

# breakthrough

Issue 4 2018

YM

## Exploring the ITA's Working Groups

Extreme  
Tunnelling in the  
Himalayas

Tunnelling Trends  
Roundtable

Photo Competition  
Winner Revealed

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## Conquering

Connecting Norway by rail: 5 Herrenknecht Hard Rock TBMs are on the move for **45 km of new first-class rail tubes** at the New Ulrikentunnel and Follo Line projects.

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## Welcome to 'Breakthrough'

Dear Tunnellers,

On behalf of the ITAYM Steering Board it is a great pleasure to present the fourth edition of Breakthrough magazine, the official magazine of the International Tunnelling & Underground Space Association's Young Members group (ITAYM). Breakthrough is made by, and for, people who work or have an interest in underground construction and aims to highlight the great future of the industry and the tremendous career opportunities available to young people in this field. In addition, we hope the magazine will help enthusiastic tunnellers around the world to tell their stories and explain why they are so dedicated to, and excited by, working in this industry.

Tunnels and underground solutions are great! They solve real challenges for our society, but you never see them. Tunnels and underground solutions help solve issues relating to transportation, water supply, utilities, wastewater treatment, parking and many others. However, they solve these challenges so effectively that people don't even think about them. With the world's cities growing so rapidly, the need for efficient transportation and infrastructure is ever-growing and underground solutions need to be utilized even more efficiently. This combined with new travel methods, stricter requirements on travel times, complex weather conditions and less restrictions in technology, etc. means that the challenges for future tunnellers will be greater than ever and require solutions that might not even exist today. I believe that the exchange of experiences and solutions across cities and national borders is an essential part of developing and utilizing such solutions!

This issue of the magazine marks the 5th anniversary of the ITAYM being formally approved by the ITA General Assembly at the World Tunnel Congress (WTC) in Iguazu Falls, Brazil. Since that time, the ITAYM movement has spread to tunnelling societies all over the world and we currently have more than thirty member nations that host domestic and regional events, which allow young tunnellers to gather in formal and informal settings, while sharing their activities through social media and connecting to other member nations. More importantly than the events themselves, these initiatives generate a common engagement in the tunnelling industry globally. This is mirrored in the increasing involvement by young people in the ITA's activities and a steady increase in young participants at the WTCs.

This issue of Breakthrough and the recent WTC in Dubai also marks the end of an era, with the last of the initial members of the ITAYM steering committee closing out their terms of engagement. Over the last years, I have had the great pleasure of working with Jurij, Petr, Lasse and Nichole, as well as new committee members, through Skype meetings across several time zones, only meeting face to face one or two times a year. Skype meetings at 23:00 on a Friday evening, and the sense of achievement we have had, has forged friendships and connections that will last a lifetime.

As this is my last editorial for Breakthrough, I would also like to thank the Tunnelling Journal team for their continuous support and help in generating this great magazine. It would never exist without the great efforts of Amanda, Dan, Kris, Gary and Tris. Thank you!

Even though the ITAYM has been very successful in setting up this organization and is now well-established as a group and within the ITA, the feeling of reunion at every WTC young members social event and the young engineers' thrill at feeling welcome and engaged at their first WTC is the greatest achievement of the ITAYM! These friendships and international networks is exactly what the global tunnelling industry needs to be able to accomplish the great challenges of the future!

Keep tunnelling!

Sindre Log  
Chair ITAYM (for the last time)

### Front Cover

*The winning entry of Breakthrough's 2017-2018 Photo Competition (see p22), which is sponsored by Bekaert Maccaferri Underground Solutions. The photo by Paul Challinor, a Project Manager with Joseph Gallagher, is titled "Reflection" and depicts Paul's former boss, mentor and friend Dickie Dexter at the end of a particularly challenging project.*





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## 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.



**Sindre Log**  
Chair

After gaining his Masters in Civil Engineering from the Norwegian University of Science & Technology (NTNU), Sindre started working for TBM manufacturer The Robbins Company. Having spent his first years with Robbins travelling to TBM projects around the world, he now works more from the office on geological issues and market development. Sindre has been involved in committee work for the Norwegian tunnelling society for the last decade and was heavily involved in the foundation of both the Norwegian Young Members group and the ITAYM.

