Interviews with Canadian Legends:

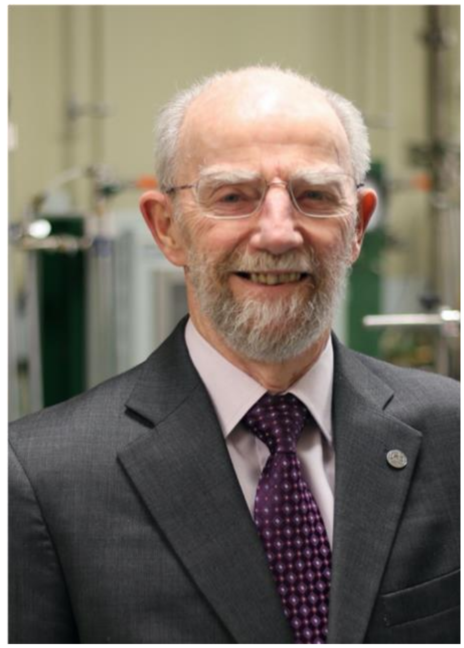
James (Jim) Graham, PhD, DSc, FEIC, PEng (Ret)

*This interview in the Canadian Legends Series (CLS) was conducted in August 2019 by **Hongwei Liu**, **Suzanne Schultz** and **Ali Fatolahzadeh Gheysari.** At the time, all were students in the Department of Civil Engineering at the University of Manitoba. The interview was facilitated by **Pooneh Magoul** Associate Professor in the same department. The CLS is an initiative of the CGS Heritage and Education committees. This is a longer version of an interview that appeared in the March 2020 issue of Canadian Geotechnique/Géotechnique canadienne. Other interviews in this series can be read at http://www.cgs.ca/virtual_archives_legends.php*

Jim Graham is a Professor Emeritus in the Department of Civil Engineering at the University of Manitoba. He holds undergraduate and doctoral degrees from Queen's University, Belfast, Northern Ireland, and taught there, starting in 1966, until he emigrated to Canada in 1972.

Jim has published more than 200 articles on a wide range of subjects, mostly related to the properties of clays. His research topics include effects of yielding, loading rates and time, temperature, incomplete saturation, chemical change and hydraulic conductivity. He was Editor of the *Canadian Geotechnical Journal* from 1985-1988 and became a Fellow of the Engineering Institute of Canada (EIC) in 1990. He served as President of the Canadian Geotechnical Society (CGS) in 1997 and 1998, and as its Secretary General (now Executive Director) from 1999 to 2007. His contributions have been recognized by the R.F. Legget Medal from the CGS, the John B. Stirling, Julian C. Smith and K.Y. Lo medals from the Engineering Institute of Canada (EIC), and the Saunderson Award for Excellence in Teaching from the University of Manitoba.

Jim Graham is recognized internationally for his contributions in the field of elastic-plastic soil behaviour. He is considered an outstanding educator with a commitment to innovative teaching as well as mentoring relationships with young professionals.



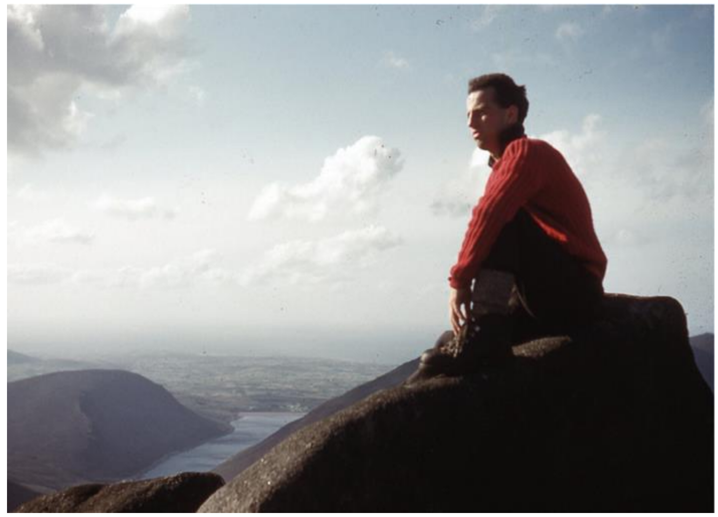
University of Manitoba Soil Mechanics Laboratory; 2020.

