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Issue 6 2020



ITA Young Members: A Growing Movement

Malaysia's Next
Generation Tunnellers

Scouting Innovation in
Switzerland

Building Diversity

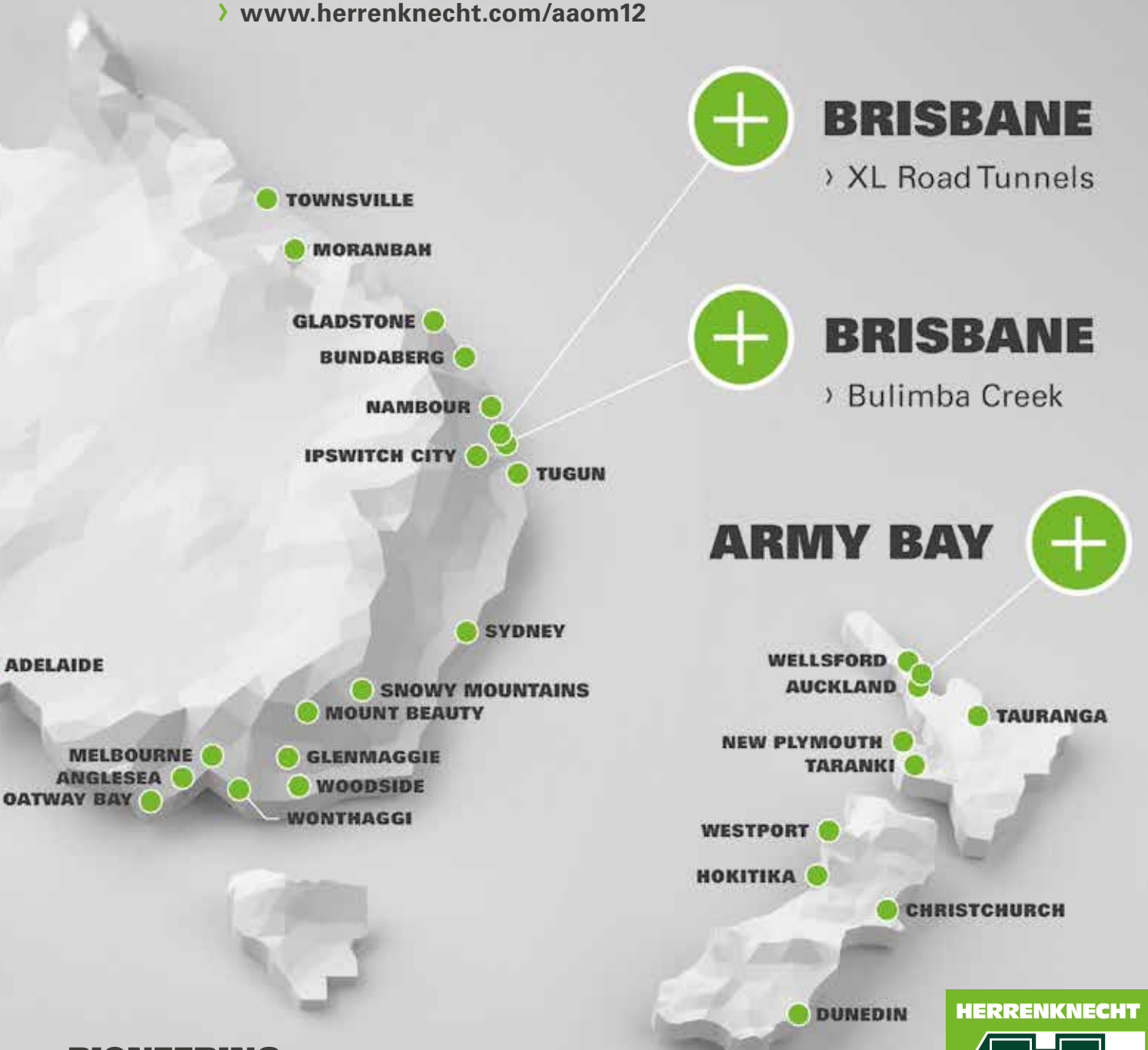




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**PIONEERING
UNDERGROUND
TOGETHER**





Welcome to 'Breakthrough'

Dear readers,

Welcome to the sixth edition of *Breakthrough*, the International Tunnelling and Underground Space Association's (ITA) initiative to promote opportunities for the next generation of tunnellers. In the following pages you will hopefully learn something new about the people and projects of the ITA family of nations, to inform, inspire or interest you.

In the 2020 edition of *Breakthrough* we are looking to showcase the diversity of the ITA Young Member (ITAYm) family. Diversity means a lot of different things to our members, but we all call ourselves tunnellers. It is an inclusive term that covers professionals from diverse daily activities, including site-based and office-based engineers, university lecturers and equipment manufacturers, as well as many other engineers and professions. To me it is this amazing diversity and inclusion that makes the world of tunnelling so engaging to work in.

I was lucky enough, in early March immediately prior to the COVID-19 lockdown, to visit a few ITAYm member nation committees to see first-hand how different nations address similar issues and look for ideas on how to further our four key goals (Collaboration, Connection, Development & Integration). The teams in Germany, the Netherlands and the UK all have an amazing passion for the development of young tunnellers in their jurisdiction, and yet there are subtle differences between these nations that are so geographically close to one another.

An initiative that has since been developed by the Steering Board is the establishment of an online forum for member nation representatives to have more regular and frequent contact via Slack. If your nation has not joined up yet, please get in touch with us via the ITAYm email address (itaym@ita-aites.org).

The initiatives from member nations during the lockdown has been impressive. The silver lining of more and more people working from home around the world has seen increasing take-up of online and digital communication between tunnellers young and old. We have seen the growth of tunnelling specific podcasts, the proliferation of online lectures and a development of online connections and communities (the recent ITAYm LinkedIn page is a great place to look!).

Although these are trying times, please make sure to stay safe and keep in touch with colleagues and friends.

As always happy tunnelling!



Keith Bannerman, ITAYm Chair

Front Cover

US contractor Kiewit's 'Future Women' initiative encourages female engineers to get together and share experiences (see p16)

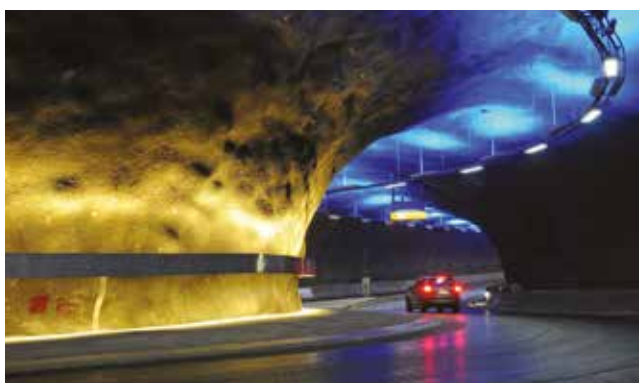


Contributing to Breakthrough

If you would like to get involved in Breakthrough magazine by contributing an article, or suggesting potential content for future editions, we would be delighted to hear from you! Please feel free to contact Breakthrough's editorial team or the ITAYM Young Members Committee (details below).

Note to YM Member Nations

All national Young Member (YM) groups are encouraged to get involved in Breakthrough magazine – we rely on your input. Please remember to document your country's YM activities and take plenty of good quality photos at any YM events throughout the year so we can make the most of your reports in the next edition!



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Meet the ITAYM Board

The governing structure of the International Tunnelling & Underground Space Association's (ITA) Young Members group (ITAYM) is a Steering Board made up of Chair, Vice-Chair, and a number of representatives selected by members of the Group. Steering Board members are elected for alternating periods to ensure continuity. The mandate is for two years.



Keith Bannerman

Keith is an enthusiastic tunneller who never misses an opportunity to get his boots dirty. Since graduating in 2008 with a Bachelor of Civil Engineering from the Queensland University of Technology (QUT) he has gained experience as a designer, cost engineer, site engineer and most recently as part of a client delivery team. Keith has been an active member of the Australian Tunnelling Society for over 10 years and is currently the ATSym Chair, as well as sitting on the ATS Executive Committee. When not wearing his high viz, you can usually find him outdoors with his wife, kids and dog enjoying the sunshine.



Jasmin Amberg

Jasmin first visited a tunnel construction site when she was 6 years old. Although she probably understood almost nothing, the virus got implemented. In 2013 she did her Masters in Civil Engineering at the ETH Zurich in Switzerland and works now as a Junior Project Manager at Amberg Engineering AG, where Jasmin is involved in several tunnelling projects at different stages. Jasmin is the founder and Chair of the Swiss Tunnelling Society Young Members group (STSsym). Outside of work, she likes cooking and spending time with her family and friends, when she's not busy acting as a basketball coach or referee.



Jekaterina Jonsson

Jekaterina was born in Estonia, a country with no mountains or tunnels. She moved to Sweden and graduated in 2012 from Luleå university of technology with a degree in Civil and rock engineering. She got into tunneling by Master study on blasting efficiency at Swedish nuclear fuel and waste management Co and worked in Stockholm bypass project in both design and construction phase 2012-2018. Jekaterina is technical consults at Geosigma, currently, assigned as project leader for construction projects in utility tunnels and rock specialist at Stockholm subway expansion project. She is a committee member of Swedish YM group. Jekaterina spends most of her time off outdoors ice skating, camping, climbing and skiing.



Chrysothemis Paraskevopoulou

Chrysothemis is a Tunnel/Mining Engineer (MEng) with post-graduate studies (MSc) in Tunnelling from NTUA (GR). In 2016, she completed her PhD, which involved working on a joint Research Project between Queen's University and ETH Zurich. She is currently an EMBA candidate. In 2017 she was appointed Assistant Professor at the University of Leeds (UK). She also works as an Independent Consultant and in the past as Tunnel Engineer. She is an active member in the Greek and British Tunnelling Society Young Members groups and the ITA's ITACUS and ITACET committees. When Chrysothemis is not working, you will find her spending time with friends and family at her Eden, a magical place in Southern Greece.



Nicolas Ziv

Nicolas ZIV is a civil engineer and urban planner, presently working on the development of Data Science algorithms to improve Tunnel Boring Machine (TBM) productivity at Tunnel Lab, the R&D department of Bouygues Travaux Publics, a French-based contractor. Nicolas undertook an industrial PhD in partnership with ESTP-Paris, developing new methods to manage the complexity of construction projects based on systems engineering, functional analysis and constructability. At Egis, Nicolas worked on the design and planning phases of several transport infrastructure projects, including the extension of Lyon Metro's line B, the Greater Paris metro and the Madinah Metro Network. Nicolas also participated in the creation of the AFTES Young Members association in France.



Sandeep Singh Nirmal

Sandeep holds a Masters in Tunnelling & Underground Space from the University of Warwick, UK, and was a recipient of the ITA's ITA-CET scholarship in 2015. He has 6.5 years' experience working in the UK and India with active engagements with various professional development organisations such as the British Tunnelling Society, Institution of Civil Engineers and Tunnelling Association of India. He co-founded the Tunnelling Association of India Young Members (TAlym) in 2018 and is currently Chair. He is a co-founder of the Symposium of Young Tunnellers of Asia (SYTA), which is scheduled to be held for the first time in 2020. In his own time Sandeep is a keen runner and amateur photographer.

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Colombia NGTs reach new depths

In their third year as a Young Members Group, ACTOS' (the Colombian Tunnelling and Underground Works Association) New Generation of Tunnellers (NGT) Young Member Group has proudly reached a number of fundamental goals set out during its establishment. The group now has over 100 members who gather every two weeks at the Colombian Society of Engineers - SCI, working to improve underground space development in Colombia, which will be a key economic activity for the country over the next 50 years. The NGT board of directors for the 2020-2022 period is composed of Paola Castillo (Chair), Camilo Ramírez (Vice-chair) and Juan Pablo Romero (Secretary). The latter two are also the Vice President and President of the Youth Commission of the Colombian Society of Engineers – SCI.

Juan Pablo Romero, a 27-year old tunneller, graduated in 2016 with a Bachelor's degree in Civil Engineering and is currently studying for a Master's degree in Geotechnical Engineering at the National University of Colombia. His interest in tunnels began when he attended a technical visit to the Sogamoso Hydroelectric Project, in Colombia, where he was impressed by the complex tunnel network needed to transport water and generate energy. This prompted Juan to study a Master's degree in geotechnics and join the Colombian Society of Engineers and especially the Geotechnical Commission of the same entity. From the Colombian Society of Engineers, he had the opportunity to interact with the tunnelling community and that is how he started work as a Tunnel Engineer on the



ACTOS-NGT members at one of their regular meetings



ACTOS-NGT at WTC 2019

3.4km-long Tesalia highway tunnel. Juan has to deal with four geological faults and the challenge of large rocks that even pose difficulties when using dynamite daily. He is in charge of supervising the tunnel works, including the civil works construction process, tunnel lining, pavements and water treatment and must always be attentive to design modifications. This tunnel represents an upgrade in the country's economic processes as it will reduce the travel time between the cities of Medellin

and Cartago by an hour and a half (at present the travel time is three hours).

Juan contributes his knowledge in tunnels to the ACTOS-NGT group in different technical discussions that are organised monthly and he also encourages members to continue their professional development. He considers professional development and continued training as the most effective method to address the variability and uncertainty of the geological-geotechnical aspects of a rock mass.

One of ACTOS-NGT's major goals is to be in the vanguard of the international tunnelling community, sharing the state-of-the-art of underground engineering in Colombia and establishing strategic partnerships with different young members groups around the world. NGT is pleased to share that it has been addressing this goal by developing articles of a high technical level, which have been chosen for

presentation at recent World Tunnel Congresses. The first, entitled "Comparison of two possible alternatives for the development of subsurface of historical buildings: a case study in Shanghai", was contributed by Diana Diaz, at the Dubai WTC, in 2018. For the Naples WTC, in 2019, the paper "Shafts and drainage tunnels sustainable design for groundwater collection as an optimal socio-environmental, economic and preventive measure to mass movements of saturated soils with seismic activity in Bucaramanga, Colombia" was presented and

Juan Pablo Romero at his day job on the Tesalia Tunnel



finally for the 2020 Malaysia WTC, the paper "Overcoming ethical and engineering challenges in the planning, design and construction of "La Línea" tunnel (8.6km) in the Central Andean Mountain Range, Colombia" was contributed by Eng. Paola Castillo.

For the period 2020-2021, the new Board of Directors has defined its action plan, titled "underground engineering and sustainability research group", which aims to generate knowledge through research and subsequent publication of a series of articles in journals and conferences at both the national and international level.