Sindre is fond of many outdoor activities such as skiing, fishing and football, but now spends most of his free time running around trying to keep his own future generation of tunnellers happy.



**Giuseppe Gaspari**

Giuseppe graduated in 2005 and subsequently got his Masters in Geotechnical Engineering at Sapienza University of Rome, Italy. While working with Geodata Engineering in Turin, he also gained the ITA-AITES Masters in Tunnelling at the Politecnico di Torino.

He is founder and President of the Young Member groups of the Italian Geotechnical Association (AGI) and of the Italian Tunnelling Association (SIG) and plays an active role representing and boosting young members on the board of the Ontario chapter of the Tunnelling Association of Canada (TAC). Giuseppe is a passionate traveller and is addicted to a number of different sports.



**Lasse Vester**

Lasse graduated with a Masters in Building Technology from the Technical University of Denmark. From 2012-2016 he worked as a Design Engineer on the Fehmarnbelt Fixed Link project and since 2016 he has been employed as a Tunnel Engineer for Rambøll, in Denmark.

Lasse is the Past Chair of the Danish Tunnelling Society's Young Members Committee and is heavily involved in his national tunnelling organisation. Outside of work he is a bit of a foodie, and enjoys cooking for family and friends. He also spends as much time outdoors hiking or trekking as he can.



**Jasmin Amberg**

Jasmin gained her Bachelors and Masters in Civil Engineering at the ETH Zurich, in Switzerland. From 2013 – 2018 she worked as a Tunnelling Engineer at Gähler & Partner AG. Since 2018, she has been employed as a Junior Project Manager at Amberg Engineering AG.

Jasmin is the founder and Chair of the Swiss Tunnelling Society (STS) Young Members group. 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.



**Nichole Boulton**

Nichole Boulton completed her Bachelors and Masters degrees in the Earth Sciences department at Simon Fraser University, in BC, Canada, in 2005. She has experience in engineering investigation, design and construction for projects in Canada, Australia, and Chile.

She is registered as a professional geoscientist with the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), and is on the Board of Directors of the Tunnelling Association of Canada (TAC).

She loves her dogs, Kevin and Emma, who grew up in her office and now spend most of their time waiting for her to come home and chill out with them.



**Doris Frank**

Doris graduated in 2012 at the Faculty of Civil and Geodetic Engineering, in Ljubljana, Slovenia. After completing her Masters, she started working as a Tunnelling and Geotechnical Engineer at Elea iC. In the past six years, she has gained experience from projects in Slovenia, Austria and the UK. Doris is an active member of the Slovenian Society

for Underground Structures, and is the founder and Chair of the Slovenian Young Members group. In her free time, she likes spending time in the company of her friends and family. She also loves to travel, explore new places and other cultures.



**Joanne Sui**

Joanne gained her Bachelors in Civil Engineering at University College London. She has been working in the UK for London Bridge Associates since 2012 and is now an Assistant Project Manager on the Thames Tideway Project, in London. Joanne was Chair of the British Tunnelling Society Young Members in 2013/14.

When Joanne is not eating, she is a keen traveller and enjoys spending time keeping active (snowboarding, skiing, water skiing, scuba diving, etc!).



**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.





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Images courtesy of Morgan Sindall

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A great conference, archaeology, architecture and art are just some of the reasons to attend WTC 2019, in Italy.

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# British Young Members Celebrate 10th Anniversary

In the United Kingdom, 2018 marks an exciting year for Civil Engineering as the Institution of Civil Engineers (ICE) celebrates its 200th anniversary and the British Tunnelling Society Young Members (BTSYM) also celebrates its 10th anniversary. At the AGM, in November 2017, the year kicked off with a new BTSYM Committee:

Chair, Nick McCrossan (Mott MacDonald); Secretary, Graham Cooper (Atkins); Professional Development Chair, Sam Huckle (Balfour Beatty); Media Chair, Chara Kalogeraki (Dr. Sauer & Partners); Schools & Universities Chair, Rashik Bhandari (London Bridge Associates); and Midlands Coordinator, Harold Brunton (AECOM).