Tell us about your background and what made you choose Geotechnical Engineering.

I'm an Ulster boy from Northern Ireland. Our family was small – my mother and father, myself, my younger sister and some uncles and aunts. My father had a small building business, mostly doing renovations. He wanted me to become an architect and join him in his business. There was no school of architecture in Northern Ireland at the time and the closest thing we could find was Civil Engineering in Queen's University in Belfast. As a third-year student in 1958, I was introduced to soil mechanics, which was then a very new undergraduate subject, having begun in British universities in about 1948-49.

The soil mechanics professor in Belfast at the time was an unusual individual who had industrial experience with an early English firm called Soil Mechanics Limited. When I was a student, he was working towards a PhD on the bearing capacity of shallow footings and pile footings in sand. He also spent considerable time in his laboratory on knitting fishing nets, repairing clocks, and working on the engine of his boat! He wasn't really a very good teacher, but he was a stimulating educator. He would introduce a topic in class, and then send us off to the library to learn more for ourselves. There was no internet, of course in those days, so we spent a lot of time in the library, digging out books, journals, conference proceedings, and essentially teaching ourselves.

Next time we went to the classroom he would say something like "Now, Graham, what have you learned about the subject I told you about last time? Come and tell us about it." The approach was a learning exercise rather than a teaching one, but a stimulating challenge in a new and growing field.



Top of Slieve Bearnagh in the Mourne Mountains in Northern Ireland; 1960.

I graduated from the undergraduate program in 1960 and was invited to come back to undertake a PhD research program on computer analysis of failure mechanisms of tailings dams, footings, piles, and walls in sands. Computers were very new in the early 1960s, so the work included development of original coding. I got side-tracked from returning to my father's building business.

It was the first time I had really come across the idea of research and it was a great opportunity. Other research students in our group were working on testing physical models, while I was working on numerical modelling. The team was producing results, PhDs, and publications. I was paid $400 per month in British pounds. I was later hired by the university as an Assistant Lecturer.

My wife and I immigrated to Canada in 1972, in part for improved job opportunities and in part to avoid the sectarian violence in Northern Ireland known as "The Troubles". Canada has been good to us and our three children.

What was the biggest challenge or achievement that you faced in your career?

My first big challenge was completing my thesis project, which used an approach for analyzing zonal failure mechanisms in sands. (There were no postgraduate course requirements in those days.) The original Sokolovski book had been translated from Russian into English. I had difficulty understanding if the translation was faulty or I simply didn't understand the mathematics. My experimental and coding work went very slowly, but in the end, was successful. Surprisingly, papers arising from that early work are still being referenced.

The biggest challenge was knowing what to do afterwards. I've told graduate students that if they are still working on their thesis topics five years after their PhD, they are probably doing something wrong. They need to look for something new.

I was fortunate. After some years on staff at Queen's University, I got an unexpected opportunity to go with Jennifer and our 2-year-old son to the Norwegian Geotechnical Institute (NGI) in Oslo. For us, it was a big challenge to move away from our home for a year to a new culture and language. It was made easier by the Director, Laurits Bjerrum, and two visiting Canadian researchers, John Brown from

Halifax and Ken Torrance from Ottawa. Cameron Kenney, who became a professor at the University of Toronto, was another Canadian who spent time at NGI. Many others followed later.

