-qualifier "pseudo", so as never to forget the non-linear nature of the reaction of any terrain to pressuremeter stress. Each time he discussed a reaction curve, in an article or freehand, to show what a secant or tangent modulus is, he naturally drew a "curved", non-linear reaction.

3.1.2. Drilling gives the shape of the curve

Michel Gambin was aware that this imperfection at the beginning of the curve would disturb theorists. He therefore quickly developed the drilling methods of the time, understanding very early on the interest of bentonite muds whose properties were exploited by oil drillers. The first drilling workshops of the Ménard companies were mechanical rotary drills used for coring, he modified them to use them with destructive tools adapted to the diameters of the probes, also testing in parallel the Delmag ram-driven corer as a tool for cutting the ground. Ménard had sized his probes based on the American DCDMA standards: the historical probes of his thesis in Illinois were 5 inches and 4 inches. In Paris, he immediately thought about not imposing on his dealers and his own teams excessively heavy drill rigs, and he sized his probes for drilling in 3 inches (76mm), 2 1/2 inches (63mm), 1 3/4 inches (44mm), and even 1 1/4 inches (32mm) and 7/8 inches (22mm), for the mini-pressuremeter which responds to roadway control, a subject on which he had his first intuitions to load the wall of a borehole instead of a plate. The cuts were not chosen at random, but designed to allow the telescoping of increasingly smaller probes. Fairly quickly, the 2 1/2-inch dimension would establish itself as the best compromise for the mechanics that Ménard hired to build the probes, the tools and their environment of fittings, rigid tubing, and flexible tubing. The "bare" 60 Ménard probe became the reference, at the same time as the patented invention (Ménard 1960) of the 63mm split tube which used the 44mm probe inside. The split tube was initially designed as a way to overcome the difficulties of holding a borehole in sand and gravel below the water table, and therefore used in direct driving, and in vibratory driving at sea, using the vibro-hammer built at Techniques Louis Ménard (Ménard and Gambin 1965). Very quickly, this driving of the direct split tube, equipped with a point or a closed corer, was limited to granular soils, and prohibited in cohesive soils. But very quickly also appeared the idea of driving or pushing the open split tube, simultaneously with cleaning the interior with a small adapted tool. The open split tube method is widely used by Ménard teams, often in soft overburden, to go deeper into small diameter drilling, allowing destructive drilling to be down extended for the 44mm pressuremeter probe.

Michel Gambin wrote numerous notes for in-house operators and pressuremeter dealers, explaining the need for drilling with bentonite injection. He modified the compressed-air "wagon-drills" used in quarries to equip them with mud injection. For this purpose, the Ménard workshops designed low-flow, high-pressure single-piston pumps. These pumps also equipped the Ménard D9000 hydraulic drill, built by Ménard for pressuremeter drilling.

To build it entirely within the Ménard group, Ménard and Gambin built a production facility in Granville, Louis Ménard's hometown, employing many native Norman workers. The D900 was one of the first lightweight hydraulic drills, equipped with all pressuremeter drilling techniques. All these methods were brought together by Michel Gambin in a notice

(Centre d'Etudes Géotechniques Ménard D10 1966 1st edition) called "execution notice" which was widely distributed and added to, both before and after its publication as an article in Sols-Soils. The development of this notice was parallel to the publication by the LPC of the operating procedure for the pressuremeter test (LCPC 1971). Michel Gambin saw it more as a healthy emulation than as competition, and considered it to be a recognition by the State services of the importance of the pressuremeter in the reconnaissance of road and motorway layouts for which the LRPC were responsible. He promoted it as much as the D10 notice and recommended that all his contacts, employees or Ménard dealers follow its recommendations. He consistently explains that, since the technique of alternating preliminary drilling and testing by passes cannot be perfect, it must aim for a "contractually standardized borehole alteration" so that the tests all remain comparable with each other (Fig. 12). These two crutches of testing practice will remain in use and operational until the first standardization in 1991, and are in fact for 30 years, before the passage by AFNOR then CEN and ISO, the standardization of the Ménard test.

3.1.3. Self-drilling of the pressuremeter probe

The emergence of the concept of self-drilling occurred in the research activities on the Pressuremeter of the Laboratoires des Ponts (Jézéquel and Baguelin 1970). It did not surprise Michel Gambin, who regularly discussed with them, and was familiar with their writings from the beginning. But he knew that only the pre-drilled pressuremeter would remain capable of producing the data necessary for the design of structures on a daily basis, and he would never deviate from this certainty, even if the Ménard group produced, in those years, the retrojet probe, capable of self-drilling in fine soils and sandy soils with moderate limit pressure. Michel Gambin did not, however, neglect the important theoretical contribution represented by the analysis of self-drilled tests in compressible soils, and he promoted the book "The Pressuremeter and Foundation Engineering" (Baguelin et al. 1978) as soon as it came out, in the press review of Sols-Soils n°28, already mentioned, published the day after Ménard's death; he acquired a stock of the book distributed widely to customers using Ménard pressuremeters, and to the group's engineers. At the same time, researchers at Cambridge University were developing the Camkometer, and when a commercial company was formed to manufacture and sell it, he invited Clive Dalton (Fig. 10) to his home in Paris. Despite the commercial competition, he would become a friend, whom he met at Congresses and Symposiums, and whom he would call upon in the 2000s to form the TC41 WG5 European standardization group.

3.1.4. The hyperbolic form of the pressiometric behaviour law.

This hyperbolic form was understood from the beginning of Ménard and Gambin's reflections: Louis' thesis (Ménard, 1957), first article in Sols-Soils (Ménard and Rousseau 1961), founding article (Ménard 1962) showing the decrease of the initial maximum tangent modulus with deformation. Michel Gambin read and annotated the fundamental articles on the subject as soon as they were published (Kondner 1963, Hardin & Drvenik 1972). The graph paper in (P | 1/V) was printed for use by engineers drawing the test points and would form a full page in the D60. At the same time, Professor Van Wambecke advocated with Ménard and Gambin for the consideration of the entire pressuremeter curve by creating the double hyperbola model (Van Wambecke & D'Hemricourt 1971, 1979). At the same time, all sorts of extrapolation methods were tested by different researchers: the relative volume method, the log-log method, the Lemée method, all were "dissected" in the Ménard group, but M. Gambin remained convinced that the best fit to the experimental points was the 1/V hyperbola on the last points of the test and the double hyperbola on all the classic curves in preliminary drilling.