The 2018 aims of the BTSYM will include tailoring its calendar of events to provide more events outside London and include broader content to make professional development activities more accessible to apprentices and new graduates. The creation of the new Midlands Coordinator role is key to this as the High Speed 2 rail project ramps up in and around the Birmingham area.

On December 7, the BTSYM celebrated the third National Tunnelling Day and marked the occasion by launching a new initiative called “#target1000”. Its goal for this initiative was to engage with 1000 young people on National Tunnelling Day, providing a glimpse into the world of subterranean infrastructure to highlight its importance and also to encourage students to consider tunnelling as a career choice.

In February, the BTSYM joined forces with the British Geotechnical Association (BGA) and co-chaired a lecture on the Lake Mead Intake No. 3



starter tunnel to celebrate the 200th anniversary of the ICE. The BTSYM also hosted its first lecture of the New Year, focussing on the Design and Build Experience of William Thorpe (Morgan Sindall) at Southam Quarry Tunnel.

In March, the BTSYM held their 5th Annual Conference, in London. The day was chaired by BTSYM Chair Nick McCrossan, with 16 young members presenting their projects and experience on the

topic of “Driving Infrastructure Forward”, to over 90 of their industry peers. The event was a great success and would not have been possible without the support of the following sponsors: Gold – BAM Nuttall; Silver – COWI, Bekaert Maccaferri; and Bronze – Mott MacDonald, London Bridge Associates and Gall Zeidler.

Over the coming months, the BTSYM has an exciting schedule of lectures, workshops and socials arranged, including



a special 10th Anniversary Celebration, the details of which will be released soon. For more details about the BTSYM, please contact Nick McCrossan (nicholas.mccrossan@mottmac.com) or sign up to the BTSYM mailing list and receive a copy of its newsletter, The Dirt, by contacting Graham Cooper (Graham.Cooper@atkinsglobal.com).

## STUVA Forum for Young Engineering Professionals Officially Founded



In December 2017, the STUVA Forum for Young Engineering Professionals (FYEP) was officially founded. Headed up by young engineers Zdenek Zizka, Ivan Popovic, Vojtech Ernst Gall, Peter Hoffmann, Alena Conrads, Sacha Freimann and Markus Scheffer, the group held its first meeting at the 2017 STUVA Conference, in Germany. Over 80 young engineers were in attendance

at the event and the meeting was a resounding success.

In an effort to maintain this momentum, on April 13, 2018, the FYEP met for a workshop followed by a networking event at the Ruhr University in Bochum. Alena Conrads led the programme, which highlighted recent developments in “digitization in tunnelling”. The thematic centerpiece was Building Information Modelling (BIM), which was

evaluated and scrutinized by young representatives through presentations from science and practice. With just over one hundred participants, the event far exceeded expectations.

With this seminar and many more to come, the STUVA YEP hopes to provide young tunnelling engineers in Germany with the contacts and perspectives they need for a successful start in the tunnelling industry.



# ATSym active at ATS 2017 Conference



Tunnellers young and old came together on Sydney Harbour to share a few stories, a few drinks and a great view, during the ATS 2017 conference, last November. The event's tag line of "tunnelling across generations" reflects a key goal of the ATSym's, namely to engage with experts to encourage and mentor the next generation of underground professionals. The strong turnout of over 300 reflects the current strength of the industry down-under and the genuine

interest from senior tunnelling figures to encourage initiatives such as this. Thanks again to Major Sponsor MST Global, and supporting sponsors Normet and Pheonix. Without their support events such as these are not possible.

In 2004, the Australasian Tunnelling Society started the David Sugden Award, to encourage young engineers to develop the art of technical writing. The Award was presented to Russell Connors as part of the ATS 2017

celebrations. Russell is a Singapore-based Project Engineer who has worked on several technically challenging and complex tunnel projects for John Holland across Australia and Singapore (see p43). In 2013, Russell was awarded the Hulme Prize Award from the Tunnelling and Underground Construction Society of Singapore (TUCSS) for a paper titled "Breakthrough and Burial of TBMs on the Brisbane Airport Link Project". His winning paper for 2017 is titled "The Challenges of Tunnelling with

Slurry Shield Machines in Mixed Ground".