Most of my work was in the soil testing laboratory and was directed by Dr. Bjerrum. It involved tests on soft sensitive marine clay from southern Norway – a big change for me. I remember one dark winter day in particular, when John Brown, Toralv Berre and I were having afternoon coffee sitting on top of the laboratory table where Atterberg limits were normally done. The conversation was about the idea that preconsolidation pressure in clay was simply a yield condition in 1-D compression. If that was correct, then yielding should also be experienced during shear loading and be evident along generalized stress paths. This led to the ideas of yield envelopes, stress boundary surfaces, and eventually, ties with Modified Cam Clay that had been introduced earlier by Schofield and Wroth.

On returning to Belfast, I introduced NGI-style sample preparation and laboratory testing. I worked with my first PhD student, Jack Crooks, to show that yield loci were also present in the soft organic silty clay known locally as ‘sleech’. It was quite different from the Norwegian ‘quick’ clay I had worked on before. Shortly after, I was hired by the Royal Military College (RMC) in Kingston ON, and Jack and his family had also come to Canada to work with Golder Associates, initially in Toronto and later in Calgary.

The next time I had one of my few original ideas, we had moved from RMC to the University of Manitoba in Winnipeg. I used to exercise at lunchtime in the dirty and dusty basement of the gym known as the Gritty Grotto. I remember thinking one day about my earlier PhD modelling of stress characteristics in sands and the effect of scale on the so-called “dimensionless” parameters that are used in analyzing walls and footings. (Just as I was leaving NGI some years previously, Bjerrum had asked about scale effects in connection with offshore drilling platforms. I had no answer.) Laboratory-scale tests produce “dimensionless’ parameters that can be significantly higher than those encountered in field projects. Hence the value of modern centrifuge testing.

Sands do not simply have a constant peak friction angle ϕ - it varies with stress level, and so, therefore do the dimensionless design parameters. The question at the time was how should we go from laboratory testing to full-scale structures for offshore oil rigs? The solution was to express peak friction in terms of stress level as suggested Atkinson and Bransby (1978) among others, and then write it into stress characteristics coding. Some of my publications from the 1980s are still being referenced.

Returning to the question of preconsolidation of clays and its influence on settlements, it is widely understood that commonly used traditional methods under-estimate long-term settlements. They assume that primary consolidation of excess pore water pressures is subsequently followed by ongoing secondary consolidation. Bjerrum in his Rankine Lecture in in 1967 said this was incorrect: we should think instead of ‘instant’ elastic compression followed by ‘delayed’ non-recoverable compression. That is, we should use an elastic-viscoplastic (EVP) model. The idea was controversial at the time.

I mentioned this to one of my Chinese doctoral students, Jian-hua Yin in the late 1980s, and about one week later, he came up with an EVP solution based on time-dependent behaviour, the so-called ‘equivalent time’ method. In subsequent years, this has achieved considerable recognition. The same general approach has also been revisited in 2008 by Kelln, Sharma and others, in terms of strain rate rather than time. These semi-empirical EVP models are relatively easy to calibrate and offer promise of being applicable to creep behaviour in sands, slopes, dams, and temperature-dependent applications. Some work has also been done in applying them to unsaturated soils and to changes in pore fluid chemistry.

Was there a project you found particularly interesting or unusual?

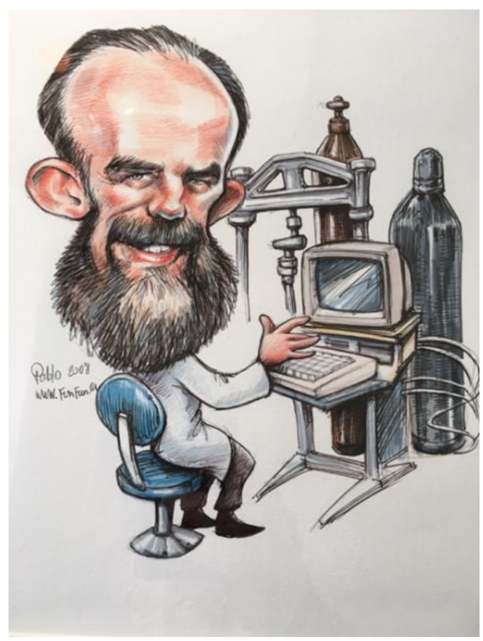
I was sitting in my office one day and there was a tap-tap on the door. A senior research engineer called Malcolm Gray came through the door and said he wanted me to work with his team at the research laboratory of Atomic Energy of Canada Limited (AECL) in eastern Manitoba. I didn't know him, and at the time, around the mid-1980s, I didn't know much about the project.