My journey with Michel Gambin began there. Shortly after I was hired, he asked me to program the 1/V method and, if possible, the double hyperbola for the EPLM design office, on the small Hewlett-Packard calculators that had just been released. With the help of Eric Füneggard, a Swedish intern who arrived at EPLM at the same time as me, we learned the subtleties of programming in reverse Polish notation. Limited by the maximum 25 lines of the first HP25s, we quickly asked to follow the distribution of successive calculators up to the HP45C, now "vintage" but still accessible on computers and smartphones thanks to a few enthusiasts. Michel Gambin sent me to Brussels in 1979 to Professor Van Wambecke's lab where I discovered what a computer was, amazed like a kid (which I was) by a screen that allowed you to zoom in on this or that portion of the curve. I will come back and say that we need one, and it will be, still from Hewlett-Packard, the HP85, with its small 30 cm² screen, its narrow-band printout, but already enough power to solve the double hyperbola adjustment in just fifteen minutes.

At that time, surprisingly for a young engineer today, there were no office computers in companies, large or small, and very few computers worthy of the name in laboratories. At the same time, Michel Gambin initiated the development of a recording pressure meter at Ménard. This would be the GE type, installed around 1981 in the chassis of a GC type, and he had us working on the ambitious prototype of an automated pressuremeter with pressure regulation. The fall of the Ménard group, less than 5 years after the death of the founder, will slow down our work, which will be completed, during the lease-management of Ménard by Intrafor-Cofor, thanks to the collaboration of Gérard Arsonnet, a long-time Ménard employee, Daniel Perpezat, who arrived just after this takeover, and a team of two subcontractors fresh from Centrale High School. This will be the PAC, computer-assisted pressuremeter (Baud & Perpezat 1984, Baud 1985), a magnificent Concorde, two of which will be used for a few years on EPLM construction sites under the leadership of Intrafor, but which will be a complete flop from a commercial point of view.

The double hyperbola curve, however, continued its development. After considering implementing it directly into the PAC, the need to add processing components and the computational time required prompted us to move the

processing to computers, which were now beginning to take over the offices. At Intrafor, Léon Mastikian, an engineer in the injection department who brought his personal Apple II computer to the office due to management's reluctance to acquire one, would become a valuable assistant to me, reprogramming the double hyperbola and accelerating its adjustment to less than a minute, a remarkable performance at the time.

Michel Gambin, then at Solétanche, was a competitor of Intrafor, especially for his work on dynamic consolidation. He nevertheless follows my path, which will be to leave Intrafor, at the time of its sale by Lyonnaise des Eaux, and he calls me to tell me that it is absolutely necessary to publish the method of solving the double hyperbola and its applications, on the occasion of the "Geotechnics and Computer Science" Conference organized by the Ecole des Ponts. We will develop both the method of resolution, and its application to "self-drilled type" curves in simple hyperbola (Baud, Gambin, Uprichard 1991).

3.1.5. Exploitation of the pressuremeter hyperbola

The collaboration with Michel Gambin will resume with greater frequency thanks to the ISP5 Symposium in 2005. Since the fall of the Ménard group and the dismantling of Intrafor, the strong demand from pressuremeter users faced with a shortage of equipment, in particular all the small or large spare parts needed by sounders for the maintenance of their probes, and pressure-volume controllers, has encouraged former Ménard employees to create production workshops for this small industry. The number of design offices practicing pressuremeters on a daily basis is increasing, as evidenced by the growth in the number of members of the Union Syndicale Géotechnique, less than 10 in 1990, and at least 40 in the 2000s. Michel Gambin has been a consultant to Apagéo founded by Robert Robin since the beginning, and myself to Géomatech founded by Gérard Arsonnet; the two companies came together in 2000, and we began to think, looking at this development, that we were almost 50 years into the somewhat tumultuous life of the Ménard Pressuremeter. Michel Gambin quickly convinced us that this celebration was not something to be done between former employees, but was an opportunity to organize a Symposium n°. 5 / 50 years / 2005. He took us to see Jean-Pierre Magnan at the LCPC, with whom he would be the organizer and editor of ISP5. Both encouraged me to delve deeper into what could be learned from the hyperbolic equation of the curve. It will be with M. Gambin a generalization of the hyperbolic equation reduced to $\varepsilon \int (\sigma)$ (Baud & Gambin 2005), in conclusion of which we express a hope of development of pressuremetry thanks to the presentation of the self-drilled split tube method (STAF©) modernizing the open split tube (Arsonnet, Baud, Gambin 2005). While this method is perfected, we take up again in more elaborate forms the hyperbolic model, during other conferences, ISC3 in Taipei (Baud & Gambin 2008) where I go in the company of François Schlosser; the long air journey will be the occasion of a fruitful discussion with him. This will be the opportunity to resume our work with the rigorous mathematical analysis of F. Schlosser who offers us a different presentation for ISC4 in Pernambuco (Baud, Gambin, Schlosser 2012), then in Paris for ISP6 Pressuremeter Symposium in parallel with the 18th ICSMSG (Baud, Gambin, Schlosser 2013). This last article shows that the pressuremeter curve is entirely determined by knowing 4 parameters: the asymptotic limit pressure p*L, the rest pressure p0, the initial tangent modulus G0 and the secant shear modulus GM at p*L/2. M. Gambin, very satisfied with this solution, and noting its application on series of tests in self-drilled split tube (Rotostaf) that I show him in different terrains, considers that obtaining a complete behaviour law from initial pressure to rupture is now feasible in any type of soil, and draws the ideal form sought by Ménard. It also allows us to return to the classic E_M and p^*_{LM} parameters, and to deduce the rheological coefficient α specific to each test (Baud & Gambin 2013), see §3.2, and therefore to propose reliable data representative of the reality of the terrain for application to any building work in the ground.