Another action item will be contributing to the socio-environmental and sustainable subject of underground engineering, with the purpose of creating awareness of the need for multidisciplinary professional teams (urban planners, architects, engineers, geologists, sociologists, environmentalists, etc.) for the development of durable, sustainable and resilient tunnel projects. Finally, NGTs intend to strengthen their cooperation with the Youth Commission of the Colombian Society of Engineers - SCI, to spread our message among young Colombian engineers.

Swiss STSym activities expand

Founded in 2017, the Swiss Tunnelling Society's young members group (STSym) expands every year and now consists now of about 90 official members. Every year the STSym organise several events. In March, 2019, the STSym visited steel manufacturer Jörimann, in Walenstadt. Jörimann supplies a lot of underground construction projects and It was interesting for the STSym members to see how the steel is produced and what the challenges are for the manufacturer. Maybe there will be some impact on future designs by the young tunnellers as a result of the visit.

In June, the annual Swiss Tunnelling Congress took place and, once again, the STSym organised a social event for young tunnellers. Luckily, the weather was good and a great evening was enjoyed on a rooftop with food and drinks.

On a second excursion in July 2019, the STSym visited the construction site for Tunnel LEB, in Lausanne, a new rail



tunnel in the middle of the city. As usual for construction sites in cities, space is really limited, which is a challenge for the whole logistics operation. All speakers and guides were young members working on the project, which is one of the goals for STSym's young member events. After visiting the interesting site, young members went for some drinks and the next day a smaller group enjoyed a hike in the near world heritage site "Lavaux".

Beside the excursions, STSym also organised an annual workshop where young members speak about their experiences in the field of tunnelling. The topics are varied, such as the handling of

a certain technical problem during design phase or the experience of a new job as young engineer (e.g. site manager), or anything else that could be interesting for other young members. In 2019, presentations were held on the design of the Gotschnatunnel (swelling pressure), the tasks of a geologist in the different project phases and experiences of a "young" site manager. In the second half of the workshop, the STSym got a small introduction into the field of MBSR - mental based stress reduction. A very interesting topic and maybe useful now or in the future...

For 2020, the STSym plan to have a joint event with the French young members, to visit the construction site at CERN, in Geneva, where we will not only try to understand what CERN is all about, but also strengthen our international young members network!



Members of the STSym group at one of its networking events

ATSym works to assist national efforts

The ATSym continue to be a key and vibrant part of the Australian Tunnelling Society (ATS). The ATSym is integrated with the view to “lift all boats” and use the enthusiasm of our young tunnellers to improve the society as a whole. Each of the Society’s individual chapters has a ym representative, as well as having a standing position as part of the national executive committee.

As well as having a key role in organising technical presentations, this year the ATSym have focussed on developing an “Australian Tunnel Design Guideline”. Historically, tunnelling activity has been sporadic in Australia, therefore tunnel design is not covered in Australian undergraduate courses and rarely offered at post-graduate level. In addition, many current local specifications do not include tunnel specific requirements that are appropriate for tunnel design. This shortfall leads to the risk that inappropriate design standards could be used in tunnel design in Australia.

The ATSym has established a working group of practicing young tunnellers to document current design best practice and where applicable and possible will reflect Australian and international standards. The document currently runs to over 100 pages and will be published very soon, keep an eye out on ats.org.au for more information.



ATSym TBMs and Trains Networking



ATSym Team: (L-R) Simon Brinkmann (NSW), Aaron Lippett (NSW), Monique Quirk (QLD), Keith Bannerman (ITAYm), Will Houghton (WA) and David Suter (VIC)

Keep in touch via the ATS facebook page (@AustralasianTunnellingSociety) or ats.ymc@gmail.com if you would like to know more about ATSym! Also visit the ITAYm facebook page (@ITAYoungMembers) to keep up with what the next generation of tunnellers are up to in all corners of the globe.

GTSyms champion collaboration during lockdown

During 2020 and COVID-19, GTSym has been increasingly active in several new initiatives and has organised a number of joint events with other national young members groups worldwide (BTSym in the UK, TACym in Canada). GTSym has also become the first young members group to host an ITACUS (ITA Committee on Underground Space) on-line workshop on “Expanding Underground Space, Passion and Knowledge to Make a Positive Impact on the World”.

The workshop was highly successful with more than 100 attendees around the world. ITACUS representatives, Co-Chairs Antonia Cornaro and Han Admiraal, and ITACUS young talent

ambassador Rosanne Verloop were accompanied by GTS Chair Ioannis Fikiris in a panel discussion that was chaired by Dr Chrysothemis Paraskevopoulou, ITACUS’ Activity Group Leader of Urban Sustainability. The panel resulted in a fruitful discussion on various topics, from sustainability to the future of tunnelling and underground space development in developing countries.



The workshop and on-line presentations are available to view on YouTube via the WTC 2023 - Athens Candidacy Channel. To get involved with YMG GTS email: ymg.gts@gmail.com

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*Tun-Mun-Chek Lap Kok Link Northern
Connection Subsea Tunnel Section
Hong Kong, China*

2019 ITA Project Of The Year Award

#AECOMTunneling

YouTubers take a leaf from BTSym

Mid-March 2020, and the months that followed, saw the world almost come to a complete halt. An exaggeration maybe, but not too far from what many within the industry may have felt, both professionally and personally.

It all started with the postponement of the British Tunnelling Society (BTS) Young Members' annual conference, which was scheduled for 13 March. Over the weeks that followed, the UK underwent a rigorous lockdown. Realisation of the scale of the COVID-19 pandemic, put both the future BTS and BTSYM live lectures in jeopardy. We therefore responded using skills gained from our lives as tunnellers.

The BTS had been operating a YouTube account since May 2019 as a part of an attempt to automate its live lecture broadcasts. So, our first response was to transfer the April lecture online and deliver it from the safety of the presenter's and our Sub-Chair's homes.

As most of our industry members are versed with



BTSym's broadcasts have drawn a large following during the lockdown

Microsoft Teams and Skype, BTSYM members championed the shifting of the BTS AGM (which saw Kate Cooksey, the founder of BTSYM, take over as the BTS Chair) online.

Through a request for a joint event from the ATS, via Keith Bannerman, we realised that

the pandemic may offer some opportunities after all.

This realisation was the key to our response. We realised that we could not only still aid the professional development of our members through webinars. But also, get them access to a more international experience;

whilst giving both local and international tunnellers in their early careers an opportunity to share their experiences – as expenses and approval to travel would not be a constraint.

We also realised that we were not the only YM committee in this boat. It was a global problem. We therefore took another leaf from the industry's collaborative nature and started reaching out and delivering joint events on our BTS' YouTube channel. Consequentially, despite the pandemic, we delivered seven BTSYM events (some jointly with TALym, TACym, CBTym and GTSYM) between April and September 2020, and have witnessed maximum viewership figures of up to 3,300 – an average of 600 per videos – and even attracted viewers outside of the tunnelling industry.

Yes, COVID-19 did hamper our plans, but has also given us a vision of what our new normal can, and will, be; it will entail more online events focused on international knowledge exchange, more YouTube content and, of course, more collaboration. *Please subscribe to the British Tunnelling Society YouTube channel for more info.*

'Down for That' initiative launched in the USA

The UCA of SME (the Underground Construction Association division of SME in the USA) has launched a new online educational resource called 'Down for That'. The new website is designed to be a one-stop resource for students, professors and industry professionals to gain knowledge and share information on the underground construction and tunnelling industry.

"The vast majority of Civil Engineering students have no exposure to any underground engineering or construction. If they ever get a glimpse, it comes from us, the UCA members. Exposing them to the exciting and long-term underground career opportunities early in their

academic careers is imperative," said Paul Schmall, PhD, PE, Vice President, Keller North America, and UCA board member. "This website provides students and educators with access to the tunnelling industry that has been lacking until now. There are viable and vibrant career paths in underground engineering and construction, and we're excited to pass it on to tomorrow's professionals."

Students can gain knowledge and university professors can support their classroom through a library of resources, videos, papers, and presentations on underground construction topics, as well as scholarship opportunities. Industry professionals contribute to the resources



through video presentations, as guest speakers, and by conducting on-site tours of tunnelling projects.

Visit the new website at undergroundcareers.org to see how UCA is raising awareness about exciting careers available in the American tunnelling and underground construction industry.

Training Day at Herrenknecht

This July, world leading Tunnel Boring Machine (TBM) manufacturer Herrenknecht opened its gates to young people from the company's home region, near Schwanau, Germany, to provide insight into around a dozen apprenticeships that are currently up for grabs at the company.

About 200 young men and women attended the event, which took place at ten work and demonstration stations across the factory complex. Fourteen experienced trainers and 50 apprentices and trainees helped the guests familiarise themselves with the industrial, technical and commercial training occupations and related opportunities at the company. In these unusual times, this chance to get a first-hand view of the possibilities available was well received.

Professional training at Herrenknecht is a high priority. There are currently 200 young people completing training or studies at the company. In July, the team around Head of Training Klaus Himmelsbach went all out to attract smart young men and women as applicants for the 2021 training year: "We spared no effort, including strict implementation of the COVID-19 rules. We were rewarded with over 100 candidates who visibly had fun at the event and showed strong interest in an apprenticeship at Herrenknecht."

Organisers planned the event in Herrenknecht's state-of-the-art training workshop with great precision. Relevant health and assembly regulations were implemented and strictly observed. Online pre-registrations for fixed appointments, distance markings, tours in small groups, disinfectants and, of

course, the requirement that visitors wear face coverings throughout. From 9:00am to 5:00pm, visitors nevertheless experienced an informative, clearly presented and varied programme.

The groups, of up to 20 people at the most, started the 2020 Training Day at Herrenknecht with a live presentation of two large Tunnel Boring Machines (TBMs). On view were machines with impressive diameters of around 10 meters each, which are destined for a major new railway tunnel project in the UK.

On the subsequent tour of the training workshop, 10 clearly and practically designed stations presented a wide range of training possibilities. A total of 12 different occupations in the industrial, technical, commercial and IT areas, as well as two options for joining the company while studying, were presented. For example, in front of the visitors, apprentices conjured up a rose from hard steel and with the appropriate welding skills. They also presented the modern interface between IT and mechanics at the CNC workstation.

Apprentices and training supervisors were on hand to answer any questions as well as queries about occupational aspects – whether about the application process, the theoretical and practical content of the apprenticeships and degree internship programmes or the chronological sequence of the training process.

This opportunity to get first-hand information was gladly and extensively used. "I liked it. I got a good insight and it was very informative. Everyone was very friendly and open to my questions," said one of the young visitors at the end of his tour.



Dutch YMs develop multiple networking opportunities

The Dutch Young Members group was established in 2017 and has since organised numerous activities. Every year in September a social event is held at the Delft University of Technology to bring together young professionals and students to create awareness of the young member group, which students can join once they have graduated. Twice a year a site visit is also organised to an underground project somewhere in The Netherlands.

In addition to these activities for young members, our members are also free to join events organised by the Department of Tunnelling and Underground Works (the Royal Dutch Tunnelling Association). At these events, young professionals mix with experienced professionals and, since the creation of the group in 2017, the presence of young members increases every year. Both young and more experienced members are excited about this trend!

In March 2019, the Dutch Young Members group's first site visit led them

to the recently completed North/South metro line in Amsterdam. Following presentations on the project, a tour from North to South started at the central railway station. The metro tunnel was constructed by immersing a pre-cast tunnel section in a trench that had been dredged underneath the nineteenth century railway station. Anecdotes and stories were shared by the contractors involved while waiting on the platform. The metro then took young members to the next station through an immersed tunnel, pneumatic caisson and a bored section of the line. The last stop was at station 'De Pijp', which was constructed with diaphragm walls, and – due to the narrow width of the existing street above – with both platforms situated on top of each other making it the deepest station on the metro line. The day ended with drinks in a pub somewhere in the south of Amsterdam.

The second site visit took place at the Amsterdam Gaasperdammer cut and cover highway tunnel, in November 2019. The tunnel has five



Visualisation of the North/South metro line works in Amsterdam

tubes providing 2 x 5 lanes + an interchangeable rush hour lane. The project will greatly transform the Southeast of the Dutch capital, allowing easier commutes, improving air quality and providing 61,000m² of extra water storage, increasing resilience. The surface area above the tunnel will become a park and will give back an enormous amount of green space to the inhabitants of the capital.

The young members enjoyed presentations and a tour through the tunnel, which showed them all the

innovative solutions that had been applied to make the tunnel as environmentally friendly as possible. The walk through the tunnel was very interactive and many questions were answered by our fantastic tour leader. The day ended with a nice dinner.

Over the next year, the Dutch Young Members group is aiming to organise two collaborative events with Germany's STUVA-YEP young members group, to exchange knowledge and grow networking at an international level.



Gathering for the Amsterdam metro tour



Dutch young members visit the Gaasperdammer highway tunnel in 2019

Tunnelling Association of Kenya is established

The Tunnelling Association of Kenya (TAK) aims to promote sustainable use of underground space in Kenya, further education and training on underground space and to improve safety in tunnel construction and operation. The formation of TAK was the result of a realization of Kenya's potential in tunnelling and underground space use and a desire to bring together and build a local knowledge base of all disciplines involved in tunnelling.

Kenya's quest towards achieving the global UN Sustainable Development Goals (SDGs) can be achieved through proper planning, design and execution of development projects and more so those that utilize underground space.

In the water sector, Kenya is currently implementing various projects that involve tunnels for water transportation, such as the Northern Collector Tunnel Project, the Itare Dam Project, the Karimenu II Dam Project, the Thwake Dam and the Mwache Dam.

The Northern Collector Tunnel (NCT) Phase 1 is a 11.7km long tunnel for bulk water transfer from three rivers in central Kenya to the Thika dam, which is the main reservoir for the capital, Nairobi. The project comprises mixed face ground conditions with six different support classes and was excavated in eight different drives. There were two tunnel adits and two 50m deep shafts that provided access for these drives. The final tunnel breakthrough between the 7th and 8th drive was successfully achieved on the 9 December, 2019.

The complexity of the NCT Phase 1 project led local professionals to champion the establishment of TAK in



Tunnelling projects in Kenya are on the rise

December 2018. Subsequently, Kenya was incorporated as a member nation of the International Tunnelling and Underground Space Association (ITA) at the 2019 World Tunnelling Congress, in Naples, Italy.

TAK held its first training event on Underground Space Use and Tunnel Project Management on the 6 and 7 December, 2018, and attracted over 75 participants. The event was facilitated by the ITACET Foundation with trainers Tarcisio Celestino (former ITA President), Olivier Vion [ITA Executive Secretary] and Han Admiraal [ITA Committee for Underground Space Use].