The ATSym are also proud to announce that David Suter (VIC) and Aaron Lippett (NSW) will join the team of young professionals heading up the ATSym. David and Aaron will join ATSym Chair, Keith Bannerman, and also Simon Brinkmann (NSW) and Monique Quirk (QLD).

To learn more about the ATSym get in touch via [ATS@engineersaustralia.org.au](mailto:ATS@engineersaustralia.org.au) with ATSym in the subject title. To keep abreast of international young member activities, visit the ITAym facebook page.



Russel receives the Award from ATS President Ed Taylor and EA GM Greg Ewing

# Young Members Regional Event at Cutting Edge

On November 13, more than 40 tunnelling engineers gathered for a Regional Young Members Event, organised by The Underground Construction Association of SME (UCA of SME), The International Tunnelling Association (ITA) and the Tunnelling Association of Canada (TAC), as part of the 2017 Cutting Edge Conference, in Seattle, Washington, USA.

Young tunnellers based in Vancouver, Canada, had an early start to the day as they drove down to Seattle to join UCA of SME Young Members at the Downtown Bellevue Tunnel (E330), which is a soft ground SEM/NATM tunnel currently under construction as part of Sound Transit's 14-mile long East Link light rail extension.

Hosted by Guy F. Atkinson, who was awarded the contract to construct the 11.6m diameter, 600m long, SEM tunnel in late 2015, young members were split into

two groups; with one group given a detailed presentation on the project, while a second group toured the tunnel with mentors from the project team and the Cutting Edge conference 2017 Organising Committee.

The highly successful event was rounded off with lunch in the project's offices, sponsored by Mott MacDonald and Atkinson, providing the chance for further networking and discussion of the project.



# ACTOS-NGT Gets Established

After several years of receiving e-mails and enquires from young engineers expressing their interest in becoming part of ACTOS (the Colombian Association of Tunnels and Underground Works), the ACTOS Board decided to create a Young Members group in 2017. Paola Castillo and Diana Diaz (see p34), were appointed Chair and Vice-Chair respectively, and took up the responsibility of setting up and leading the group.

Named ACTOS-NGT (New Generation of Tunnellers), the group's main objective is to reach out to young professionals and students with an interest in becoming involved in underground engineering, providing a

network to discuss professional development and experiences, both in Colombia and in other parts of the world. With the support of ACTOS, and several other important associations, government departments and entities, this group of future Colombian tunnelling talent has quickly begun to formalize agreements and work strategies.

To date, technical events have been held monthly, with topics of national relevance in the field of underground space being discussed and analyzed, creating and strengthening relationships between students, young professionals, companies and government authorities in order to build a stronger future for the industry.



Currently, ACTOS-NGT members are focused on organising events to exchange knowledge, experience and technology among young professionals, students and experts. New ideas and activities flourish during each monthly meeting, always guided by the vision of making ACTOS-NGT that new generation of engineers that Colombia needs. Engineers capable of addressing the challenges of this new century; setting criteria for design and construction in order to guarantee the sustainability of projects; developing the ability to understand and communicate the fundamental

*The ITA's ITACUS Committee Chair, Han Admiraal, joins ACTOS-NGT for a panel discussion*

concepts of underground construction in an economic, social, environmental and international context, to boost decision-making capabilities in both the evaluation of projects and in their implementation.

To find out more about ACTOS-NGT connect with the group via Facebook at [www.facebook.com/ACTOSCO/](http://www.facebook.com/ACTOSCO/), twitter: <https://twitter.com/actostuneles> or LinkedIn: [www.linkedin.com/company/actoscolombia/](http://www.linkedin.com/company/actoscolombia/)

## Sweden's BYM Growing Rapidly

Since WTC 2017 Sweden's national Young Member-group, called BYM, has developed further and now has 220 members (since the start 2016). This is encouraging when compared to its original goal of 70 members within two years. The BYM communicates through its Facebook-page "Svenska Berggruppen för Yngre Medlemmar" where everyone is welcome to post or highlight different events.

BYM has the goal of arranging one or two big events per year, in addition to a few smaller events. The purpose is to allow members to connect, exchange experiences and develop the network. Events may be lectures or study visits combined with a networking activity.