The exploitation of the non-linearity of the pressuremeter response, and of the "damping rate" during the decrease of the tangent moduli measured by the pressuremeter has today reached a very high level of analysis, which would not surprise M. Gambin, presented by several speakers in this Symposium (Lopes Dos Santos & Habert 2025, Hughes & Whittle, 2025, Contreras et al. 2025).

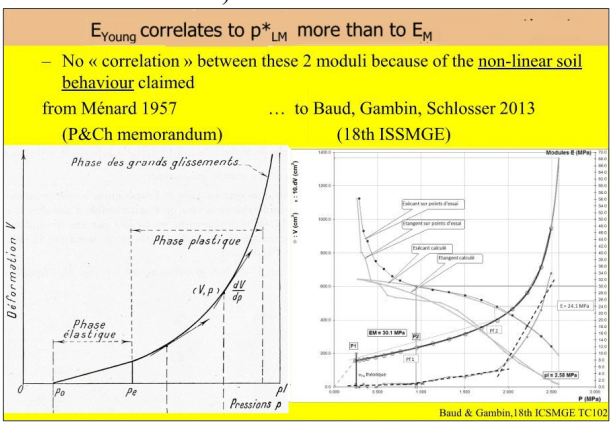

Figure 13. Perfectly hyperbolic pressuremeter curve (Baud & Gambin 2013). Slide comparing the simple hyperbola curve obtained by self-drilling with the original drawing by L. Ménard (Ménard 1957)

3.2. Pressuremeter Classification of Soils and Rocks, and Ménard's rheological coefficient α (alpha)

In my early days in pressuremeter practice, after having intensively absorbed under pressure from Michel Gambin the essentials of the D notices, the Sols-Soils and of course the D60 notice, the answer to the "Talk to me about it" was a bit slow in coming, but I began to "harass" him on the question of knowing for what deep reasons the pressuremeter test behaves differently in clays and in sands, and that of knowing what were the justifications of the rheological coefficient α. Indeed, the controversies on the use of the pressuremeter were still lively at that time (end of the 70s) when the pressuremeter actually had many followers, but still many detractors. One could find people who admitted that the pressuremeter test can mean something in clay, but certainly not in sands, or vice

versa. And besides, this natural tendency of soil mechanics to only be interested in well-defined extreme cases was somewhat embarrassing for a geologist who noted that these two cases were the rarest, most grounds being between these two extremes, and the most variable in proportions and grain sizes. In 1979, M. Gambin sent me alone to represent Ménard at an ITBTP conference chaired by P. Habib on foundations subjected to horizontal forces. The entire conference was devoted to considering the effect of forces on the pile or wall from the intrinsic parameters of the soils, and the great difficulties of predicting displacements. Surprised, I risked a remark on what the pressuremeter brought to this problem, I was immediately sent back to my seat by P. Habib "The pressuremeter cannot allow this calculation of deformations, and the limit pressure is a poorly defined and unpredictable concept." I fell silent in the face of the argument from authority, and an audience that I thought was quite won over to the speaker. After a few more questions, someone behind me spoke up to say, "I build dolphins every year, all of them are sized by pressure meter and give me satisfaction; I am the Director of the Autonomous Port of Bordeaux." Reporting the incident, I understood that Michel Gambin had deliberately sent me into the unknown territory of the pressuremeter.

Michel Gambin never gave me a complete answer on the origin of the coefficient α (Ménard and Rousseau 1962), nor on the short sentence in D60 saying "there is a direct relationship between the coefficient α and the concentration coefficient highlighted by Fröhlich", a sentence which he omitted in the revision of D60 in 1998. I did not obtain any further clarification from Jean Rousseau, with whom I had been an intern, nor from Maurice Cassan, who attempts in his book (Cassan 1978) to give a rational justification. The relationship between α and the nature of the soil is of course evident in Ménard's table giving α as a function of E/PL, which has remained virtually unchanged since its origins up to the Eurocodes, even though Ménard had added the codicil to the table: "The values of α will be reviewed in the light of experimental test results." The criticism made of the pressuremeter method of calculating settlement is that the result can vary from simple to triple, or even quadruple, depending on the value that the engineer attributes to the coefficient; fortunately, the comparison of the predictions with the measurements on instrumented foundations is very good, proof that the engineers concerned estimated a value for α in adequate relation to the behaviour of the soil according to its classification, as shown in "The pressuremeter and foundation engineering" (Baguelin et al. 1978). Michel Gambin left me around 1982, before his departure for the USA, with an injunction: since this question concerns you, find me a more rational way to express α as a function of the pressuremeter test. Professional vicissitudes meant that I only began to respond to him for Pressio 2005 by proposing to distribute the test results, E_M and p^*_{LM}, in a bilogarithmic diagram (Baud 2005). From there, Michel Gambin decided that we would try to draw a nomogram of the isovalues of α, then to give it a numerical expression. It quickly becomes apparent that the resting earth pressure p_0 plays a role in this expression, and that this nomogram cannot be plotted in (p^*_{LM} | E_M), but in (p^*_{LM}/p_0 | E_M/p^*_{LM}) and we progressively become able to propose for α an expression that is a function of these test data (Baud and Gambin 2013). At the same time, at the 18th SISMG congress, J.L. Briaud in his Ménard Lecture (Briaud 2013) gives a simple explanation of the need for the coefficient α in the pressuremeter method by considering the ratio, which varies according to the nature of the soil, between the compression modulus and the traction modulus. Michel Gambin was really pleased to note this convergence. The interest of considering the coefficient α in the prediction of deformations had been shown and confirmed well before in the analysis of the deformations of vertical wall (Ménard, Bourdin, Gambin 1969, Schmitt 1995, 1998). In parallel with this research, the Pressiorama diagrams used had led us to propose a classification of soils by pressuremeter results, completed by extending it to soft rocks up to test pressures of 3 to 5 MPa, made possible by technological advances towards high pressure in this field (Arsonnet et al. 2011, 2014, Baud & Gambin, 2011, 2014).