A second event 'Introduction to Tunnelling – From Design to Construction' was held on 5 and 6 December, 2019, also facilitated by the ITACET Foundation with trainers Lars Babendererde, Gérard Seingre and Maud Macary. This attracted over 90 enthusiastic participants.

As there are a number of tunnels underway in Kenya, as well as many planned tunnels for road and rail transport, TAK intends to hold many more training and networking events

for its members comprising of professionals from various disciplines involved in the planning design and construction of tunnels.

TAK further intends to engage in a rigorous outreach

programme to various other engineering institutions with the view of sharing knowledge and shaping future engineers in the industry. For more information on TAK visit: <http://www.tak.or.ke/>

Brazil launches 'CBTym Talks' pandemic initiative



The Comitê Brasileiro de Túneis' (the Brazilian Tunnel Committee) Young Members group has launched 'CBTym Talks', an initiative to bring the tunnelling community closer during the social restrictions imposed by the COVID-19 pandemic. The virtual meeting series expands upon CTB's existing webinars (and 'Conversa dos Tuneleiros!' online pandemic meetings) and addresses different themes related to underground space. Talks are being broadcast live on Youtube and participation is free. For more information and links to future events visit the CBT facebook page.

Diversity Matters

A new generation is changing the narrative when it comes to attracting more women into the tunnelling industry – and keeping them there.

Kristina Smith reports.

In 2016, *Breakthrough* looked at the issue of gender balance, as more tunnelling clients and companies were waking up to the value of diverse teams. One of the people interviewed was Erin Keogh, a Field Engineer at Kiewit in the US who was starting her career, having graduated just two years earlier.

Today, Keogh, is still with Kiewit's underground division, working as a Superintendent. She is also heavily involved in a company programme aimed at recruiting, retaining and developing women, something she was instrumental in setting up in 2017. "I was getting frustrated with seeing women leaving the company and leaving the industry," says Keogh. Rather than let that frustration demotivate her, she decided to do something about it.

As the International Tunnelling and Underground Space Association (ITA-AITES) celebrates its first female president, Jenny Yan, it is a good time to revisit the issue of gender, to look at some positive trends – as well as some of the remaining challenges.

"The industry has accepted a woman as the ITA president. I think that's quite positive," says Yan. "I am happy that my work and my contribution to the industry has been recognised. When they see women being successful, more women will join our industry."

Visibility

Diversity is big news. Ever since management consultant McKinsey published its 'Diversity Matters' report in 2015, which showed that companies in the top quartile for gender parity performed on average 15% better than their peers, companies have been keen to demonstrate how diverse their teams are.

In tunnelling, and construction generally, one result of this desire to appear diverse is that there are many more images of women at work on sites being published: online via LinkedIn

or Instagram, in company marketing materials, even on billboards. And though employing and photographing a few 'token' women is not the answer to making better-performing teams, these photos do help get the message out that this is a career for women, as well as for men.

“The industry has accepted a woman as the ITA president. I think that's quite positive. I am happy that my work and my contribution to the industry has been recognised. When they see women being successful, more women will join our industry. Jenny Yan

London's 'Tideway' super sewer project is a prolific publisher of photos showing women in high-vis gear, following on from its CEO Andy Mitchell's commitment in 2014 to achieve gender parity in the owner and delivery partner teams by 2023. Tideway's strategies to attract more women have included changing the message about what the project is (an environment saver, not a massive civil engineering feat), creating a returners programme and introducing PPE that accommodates pregnancies.

Aside from attracting graduates into the industry, visibility of women in more senior roles sends out an important

message for women at the beginning of their careers. The wider Kiewit group holds two 'Future Women in Kiewit' conferences a year, the first of which took place in December 2018. New recruits and would-be recruits are invited along to hear from experienced female engineers about their working lives and what their roles involve.

Role models

Jekaterina Jonsson, a designer at Geosigma in Sweden and a member of the ITA Young Members' Steering Board, believes that finding a good role model – whether female or male – is vital for young women starting out in tunnelling.

"On the first project I worked on after graduation, I had two strong female role models," she says. "I think that gave me the strength and the confidence to develop and succeed. Women aren't generally as competitive as men and it can be easier to talk to another woman. Later on, I had role models who were men too."

Keogh has also had some great role models, she says, although hers have all been men, since there were no women around. Her mentors include Mike Romero, a General Superintendent at Kiewit, who encouraged her to pursue her mission to keep more women in the industry: "He pushed me to start the programme," she says. "He was a great advocate." Keogh now looks to mentor younger women in her company and is working with the US 'Women in Tunnelling' (WIT) organisation to set up a mentorship programme there.

Jenny Yan, who herself has 35 years' experience in the tunnelling industry, thinks that senior role models are important. She holds up the example of Chinese Tunnel Boring Machine (TBM) manufacturer CREG where both the former CEO and the Chief Engineer are women. "That's very impressive in this industry," says Yan. "But a successful company is not about individuals, it's

Professor Jenny Yan,
President of the International
Tunnelling and Underground
Space Association (ITA)

Chrissi McCarthy,
Managing Director
Constructing Equality



Erin Keogh,
Tunnel
Superintendent,
Kiewit

Dr Patricia Galloway,
CEO, Pegasus-Global
Holdings

Jekaterina Jonsson,
Designer and Project
Manager, Geosigma



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about diverse teams. For any CEO to be successful they have to be good at creating teams.”

Women in Tunneling (WIT) has recently begun to publicise senior women in the industry with its #WomenWhoTunnel series. Among those featured is McMillen Jacobs Principal Sarah Wilson and Erika Moonin, Engineering Project Manager for a huge intake project at Lake Mead for the Southern Nevada Water Authority.

Organisations in the UK are working hard to provide female role models in engineering too, says Ailie MacAdam, Operations Manager, Infrastructure, with Bechtel. “Businesses and organisations, including the Institution of Engineering and Technology, the Royal Academy of Engineering and EngineeringUK, have been working hard to share female role models and normalise engineering as a great career choice for women,” she says.

Support

Whereas previous generations of female tunnellers and engineers might have been more inclined to try and blend in and get on with it, younger women are being encouraged to discuss their differences and the challenges they face.

“You don’t have to act like a man,” advises Elisa Comis, an Associate at McMillen Jacobs and Co-Chair of Women in Tunneling. “Don’t lose your grace, use it as a strength.”

Comis has plenty of personal experience to draw on, working previously as a TBM Engineer and often finding herself the only female on site. She has had to fight for respect, sometimes for equal pay, and even to have a toilet on one project. “There is a learning curve and you have to live with it,” she explains. “As soon as you start to talk, and people understand that you are knowledgeable, attitudes change. The older and more experienced you get, the shorter the reaction time.”

One of the devices that Jacobs McMillen has introduced, as it works to improve its proportion of female engineers (which is already higher than industry norms) is a resource group called the WISE Network (Women in Science and Engineering) that links women around the world who work for the company. The group has a monthly conference call, open to any woman in the company. “We don’t open it up to men, because we are very honest in it,” says Comis. “We might be talking about pumping breast milk or how we are feeling overwhelmed, juggling the kids’

homework and activities with running a big project.”

With most societies still seeing women as the default carer in a family such issues can make or break a career in construction. Yan points out that she has only been able to manage her long and illustrious tunnelling career, which has taken her all over China and the world, because she has had support from her parents-in-law and from her husband. “Women sometimes need to balance their career and their family. That’s more challenging,” she says.

“**As soon as you start to talk, and people understand that you are knowledgeable, attitudes change. The older and more experienced you get, the shorter the reaction time.**

Elisa Comis

”

MacAdam urges young women to grab opportunities and be more bullish about their achievements. “I advise my mentees to map out their ideal career path but be flexible and open to opportunities as they arise. Some of the best career decisions I have made deviated from plan,” she says. “I’ve found that while women are forthcoming in taking ownership of their mistakes and praising others, they can be reticent to own their successes. It’s important to see our role models taking pride in their personal achievements.”

Social norms

Though the tunnelling industry is, by nature, global, with people often moving from continent

to continent to work on major projects, attitudes towards gender do vary between countries.

In the US and UK, where percentages of women in construction are generally quoted at somewhere between 10 and 15%, the woman-as-main-parent attitude prevails. There’s also an ingrained perception that construction and engineering professions are best suited to men.

In China, there are more women in tunnelling now than there were, says Yan, but they are mostly confined to design offices – which can limit their careers. It is important for young engineers to get site experience, insists Yan: “No matter what your job is, whether its design or research or environmental, it’s very important to get out to the job site and learn from the job site.”

Scandinavian countries tend to be far more progressive when it comes to parental leave. Norway, Sweden and Finland offer fathers as well as mothers the chance to take several months off work after their child is born. Gender isn’t



Elisa Comis
Associate,
McMillen Jacobs

an issue in Sweden, says Jonsson: "It's quite different in Sweden compared to many countries. I feel that the industry is very inclusive of women and female engineers, people don't notice any difference between men and women."

Jonsson also notes that gender was similarly unimportant during her parents' careers in the Soviet Union. Both worked as engineers. "It did not matter if you were a woman or a man or what part of Russia you came from. As long as you put in effort, you got rewarded."

However, enlightened attitudes towards equality do not necessarily equate to more women in tunnelling or engineering, according to research by Gijbert Stoet of Leeds Beckett University in the UK and David Geary of the University of Missouri in the US. They found the opposite was true. For instance, Finland, Norway and Sweden are rated highly with respect to gender equality but also have the largest gender gaps for STEM (science, technology, engineering and maths) subjects at degree level.

Stoet and Geary also report that generally there are no differences in science ability between girls and boys in secondary education. However, more boys identify sciences as their best subjects, while girls see themselves as better in other subjects.

In several countries that are low in the gender equality rankings, proportions of women in STEM careers are higher. Researchers suggest that the attraction of a well-paying STEM career overrides the perception amongst girls and young women that science is not their best subject.

In Australia – which was ranked 44 out of 153 for gender Equality by the World Economic Forum – the Daily Mail suggests that it is good pay cheques that are attracting young women onto tunnelling projects, including the Metro Tunnel and West Gate Tunnel. Last year, the Daily Mail reported that young women were moving into roles as construction site operatives, due to pay rates of over Aus\$100 (€62) per hour, four times that of the wage of a nurse or teacher.

There is also a push to attract a more diverse workforce, including women, from some of Australia's major projects. On the West Gate Tunnel project contractor CPBJH JV – CPB Contractors and John Holland – is pushing hard to employ more women, in line with the



The equal ratio of females to males is an important measure but, equality for everyone is what we should be aiming for. That's our focus at Bechtel – how to make our industry more inclusive so everyone can participate.

Ailie MacAdam



goals of its client Rail Projects Victoria. A CPBJH job advert for engineers says: "We are actively looking to attract and promote women into non-traditional roles and putting support structures in place to help them succeed."

Changing behaviours

One of the issues that Patricia Galloway, an international arbitrator and CEO of Pegasus-Global Holdings, Inc. – who became the first female President of the American Society of Civil Engineers in 2004 – has highlighted in the past is retention, or rather lack of it, where women are concerned. Far more women study engineering than end up working in it and women often leave after just a few years in the industry.

This isn't necessarily about women, it has more to do with company culture generally, says Galloway. She thinks that companies should be working

**Ailie MacAdam,
Senior Vice
President,
Bechtel
Corporation**

hard to retain all their good people. "Here in the US, we have a pretty bad shortage of engineers right now, especially in the construction industry, so most companies are trying to put retention strategies in place. Companies with core values that cover ethics, sustainability, integrity, expect all their employees to abide by those core values. Those values feed into the company culture and make it a fun environment to work in."

MacAdam agrees: "The equal ratio of females to males is an important measure but, equality for everyone is what we should be aiming for. That's our focus at Bechtel – how to make our industry more inclusive so everyone can participate. We need people from a range of backgrounds to feel included, so their ideas and insights are part of all decision making."

Chrissi McCarthy, Managing Director of specialist UK consultancy Constructing Equality, and an expert in equality,





Kiewit women on site

diversity and inclusion (EDI) has observed that companies with poor corporate cultures fail to retain women and other minorities. “You need an inclusive environment, and then diversity will be an outcome,” she says. “You can’t just recruit people from diverse backgrounds and expect there to be immediate benefits. What seems to work is best is when a firm’s overriding strategy for EDI ties into and feeds the organisation’s strategy.”

One of the first – and most difficult things companies can do is to work out what the true culture and behaviours are within their organisation, says McCarthy. McMillen Jacobs’ all-women group, for instance, creates a space where people can talk openly about challenges without risking damage to their career.

McCarthy, who has had many conversations with women who have left the construction industry, observes that most women did not feel able to voice the challenges they faced at the time. “If we cannot even talk about the issues, how can we overcome them?” she asks.

Identifying – and changing – behaviours is no easy task. But it is essential if tunnelling, and construction more broadly, wants to hang on to the women and other minorities it has, as well as attract new people.

“Unfortunately, it may take decades to close the gender imbalance. That’s another reason why including the women we already have is so important,” says MacAdam. “Having their contributions in decision-making will help us remove any blockers that may be preventing people from thriving and staying in the industry.”

Thank you to our panel...



Professor Jinxiu (Jenny) Yan became the president of the International Tunnelling and Underground Space Association in May 2019. Yan, who has worked as an engineer on design, on construction projects and in research for 35 years, is deputy general manager of the China Railway Academy. She has worked on numerous tunnelling projects over her career.



Dr Patricia D. Galloway is CEO of the international management consultancy Pegasus-Global Holdings and chairs the Nominating and Governance Committee of the Granite Construction Board of Directors. An international chartered arbitrator, Galloway has worked on tunnelling mega-projects including the UK’s Crossrail, Alto Maipo in Chile, Casecnan in the Philippines and the Alaskan Way Viaduct Replacement project in Seattle, USA.



Elisa Comis is an Associate at McMillen Jacobs, with over 14 years’ experience in mechanised tunnelling. She has worked on projects all over the world as an engineer for tunnel boring machine manufacturers, first for Italian contractor SELI and then for US supplier The Robbins Company. She is co-chair of the Women in Tunneling (WIT) group.



Jekaterina Jonsson is a designer and Project Manager for consulting engineer Geosigma, based in Sweden. With over six years’ experience in rock engineering, Jonsson worked for contractor BDX before joining Geosigma. Jonsson joined the Steering Board of the International Tunnelling and Underground Space Association’s Young Members group in 2018.