The overall project led to a wide variety of interdisciplinary research, including engineering geology, rock mechanics, hydrogeology, soil chemistry, and construction of the Underground Research Laboratory at Pinawa MB. I was not involved with all of these projects, of course, but I did get to know researchers in Sweden, France, and Spain; and learned of collaborative work in Europe, Asia, and the United States. My role was principally to study the thermo-hydro-mechanical (T-H-M) behaviour of an unsaturated sand-bentonite mixture that could be used for protecting containers of nuclear fuel waste against high swelling pressures up to 10 MPa, temperatures up to 100C, and the effects of groundwater flow. Research for AECL was funded a series of about 30 students for about 20 years, some of whom were AECL employees. This was probably the most interesting and largest-scale research project I worked on.

At the time, Canada's overall research on containment of nuclear waste was very well recognized internationally. Later, the federal government closed it down for financial reasons and I moved on to other interests.

In terms of intuition and general/practical knowledge, how do you compare current geotechnical graduates with ones from the past?

Students are more rounded and have stronger technical backgrounds than I had 60 years ago. They probably have a better awareness of topics like design principles, teamwork, the general nature of engineering, and engineering ethics. These were simply not part my undergraduate or postgraduate programs but were left to be introduced later by employers and professional licensing bodies. As students, we were taught mathematics, principles of engineering analysis, some information on available technologies, and testing techniques. We were not taught about site investigation, and were taught little about design procedures, case studies, or client relationships.



Cartoon by Pablo presented
by Manitoba Section, CGS; 2008.

In those days, becoming a productive junior engineer was facilitated almost exclusively through company training and professional development courses offered by licensing bodies. Universities and nearby engineering companies tended to keep themselves largely apart, although were always some interactions, mostly through professional development programs. As an undergraduate, I saw little of this, but began to see it as a postgraduate student.

I would add one more thought. The nature of our learning was largely the presentation of ideas by professors. Assimilation of those ideas was largely our responsibilities as students. Lectures did not come from books or printed notes - those were days before slide shows or pictures. My PhD thesis in 1967 was the first in Queen's University, Belfast to be printed by photocopier. I was the first lecturer in the Civil Engineering Department to use an overhead projector. For my computing, I rented the walk-in computer three hours at a time and my wife brought me supper. The computer had no graphics capability, less memory than my current cellphone, and no print-out facility. (Results came on stacks of cards that had to be carried carefully to a printer.)

If I needed books and research papers for a project, our librarian could order them, and I would get them two weeks later. To some extent, we were perhaps more responsible for our own learning than present students, but self-learning opportunities were much more limited than now. I survived, and I appreciate the advantages we now have.

I am not suggesting we should go back to those former conditions. I do suggest, however, that the greater availability of information makes it possible for undergraduate and postgraduate students to have wider access to learning opportunities than I did.

While immediate access to information might be better, it seems reasonable to question whether it stimulates independent thinking and broadly-based answers.

What do you think is the future of geotechnical engineering? Is there an area of research you think is particularly promising in the next few years?

Almost all civil engineering projects have a ground connection, so geotechnical engineering certainly does have a future. It is now a much broader discipline than just soil mechanics, but it is still pretty new. We are now only about 90 years from the first statement of the effective stress principle, the key to the science-based development of soils engineering, and about 60 years from a period of major expansion in the 1950s-1970s when analysis and many new topic areas began to develop. These have been successfully accepted into general practice. Many of the innovators from that period are now pretty old like me and have retired or are no longer with us.

Some say that researchers learn more and more about less and less until we know everything about nothing. With the advancement of computing technologies and numerical analysis, smart researchers began to develop new areas of specialization and research.