3.3. The behaviour of foundations, shallow or deep

From the earliest uses of the pressuremeter, Ménard and Gambin subjected the design of failure based on ultimate pressure to an allowable displacement condition based on the pressuremeter modulus. While Louis Ménard established the fundamentals of his settlement prediction method (Ménard and Rousseau 1961, Ménard 1962, Gambin 1963a), Michel Gambin assimilated all the literature of the time on pile behaviour, for which settlement prediction was still very underdeveloped. Pile loading tests were still few, and their interpretation was the subject of debate. Throughout his lectures, Michel Gambin often recalled that his work with Ménard were developed together with concept of critical depth (Figure 14).

He developed (Gambin 1963b) his iterative method for modelling loading, minimal displacement of the tip and progressive mobilization of friction along the shaft, based on a relationship between friction and ultimate pressure for which he had little real-life experience. His method was innovative at the time compared to designs on the operation of piles based on laboratory soil data or in situ penetration tests.

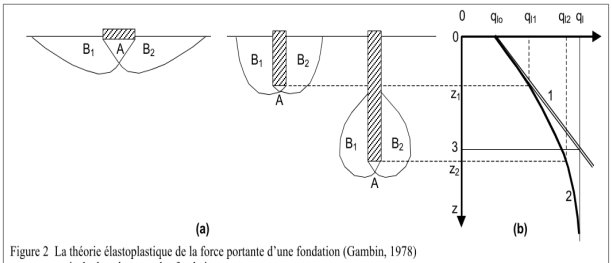

Figure 2 La théorie élastoplastique de la force portante d'une fondation (Gambin, 1978)
a. coupe verticale du sol autour des fondations
b. variation de la contrainte de rupture en fonction de la profondeur :
1. Théorie rigide plastique de Terzaghi ;
2. Théorie élastoplastique ;
3. Profondeur critique

Figure 14. Classical diagram for critical depth. In (Gambin & Magnan 2000), see also Coulomb Conference, slide 112 (Gambin 2010)

For several years, Michel Gambin, due to a lack of resources, had few opportunities to verify his method on instrumented piles. As the pile loading results from the Laboratoires des Ponts et Chaussées network were published, he had the opportunity to see that the friction curves as a function of the limit pressure required a greater diversity of soil types than the initial abacus (Ménard 1975). The publication of this revision of the friction curves (Bustamante and Gianeselli, 1981) was an event in the world of pressuremetry. The engineers at the EPLM office were somewhat taken aback by the change compared to "their" D60. M. Gambin, on the contrary, saw it only as confirmation of his method and a major advance in the experimental relationship. He made an appointment with Michel Bustamante on Boulevard Lefevre (LCPC headquarters); he took me there even though I had only recently learned how to apply the method, programmed, still in reverse Polish, on our HP calculators. At the same time, the work of Roger Frank provided a rationalization of the method with the concept of the p-y transfer function (Frank & Zhao, 1982).

The operational success of this method established it in all regulatory and, later, normative documents. Although his initial work from 1963 is sometimes somewhat overlooked, Michel Gambin has always been delighted with the success of this application of the pressuremeter method and committed to its dissemination (Gambin & Frank 1995, Bustamante, Gianeselli, and Gambin 2009, Frank and Gambin 2009).

3.4. Dynamic consolidation and soil improvement

From the first years of daily use of the Pressuremeter with teams of sounders criss-crossing France and sent abroad, the attention of the engineers of the Ménard group had been focused on the numerous cases where the ground was not quite sufficiently load-bearing on the surface for a direct foundation, and weak on limited thickness which made it regrettable to have to plan for deep piles. Louis Ménard's orientations go towards research in various directions which can provide economical solutions for such cases: calculation with the pressuremeter data of the foundation pits, Ménard expansive short piles in which a rubber sheath was planned to press the concrete against the walls, and which led to the creation of a construction company (Techniques Louis Ménard), mini-truncated conical piles for which the group builds vibratory driving machines, brush-rafts on a mesh of mini-piles which constitute a case of mixed foundation. Ménard filed the patents for what would become dynamic consolidation in 1969. 15 years after his patent for the pressure meter, which he left to develop on its own, Ménard decided to launch the works of his company into this new development. He initially described it as "compaction by heavy tamping" (Ménard 1970), then dynamic compaction. Michel Gambin accompanied these numerous initiatives, immediately trying to understand and explain the mechanism. He would closely monitor, from the first construction site of land reclaimed from the sea in Mandelieu-La Napoule, the rise in power of the energies implemented, the construction of the tripods, and then the challenge of building the mega-machine for Nice airport. Gradually understanding the mechanism of soil shearing by the impacts and the reconstitution of a densified soil, he pushed to adopt the term dynamic consolidation, a title he would give shortly after the death of Louis Ménard to the summary article "Ménard Dynamic Consolidation" (Gambin 1979), written and presented from Ménard Inc. in Pittsburgh. After the closure of Ménard Inc. US in 1982, Michel Gambin joined Solétanche with already solid experience in dynamic consolidation, which he would put to the service of numerous construction sites around the world. At the same time, by organizing internal training courses with a very generous menu, he introduced many engineers, not only to dynamic consolidation techniques, but also to numerous soil improvement techniques. From 1982 to 1992, courses and articles followed one another: on solid injection, described under the more descriptive name of horizontal static consolidation, on compaction by explosives, on jet-grouting, on the treatment of collapsible soils.