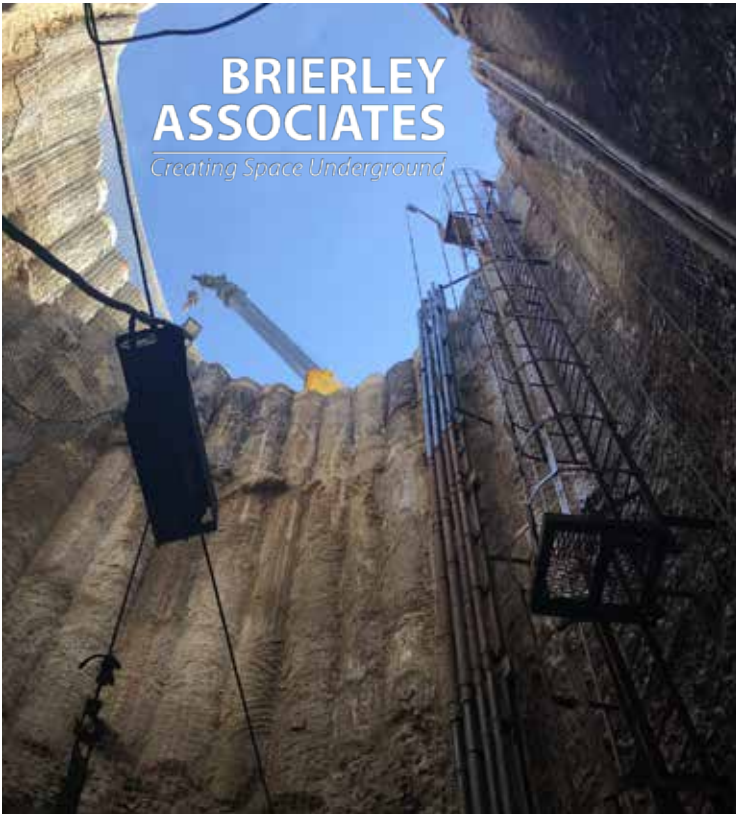
Chrissi McCarthy is Managing Director of Constructing Equality, a consultancy that advises firms on achieving more diverse workforces. McCarthy started her working career on site, working for a number of contractors before leaving to set up her own business in 2007.



Ailie MacAdam is a Senior Vice President of Bechtel Corporation and Operations Manager for Bechtel Infrastructure. During her 30 years with Bechtel, she has worked on major tunnelling projects including Crossrail and High Speed 1 in the UK and Boston’s Big Dig in the USA.



Erin Keogh is a Superintendent in Kiewit’s underground and tunnelling division. She joined the industry and Kiewit in 2014, having studied at the Colorado School of Mines and is an active member of the Women in Tunneling group in the US.



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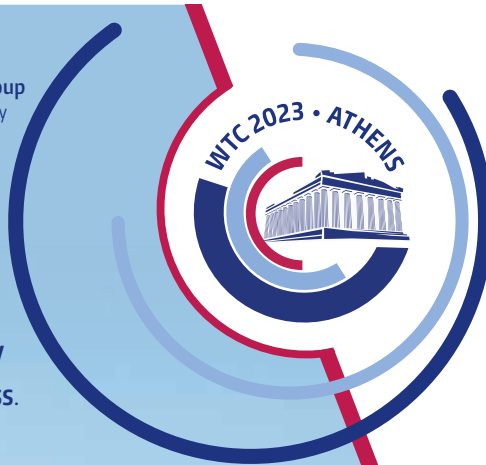


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My Tunnel Vision

Sweta Nemani is a Senior Design Engineer for Lombardi India and TAIym's Media Chair

When I was 18, my father and the father of another would-be female engineer had the following conversation:

Father 1 [after his daughter chose to study Civil Engineering at one of the best universities]: "Daughter, I am so happy you got the field of your choice, congratulations!"

Father 2 [next to him, who overheard this exchange, smiles and says]: "Sir, are you sure about this choice? Do you really think she can manage standing under the sun in a dusty place with a helmet and, more importantly, in a male-dominated environment?"

Father 1 [smiles back and says]: "Let's see."

Such questions were typical and cliché then. Rolling forward 13 years, I had my picture taken in front of a huge Tunnel Boring Machine (TBM), at the Herrenknecht factory in Germany, which was being tested prior to being shipped. I shared the picture with my father right away, to which he replied, "Happy to see this beta [son in Hindi]".

As much as it is rare to find women in engineering, it is rarer to spot them in civil engineering; especially in developing countries such as India with a different cultural set up. I went on to specialise in geotechnical engineering and after few years' stint as design engineer on various projects, did my advanced Master's in Tunnelling.

The journey has been wonderful so far, I have carved my own path, nurtured my skills in design and analysis to take part in some of the most interesting underground projects, both in India and abroad. This journey has taken me to new places, thrown me into exciting construction projects and has always been varied and interesting.

The most satisfying part of being a tunnel engineer is that what I do makes connections (the tunnel) that directly impact lives. Many fail to understand that one can be in the tunnelling business as a site

engineer, a geologist, a foreman, a tunnel designer, an architect, an electrical engineer, a ventilation specialist or an arbitrator. It takes whole village to conceive a tunnel project and build it.

Currently, I am working on a project of national importance, a prestigious rail tunnel through the lower Himalayas in the north of India. The geography is harsh, the geology is challenging, the timeline is tough, but my spirits are high. The best aspect is that it will connect thousands of people in the region, as well as other visitors from across India, who currently have only one road that is prone to landslides and blockages. People in the vicinity will have greater access to healthcare, education and business opportunities.

My current focus is on optimising the tunnel design (for conventional 'drill and blast' tunnelling) by re-examining the type



of ground support used. It is interesting to compare and evaluate support classes from various tunnel design strategies, for example Barton, RMR, ADECO, NATM, etc. It is important to understand the basis of such evaluations, the regions in which they were developed, the geologies they most refer to, the standards or codes that govern them and the limitations of each method.

Tunnelling and underground structures have huge scope to shape India's future. Metros, elevated or underground, have proven revolutionary for Indian public transport. My long-standing dream is to see all the utilities in India placed underground. For sure it will be a huge undertaking, but would result in much more efficient, safe and uninterrupted services and better utilisation of the surface space. This can be achieved by well-planned initiatives employing tunnelling and micro-tunnelling techniques. It will be a huge shift for the country and I hope to be a part of it.

I have worked with the Tunnelling Association of India's young members group (TAIym) as Media Chair for about a year now. We have found it extremely important to bring young tunnelling engineers together on one platform. Tunnelling is a young industry in our country and is thriving with the support of many expat experts. The successive experts will be today's young engineers who need to collaborate, share and nurture their knowledge and ideas. It is a dream we all must believe in.

Happy Tunnelling!

Next Generation Tunnellers

Malaysia's burgeoning tunnelling industry has shown rapid growth over the past decade. Breakthrough speaks to five young tunnellers who are making waves in the country.



Derek Eng graduated in civil engineering from Universiti Sains Malaysia. He was a past manager of one of the tunnel drives for the Sg. Buloh-Serdang-Putrajaya Line and was also involved in the development of Malaysia's Tunnelling Training Academy. He has worked on Variable Density Tunnel Boring Machines and received the Young Tunneller of the Year award (2016) from the International Tunnelling Association. He is now Head of Operations at Great Tunnel Sdn Bhd, focusing on microtunnelling projects.

Mandy Ang graduated from University College London, UK, on full scholarship. Her academic excellence won her numerous sponsors, including an ASEAN scholarship. Mandy has over 9 years of tunnelling experience and is currently working on her 3rd 'mega' tunnel project. She is currently an Assistant to Deputy Project Director overseeing Tenders, R&D and Business Development, at Gamuda Sdn Bhd. She recently worked on the 5km subsea twin tunnels of the Hong Kong-Zhuhai-Macau Bridge project and was a finalist for the ITA's Young Tunneller of the Year award (2018).

Dr Boon Chia Weng received his BEng from Nanyang Technological University and DPhil from Oxford University. He was awarded the Rocha Medal in 2016 by the International Society for Rock Mechanics and Rock Engineering (ISRM) and was a recipient of the Lee Kuan Yew Gold Medal, Professional Engineers Board Gold Medal (Singapore) and the Yang di-Pertuan Agong Scholarship (Malaysia). He is presently the Malaysian Representative for the ITA Young Members group (ITAYm), a Future Leader Member of the American Rock Mechanics Association (ARMA) and works for MMC-Gamuda on the Klang Valley Mass Rapid Transit project (KVMRT), in Kuala Lumpur.

Ir. Frankie Cheah received his BEng from Universiti Malaysia Sabah, and MSc from Nanyang Technological University, Singapore. He has over 15 years geotechnical experience across the Asia region and is a committee member of the Tunnelling & Underground Space Technical Division (TUSTD) of the Institution of Engineers Malaysia (IEM). He is an associate director of AECOM Malaysia and lead geotechnical design engineer for the Klang Valley Mass Rapid Transit project (KVMRT) Line 2 for Detailed Design Package 4 and Package 6. He is presently the Malaysian Deputy Chair for the ITA Young Member group (ITAYm).

Dr Siti Norafida binti Jusoh is a Senior Lecturer at the Department of Geotechnics & Transportation, School of Civil Engineering, at Universiti Teknologi Malaysia. She is Deputy Quality Manager of the Civil Engineering Testing Unit and group leader of Future Ready Engineering Education for 21st Century Teaching & Learning. She was previously a Co-Opt member of Tunnelling & Underground Space Technical Division, IEM from 2017-2019.

How much did your university education prepare you for a career in tunnelling?

"I studied the basics at university, but it was skill acquired from actual work experience that became my career foundation. When I started, it was a matter of sink or swim; this was something my degree hadn't really prepared me for," says Derek Eng.

Mandy Ang agrees: "Tunnelling is made up of several disciplines of engineering and the world class education I received at University College London covered these disciplines. Every quarter, we were involved in high-paced case studies that addressed real life projects including tunnelling; these prepared me for the working world. However, the tunnelling industry is very technical and many skills have to be learnt hands-on."

Dr Boon Chia Weng believes knowledge is power. "Most people will agree that on-the-job training is required in the construction industry. But what I learnt in university gave me an edge. It also ensured that I learnt and developed difficult design concepts quickly. At Oxford University, I developed the concept of an interaction diagram to better quantify the role of tunnel lining in relation to rock bolts. This was part of my thesis, which won the Rocha Medal Award from the International Society for Rock Mechanics & Rock Engineering, in 2016. Theoretical knowledge also enabled me to contribute further to tunnelling impact assessments, which was acknowledged with the Tan Sri Zainal Prize from IEM this year."

Ir. Frankie Cheah said education gave him the foundation to be the best that he could in this field. "I received an all-rounded tertiary education and was trained in the basics of civil engineering skills, such as concrete, structures, geotechnical and steel; all these were integral to my tunnelling career. Unfortunately, local universities don't have core Bachelor's or Master's degrees in tunnelling, though the Gamuda Tunnelling Training Academy has done a good job enabling young Malaysians to be equipped with hands-on skills."

Dr Siti Norafida binti Jusoh says her education began at home. "The foundation was laid by my parents and my family. From a young age, I was encouraged to think out of the box and be creative when solving problems. Growing up in the kampung, nothing was off-limits for me. My mother always encouraged me to





face challenges head-on, telling me that there was no problem I could not solve. Tunnelling is complex and one needs to have courage and the desire to try new things.”

Did you receive mentorship that helped you to better adapt to the tunnelling industry? Have you offered any kind of mentorship in return?

“Not specifically, but I received guidance from various mentors as I worked, on a project-by-project basis,” says Derek. “I was fortunate to learn from expats who were experts in their field. These included why a tunnel lining had to be a certain measurement and why a particular skill had to be applied a certain way. There were always challenges, such as a crack in the lining/grout and why the cement didn’t set. I learnt to fix problems from those who were willing to share. Knowledge should be transferred coherently and so, in return, I spend a fair bit of time with younger tunnellers. We’re always learning from each other on projects.”

From his first day at his company, Boon was fortunate to be able to work with very capable management staff. “I worked in the geotechnical department and I learnt problem solving skills from my superior, Dr Ooi Lean Hock. In the design and technical department, I developed informal mentoring relationships with my superiors, especially those in the geotechnical team. My superiors at the head office are equally supportive and will check on my career development from time to time. From the operational and contractual perspectives,

their knowledge.”

Frankie says he is fortunate to have had mentors throughout his career. “As a young engineer, everyone I worked with became my mentor. Even today, I am still learning and I will keep on learning. Mentorship is not only what we learn from the experiences of seniors, but also respecting them for it. You don’t have a future if you refuse to accept [knowledge from] the former generation.”

Siti has had many mentors. “For now, I’m not specifically mentoring anyone, but I have students who learn through the many experiments we conduct at the university. These experiments and projects are as close to real life as possible. As for myself, I was mentored by my supervisors, Prof. Aminaton and Dr Hisham Mohamad as well as my IEM colleagues, especially Ir. Dr Rini Asnida and Ir. Khoo Chee Min. They led me into this field, and I benefited from their experiences.”

Has on-the-job training and experience helped you to advance in your career?

At the start of his career, Derek worked 12-hour days and six-day weeks as a shift engineer. “During this time, I had to know the ins and outs of the job and of those on my team such as how to ensure continuity when using the TBM and how to make sure each lining was accurate. We also had quotas to fill and incentives for speedy work. I had to push the team and make sure we were prepared for the unexpected. Tunnelling is a very skills-specific job; you either have the skills or you don’t.”

Mandy believes that any success in

“As a young engineer, everyone I worked with became my mentor. Even today, I am still learning and I will keep on learning.”

Frankie Cheah

I realise that cross-exposures are important. I am fortunate that this is easily accessible when various departments work on the same project. But like Derek says, cross transferring exposure is important, and new tunnellers need to learn what they can, where they can.”

Mandy says: “My immediate superior was an invaluable guide when I entered the industry, helping me understand what I was doing, mentoring me and shortening my learning curve. Like Derek, I found expats to be very helpful as Tunnel Boring Machine (TBM) tunnelling was still new in Malaysia then. The expatriate tunnelling experts on my first project were very generous sharing

tunnelling is due to the expertise of those working on the projects. “I made the choice to work overseas because I wanted the experience. I worked on building the largest tunnels using TBMs and I took the opportunity to be trained on-the-job as a TBM operator and superintendent on 12-hour shift in the tunnel. This way, I understood better everyone’s roles and how we all worked together. We had to be on point in everything we did and through mentorships and training, I became better at making management level decisions.”

Boon is a strong advocate of on-the-job training. “I need to monitor and change design as I receive information from various

departments. On Line 1 (Klang Valley Mass Rapid Transit), on-the-job training allowed me to appreciate the importance of getting correctly, before site mobilisation, the capacities required by the machine and accessories for constructing the retaining walls for the shafts and stations launching or retrieving the TBMs. On Line 2, I spent time with the contracts team and the construction managers during the critical site investigation period, pre-empting potential changes to the retaining wall lengths and highlighting the need for pre-treatment works while site investigation was ongoing. Breaking barriers within the organisation had allowed us to complete the job on schedule despite the very challenging ground conditions. As a result, we were shortlisted as Finalists for the Technical Excellence Award for Ground Engineering (UK) in 2018.”

