Interview by Sarah Milstead

PILE BUCK'S INTERVIEW WITH BENGT FELLENIUS, P.E.

Renowned Foundation Engineer, Philosopher, Mentor

Bengt Fellenius has changed little since our last meeting. Age seems to elude him as he remains boyishly-handsome and still carries a discernible Swedish accent. He was wearing sneakers which seemed to ease his great stride as he energetically led the way to find a quiet place in the busy Orlando hotel where he and Mohamad Hussein, PE of GRL, are giving a short-course weekend seminar. After our interview conversation, Dr. John Garlanger of Ardaman & Associates joined and the four of us had a lively discussion of Theory and Pile Dynamics delightfully interspersed with a display of jokes and humor. I guess one would need to attend a seminar to experience this true wealth of knowledge and historical reminiscing.

PB: Bengt, let's start the interview with your family history. Can you tell us about your father and your grandfather?
Bengt Fellenius: My grandfather was a civil engineer as was my father.

PB: In your bio, you speak of your grandfather as of "slip circle fame." I'd like to know what that is.
BF: My grandfather rationalized the method for analyzing landslides and slip failure using a slip circle analysis. Every geotech knows that term. (Laughter) He also did some other developments in geotechnical engineering, although his main interest was not geotechnical but hydraulics. He was also one of the first to use reinforced concrete and he built the first reinforced concrete building in Sweden. Actually, the concrete specialists in Sweden claim him as their pioneer as much as the geotechnical engineers claim him as one of theirs.

It is a bit of a tough act to follow. Not so much for me but for my father, I assume. My father was also active as a geotechnical engineer. Of course he was always compared to his father which was not always that welcome to him.

PB: So he was well renowned as well?
BF: Oh, he is also well renowned for his accomplishments in geotechnical and foundation engineering. I essentially just followed in the footsteps of my grandfather and father. One difference between my experience and that of my father's is that my father made a point of never ever trying to influence me or tell me what to do. Which I believe is what my grandfather might have tried to do with him because my grandfather he was a very powerful man.

PB: What made him powerful?
BF: Personality, presence . . . I don't think in that in his adult years anyone ever gave him an objection. He radiated a power and authority.

PB: Where do you think he developed this authority?
BF: In the late 1800s, you needed to have that to manage. Most of the pioneers in geotechnical engineering had that more or less. For example, Terzaghi, Atterberg, Tchebotarioff, Casagrande, and other famous professors were powerful and forceful individuals. I think they had to be that in those days. We live in more gentle times now.

PB: The word "Geotechnique" was actually first used by your grandfather?
BF: Yes, he chaired a government-appointed commission of geologists and teknologists — "teknologer" which is what civil engineers were often called in Sweden in those days. The *Commission of Geologists and Technologists* became too long a name even in Swedish, so it was changed to the *Geotechnical Commission*. When the report was published, it was the first time the term was ever used in print. And now, of course, it is the main word for the profession.

PB: And your father?
BF: He was in civil engineering and went into geotechnical engineering. At the end of his career, he was the head of the geotechnical office of the Swedish State Railroads, which was the main center for geotechnical engineering in Sweden up to the 1950s.

When I was in my teens, I needed a summer job, of course, he arranged for me to work somewhere where he had contacts. I actually worked on soil exploration teams when I was 15 which is a long time ago. (Laughing) My field experience goes back a long time.

PB: What about *your* sons?



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BF: I have three sons — no daughters. One son went into civil engineering and geotechnical and he is still close to that field. It is very enjoyable to be able to exchange views and discuss engineering questions with him. One is a social worker and works with homeless people and people in need of assisted living. I used to say that he follows the path of his paternal grandmother who came from a line of people, men and women, active in social issues from even before there was socialism. The third went into geography and oceanography. He is now pursuing reef rejuvenation and marine environmental aspects in the South Pacific.

PB: Are you interested in that subject as well?
BF: Oh, very interested! And I know nothing. (Hearty laughter)

PB: Would you like to discuss the cultural influences of growing up in Sweden and then moving to Canada and how this has shaped your perspective in the field of geotechnical engineering? How has it impacted your international connections?
BF: It makes you notice and experience culture differences amongst engineers. I can remember at a meeting in the 1970s when we were starting up the Deep Foundation Institute and there were several votes with dissenting views. In my background, a chairman doesn't ask for a vote until it is quite sure that it will show a consensus. The culture in Sweden is much more looking for a consensus agreement than is common in North America.