These have stimulated technical capabilities and added reliability in many new topic areas. They result, also, in current opportunities for re-invigorating research in early subject areas. For example, cold regions engineering was an early topic in the NRC Division of Building Research and a number of Canadian universities. The quality of that research was highly regarded internationally and generated considerable consulting activity. Recently, with increased attention being given to climate warming, research on cold regions engineering is again active, especially with regard to field instrumentation and modern numerical modelling. Similar initiatives are taking place in railway engineering and infrastructure for public transportation.

There are probably other subject areas that will stimulate renewed research interest. Some of these received considerable interest in the past and the results were then adopted in practice. Improved field instrumentation and numerical analysis are leading to new studies in areas that include muskeg (peat) engineering, geochemistry, earthquake engineering, and time-dependent behaviour of clays.

I also see three additional areas that can benefit from increased attention. The first of these is Geology, not necessarily at the research level, which is still active, but rather at the instructional level from the point of view of Geotechnical Engineering. Due to other pressures on Civil Engineering curriculums, Geology seems to be receiving less attention than before. Many students now graduate with BSc, MSc and PhD degrees in geotechnical engineering with very little understanding of geology. To me, this seems inadequate.

The second area is the relationship between evaluating material properties in laboratory or field tests on the one hand, and selecting constitutive properties for numerical analysis and design on the other. Engineers who manage and interpret laboratory testing programs may not understand, or be unable to produce, material parameters needed by numerical analysts. In turn, analysts, may not understand that laboratories cannot always produce the large numbers of complex inter-dependent parameters needed for modern numerical analysis in site materials that are inherently variable.

A third area is assessment of levels of uncertainty, whether in terms of probabilistic analysis, assessing material properties, or the variability of natural processes such as to rainfall, temperature changes, groundwater conditions, creep movements, river or lake levels, or permafrost degradation. Practice and research are of course are proceeding in these areas, but more can be helpful.

Have you come across an ethical dilemma in your career? How did you deal with it?

I've had some experience of this, as most people have. I will first say that we didn't think especially about ethical issues 50 or 60 years ago. They were certainly there, but I was not aware that there were many of them. Perhaps I was just a naive, simple soul influenced by my upbringing.

I have seen several ethical issues in Canada, but none too serious. As an example, my graduate students normally studied together in the same room in separate cubicles. One of them regularly came in later than the others, did a round of social visits, and made a lot of noise. I never did manage to get him to be quiet and respect others who were already working on their research.

Listening, thinking; 2015.

As an academic, I used to tell my students I expected them to be honest. If they were going to act ethically as an engineer in their workplace, I said they would have to start doing so during their coursework and research. They needed be honest with me. If they didn’t understand something, I wanted to know about it. If they were producing results from laboratory tests, I wanted the answer that would come from the data and not some artificial, but more expected, answer. Their original, and perhaps imperfect, work was more important than something that had been stolen or plagiarized. Students seemed to respect this position.

There is another sideline to always telling the truth about test data from laboratory tests. In Norway, I learned that if a test and does not produce the data you expect, you should remember that your understanding may be incomplete. The test may, of course, have simply gone wrong. The data may also, however, reflect behaviour that you do not yet understand. In the latter case, you may gain new insights.

Another case I remember was having to deal with a paper that came in for review when I edited the Canadian Geotechnical journal. It turned out that the paper had also been recently published verbatim in another journal. This is considered unethical. I withdrew the paper from review, returned it to the authors, and said I would not accept future submission from them for several years. I also informed other North American Editors about the situation.

In publications, I've had a number of cases where assistance from the authors' colleagues was not acknowledged. This is always a disappointment. I also had a case where a senior colleague from a different specialty area was verbally abusing a female secretarial assistant. Twenty-five years ago, it was difficult to know how to deal with this, but it is probably easier now.