Frankie says: “Of course it is what I have learnt, what I practice and what I see that motivates me to move ahead in this industry. From the design point of view, I have to ensure that all relevant departments are consulted and that feedback based on their experiences is applied.”

“Exposure to and interactions with other tunnellers when attending courses and conferences help me understand more about the practical work of tunnelling,” says Siti.

What were your biggest challenges and how did you overcome them?

For Derek, the biggest challenge is absorbing the immense amount of information learnt and understanding the technical skills. “It takes time and we are expected to make informed decisions at all times; we are judged if we make the wrong call. It is hard to remember everything and different personalities can rub others the wrong way. So, there is a lot of adjustment and adaptations involved but, over time, as we mature, it all becomes manageable.”

Mandy feels that as a woman in a male-dominated industry, she has to work extra hard to be taken seriously. “My biggest challenge is gender. Being a woman means my experience is different from that of male engineers. I’ve often had to step up and take charge to make myself heard. Getting my hands dirty and be hands-on before navigating or leading the team is important. I think European tunnellers are better at adapting and working with women, while Asians still have to catch up.

Boon says young engineers should

be specific and clear when conveying information. “They should know their jobs thoroughly and be prepared with answers. Challenges are resolved through team effort and collective deliberation. The young engineer is usually the one most familiar with site conditions, design and how the ground responds. It is important to be able to express ideas clearly in order to contribute positively. I have learnt to digest information, assess the conditions and table possible solutions in group discussions.”

Frankie jokes that lack of height is his

“The young engineer is usually the one most familiar with site conditions, design and how the ground responds.”

Boon Chia Weng

challenge and that he may be taken more seriously if he was taller. “Jokes aside, I think my biggest challenge is trying to convince senior engineers. But we are all engineers and as long as we have a good understanding of what we do and are prepared, convincing others should not be too difficult after all.”

Siti feels that young tunnelling engineers find it difficult to understand what really happens during the excavation process. “Tunnels are built in complex and challenging geological formations, so meticulous analyses and evaluations of various possible failure modes are needed to ensure the process is carried out within safety margins and with economical design. Understanding the philosophy of tunnelling itself is important and crucial for modelling and design verification.”

What do you hope to accomplish in the next five years?

Derek is moving to a new field, though still in the tunnelling industry. “I have always worked on large diameter tunnelling projects, but in the past few years small diameter tunnelling has picked up. It is trickier and uses smaller TBMs, from 800 to 2,000 millimetres. I believe this is the next generation of tunnelling in Malaysia.”

Mandy wants to be a construction manager. “Having worked for contractors my entire career, there is always the perception that women are not as capable as men. So, I hope to improve my management skills and engineering knowledge so that I can take on more challenging positions to erode this sentiment. I believe in lifelong learning. Having worked on one of the most

challenging projects in Hong Kong, the experience is extremely valuable to me. The more I gain, the more I can contribute and deliver.”

Boon wants to continue to achieve more in tunnelling and underground space industry. “It is hard to imagine what I will accomplish but I am looking forward to opportunities to embark on exciting projects as well as to moving on to more challenging roles.”


Like Mandy, Frankie has big ambitions. “I’ve always wanted to be a technical guy and I want to be the technical director of my company. That’s my target.”

Siti will continue with academic work. “I want to be a problem solver and solution provider, particularly in enhancing design and analyses via promoting continuum modelling.”

Do we need more research & development on design and construction to further improve the industry?

Derek feels that project feasibility studies ensure streamlined projects with limited consequences to the environment. “Local engineers are doing wonders. There are many talented local tunnellers who are working on research in technology upgrades and machine updates. We are very strong on innovation, and we need to maintain that.”

Mandy agrees. “I am currently leading R&D in my company. The benefits are immense as with this, we can improve safety, increase collaboration across the board, develop better consistency of delivery and make quick, accurate decisions with improved efficiency and productivity. R&D is really important as it accelerates production and increases efficiency. Eventually we will be able to use machines or robots to replace human intervention in hard-to-reach places or in places with extreme low pressure... and all this is due to R&D.”

Boon believes there can never be enough R&D. “There is always room for improvement. It is also important to be able to communicate the findings well because tunnelling involves many parties, including the authorities and third-party stakeholders. Engineers should not neglect the ‘human’ side of working in a society, as most engineers are inclined to focus on getting on with the technical solution.” 

Start of the Shift

Numerous tunnel projects are located in remote regions around the world. Ahmed Shaz, a Tunnel Engineer with RITES Ltd, gave Breakthrough a first-hand account of one morning's travel to an isolated project in Manipur, north-eastern India (close to the Myanmar border), where he has recently been working

My day starts with our cook shaking my legs, telling me to get up for breakfast. Yes, it's a wake-up call at 5.30am in the morning, all my alarms having failed to bring me back from the world of dreams, giving me feelings of nostalgia for long-gone school days when my mother used to wake me up early in morning.

I am a tunnel engineer and I have been working at a site near the Barak area of Manipur, India, for the last month. Manipur is a fairly remote region of north-eastern India with a mostly tribal population and little employment. Although, thankfully, I haven't seen it with my own eyes, there are many stories of security threats in areas of the state and numerous people have been abducted for ransom over the last decade. Our tunnel site is located in that disturbed zone and therefore many precautions are taken while working in this region.

We have found a safe place to stay, in a small Assam town called Silchar, which is about 130km from the job site. However, it means that travelling to the tunnel takes at least four hours, so we have to leave by 6am to reach our site by 10am.

As soon as I'm awake, everything moves

like a bullet train. My flatmate, colleague and geologist Mr. Mukesh, who is one of the most disciplined men I have ever met in my life, has already half finished his breakfast before I even get my toothpaste on a brush. He gives me an upset look and says "How will we reach by 10am" before heading downstairs to our vehicle. His concern gets my muscles moving.

Refreshed, packed, dressed and breakfast completed in five minutes, I rush down to our vehicle, only to realize that our third colleague Mr. Pradeep, an instrumentation engineer who lives nearby, has yet to arrive.

We set off at 6.15am in a small jeep with a carrier at the back for market goods. The condition of vehicle is not great and the seats are flat and honestly uncomfortable. But this vehicle was intentionally hired to



provide the impression to the Naxalite (local insurgents) that we are simply poor labours, so we are not targeted by extremist groups. We are also dressed in a way that, if anyone stops us, they will be tempted to give us some pennies rather than try to take any.

However, the mornings are always fresh and beautiful in Silchar and we cross the narrow streets of the town in a couple of minutes at this early hour, which otherwise is a densely populated area and full of traffic.

Soon we are out into the countryside passing dew soaked lush green meadows, standing rice crops, cattle feeding on the wet grasses, dense pockets of supari and banana trees with a blurred vision of the mountain range filling our eyes at the horizon. It looks amazingly beautiful in the misty morning of the winter, the cold breeze in your face and hair, it energizes your body and enlightens your soul.

Soon we pass through a small settlement called Baskandi where the Barak river also fills the space around you and the serene view is a treat for the eyes and the soul. This is a time to relax and appreciate the beautiful creation of God.



The mountains, the jungle and the Barak river

From there, we start on the NH-37, crossing the town of Fulertal and then Jirghat, which is the border town of Assam and Manipur. Just after entering Manipur we halt at the Jirbam police station, where we have to report our visit to the security control room and get clearance to proceed onwards to the project site.

Our next halt is at the Jirbam checkpoint where all our details including contacts and vehicle number are noted and passed on to the security checkpoints every 20km along the journey. They track our vehicles and report our location to the control room from time to time. Sometimes we are escorted by army vehicles and sometimes we are even asked to turn back, if the conditions are too unfavourable.

At this point, the eastern extension of the Himalayan ranges, known as Purvanchal mountains, begin. Life is no easier from this point onwards and we prepare our bodies for a bumpy ride of hurdles and challenges. The mountains aren't very high in altitude, but their formation is highly non-uniform. The road is a single lane, irregular, and has valleys and hills on either side. The greenery thickens, which marks the start of the jungle. There is dense vegetation on both sides of the road, which often makes a hindrance to the valley view.



Makru bridge

an atheist start thoroughly praying to God before stepping on it. Although there are twin bridges, one is outdated and only small vehicles are allowed on it. The second can take heavy vehicles too, but only one vehicle at a time is allowed, making traffic jams mandatory on either side.

The trucks completely occupy one side of the road and if you wish to overtake them it creates an obstruction to oncoming vehicles, so our driver has to reverse our jeep once again and make way for the other vehicle to pass. This is how we kill an hour or more sometimes at the bridge. And, sometimes, after reaching Makru we find out the bridge is under maintenance, so we wait for hours, sitting beside truck drivers and fellow passengers, having a good time

Traffic jam at the bridge



It seems like a roller coaster ride, where the friction between you and your seat is not sufficient enough to hold you in one position, and you keep slipping and toppling and jumping. Pradeep, who joins me in occupying the back seat of our vehicle, collides with me on a regular basis during this turbulent ride.

As we proceed towards Makru bridge, lots of trucks can be observed, which is again a pity for our vehicle and our driver. Makru bridge is some 80km and 2.5 hours from our destination and is a hanging steel bridge over the Barak river with a roadway made of wooden planks. From its condition, it looks like the first bridge to be built by human kind, and would even make

talking politics and social issues.

From Makru the second phase of our journey begins, 50km remaining in a target of 1.5 hours. We move fast along the road through the jungle, thick with bamboo, banana trees, short and tall grasses and wild cultivation everywhere we look. The beautiful scattered sunlight from the mountain peaks and fresh water springs on the roadside provides a little relaxation to our tiring journey.


There are small villages along the route of small wooden huts with tin roofs. Women can be spotted carrying baskets on their backs and collecting wood from the forest, which often makes you forget your hardship in front of theirs. Sometimes villagers stop your vehicle to collect an informal toll for repairing the road, and you wonder why the

road is always broken only in front of their house.

There are places where the road widens and visibility is slightly better, making it comparatively less risky to stop and take a quick comfort break in the minimum possible time. The twists and turns continue throughout the remaining journey crossing all the military checkpoints, bridges, sharp bends, villages, mountains, valleys, springs, and broken roads to reach Barak bridge.

This is a replica of Makru Bridge with the same traffic conditions, but worse roads. Here we also need to protect our heads from banging into the roof of our vehicle and moreover, if a little bit of our window pane is open, we can end up with a facefull of mud.

It's rightly said that the value of anything becomes great if the effort in getting that thing is high, and that emotion can be truly felt when we get a glimpse of our own, very own, lovable site from the bridge. There is a look of relief on our dusty and tired faces and it makes us forget the hardships of the journey; with a spirit of enthusiasm we finally reach our site.

The start of the shift for the NFR railway tunnel project in Manipur therefore commences with enthusiasm. I am off to supervise the construction of the tunnel lining, ensuring quality standards, educating labourers about safety and to take part in various review meetings with contractors and clients. 

NFR railway tunnel project



GZ

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Passage to Sweden

Claudia Sanchez was born in Lima, Peru, but undertook an epic career migration to live and work in Sweden as a Design Manager for nuclear fuel and waste management company, SKB, on the country's Spent Fuel Repository.

Claudia was born in Lima, Peru. Throughout her school life she was excellent at math and saw higher education as the way forward into professional life. Claudia's choice of profession was driven by a will to travel and by coincidence she heard of a family relative who was an engineering geologist and did great deal of travelling for work. She decided upon a Bachelor's degree in Geology, knowing that she could undertake Masters studies after two years of professional practice.

In contrast to many others who obtain geology degrees and aim to work in mining, Claudia preferred civil tunnelling. While studying she worked extra hours at a hydroelectric power project where she met Japanese tunnelling engineers who further evolved her interest in this field of engineering. However, by the end of her degree, there were no tunnelling opportunities in Peru, so when an opportunity to work on the Changuinola Dam Project tunnelling works in Panama came about, she jumped at it. The diverse team Claudia was working with included many Europeans and in particular, Swedes, Norwegians and Latvian engineers.

Claudia learned that Scandinavia was home to a big tunnelling market and just two years later, she finished her Masters' degree in rock engineering at Sweden's Luleå university of Technology. She went on to gain experience as a geologist on some of Sweden's most challenging tunnelling projects, such as the Hallandsås Tunnel (a major TBM driven tunnel through a part of a geological horst formation) and the Förbifart tunnel in Stockholm (Europe's longest motorway tunnel). However, it was learning Swedish and taking driving lessons that felt like the greatest challenges of her life at that time.

In 2018, Claudia began working at SKB, the Swedish nuclear fuel and waste management company. At the time SKB was transitioning from thirty years of advanced research and planning to the realisation and construction of a planned Spent Fuel Repository (SFR) at the Forsmark nuclear power plant.

The SFR is Sweden's largest environmental protection project, planned to ensure the safety of humans and the environment alike for hundreds and thousands of years. All the requirements of the project are unique and innovative, developed through careful research and strictly assessed by the SSM (Swedish Radiation Safety Authority).



Challenges at SKR

What are the current challenges of your role?

My role is Design Manager for Rock Mechanics on Project SFR – the extension of the final repository for low and intermediate level radioactive waste. Right now, we are working on the tender process for the detailed design phase and start of construction. It is a unique project and there are very few similar jobs in the world. What I really like, is that I can apply all my field experience that I have gained in my previous roles in the theoretical and design phase.

It is very interesting, as there are new things I learn every day. It is my first experience as a design manager, which can be demanding at times. Fortunately, I have a team of multi-national colleagues, with diverse expertise who I can receive guidance from.

What are the major challenges of the project?

The project consists of six storage vaults for the low and intermediate level radioactive waste, two transport tunnels and two drainage pools (among other things) within the bedrock. The project is located about two hours north east of Stockholm, right beside the Forsmark nuclear power plant and existing storage facility for radioactive waste that is due to be completely filled by 2030. The challenges that we have are the strict requirements for safety and environmental impacts. Currently we are working on a solution of possible connection to existing



Entrance to the intake tunnel

transport tunnels that are classified as nuclear infrastructure and will be in full operation during the upcoming construction phase.

There are a number of various challenges ahead, but we are planning and preparing to meet any of those. By the time construction works starts, SKB will need many skilled people in rock mechanics and construction. There will be endless opportunities to join this unique project and our diverse team.

What are your thoughts on the lifespan of the project?

The project is being designed for a life cycle of 100 years and should keep the nuclear waste safe for 100,000 years. The radioactive waste will be stored in specially designed containers, placed in rock

tunnels. This unique project is very closely linked to ongoing research work and the design requirements are based on SKB investigations that have taken place over a number of decades. Our greatest challenge is to build, and in the case of this project, expand an existing nuclear plant while in full operation with requirements that are uncommon on other tunnelling projects.