That's a small thing but it is stimulating and efficient, I think. In North America, you can actually have an argument and heated discussion with someone without it becoming an issue for the personal relations. I believe this originates from the sports participation amongst youngsters; you hit someone over the head with a hockey stick but next year you will be on the same team! (Laughing) No big deal, therefore.

I find cultural differences very stimulating when working with an engineering team. It is sometimes the main reward of a project. Sure it's great to be involved in an interesting project and learn from it, but, the main personal reward is that you are learning it together with a group other engineers.

PB: Geotechnical Engineering is international at your level?
BF: Well, all engineering is international if you pursue it that way. The civil engineer comes out of the university like every other guy or woman (and women are in civil engineering today . . . it's a social science). If you decide to work in any city in the world, there is a job for you. You can stay in your own municipality and work there for the rest of your life and have a good life. Or, you can be a globetrotter or anything in between. By chance, I developed into moving around with my family more than some others in my work.

PB: My impression is that geotechnical engineers are more connected to the earth and the environment.
BF: Yes, a good part of geotechnical engineering is connected to environmental engineering. Like most educated people, which engineers are, they get concerned with society and the environment.

The geotechnical engineer actually has the environment as part of our profession. You'll find more geotechnical engineers having an opinion about the critical environmental issues of today. So, people interested and concerned in the environment who are not engineers will find a connection to the geotechnical engineer that they may not find with those in any of the other engineering field.

PB: Engineers can be influenced by business and politics.
BF: We all are.

PB: The engineer is not necessarily astute in business.
BF: We have no formal training or direction in business. I don't think modern graduates have had a course in bookkeeping. I had to take a course in bookkeeping when I was a civil engineer student but all I learnt was that if I made an error I had to use an eraser in two places. (Laughing)

The matter of economics and market economics and the investment involved in structures and so on, is not taught in universities. Yet, it is an integral part of engineering. That is a miss in the education in a sense but like so many other things, you continue learning after you leave the university. You have to make an effort at times to do this.

I don't think that there is much that I learned at a university that I would still need today and I probably will have forgotten it even if I would need it. (Laughter)

PB: Why is that?
BF: Most of what I am involved in today did not exist when I was in school and a good deal of the fields that I had training in as a civil engineering student, I don't use today. I have a slight understanding of it and that is true I think for everyone. You keep learning and emphasizing the new things.

The university education just provides you with a platform from which you can rise. The structure you build on that is stable because of your education. The platform itself you don't use much; it's down below there, somewhere, though.

PB: What are you working on now? What are some of the important projects?
BF: I am involved in a couple of current projects in North America and overseas with a few specific foundation questions. Essentially, my involvement is more and more concerned with the settlement of heavy foundations in different type of soils and how to measure and test and find the final solution for the analysis of the foundation response to load. Frequently, a project I get involved in, I don't know how to handle until it's over.

PB: Yes I've heard that from others.
BF: You develop through the years an approach and you follow that. When you are done, you will always have found some new insights and learnt from them. Experience and approaches are always changing. For example, what I have learnt I use in teaching courses, but they keep evolving. I remove slides, I add slides, I find a better phrasing of something.

PB: You'd have to like that. Some people like non-changing, certainty about things.
BF: I'd die! (Chuckle) I would not want to do today what I did four or five years ago and I don't.

Twenty five years ago, I was still using my slide rule for calculations. I still at times bring it along, but I use it to make an impression, as a joke. It's only a half joke, though, because it is a very convenient tool but modern engineers don't use it.

I make a point in my teachings to go back to the basic parameters and show that they fit in with the most sophisticated analysis we do today. I keep giving young engineers that I meet a copy of Terzaghi's original *Engineering News* papers which were published 90 years ago. They often say, "Gee, it's far more interesting and useful than any textbook on these particular issues."

Even the most sophisticated and detailed computer programs are built on very, very basic key assumptions. To understand the results of a sophisticated computer program, you must also understand the basic input and its limitations. Having grown up, so to speak, before computers, I find that aspect coming easier to me than to many younger engineers. The "sophisticate program" itself is a bit harder, though.