This is the period of Michel Gambin's life that I know the least well. I had lost contact with him a little since his departure to the United States, and upon his return I was an advisor to the company Géomatech, created by Gérard Arsonnet with some former Ménard employees dismissed by Intrafor, while Michel was already an advisor to Apagéo created by Robert Robin, also a Ménard employee dismissed two years earlier. The two former collaborators were competitors in the same niche of distributing pressuremeter equipment, and innovations by developing their respective pressuremeters, classical or digital recorders. This did not prevent Michel Gambin from contacting me to tell me that a Geotechnical and Computer Science Conference was being prepared in Paris, and he ordered me, as he had done when he was my boss, to write down where we were on the double hyperbola (see §2.14 & 2.1.5), and he wanted it in English. The conference organizers being reluctant to have an article in English from French geotechnicians, I called Tom Uprichard, a perfectly bilingual Irishman whom M. Gambin had hired at my request at Ménard, explaining to him that the pressuremeter would be better explained internationally by a British person with his authentic accent, than with my execrable one. We had formed the "Ménard International Pressuremeter Surveys" unit, until 1986 within Intrafor-Cofor.

The work of Michel Gambin in those years, who had to put an end to the "pressuremeter" production of the journal Sols-Soils, focused much more on the different techniques of soil improvement. His colleagues at Solétanche, such as Pierre Schmitt, Nicolas Utter, Jean-Marc Desbats, or his former colleagues and competitors at Ménard Soltraitement at the time, Jean-Marie Cognon, Philippe Liausu, Serge Varaksin, could testify to this better than I. What can be retained from all his work on soil improvement techniques is the major role played by the relationships between grains, with occurrence of pore pressure, in a soil improvement process, which always amounts to a densification and a more compact rearrangement than before the artificial intervention to consolidate it. In this, the analogy with the role of shear in the pressuremeter test is strong. M. Gambin published numerous contributions on the various soil improvement

techniques during these “Solétanche” years, and he had several opportunities to present a summary of them (Gambin 1979, 1984, 1987, 1992).

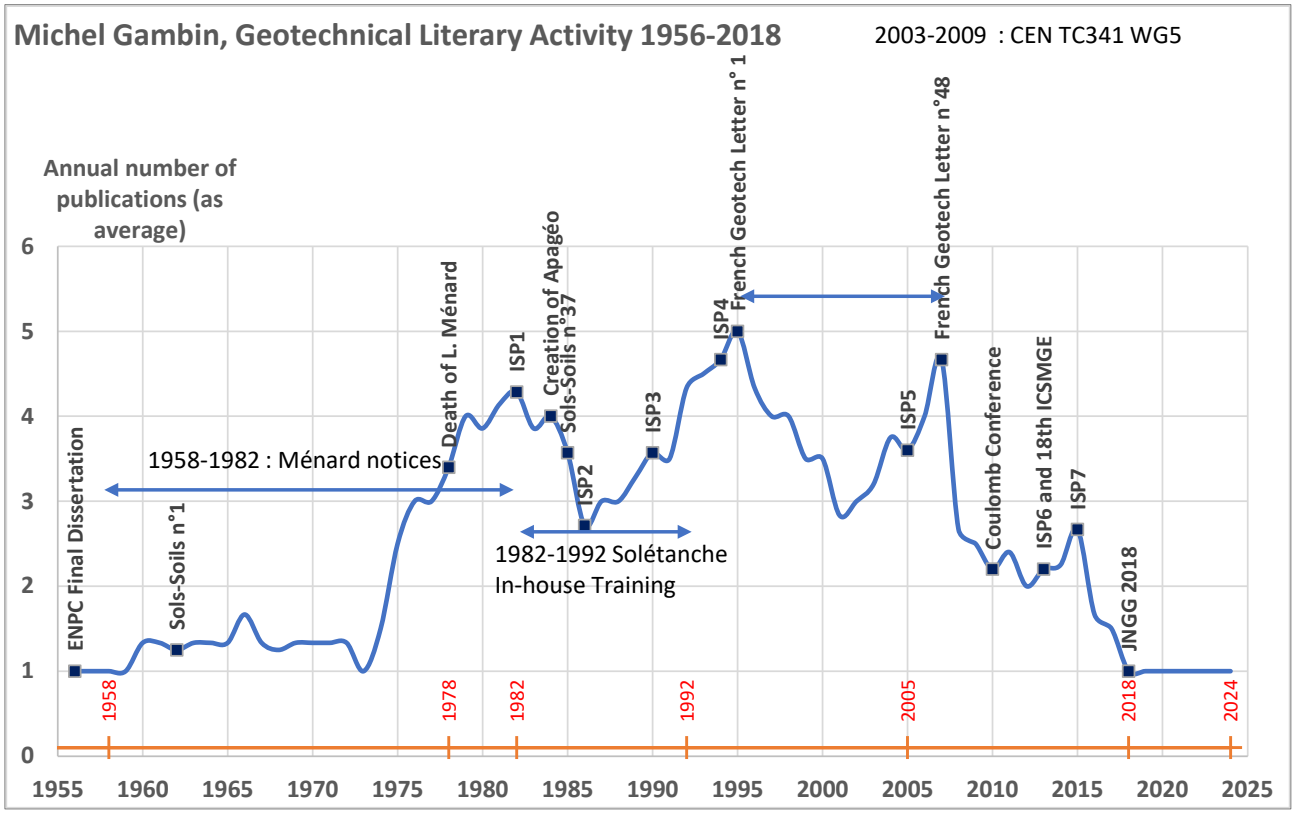

Figure 15. Graph of the rhythm of publications according to Michel Gambin’s bibliography (Apagéo 2024)