My father would have said about these things "Just put them down to ignorance." In my opinion, what we should be looking for is honesty. Be frank, open and respectful.

Another of the things I learned in Norway was the importance of dealing with others in the same way we would treat our family members. Bjerrum used to refer to his colleagues as the "NGI family".

We are developing intricate numerical modelling tools, but we are still using older, more limited models in design. What are your thoughts on this?

It seems that gaps are developing between our undergraduate programs, research tools that are being developed in postgraduate programs, and the advanced technical skills being used in strongly innovative companies.

I see one of the roles of university research as exploring ideas that may, or may not, be eventually useful in industry. Postgraduate programs teach some of these advanced techniques. The choice of whether to use or not use them lies with companies. For me, that is the right relationship.

We also see, however that many strong innovative companies are ahead of the technical training that universities can provide. I have felt for some time that the problem raised by this question lies in our undergraduate programs. Most of the content in current introductory textbooks on geotechnical engineering, even recent ones, is out of date. They often describe approaches that were new 50 years ago but do not provide sufficiently strong preparation for postgraduate programs or routine current practice.

One of the problems faced by universities is that Canadian undergraduate programs have been greatly diversified by the Canadian Engineering Accreditation Board in terms of topics and attitudes that must be taught. While 'education' has advanced and should be supported, 'skills-training' in the many different areas of Civil Engineering has suffered. As I mentioned earlier, Geology is one of these areas. Laboratory testing is another.

In Canada, engineering is now one of the very few professional disciplines in Canada that requires just an undergraduate degree, (plus guided experience in practice), for professional licensing. Most other advanced countries require postgraduate degrees. Currently, undergraduate degree programs in Canada are very demanding but in some ways they are inadequate. Postgraduate programs are optional. I suggest this needs to change.

I want to see new technologies brought into undergraduate programs and out-of-date technologies taken out. This will require professors to change. Not all professors may be willing to change.

Over the years, more women have begun careers in engineering. How has the acceptance of women working as engineers changed over your career?

When I started university studies in the mid-1950s there were no women in our classes. By the 1970s in Canada, there were small numbers of women in practice, and a few more were attending classes. Women in senior positions in practice seemed to come mostly from science programs like geology or chemistry, rather than coming through an engineering stream.

Soils engineering at the time was very masculine in offices, at construction sites, and in universities. At meetings, participants would endlessly smoke cigarettes and pipes; tobacco smoke would be everywhere. Many words and phrases used in conversations would be unacceptable today. I do not justify this, but it is how it used to be.

Gradually, that has changed. Having a daughter at home helped to some extent! When beginning my lectures, I used to say, “Good morning, guys”, an opening I had used for years and thought that it included women. One morning after my lecture, six women students came to my office to complain about me using “Guys” in the greeting. They were courteous, but firm. After that, I started using “Good morning, everyone”. It worked. From that time. I believe my relationship with our women students was much better. With all students, I always kept my office door partly open.

Vacation time; 2016

I now see women in senior positions in consulting offices and sitework; finding opportunities for advancement; and having their recommendations and decisions supported. I also see some trends for women to be especially interested in areas like geo-environmental engineering, advanced laboratory work, hydrogeology, climate change, and permafrost engineering. A fairly recent Director at the Norwegian Geotechnical Institute was Suzanne Lacasse, a Canadian woman from Québec, and there are regularly women in senior leadership positions in the Canadian Geotechnical Society.

Compared with conditions when I started in geotechnical engineering, it now seems that men are gradually learning to respect women's presence. They are beginning to know and accept that women often deal with inter-relationships and solve problems differently from men. Women’s approaches to problem-solving are not necessarily better or worse than men’s, just different and often just as successful. Women are often good at dealing with clients, good in discussion, and often very good at finding solutions. Women are now forming a majority in many professions and are certainly increasing their impact in geotechnical engineering. Numbers and relationships have improved, but there are still opportunities for growth and improvement.

You have worked in several countries throughout your career. How do you view Canada’s position in the academic and industrial geotechnical community?