PB: What do you think of the slide rule generation and the generation now who have always known computers?
BF: Production. The amount of material that the computer-generation can produce is of significant value. But competent engineers today, and it's true beyond geotechnical engineering, can produce much more meaningful work than their counterpart of 25 or 30 years ago. They can rely on much more communication and sharing of ideas than their fathers and grandfathers did. However, they can also produce with computers an awful lot of reports and such that do not have much value.

PB: It appears that engineers are much more cooperative, than say, the business side of projects.
BF: Engineering, whether geotechnical or structural, relies on the sharing of ideas and facts. It is a social profession in a sense — you have to communicate with others.

You can do it to a greater or smaller degree but communication, even face-to-face communication, is very important. And this is true much more so today than it used to be. But today we have email, Skype, and so on so we can act much faster than when we had to write letters and travel.

PB: In our previous interview, I spoke with you on the fact that you do not hear well.
BF: Yes, someone with my level of hearing impairment is considered legally deaf. I had an accident when I was doing my army service and went from normal hearing to not hearing much and a full flow of tinnitus, but I am stubborn so I decided to function anyway.

Most of what I get from what people say, I have to guess, and I think I manage reasonably well by that. But I can usually manage a telephone conversation, although I frequently have to request repeats. I hear very, very little correctly. Everything comes in distorted. I only hear up to 1,000 hertz and that means 10 to 15 percent of what is spoken. I work from there.

I rely on lip-reading and I read body language. Actually, lip-reading includes paying attention to more than lips, equally important are the small facial movements and twists of ears, eyebrows, eyes, etcetera. That, plus the little that I hear, makes it work. A side benefit is that by the body language of a person I talk with, I can tell, "hear" if



they are lying, sad, or happy, or content or not. I can never hear — understand — a single word, a name or word without a context. If I have grasped the preceding words, the next words are easier to get. In a conference, I go by what I see. I go by the slides. I don't hear the speaker.

George Goble, you have heard of him I am sure; he is one of my heroes. Once, at a conference, he came up to me in his usual, straight-forward way and criticized me for having so many colors in my diagrams, and said it was unhelpful to those in the audience who cannot see colors. I love color, and even dream in color. This was the first time for me that I thought it would not be helpful. It turned out that he is color-blind.

Then, Mohamad Hussein, who was there, said, "It's funny with you two guys. George cannot see the slides and you cannot hear the speaker but the two of you ask the most questions of anyone in the audience!" (Laughter)

People have limitations and some are more obvious than others. I manage with mine. But after two hours, I'm tired and I leave. When my wife and I will go to a dinner or reception, we have an understanding that after two hours, we go home.

PB: You mentioned that Dr. Goble is a hero of yours.

BF: Oh, yes! He is one of many. I admire him. He stubbornly, stubbornly persisted when others told him that it was not worthwhile to do pile dynamics and over many years of solid work he succeeded. Of course, along the road he got tremendous people like Rausche (Dr. Frank Rausche) and Likins (Garland E. Likins) to work with him. He developed a new foundation technique that didn't exist. People kind of knew of it but he made it work and pursued it both for practical engineering and for research. Both areas. He never gave up the research.

When I look back on my life, I find that I have been fortunate, more by chance than by design, to have worked for and with many extraordinary people; extraordinary both as engineers and as persons. Of course, my dad is one. A man named Sölve Severinsson, who happened to be a good friend of my father's, took me on when I was a student and gave me a few challenges to work on and to assist him with, which became my first steps in independent geotechnical engineering work.

When I came to Canada, I started working for a French-Canadian company in Montreal. The company president, Laval Samson, was one of Canada's foremost geotechnical engineers. I got a lot of mentoring and learning about Canadian geotechnics. I continued to pick up much of that from those I worked with as I went along. I was lucky in doing that.

PB: Mentoring can be so essential to learning, don't you think?

BF: If you start checking, you'll find most success stories of pioneers or great achievers in their field have had mentors. Later, when you start emulating some of your own mentors, you realize that they were often making the effort because they got a lot of satisfaction from teaching and showing the ropes to a young person. One of the things I enjoy very much wherever I go is to communicate and talk to the younger engineers. Often, I like this more than talking with the senior guys in that field.

When you are in a team where there are younger engineers, something magic happens. You have a young person, often younger than your kids, who asks a question, who listens, who considers the replies. That's very stimulating.