3.5. Geotechnical information and teaching

Michel Gambin felt from the start the need for an appropriate pedagogy to make the beginner pressuremeter understandable to an audience of engineers discovering the device, either with avidity, or on the contrary with suspicion. Many of the D notices that he patiently compiled and updated, testify to an organization of the Ménard Group to develop a permanent information tool, for use by employees as they were hired, and for the use of the growing number of "dealers" of the Pressuremeter. To this aim, Michel Gambin demonstrated talents as an editor and printer, for the notices as well as for the founding of the journal Sols-Soils of which he is the director and editorial committee jointly with Jean Rousseau. In addition to the articles specific to the pioneers of the pressuremeter, he solicits authors from the academic world whom he gradually gets to know, and always himself ensures the critical review of geotechnical books published in the world. It was with regret that he had to end the publication of Sols-Soils in the 1990s. Almost immediately, he compensated for this thirst for dissemination of geotechnical information by initiating at the CFMS, under the presidency of François Schlosser, the publication of a French translation of ISSMGE News, under the name of "Bulletin de la SIMSTF". Then quite quickly he became editor-in-chief of "La Lettre de la Géotechnique" created under the aegis of the International Society of Soil Mechanics and Foundation Engineering, the name of the time, with the subtitle "The link between French-speaking geotechnicians". The first issue (December 1995) is already rich in information on the various conferences of the year, and in particular a report of the ISP4 Symposium (Sherbrooke, Canada), and the First Louis Ménard Day organized by the CFMS. It was only in issue 2 that M. Gambin brought in Professor Van Impe, then Vice-President for Europe, to write an editorial to remind people that French, along with English, was one of the two official languages of the International Society, a notion that Michel Gambin, who was otherwise perfectly fluent in English, was keen to maintain and recall. He would write "The Letter" during12 years, for 48 issues, having increased the frequency and pagination of the publication (Fig. 16).

Figure 16. “The Geotechnical Letter,” or link between French-speaking geotechnicians, from 1995 to 2007

One can imagine the amount of work Michel Gambin took on; at the same time, he had organized and edited the 130 articles of the ISP5 Symposium in Paris with Jean-Pierre Magnan, and was teaching at various universities, schools, and training centers. Moreover, these years, when he was between 65 and 77, were not the least productive for him in terms of articles in various conferences and journals (see Fig. 15).

I still remember him saying to me then: "Hergé limited young people from 7 to 77 years old, so now that I can't read Tintin anymore, I have to slow down." And that is exactly what he did, very gradually, while continuing to give his advice, sometimes instructions, particularly at Apagéo.