Geotechnical engineers are well regarded in Canada and other countries. Initiatives like the Canadian Geotechnical Journal and the Canadian Foundation Engineering Manual are always mentioned very favourably when I go overseas. Our senior members regularly take leadership roles in major organizations like the International Society for Soil Mechanics and Geotechnical Engineering, the International Association of Engineering Geology and the Environment, and the International Association of Hydrogeologists. Senior academics often collaborate with university colleagues in other countries.

Our major engineering companies work extensively internationally and have contracts all over the world. I'm thinking of the United States, South America, Asia, the Middle East, and perhaps to a lesser extent in Europe. Leaders of these companies are often invited to participate in specialist review panels for major projects in other countries. I was talking recently with a person who has just returned from China and I know others who regularly review projects in Hong Kong, Malaysia, and South America.

One of the strengths of Canadian geotechnical engineering is that it is open to many different associated specialty areas. For example, the CGS has technical divisions that include Soil Mechanics and Foundations, Rock Mechanics, Engineering Geology, Hydrogeology, Cold Regions, Geosynthetics, and Geoenvironmental Engineering. Specialist committees include Transportation Geotechnique and Landslides. Membership of the CGS is open to scientists as well as engineers. This very wide range of membership interests goes back to the earliest days of the society. It means, for example, that Canadian national conferences welcome papers on a wide range of subjects, and broadly-based skills can be easily shared with other members of the CGS. In international terms, this is very unusual, but it has added significantly to the strength of Canadian geotechnical engineering.

How do you view the connection between industry and academia?

This can be very positive, but also at times negative. When I started working in universities, almost 60 years ago, most academics taught during term-time and worked in consulting practice during the rest of the year. Canadian universities began to emphasize engineering research in the late 1960s and early 1970s. The view at that time was that universities should concentrate on ‘learning’, which was seen as a combination of teaching and research. Collaboration with industry was encouraged, but direct competition was not. In those early years, engineers from industry told me that some academics abused their positions because they were doing ordinary consulting work without having the usual overhead expenses. Academic positions were seen as adding to reputations and attracting contracts. In turn, this could reduce the number of contracts that would go to full-time consultants.

In my opinion, academics benefit when they concentrate on working with undergraduate and postgraduate students; advancing their national and international reputations through research; and providing specialist advice to consultants when asked. When invited, academics can act as consultants to consultants, rather than as consultants to individual clients.

Interactive collaboration can be very helpful to industry, universities, and government departments and agencies. There are many advantages. Collaboration brings applied research opportunities to university staff and postgraduate students. Its benefits also spill over to undergraduates in terms of adding competency to professors’ abilities and credibility to their teaching. Hopefully, this can be a two-way process. Findings from interesting research projects will gradually work their way back into consulting and government offices.

Another trend is happening as well. Some consulting companies and government agencies in Canada are collaborating with universities on challenging projects, often in the form of case studies. As part of their original project, they may have collected valuable field data but do not have resources to learn in detail about their project’s successes and weaknesses. They may also have identified topic areas that would benefit from additional examination.

Financial support directed to a local university can support one or more postgraduate students to determine lessons that can be learned from the project. Students benefit by learning real-life experiences that can be taken into practice later. The consulting company or agency will benefit from spin-offs and a possible candidate for hiring; the original clients will benefit because they get additional support from low-cost advanced study; the student is hopefully successful in getting broadly-based experience on a real-life project; and the academic researcher benefits in terms of college-community relationships and increased hands-on experience. It is often a win-win-win-win situation.

I see academic collaboration with industry as valuable; direct competition less so.

In conclusion, I have enjoyed my career as an academic who has worked mainly in the area of soil mechanics. I have been fortunate in making many friends in the profession, both peers and younger colleagues who I respect; and have been able to serve our community in some small ways.

Interview Team (left to right): Hongwei Liu, Dr. Jim Graham,
Suzanne Schultz and Ali Fatolahzadeh Gheysari