On my web site, everything is open. The web site has resulted in a large number of young people contacting me with many questions. I spend more than half-a-day a week replying to emails from students and young engineers. Some of these contacts have resulted in my participating in a project and/or co-authoring a case history; much of the writing with the young fellow as first author. I don't need any more papers. I write papers because it is stimulating to force me to do it. But to a young engineer, getting a paper in his name that he worked on is different. It is fantastic to see how they rise up to that.

I now realize why many of the so-called old goats, spent time with me! It wasn't that I was particularly bright, but they enjoyed seeing someone latching on to something of what they wanted to say. That interaction, when you become a specialist in something, is what makes you keep going.

All of my career, I have been trying to understand better. As I do, I've enjoyed sharing that with the younger generation, of course, also with friends my own age, most of whom are also geotechnical engineers.

PB: Are you a believer in Open Source?

BF: Oh, yes. I made all of my own papers available to everyone. I think we write and disseminate papers to educate ourselves on what we really did and put it on paper, but then, you want that to be read and used. Anything I ever published, with a couple of exceptions, I have on my website. Of course, it is too much for anyone to read and use. But, I will not make preferences or remove the ones I consider have little value for the long term. That would be passing judgment on my own work. Others can do that.

PB: You recently published a book with Mohamad Hussein of GRL, or, was that a book in your honor?

BF: That was a book published by

the ASCE GeoInstitute in my honor containing a large number of interesting papers written by friends and colleagues. Mohamad Hussein, who was the primary editor, and the other editors are long time friends of mine.


Mohamad Hussein, P.E. with Bengt Fellenius, P.E.

PB: You have been honored by the DFI (Deep Foundations Industry).
BF: Through the years, you pick up some of these awards. DFI recognized me because I was one of the small group that started the DFI which became a success due to Hal Hunt, Jack Dougherty and Bob Compton who pursued it from the start and managed to attract support and involvement from others.

Its impetus was a lecture I gave in 1972 about the Swedish-similar organization. Sweden has a commission that was started by my father and a couple of other engineers back in the 1950s. I tried to start something similar in Canada and promoted the idea in this 1972 lecture.

It didn't come about. One person cannot start something like that. The effort must be a collaboration of a team, and the DFI group had that. Hal Hunt attended the lecture and he said, "We should do something like this." That's how I got involved in the DFI committee from the beginning. But I haven't done much after the early years.

Hal Hunt was the main instigator for the start. Jack Dougherty was the one that supported it and pushed for it and also provided some of the monies needed. Bill Loftus and Bob Compton were there from the beginning. Bob took over the helm one critical moment later on. The present director, Theresa Rappaport, is a fantastic achiever. It's an interesting organization.

PB: Tell us about your family and what you presently do.
BF: I have a very nice social life with my family and my wife of 53 years, Annbrit, who has been tagging along with me on our various moves and what I have done through the years. We have a good life together and the kids are marvelous.

PB: You have a software company?
BF: I do and I don't. In my teaching, I was emphasizing how to do certain analyses. There was this excellent student, Pierre Goudreault, whom I hired when he graduated to work for my consulting company, and he said that he could write a computer program based on my methods. This was at the time the IBM PC had just been introduced.

When Pierre showed what he developed, I said if you can fix it so that even I can handle it, it can be marketed. He so did, and we started a separate company to market the software.

At first, I kept control of the software company, but a couple of years ago, I decided that I was not needed anymore, and Pierre has taken it over. I am still involved for all geotechnical issues, and we often discuss the ongoing development. The company is doing great, and it keeps me supplied with the software of the sophistication level I need for my work.

Similarly, when I started doing pile dynamics research, I simply couldn't get the grants needed to buy that expensive equipment. So I bought it myself. In order to justify that expense, I then had two former students work with me to pursue the business aspect of it. Best of two worlds, really. I got the data to assist me in my research and it also kept me involved in the practical engineering aspect of pile dynamics. I was never a business man, so my partners, the former students, looked after that end of it.

I am still in touch with a good number of my former students, which is very pleasant. Many of them contact me if they have questions. For example, two who graduated on the bachelor level, work in the geotechnical field in the U.S. Their clients are mostly developers and their projects are smaller than those I normally encounter. Through them, I get to see the tricky end of geotechnical engineering. I can address a foundation design of a 20-story building without too many problems. I am not sure I would be able to find it as easy with a two-story, single-family building. Or rather, I could, but the investigation would be too costly. I'm not used to working with that limited information.