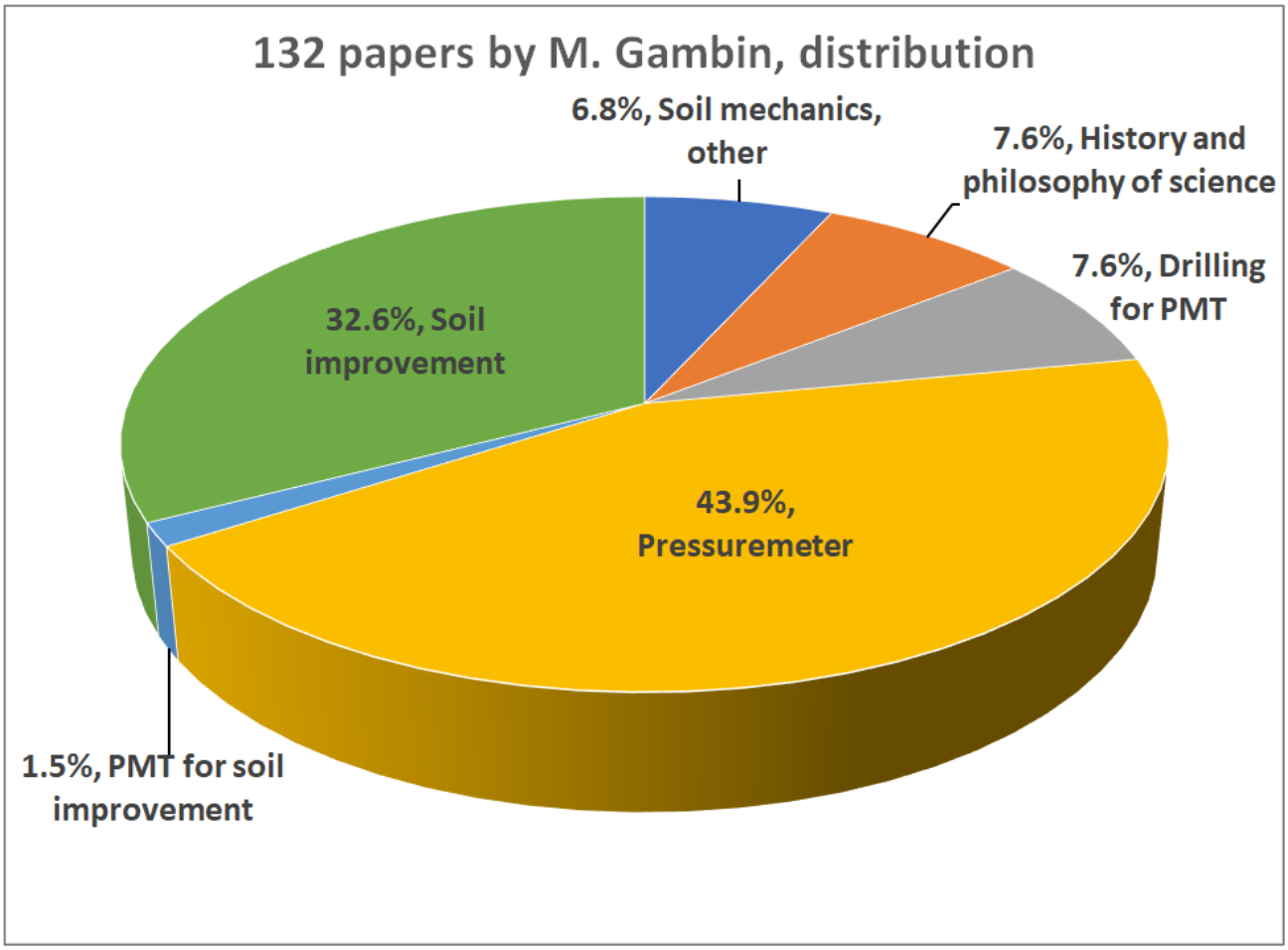

Figure 17. Thematic analysis of Michel Gambin's written production

3.6. Standardization

Establishing a single, stable loading protocol for the pressuremeter test was a major element for Louis Ménard and Michel Gambin from the outset. First, it was necessary to impose that the loading be in regularly spaced pressure stages, and not in volume increments, then to set a constant duration for each stage, in order to have an element for quantifying creep. In the first experiments, from around 1956 to 1960, the stages were carried out for 3 minutes, then fairly quickly for 2 minutes. After some experimental studies showing that stabilization was fairly rapid in most soils, it was decided that over a 1-minute stage, the difference in volume between 30 and 60 seconds was sufficient to assess a significant "creep index." This is the practice that was imposed on Ménard survey teams and pressuremeter dealers, disseminated with the operating instructions for model F and then G pressuremeters, and which was adopted by Ménard in 1960 and ratified by the LCPC operating procedure of 1971. In France, the Ménard instructions and this operating procedure were considered a standard for the Ménard pressuremeter test, as J. Kérisel wrote after Ménard's death (Kérisel 1979). Michel Gambin took advantage of his stay in the USA to prepare with J-.L. Briaud (Briaud & Gambin 1984) a first version of the ASTM D4719 standard (ASTM 1991).

At the same time in France, the LCPC alerts geotechnicians to say that they must prepare for the implementation of European standards based on national standards, and that our DTU and other operating modes will not be recognized as national standards, which must be established quickly. Geotechnical standardization will begin under the leadership of Gérard Bigot, delegated by the LCPC for this; Michel Gambin participates "as an expert" in the NF 94-110 standard "Ménard pressuremeter test" of 1991, not always agreeing with G.

Bigot on certain orientations, notably on the subject of the split tube and the break with L. Ménard's doctrine of not taking the thickness of the incompressible tube into the calculation for the probe volume. This will require manufacturers to adopt a so-called "short" internal probe with a 21cm length, whereas Ménard had designed his probe at 37cm to achieve the same volume as a "standard" probe with a diameter of 60mm. Thirty-five years later, the two types of probe coexist; their use leads to risks of confusion, not to mention the increased risk of bursting due to the low H/D ratio of this short cell, and the hesitation over the average volume to adopt for calculating the modulus. Reference is made to the communication in this conference of a new study on this issue (Grégoire et al. 2025).

A second version, NF P94-110-1, was published in 2000, without major changes on most points, except for one: the introduction of the quasi-mandatory use of pressure and volume recording devices at each pressure step, at 1 second after pressurization, then 15 seconds, 30 seconds, and 1 minute. From this publication, Michel Gambin took the initiative to create within the CEN, European Commission for Standardization, the working group TC341 WG5 dedicated to expansion tests in drilling, of which he was the President for about ten years for the publication of several standards: shell jack tests, Ménard pressuremeter test, self-drilling pressuremeter test, pressuremeter test by sinking, so-called flexible dilatometer test. The current state of these CEN-ISO standards, adding the phicometer test, which Michel Gambin wanted to develop, is presented in this Conference (Habert et al. 2025).

3.7. The Coulomb Conference, 2010, Michel Gambin's geotechnical testament

Michel Gambin never wrote a book on "The Pressuremeter." When asked why, he replied that it seemed more useful to keep Louis Ménard's creation alive and to allow it to develop. I also believe that he thought it was up to academics to write books and develop concepts, and up to engineers to develop tools. He would surely have dreamed of being an academic in another life, like his wife Marie-Thérèse, a professor of Geography at the University, specializing in graphic semiology, whom he admired as much as she did in return. He would have liked to finish with her and for her his work on Ptolemy, for which he somewhat abandoned geotechnics in the last years of his life, lamenting, as he often told me, that age slowed down their work. He writes in "I remember" (Gambin 2005) that his first discussions with Louis Ménard, in 1953, were on philosophy and metaphysics, before the birth of the very idea of the Pressuremeter. And from his reflections on Terzaghi's teaching (Gambin 1995a, 2003, 2008), he undertakes to formalize that what he practiced with L. Ménard and since the latter's death, is the implementation of the experimental method and the analysis of its practice before theoretical analysis; he wants to make it understood that the qualifier empirical or semi-empirical attributed to methods that have long had the success that we know (Gambin 1995b) is to be taken as a confirmation, more than as the negative connotation that this adjective retains in French (and in English too). Between ISP4 (Gambin 1995b) and the preparation of ISP5 10 years later, I remember that our discussions, both oral and written, often focused on epistemology, the philosophy of science, the driving role of the experimental method, and the necessary reflection to seek the rational and theoretical explanation of verified and repeatable observations. It was during these years that he insisted on the importance of teaching geotechnics in a historical way (Magnan & Gambin 2000), and that his reflection led him to write, somewhat provocatively, that the perfect theory is a myth (Gambin 2003). He would like to repeat the same message in English (Gambin 2008). Immediately afterwards, Michel Gambin devoted a great deal of energy to coordinating, for the IFCEE (International Foundation Congress & Equipment Expo) in Orlando, a review of the practices of the Ménard pressuremeter, which he had published with the authorization of the ASCE under the name "Foundation design with Ménard Pressuremeter tests. French Contributions" (Apagéo 2009), grouping 5 papers among which he co-signed two majors (Frank & Gambin 2009, Bustamante, Gambin & Gianeselli 2009).

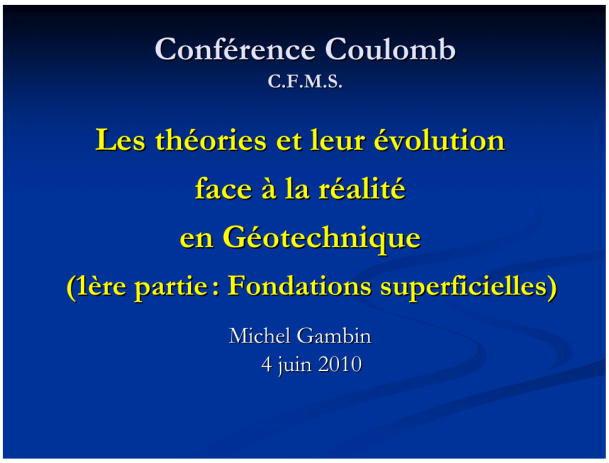

Figure 18. Coulomb Conference of M. Gambin, 2010. Title slide "Theories and their evolution in the face of reality in geotechnics - Part 1: Shallow foundations"