What is your advice to other young engineers seeking opportunities abroad?

Learning the language is the key to communicating and understanding the culture, as well as the working environment, of any country. It's hard work, but I still feel there is a lot to strive for. I am inspired by the knowledge and achievements of my colleagues and feel grateful to be able to work and learn



Claudia (left) rock mapping



Inspection of a shaft




The dam site



The intake tunnel

from them. It is also necessary to make good contacts and network in the new country, possibly more so than in your home country. What helped me most in establishing myself in Sweden was listening to advice from experienced people around me.

Every experience is a step forward. In any position you are in, try to do your

best – people will see your efforts and will help you to move forward. I was always inspired by Nobel prize winners, telling that it is possible to achieve great things with will power alone. You don't need to be the smartest all the time, you just need to want it and work hard. One of the greatest rewards of my career is that I feel I can be inspiration to my family. 



Cludia in action

ABOUT PROJECT SPR

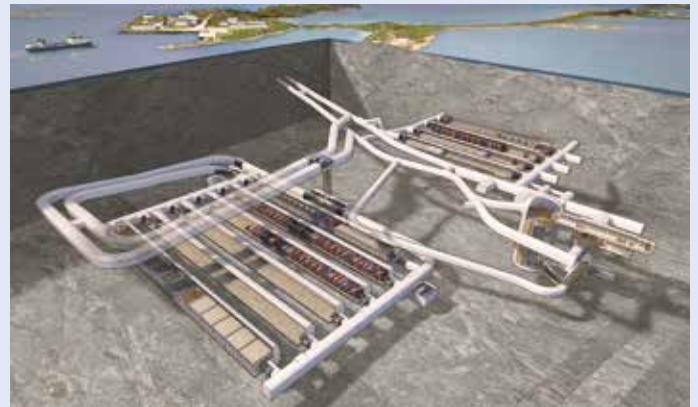
SKB, the Swedish Nuclear Fuel and Waste Management Company, is tasked with dealing with all the radioactive waste from nuclear power plants in Sweden in a safe way. Irrespective of the question of the future of nuclear power, today there is nuclear waste that has to be stored in the short and long term to protect mankind and the environment. That is SKB's task.

Since the 1970s, SKB has been developing a method to enable the handling and management of spent nuclear fuel safely for long periods of time. Much research and development has been undertaken including numerous studies and investigations. A number of technical breakthroughs have been achieved during this time.

The planned Spent Fuel Repository (SFR) at Forsmark will be located at Söderviken, close to the Forsmark nuclear power plant. Here at a depth of 500 metres, in rock that is 1.9 billion years old, 12,000 tonnes of spent nuclear fuel will be deposited in a final repository.

The storage method SKB has selected means that the spent fuel will be encapsulated in copper and nodular cast iron canisters at an encapsulation plant, before the spent nuclear fuel is transported to the Spent Fuel Repository at Forsmark for final disposal. The canisters will then be surrounded by bentonite clay about 500 meters underground in the Swedish bedrock.

The canisters are constructed to withstand corrosion and mechanical forces that can result from movements in the rock surrounding the Spent Fuel Repository. If any cracks occur in a canister, the clay buffer will prevent water from entering it. The buffer also prevents the escape of any radioactive substances into the rock. The bedrock and the great depth help to isolate the spent fuel from humans and the environment for at least 100,000 years.



Diagrams showing the arrangement of the planned Spent Fuel Repository (SFR) at the Forsmark nuclear power plant, in Sweden



A Growing Movement

What happens when Young Members move on? Kristina Smith talked to committee members past and present to find out.

The Young Members group for the International Tunnelling and Underground Space Association (ITA) was formed in 2014. It was the brainchild of Petr Salak, who was part of the very first committee and served for two years.

There was one overriding reason for forming the young members' group: to grow the industry's talent pool by attracting more young people to the industry and by retaining and developing the young people already in the industry. The ITA also hoped that, as young members gained more years and more experience, they would graduate into the other parts of the association.

"Young members are an important part of the ITA," says president Jenny Yan. "Several of our Member

Nations' representatives are younger people, and they are on Working Groups and Committees. We also have some younger engineers on the ITA Executive Council, who were elected at 35 and became vice presidents before the age of 40.

"We are a diverse Executive Committee, in terms of age, region and activities and I am very happy about that. I always encourage people to learn from each other so that we understand different cultures, different tunnelling practices and priorities."

Six years on, the original young members are no longer under 35, but many of them are still heavily involved with the ITA and their local tunnelling organisations. We tracked them down to try to gauge how the influence of the ITAYM is spreading.

JURIJ KARLOVSEK

Assistant Professor at the University of Queensland

- The inaugural chair of the ITAYM; served from 2014 to 2016
- Amateur for ITA Working Group 22 on Information Technology; involved with various digital construction groups (buildingSMART International, BrisBIM); committee member for the Queensland Chapter of the Australian Tunnelling Society committee.

"My work is very simple: I try to find my students' passion in civil engineering. I do this by providing them with a non-intimidating setting where they try to find their engineering spark. I cannot find more satisfying pleasure than to see my students, our new engineers, prosper in their career."

JURIJ KARLOVSEK



PETR SALAK

Managing Director, Israel, Dr Sauer and Partners

- Founder of the ITAYM and inaugural Vice Chair; served from 2014 to 2016
- Steering Board member of the International Tunnelling Association Committee on Underground Space (ITACUS); Activity Leader for Young Professional's Think Deep Programme (YPTDP); Co-founder and committee member of Think Deep UK.

"Being part of the ITAYM committee was a great opportunity to work with and encourage the bright, young engineers within our industry and to tell them about the amazing things that we as tunnelling engineers get involved in. There was some scepticism about the movement at the beginning, but our hard work and

PETR SALAK



determination helped us to overcome the initial obstacles and allowed us to build a strong, functional and productive organisation."

LASSE VESTER

Senior Engineer in the Tunnel Department of Ramboll

- Founding ITAYM committee member from 2014 to 2018; Vice-Chair 2016 to 2018
- Now on the board of the Danish Tunnelling Society and the Organising Committee for the World Tunnelling Congress 2021 in Copenhagen.

"The ITAYM committee gave me a much better understanding of the ITA organisation and how it works, and it helped me create an extensive network in the industry and ITA family at all levels. That network was instrumental in me changing jobs, from

LASSE VESTER



working for project owner Femern to an international engineering consultant, Ramboll, which has given me a better technical platform from which to grow my career.”

NICHOLE BOULTBEE

Project Engineer, Michels Canada

- Founding ITAYM committee member from 2014 to 2018
- Now board member for the Tunnelling Association of Canadian; still involved in Canadian young members’ group; at on ITA Working Group 14 on Mechanised Tunnelling

“One of the best things about being involved in setting up the ITA Young Members was that it was really encouraging to see how positive everybody was and how much support we got from the ITA and the different member nations. Everybody was excited about the idea.”

SINDRE LOG

Product Manager – Cutters and Tools, The Robbins Company

- Founding ITAYM committee member from 2014 to 2018; Chair from 2016 to 2018
- Chair of the international committee at the Norwegian Tunnelling Society; Chair of the programme committee and member of the organising committee for the World Tunnelling Congress in Bergen in 2017

“When I first got involved in ITA I was a young engineer with only a few years’ experience. The nature of my work was truly international at the time (still is) and it was very helpful to meet and talk to other young engineers that are part of this global tunnelling industry. “

SENTHILNATH G T (SENTHIL)

Lead Engineer, GHD Australia

- ITAYM committee member from 2015 to 2017, responsible for starting ITAYM’s social media activities
- Was active in the Singapore Tunnelling Society (TUCSS) and Singapore Geotechnical Society (GeoSS); helped to form the Tunnelling Association of India’s young members group; now active in the Australian Tunnelling Society; involved with ITACET as foundation lecturer and conference organiser

“Some of the soft skills gained during my tenure include communication and engaging with community and industry leaders. These skills helped me to contribute later to local technical



NICHOLE BOULTBEE

societies and participate as a speaker in ITACET Foundation courses. I believe my contribution to ITAYM was one of the key factors in receiving Young Tunneller of the Year 2016 recognition during the NCE Tunnelling Awards in London.”

DORIS FRANK

Project Manager, Elea iC, Tunnel and Geotechnics

- ITAYM committee member 2016-2018
- Active member of the Slovenian Society for Underground Structures (SSUS) and Chair of the SSUS Young Members

“I’ve made lots of new friends and met many professionals from all over the world. I also gained experience working in an international society.”

KEITH BANNERMAN

Senior Associate, Bamser

- Joined ITAYM committee in 2017; current Chair
- Member of national executive committee for Australian Tunnelling Society (ATS); judge for the 2019 ITA Tunnelling Awards; organising committee member for the ATS conference 2017

“There is a continued emphasis being put on the next generation of tunnellers in the ITA, as evidenced by the ever-increasing numbers in our ITA young members family. It is a pleasure for me to say that I get a chance to represent young members from all corners of the globe at the ITA General Assembly.”



SINDRE LOG



SENTHILNATH G T (SENTHIL)

JOANNE LAMBERT (NEE SUI)

Associate, London Bridge Associates

- Committee member 2016 – 2018
- Past Chair of the British Tunnelling Society Young Members (BTSYM)

“I would encourage all new professionals in the industry to get involved with their nation’s tunnelling society. It is a great way to meet new, like-minded people with similar interests and goals to you. The ITAYM was a great experience where I met many professionals who will succeed to do great things soon.

GIUSEPPE GASPARI

Associate Vice President – Tunnel Practice Leader – Canada, AECOM

- Joined ITAYM committee in 2016
- Founding member of the Italian young members group; on the organising and executive committees for World Tunnelling Congress 2019 in Naples; involved with young members’ committee in Canada; contributed to ITA Working Group 2 Research; currently on Working Group 20 Urban Problems, Underground Solutions. Tunnelling Association of Canada Ontario chapter executive member and scientific committee member for TAC2020.

“Everyone who is a young member should take the opportunity to get involved more. It takes up a lot of your free time, but it gives a lot back, providing you with the



DORIS FRANK

experience of working in an international group of people, based in different time zones and learning how to coordinate and work efficiently."

JASMIN AMBERG

Junior Project Manager, Amberg Engineering

- Joined the ITAYM committee in 2017; current Vice-Chair
- Founded and leads Swiss Tunnelling Society's young members group and works closely with the steering committee of the STS

"It's great to be part of this motivated group, all with the same interest in bringing the new generation of tunnellers forward and strengthening their position in the industry. I really enjoy encouraging other nations to establish a national young members group and help develop them."

JEKATERINA JONSSON,

Designer and Assignment Manager, Rock Engineering, Geosigma

- Joined the ITAYM committee in 2018
- Swiss representative on Working Group 23 Design and Construction of Shafts

"I want to encourage young people to get involved. If there's something you don't like, don't just complain, get involved and try to move things forward. If you see that something needs to be changed, you need to make it happen."

NICOLAS ZIV

- Joined the ITAYM committee in 2018
- Founded young members committee in France; contributed to ITA Committee on Underground Space (ITACUS); member of ITA Committee for Education and Training (ITACET), working on the development of a tunnel boring machine operator training course

"In France, we are building far more tunnels than we were 10 years ago. It's very difficult to find enough people with the appropriate experience and expertise to build tunnels. We need to transfer the expertise from the generation that built tunnels 30 or 40 years ago to young professionals who are on site today."

CHRYSOTHEMIS PARASKEVOPOULOU

- Joined the ITAYM committee in 2018
- Member of ITA committees ITA-CET, ITACUS; member of the British Tunnelling Society and the Green Tunnelling Society; part of team bidding to host the World Tunnelling Congress 2023 in Greece

"I am a big believer in getting involved in these collective organisations that make decisions and represent the younger generation. I really enjoy it. Networking is very important in our industry, and that's something you can do through these teams and committees, if you get involved."



JASMIN AMBERG



JEKATERINA JONSSON



JOANNE LAMBERT (NEE SUI)



NICOLAS ZIV



GIUSEPPE GASPARI



CHRYSOTHEMIS PARASKEVOPOULOU



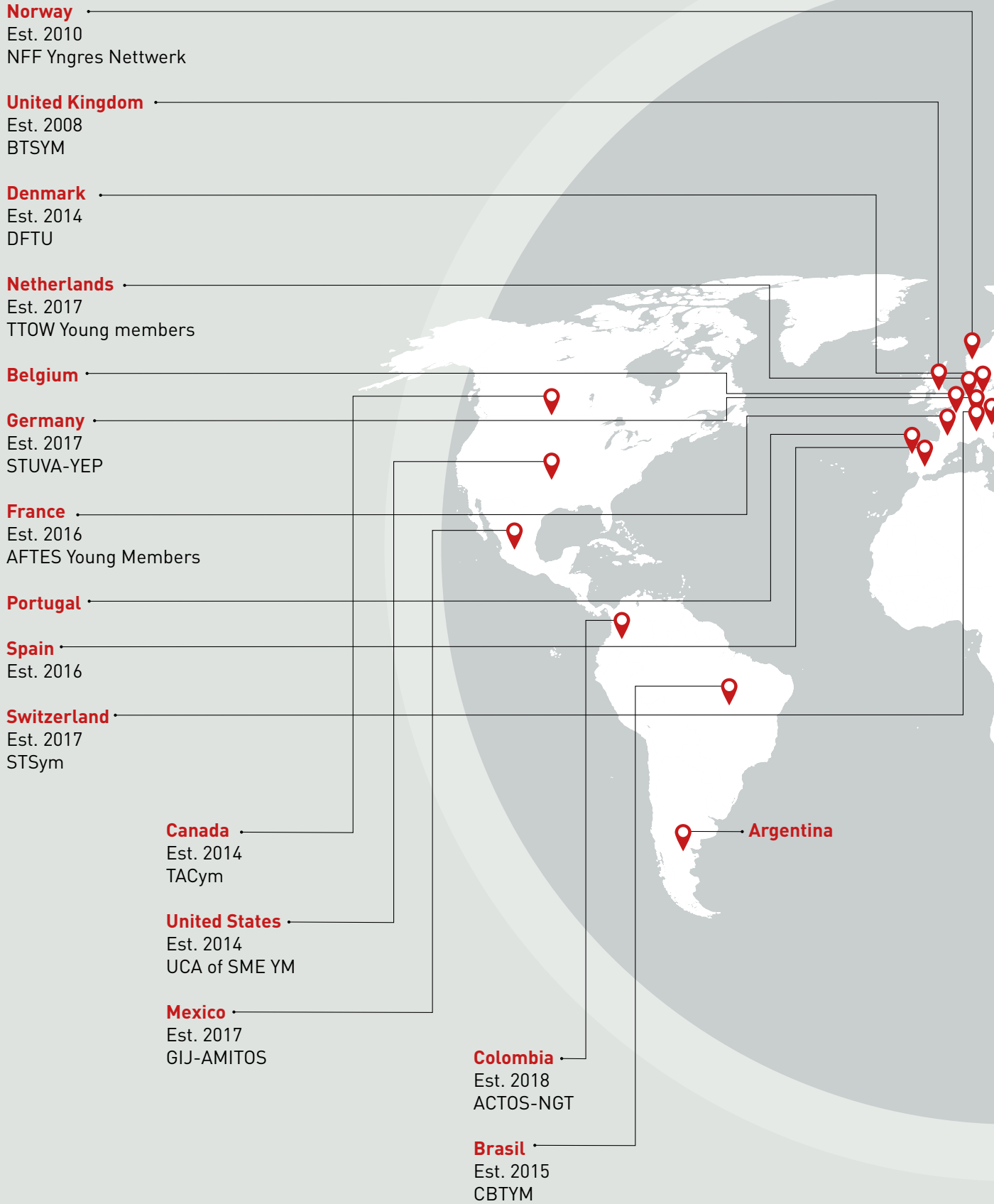
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The Young Members World Map





Down for that.