PB: You are having a workshop with Mohamad Hussein of GRL this weekend.
BF: Yes, we share an interest in the dissemination of what we have learnt. Mohamad is an unusual individual. He's running a business and he is good at it. But he also has a drive to

disseminate the state-of-the-art to other professionals.

He chaired the ASCE Deep Foundations Committee for several years and, typically, engages directly with people who have knowledge to share, encouraging them to present what they have in papers in various publications. For example, he has edited several ASCE Special Geotechnical Publications. This has been an enormous contribution to his profession. There are no monetary rewards for this effort. He is overall respected and liked. I very much enjoy meeting with him and appreciate our many discussions.

PB: He introduced me to Clyde Baker.

BF: There you have an additional great person. Clyde Baker is not an academic. He has written very few papers, but he is justly recognized for his professional achievements. He has worked for some very big and competent companies so he has been challenged with some very important projects.

Talking about greatness, I found long ago a definition for separating the truly great individuals from the other kind, as follows. When I started out as a young engineer, I was eager to learn. For most of the issues I worked on, I would search out and read all papers I could find on the topic.

Invariably, I got stuck and had a question. So, I sent the question to the author. In those days, you wrote letters and you got letters back. I had letters of reply coming from Casagrande, Peck, Bjerrum, Tchebotarioff, and many others. (I now regret that I did not keep these letters.)

The definition is very simple: the lesser ones are those who did not find it worth their time to answer a silly question from below. The truly great persons took the time to reply with patient answers or suggested additional papers to read.

Today, when I myself am getting letters with questions — emails, actually — I feel that while I am not able to live up the full greatness of the persons past, at least I can follow their lead and reply; in a small way, return the favors I received years ago.

PB: We are coming to an end. Is there anything that you would like to express beyond what we have talked about?

BF: One of the ambitions I have had ever since the very beginning, and I feel it more strongly today than ever before, is that the main aspect of all our foundation engineering should be *settlement*. Although our codes and standards, as well as our textbooks, put the emphasis on capacity: capacity of piles, capacity of footings, etcetera, I argue and have been doing this for quite awhile, that capacity is irrelevant.

The issue is settlement and deformation. If you take a piled foundation, for instance, that has an adequate capacity, it is generally thought that the foundation is safe and will not settle excessively.

Settlement is thought to be looked after automatically if the factor of safety is OK. This is not true. I know a number of instances where the structure settled, even collapsed, despite the piles having adequate capacity.

On the other hand, if you design for settlement, capacity is always looked after. So it is logical for me to say, "Check settlement and deformation first, and leave capacity aside."

I have in the past been involved in prediction seminars. I am in the preparation stage for one right now in Bolivia this spring. It will be an international effort where the people will submit predictions of load-movement and capacity. I expect one of the conclusions of the event will be that capacity is a "fudge" concept that we should abandon.

The concept of capacity was introduced about 60 or 70 years ago, and it is about time we abandon it and go back to the thousands of years of experience of designing for deformation.

Nobody talked about capacity much before 1940. But then it became such a simple concept numerically. You could put numbers in a formula, and engineering became arithmetic. Fifty years ago, the profession did not quite know how to analyze for settlement, but now we do.

I have been pushing this now for about a bit over 25 years since I realized that it was the key issue. That's what I'm still driving right at, and I know that if I have another 10 to 20 years, I will eventually succeed.

PB: Many of us can be resistant to change.

BF: We are very curious animals and created to try new things until those of us who survive long enough will become sure of what works and from then on we will not change. That's good in a nature state.

What we learn from parents and society for the first years we tend to retain and don't want to deviate from. You find very few 30- or 40-year-olds questioning what they have learned whereas the 18- or 20-year-old questions everything.

Most people will reject new knowledge if it conflicts with their early teaching. Old societies were homogeneously composed, so this way was useful to them. Today, we function in society where we everyday work with people from different cultural backgrounds, and more and more, we realize that there are just a few basic tenets for humans to follow, and all cultures have them in common. The rest is a dressing-up of rules imposed to keep us in-line and to obey authority. This new situation is one of the benefits of the current globalization of society. The staying power of old engineering concepts comes from the same genetic background.