Then in 2010 he delivers the 8th Coulomb Conference of the CFMS, which gave him the opportunity to develop the previous articles on his philosophy of geotechnics, variability of so-called rigorous theories and the need to adapt them confronted with experimental results. The entire first part of the conference is devoted to reviewing the different theoretical contributions, from the 19th century to the present day, to the understanding of the phenomena involved in soil-structure interaction, and how K. Terzaghi arrived in 1943 at his famous formula for calculating the bearing force. He thus shows that compatibility is not obvious between these different theoretical approaches, and that Terzaghi himself, on numerous occasions, warns practitioners about the very simplistic nature of theoretical equations, and their frequent inadequacy to the reality of the behaviour of structures. Some key phrases: "Rigorous mathematical solutions are often too complicated to be used in a general way." "The need for simplification is due to the very nature of the soil: its heterogeneity and the complexity of its properties." "Obtaining rigorous solutions is not a

necessary condition for the success of research in the field of soil mechanics."

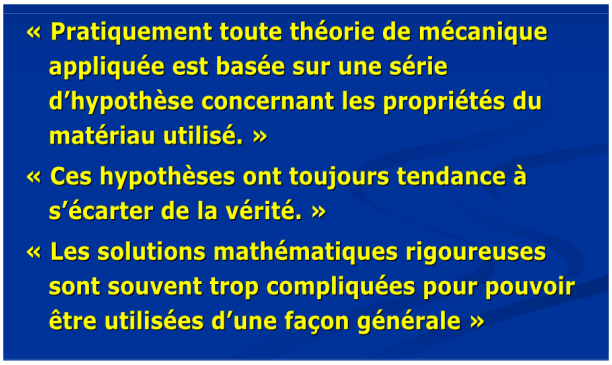

Figure 19. Coulomb Conference of M. Gambin 2010. Selected quotes from K. Terzaghi (slide 44) "Virtually every theory of applied mechanics is based on a series of assumptions concerning the properties of the material used." "These assumptions always tend to deviate from the truth." "Rigorous mathematical solutions are often too complicated to be of general use."

This long approach is intended to explain Louis Ménard's radically innovative contribution to geotechnics, and how he moved away from linear elasticity to introduce, with the coefficient α in particular, an implicit consideration of the decrease in modulus with deformation. It is based on the verification of the validity of this approach to deformation prediction by Ménard and the LPC network (Baguelin et al. 1978). He provides a lengthy discussion of the "Settlements 94" settlement prediction exercise (Briaud & Gibbens 1994), which he considers insufficiently considered in France, and for which he notes that the use of the Ménard pressuremeter method produced the results closest to reality. Although he devoted his lecture to showing the limits of "rigorous" theoretical approaches and in particular to dismantling Terzaghi's classical formula for bearing force, his conclusion is based on what the founding father of our discipline taught him:

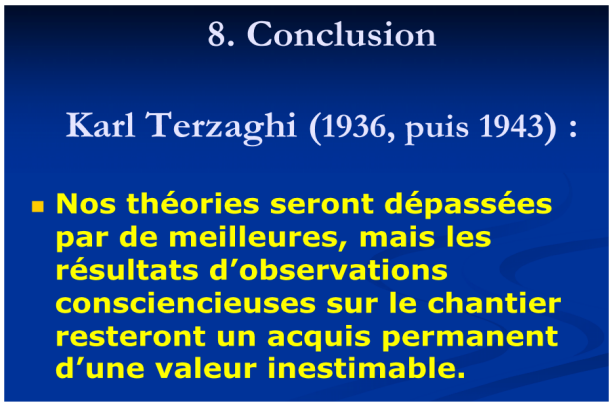

Figure 20. Coulomb Conference of M. Gambin, 2010. First concluding slide: Our theories will be surpassed by better ones, but the results of careful observations on the construction site will remain a permanent asset of inestimable value.

And he recalls that he applied this teaching, with Louis, the very year that Terzaghi gave it in one of his last recommendations, in 1961 (Fig. 21), and as soon as 1950 (Fig. 22):

Figure 21. Coulomb Conference of M. Gambin, 2010. One of the concluding slides, quote K. Terzaghi 1961: While most problems in the strength of materials can be solved in textbooks and tables, …in Applied Soil Mechanics, if the engineer lacks the required geological training, imagination, and common sense, his knowledge of soil mechanics can do him more harm than good. Instead of using soil mechanics, he will abuse it.

Figure 22. Coulomb Conference of M. Gambin, 2010. Last slide, quote K. Terzaghi 1950: It is not reasonable to establish a project with maximum security at every stage. It is better to establish a project where it will always be possible to modify a feature to maintain acceptable security:" Learn as we go."

4. Conclusion

We can consider Michel Gambin's geotechnical legacy (Fig. 17) through the 132 titles in his bibliography (Apagéo 2024), and look for what he wanted us to remember from his work, associated with that of Ménard for the experiments on foundations at Saulx-les-Chartreux, completed and developed by his successors cited in this conference, the work of the LCPC researchers, and that of Jean-Louis Briaud.

I believe I can understand, based on my last conversations with Michel Gambin, that he would have retained:

- the D60 manual, which he was very keen to revise and to which he devoted a great deal of time (Gambin 1998)
- the State of the Art of the pressuremeter (Amar et al. 1991)
- the chapter "Pressiometer Testing" (Gambin 2005a)
- the synthesis "Foundation Design with Ménard Pressuremeter Tests" (Apagéo 2009 excerpts from ASCEE 2009)
- the hyperbolic form of the ideal pressuremeter curve (Baud, Gambin, Schlosser 2013) and the deductions on the decrease of moduli with deformation (Baud, Gambin, Heintz 2015)
- finally, the Coulomb Conference (Gambin 2010)

Epilogue rather than conclusion. We have, you have, to continue and support the pressuremeter adventure, after ISP8.

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