Do you consider yourself in the “underground industry”?

I do, primarily as an academic, consultant, and enthusiast! As an Engineer Officer in the US Army, I engineer solutions for our Nation’s toughest challenges. In my ten years of service, these solutions have included diverse teams in variable and uncertain environments, much like the underground industry. Upon completing a Master’s degree in Underground Construction and Tunnel Engineering at Colorado School of Mines, I found myself as one of the few US Army Officer’s trained in underground engineering, which has created unique opportunities for me.

Jes Barron is the current Chair of the UCA of SME Young Members (Underground Construction Association of the Society for Mining, Metallurgy & Exploration in the USA) and is an Instructor for the Department of Civil & Mechanical Engineering at the US Military Academy at West Point. He recently shared the story of how he entered the underground construction industry to promote the UCA of SME’s new ‘Down for That’ initiative, which aims to promote careers in tunnelling to civil engineering undergraduates in the USA.



What correlation is there between the underground industry and the military?

I think we can look at this question in two different ways. First, both the underground industry and the military deal with diverse teams working in variable and uncertain environments. The leadership, construction management, and risk management principles used in both professions have many similarities. The second way of looking at this question is from a historical perspective. The underground has always had an important role in military operations. The Greek and Roman histories include accounts of siege mining, which can be seen again in the Middle Ages. There are multiple accounts of tunnelling operations in World War I. The Battle of Britain in World War II demonstrated the protection that underground facilities can provide. Both the Korean and Vietnam Wars involved immense tunnelling operations. Recent conflicts have also involved tunnels. I believe the underground will continue to play an important role in military operations.

How does the military help students prepare for a career in underground?

The military does an excellent job of rapidly developing young professionals to serve our country honourably as members of a diverse profession in variable and uncertain environments. The knowledge, skills, and behaviours these young professionals develop transfer amazingly well into

many aspects of civilian life, especially areas such as the underground industry that are also made up of diverse teams working in variable and uncertain environments.

What do you think is interesting to students about this field?

The underground is mysterious! In sharing my excitement for the underground, I have found that most people initially think nothing of their basement, the subway they ride on, or the road tunnel they drive through. However, after a few guided questions, the complexity of the process and product has a way of exciting engineers across many disciplines.



How can professors get more informed about the underground field?

There are multiple outstanding short courses and conferences that provide great initial exposure. www.tunnellingjournal.com and www.tunnelingonline.com are great places to stay current on industry news. The International Tunnelling and Underground Space Association (ITA) has educational material on its website. And hopefully soon, the Underground Construction Association of SME’s Down for That campaign will provide valuable resources too!

How did you first get introduced to this field?

I attribute the introduction to two people, my grandfather, and my undergraduate geotech instructor. My grandfather was a geologist and had a cabin in an old silver mining town in New Mexico. He would sometimes take me on hikes to visit the abandoned mines (but not enter!). The black holes in the rock had a way of igniting my imagination, but I think I was too young to make the connection to a profession. However, in college, I had a great undergraduate geotech instructor whose enthusiasm for geotechnical engineering stuck with me. He also took us to the Moles Society student day in 2008 where we visited the World Trade Center, which was then a large slurry wall “bathtub.” I found it fascinating, but what really caught my attention was an adjacent subway project. From then on, I was sold on wanting to be a part of the underground construction industry!

For more information on the UCA of SME’s ‘Down for That’ initiative, please visit <http://undergroundcareers.org/>

**Down
for that.**

A New Website for a New Generation of Underground Engineers

Down for That encourages engineering students to pursue a career in underground construction and tunneling by providing students and professors with introductory industry information including:

- Resource Library
- Tunnel Tours
- Industry Profiles
- Presentations
- Case Studies

Together we'll grow the underground workforce.

Share the excitement and reward of a career underground.
undergroundcareers.org





Connecting Sydney

Client: M4-M5 Link Group
Project scope: 7.5km twin road tunnels
Tunnelling method: Mined tunnels using roadheaders
Estimated production time: Detailed design commenced July 2018 | Tunnel due to open in 2023
Estimated project cost: AU\$ 3.2 billion

NICK MIRSEPASSI



Nick Mirsepassi is a tunnel engineer from Aurecon, involved with the delivery of various tunnel design packages for the Jacobs Aurecon Joint Venture (JAJV) as part of

the WestConnex M4-M5 Link (Stage 3A project) in Sydney, Australia. The project includes the construction of 7.5km twin highway tunnels, accommodating up to four lanes of traffic in each direction between the New M4 motorway at Haberfield and the New M5 motorway at St Peters. The project is also being built with stub tunnels that connect to the Rozelle Interchange.

Since joining the project in January 2019, Nick has worked as part of the detailed design team and has been responsible for the design of the primary support for various sections of the tunnel alignment. It includes a few large caverns where the ramp tunnels merge with the mainline tunnels (Y-Junctions), as well as sections of the mainline tunnels, ramps and cross passages. In addition, he is responsible for carrying out impact assessments on adjacent critical infrastructure assets.

Nick also works closely with the Construction Phase Services (CPS) team which provides design input in response to queries raised by the contractor.

The WestConnex project is the largest road transport infrastructure project in Australia and part of an integrated transport plan to keep Sydney moving. It is the most significant investment in road infrastructure in Australia right now and will help ease Sydney's congestion, create jobs and re-connect local communities. The Lendlease Samsung Bouygues Joint Venture (LSBJV) and Jacobs Aurecon Joint Venture (JAJV) were appointed to provide the construction and detailed design services for the WestConnex M4-M5 Link.

The new motorway network will provide crucial support for the long-term economic and population growth of Sydney. Other stages of the WestConnex project includes modification to the existing M4 motorway to the west, duplication of the existing M5 tunnel to the south together with a new section of motorway and interchange connecting these stages.

The M4-M5 Link mainline tunnels are constructed primarily in Hawkesbury Sandstone, which is a favourable medium for tunnelling. The design and constructability considerations for a 34 meter wide tunnel span was particularly challenging due to the limited cover

and potential risk of excessive surface settlements above the caverns.

Nick played an important role in establishing effective channels of engagement with the joint venture site teams. This was a key component in the development of an optimised design in order to mitigate the settlement risk and provide a solution that utilised suitable ground support systems and flexible excavation sequencing. As part of the design team, Nick further developed his technical design skills by undertaking impact assessments on two critical water distribution tunnels. Nick also undertook the structural impact assessment considering the specific conditions of each existing asset which included the age, residual design life, structural conditions and proximity to the M4-M5 Link tunnels.

Key factors considered in the design and construction process included the depth of the tunnels, potential high in-situ stresses, possible variations to the ground behaviour, geological features (such as faults or dykes), groundwater conditions and interfaces with other infrastructure.

Construction of the caverns is undertaken using an observational approach to install



A 135 tonne roadheader excavates sandstone



Shotcrete support being installed during social distancing



Inside the temporary access tunnel at Pyrmont Bridge Road tunnel site



A roadheader at work

pre-approved support types which have been developed to suit a range of expected ground conditions and behaviours. A key aspect of this approach requires validation of the design applicability through a permit to tunnel process which involves daily review of geological conditions and tunnel behaviour together with in-tunnel convergence and surface monitoring.

Nick's involvement in the support design for the caverns included the development of a suite of primary support types which comprised permanent rockbolts and sprayed concrete to be installed close to the tunnel face together with the establishment of predicted ground movements.

While designing the Y-Junctions, Nick explored a number of different options for the construction sequence which addressed excavation of a central heading prior to the external side headings as well as excavation of the side headings in advance of the central heading in order to enable the Contractor to maximise production rates.

Where the primary support is temporary with design life of approximately five years, it was necessary for Nick to design a secondary support system comprising a combination of either sprayed concrete or


sprayed concrete and additional rockbolts, which may be installed in conjunction with a water resisting membrane.

The M4-M5 Link mainline tunnels have been designed as drained tunnels. A drainage system collects groundwater around the tunnel limiting the build-up of external seepage pressures. The water ingress limits have been defined within the Client's technical requirements. Control of seepage is typically carried out using the application of the water resisting treatment and drainage systems. In areas where groundwater ingress is likely to exceed the limits, the ground is locally treated with grouting. The grouting can be carried out in several ways:

- pre-grouting from surface;
- pre-excitation grouting ahead of the tunnel face during excavation or
- post grouting in the tunnel.

At the deepest point, the M4-M5 Link mainline tunnels are located 58 metres below ground level with the tunnel span of maximum 34 metres at the largest cavern located at Rozelle, becoming one of the largest spans in Sydney. Nick carried out additional analysis and sensitivity cases for the caverns to investigate a

range of possible ground conditions using finite element design modelling to predict ground movements induced by the tunnelling activities. Nick also specified various instrumentation and monitoring requirements (extensometers, inclinometers, convergence points and endoscopes) in areas with the tunnel span is greater than 26 metres and at the rock pillars adjacent to the cavern headwalls in order to monitor the ground deformation behaviour during construction.

Tunnelling is undertaken 24/7 with the excavated material removed from three construction sheds in St Peters, Camperdown and Haberfield. Tunnelling is now well underway in several locations across the project with 17 specialised tunnelling roadheaders currently excavating at an average of approximately 49,000 tonnes of muck per week. The tunnelling operation will continue to grow as the excavation progresses from the access tunnels into the mainline tunnels at St Peters, Annandale and Stanmore. Up to 27 roadheaders will be used at the peak of construction. 

Scouting Innovation in Switzerland

Since March 2018, young member Klaus Wachter, an Austrian tunnel engineer, has headed up the Swiss Centre of Applied Underground Technologies (SCAUT). Breakthrough met up with him in Switzerland to learn more about the innovative projects he is currently working on.



Breakthrough: Klaus, in a nutshell – what is SCAUT and what are you working on?

Klaus: SCAUT is a competence centre that looks at new innovative concepts and solutions in the use of underground space. We see ourselves as enabler or catalyst, linking partners from different industries and supporting them in the joint development of new technology or products. It's my job on the one hand to contact new partners, convince them to join our network, and discuss and develop new ideas and concepts to start projects. On the other hand, I also manage our existing projects and organise different SCAUT events.

Breakthrough: What role does digitisation play in your various projects?

Klaus: We have launched a series of projects under the banner of 'Construction 4.0' that should generate added value for our partners. For example, we have collaborated with two partners to develop a tracking system that can precisely track deliveries of steel during both the

production and the transportation phase. By merging all the information in an internal IT system, the processes can be made leaner and more efficient and what is more the client – in this case the site foreman – can call up the delivery information at any time using an app on his smartphone. And in our Rebar modelling project, we are developing a process that will allow production-relevant data to be transmitted from the Building Information Models (BIM) directly to the production-shop machines.

Breakthrough: In your work how do you actually put your ideas into practice?

Klaus: Innovative ideas and new concepts are generated through discussion and brainstorming. They can be sketched out and graphically presented but at some point, you have to say: 'OK, let's test it. Let's make it.' Because only when you implement it can you reveal issues and resolve them in all their fine detail. Besides, we humans essentially only believe what we can see, and ideally what we can

touch. To overcome this, we develop and implement 1:1 scale prototypes. Currently, there are two prototypes running at the Hagerbach Test Gallery in Switzerland, one on Underground Green Farming and one for our Underground Data Centre project.

Breakthrough: Can you tell us something more about this Underground Data Centre project?

Klaus: Automation, 5G, robotics, the Internet of Things and artificial intelligence are enabling all kinds of new applications and business models, but at the same time all this is producing huge quantities of data. 'Edge data centres' as decentralised mini- and micro-computing centres are now being used increasingly so that this data can be locally processed quickly and efficiently. In urban areas where the data is being produced, however, space availability at ground level is limited. To overcome this problem SCAUT has been working with industry partners in a pilot project whose aim is to develop the concept of 'Edge Computing – Underground!' as a space and cost-efficient, reliable and sustainable alternative for the challenges posed by our smart cities. The underground space offers protection against the forces of nature and a high level of security, while its stable climate provides conditions for high energy efficiency. In September 2019, we put into operation a modular data centre specially developed for placement below ground and we are now taking the next step towards commercialisation of the product. 



More information about SCAUT: <https://www.scaut-association.com>

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from Five

How do young engineers find their way into tunnelling? This year we asked the five finalists for the International Tunnelling and Underground Space Association's Young Tunneller of the Year award.

Kristina Smith reports...

Leading the field

Amanda Kerr, ITA-AITES Young Tunneller of the Year 2019

- Lead Project Engineer, Large Diameter Tunnelling Division, Michels Corporation
- Bachelor of Science in Civil Engineering and Master of Science in Construction Engineering, Arizona State University

Amanda Kerr has come a long way since joining Michels Corporation on an internship at the start of 2015. In less than five years, she has progressed from a heading engineer to field engineer to project engineer and is now lead project engineer. "At first sight of the TBM, it was overwhelming," she says of her first underground role as heading engineer on Seattle's Northgate Link Extension, in the US. "At the end of my time in Seattle, I could not imagine doing anything else."

On speaking to Kerr, the reasons for her swift progression becomes apparent: this is a talented engineer with a great enthusiasm for what she does who works incredibly hard at every task she tackles. She is also an enthusiastic advocate for the industry, speaking at schools and mentoring young engineers.

Kerr chose to study civil engineering at Arizona State University, her local university, which also has an excellent reputation in engineering. Her studies were funded with several scholarships: she was a National Merit Scholar – which only around 1 percent of the 1.6 million applicants for the scholarship achieve – and also won several other in-state scholarship from Arizona.