PB: Today you have to be able to change.

BF: Change yourself and accept differences when you don't want to change. When something new comes in, you have to think of it honestly and not reject it out-of-hand.

The past society rejected everything and everyone that came with a different background. It was helpful for survival in those days.

Today, the survival rule is adjust to change. That's why the western world is still going to manage because non-western cultures don't have the same ability to accept change. ■

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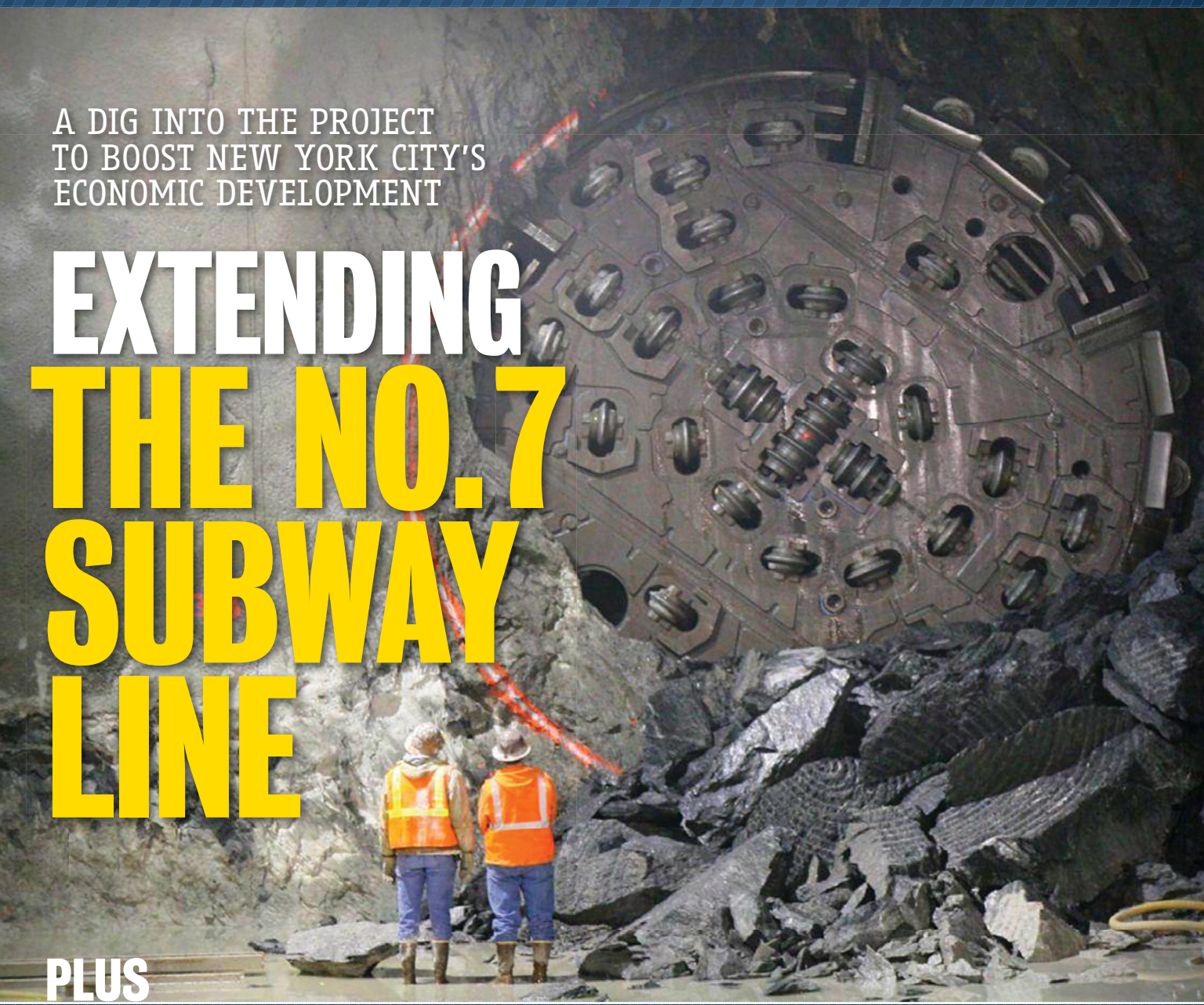

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