Kerr, who is now 26, developed her interest in tunnelling and underground



■ At first sight of the TBM, it was overwhelming. At the end of my time in Seattle, I could not imagine doing anything else. ■

structures thanks to Dr. Samuel Ariaratnam, who also involved her in the North American Society of Trenchless Technology (NASTT). Kerr also remembers lectures with fibre reinforced concrete specialist Dr. Barzin Mobasher and the excitement he brought to the subject.

After an internship with Granite Construction was completed, Dr. Ariaratnam's links with industry, which often saw him bringing in people from different firms to talk to his students, led to Kerr securing an internship with the Michels Corporation. During her first year of work at Michels, she was also studying an accelerated Masters course in construction engineering, with a scholarship from NASTT that went towards the cost of her studies.

After Seattle, Kerr moved onto the Blacklick Creek Sanitary Interceptor Sewer project for the City of Columbus, Ohio. Always looking for ways to improve productivity or do things differently, she says that the best part of her job is the problem solving.

"There's always something that you

have thought about, but with an aspect you hadn't considered," says Kerr.

"Having to come up with a complete solution and make sure that you can coordinate with the whole team and implement the solution, that's a really rewarding part of that role."

The most important skill she took away from her studies was the ability to research and assimilate new information. "The biggest take away from school was how to jump in to immerse yourself and try and learn as much as you can," she says.

What Kerr hadn't realised was the importance of written communication in her job as project lead. "There is so much writing and comprehension," she says. "I have always been a big reader, but I didn't think that would be something I would rely on as much as I do."

Tunnelling, she says, is a great choice for any budding civil engineer because of the huge variety of works involved. "As a tunnelling engineer you get to work on so many more types of civil engineering than I would think most general civil engineers do," she says.

On a mission to innovate

Yukata Okuda

- Project Manager, Taisei Corporation
- BSc in Civil Engineering, Tokyo Institute of Technology; Masters in Development Policy from the National Graduate Institute for Policy Studies

Yukata Okuda thinks that Japan should share its tunnelling expertise with the rest of the world, especially developing countries where there have been fewer tunnelling projects. "In Japan, we are working on a lot of complicated underground developments," he says. "We know how to carry out this sort of construction and we should be sharing our technologies around the world."

Okuda, who is 35, is already trying to do just that. With other authors, he submitted a paper to this year's [2020] World Tunnelling Congress about the construction of a connecting tunnel between the two main highway tunnels for the Yokohama Circular Northwestern Route project.

Okuda, who is a project manager for the Taisei Corporation, is leading the construction of the connecting tunnel. He came up with a novel logistics solution, creating a working platform half way up the side of the tunnel, so that the connecting tunnel construction could start while works in the main tunnel were still underway.

Growing up in Hong Kong, Okuda was inspired to consider construction by the city's bright lights and skyscrapers. At the Tokyo Institute of Technology, where he studied civil engineering, Okuda's main interest was in geology and hydraulics.

He went to work for Taisei Corporation, one of Japan's biggest construction companies, straight after graduating. He remembers someone from the Corporation coming to speak to him and his fellow students. "His lecture was comprehensive and it enthused me," he recalls. Okuda also had the opportunity to



■ In Japan, we are working on a lot of complicated underground developments. We know how to carry out this sort of construction and we should be sharing our technologies around the world. ■■

... speak to former students of his university who were working at Taisei to find out what the company was like.

Most of Okuda's time at Taisei has been spent tunnelling, with the first seven years spent in design. The company also sent him to the National Graduate Institute for Policy Studies (GRIPS) for a year to study a Masters on Development Policy. "I wanted to research how to maintain infrastructure efficiently, as well as knowing about civil engineering," he says.

Now Okuda works in construction management and worked on several large projects before the Yokohama Circular Northwestern Route, a road that aims to improve traffic flow in the North West of Yokohama.

The connecting tunnel he is currently building runs between one main tunnel being constructed by Taisei Corporation and the other tunnel, which another contractor is building. Usually, it would be impossible to start excavating a connecting tunnel without disturbing the flow of traffic and materials to and from the TBM and invert construction activities.

Okuda's solution saved several months. This is very important, since the connecting tunnel was on the critical path, and the highway must be completed before the Tokyo Olympic and Paralympic Games this year [2020].

"I enjoy technical challenges," says Okuda of his current role. "Coming across difficulties encourages me to be innovative."

Worldwide quest for knowledge

Diwakar Velu

- Deputy Project Manager, Land Transport Authority, Singapore
- BE in Civil Engineering from Anna University; Masters in Project Management from the National University of Singapore; Masters in Tunnelling and TBM from Politecnico di Torino

Whenever Diwakar Velu returns to his home town in Tamil Nadu, India, he makes a point of going to speak to students at his old university where he studied engineering.

"Many people are not aware of the possibility of a career in tunnelling, especially undergraduates," he says. "There's a great demand for tunnelling professionals in Asia. We are building tunnels everywhere."

Diwakar's construction career didn't start in tunnels. His first job was constructing huge cement silos and Chimney's (60-100m tall) using slip-form technology, working for L&T Infra Engineering - India.

After two years with L&T, Diwakar wanted to spread his wings, moving to Singapore to study a Masters' degree in Project Management. "I chose Singapore because I knew it was a place that was developing fast, where there were good project managers as well technological advancement. I knew I could learn from experienced people there."

Six months into his Masters at the National University of Singapore (NUS), Velu had an internship with the Land Transport Authority (LTA) which led to an offer of a job. He switched from full-time study to part-time so that he could accept the role. "It was tough to work and study at the same time," he admits, "but I am glad I made that decision. I was able to build my experience in project management at the same time that I was learning about it."



Having been deployed on a tunnelling project, Velu made it his business to learn everything he could about tunnel boring machines (TBMs) and how they work. He was involved in two major projects for LTA: Bendemeer Stations and Tunnels (Downtown Line) and the tunnels for Outram Station (Thomson Line). Both were special projects: one was the first in Singapore to use steel fibre reinforced concrete (SFRC) segments and the other was the first project where a TBM had to bore under an active metro line. "Being Involved in special projects makes the job interesting and also increases the scope for learning," says Velu.

While working on these projects, he came up with a prototype system called Real Time Excavation Management – which won him an innovation award – as well ways to automate some of the reporting. "I always try to think out of the box, to stay one step ahead of others. That leads to better solutions," he says.

Velu still had a thirst to learn more and so his next move was to Politecnico di Torino to study tunnelling and TBM technology with Professor Daniele Peila.

■ Many people are not aware of the possibility of a career in tunnelling, especially undergraduates. There's a great demand for tunnelling professionals in Asia. We are building tunnels everywhere. ■

The course was full time and he had to move to Italy. When notified about his plans his company offered to fund his tuition and grant him eight months leave to attend the course, so they could have him back.

One of the best things about the course in Italy was forming strong bonds with the nine other people on it, who came with a wide variety of backgrounds and experience from all over the globe. "Now that we have left the course, and spread out around the world, the knowledge gained by our friends can benefit us all," says Velu. "We can call each other to ask for advice and information."

Velu's tunnelling Masters also involved an internship. He chose to work for global TBM manufacturer, Herrenknecht, to learn about the design of TBMs, with two months spent on the Grand Paris Metro project to experience large-diameter machines.

Among the jobs he is preparing for now, back with LTA, is a project that will require a large-diameter machine, a first for Singapore. "One of the best things I brought back from Italy was my experience with TBMs," he says. "Now I can confidently question aspects of TBM design as well understand the components and functionality."

Velu's quest for knowledge and experience has certainly not faded. Having already worked for a contractor, and had insight into working as a supplier, he would like some experience in design to help hone his project management skills further. "Don't stay in the same role," he advises. "Moving around helps you to see problems from different angles."

The freedom of a specialist

James Fern

- Project manager, Amberg Engineering and Scientist at the Swiss Federal Institute of Technology of Lausanne (EPFL)
- BSc and MSc civil engineering from EPFL; PhD in Engineering from the University of Cambridge

“Two jobs are better than one!” says James Fern, an expert in computational geomechanics who works for both Amberg Engineering and EPFL.

Fern describes himself as a sort of calculator. Geologists provide him with information about the ground, engineers ask how the ground will behave around the structures they want to build, and Fern uses computing to provide answers.

“I do the same things in industry and academia,” he says. “Industry seeks efficiency whilst trying to be the best. Academia seeks excellence whilst trying to be efficient. The emphasis is slightly different.”



At 35, Fern has worked in companies and academic institutions in several countries. But when he first started his university studies, a false start put his dream career of engineering in jeopardy. He failed one of his exams – by a fraction of a mark – at the end of his first year and had to sit the exam again a year later.

“When something like that happens, you question yourself,” he says. “But I knew I wanted to be an engineer and I knew that being an EPFL engineer was to my advantage, so I knew it was worth trying a second time.”

Fern went on to become an academic

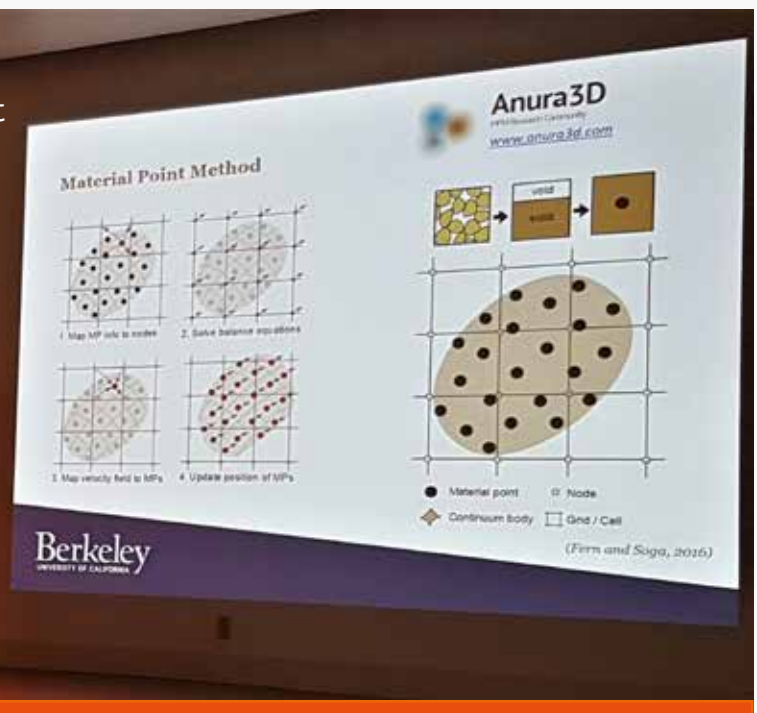
high flyer, undertaking his PhD at the UK’s prestigious Cambridge University under the supervision of Professor Kenichi Soga. In between his studies, he has also worked in industry, meaning that he can happily straddle both worlds.

“I like the freedom,” he says of his current roles. “I do very specific jobs on many different projects, so I go where the projects are. I also like the fact that, as a specialist, I am more focussed on the science and engineering than on administrative matters.”

One of Fern’s jobs in industry was the design of a deep shaft for the new High-Luminosity (HiLumi) facility at the European Centre for Nuclear Research (CERN) in Geneva. In academia, he has been busy helping to form a group of 11 organisations, the Anura3D MDM Community, to develop the Material Point Method (MPM) for geotechnical engineering.

If there was one thing Fern would add to his studies at universities, it would be software development. “I have developed a few codes, but I learnt it the hard way, the dirty way, which is not always the best way,” he says. “If I had a background in coding, it would have been a lot easier and better.”

■ I do the same things in industry and academia. Industry seeks efficiency whilst trying to be the best. Academia seeks excellence whilst trying to be efficient. The emphasis is slightly different. ■



Designing China's mega-projects

Sun Feng

- Studied Civil Engineering at Wuhan University
- Tunnel engineer at China Railway Siyuan Survey and Design Group Co., Ltd

As a junior high school student, Sun Feng remembers watching a TV programme about the construction of the Three Gorges Project on the River Yangtze, the largest dam in the world. It was the largest construction project in the world at the time and Feng remembers what an impression it made on him. "That scene gave me a great shock," he says.

Now 34, and working for China Railway Siyuan Survey and Design Group Co., Ltd, Feng has worked on some huge projects himself, such as the Wusongkou Yangtze River Tunnel in Phase II of the Shanghai-Nantong Railway Project, the Wuhan Greater Donghu Core Area Sewage Conveyance System and the Wuhan Sanyang Road Yangtze River Tunnel.

"As a tunnel engineer, I have been fortunate enough to participate in the construction of many famous tunnel projects, which made me feel very fulfilled and made me proud of my work," says Feng.

He studied civil engineering at Wuhan University, which was not too far to his hometown and had a good reputation. The university had played an important part in the famous Three Gorges Project too. "When I enrolled at the university, civil engineering was becoming a very mainstream course in China because there was more and more investment in infrastructure and lots of job opportunities," Feng says.

Feng remembers that he enjoyed learning about practical applications of civil engineering such as tunnel engineering and road engineering. But once he began work as a designed it was the basic principles such as




■ ■ As a tunnel engineer, I have been fortunate enough to participate in the construction of many famous tunnel projects, which made me feel very fulfilled and made me proud of my work. ■ ■

engineering mechanics, soil mechanics and engineering drawings that were the most useful.

When he graduated from college, Feng wanted to work for China Railway Fourth Survey Design Institute, which he explains is China's most famous designer. Rather than send an application by email, which he felt would get lost among the huge number of applications the designer receives, he decided to visit in person with his CV.

"They felt that my resume was good enough, gave me an interview opportunity and then gave me a job," says Feng.

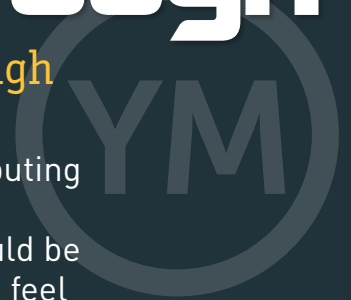
Currently Feng is working on the Qinwang Pass Project in Fuyang, Hangzhou, an underground engineering project combining a highway-railway tunnel and a large underground space complex.

Over his time in the industry, Feng has already seen tunnels get larger, deeper and go through more challenging ground. This is a trend that he thinks will continue. "Tunnels will have to cope with larger water pressures, they will be larger diameter and longer," he says. "We will need more mechanization, more information and better intelligence." 

breakthrough

Contributing to Breakthrough

If you would like to get involved in Breakthrough magazine by contributing an article, or suggesting potential content for future editions, we would be delighted to hear from you! Please feel free to contact Breakthrough's editorial team or the ITAYM Young Members Committee (see details on page 4).



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