In 2017, BYM arranged a 2-day study visit to Kiruna, in October. The event was a cooperation with ITA Young Members and gathered 35 Young Members from Sweden, Norway and Switzerland. Day 1 consisted of a mini-conference including presentations from Nordic Projects, Atlas Copco and from all the National and ITA Young Member-groups.

This continued with a workshop and discussions about raising awareness of the ITA and World Tunnel Day. A social event rounded off the first day.

On the second day participants were picked up from their accommodation and taken down to the LKAB mine visitor center. Here they listened to a technical presentation, had lunch and

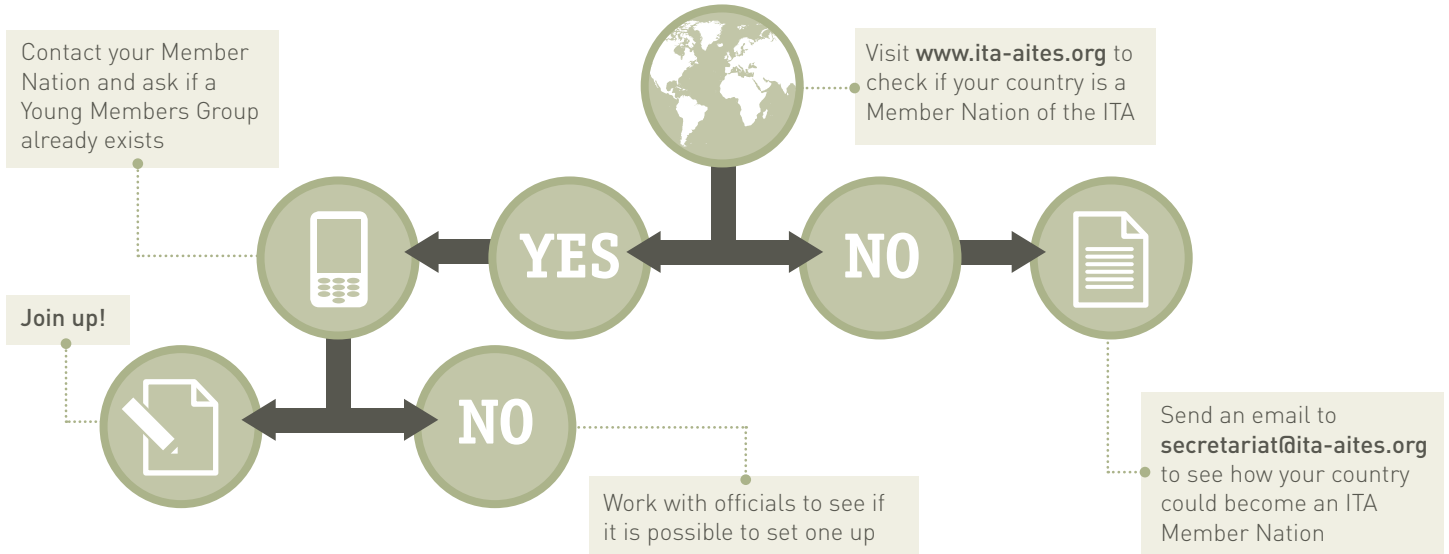
a look around, before the bus returned to the airport. Overall, two really good days.

During the Swedish Rock Engineering Association's symposium in Stockholm on March 20-21, 2018, BYM proudly launched DevelopYM – a Young Member's Mentor Programme. This will be a 1-year programme where BYM will arrange a kick-off-event, a mid-term-event and a closing-event.

The Swedish Rock Engineering Association, the national member and Swedish secretariat for the ITA, has been going through some exciting changes. As part of this change, BYM has become an official permanent working group within the association, helping the BYM to develop and increase its capacity further.



# How to set-up a Young Members group



## SETTING UP A YM GROUP

1.



Contact your national tunnelling association about the idea of establishing a Young Members group.

2.



Use your own network! Invite your friends and colleagues to help establish the group, spread the word, and get publicity.

3.



Arrange a gathering for those that are interested in contributing. Discuss what people would like to get out of the Young Members group, how to organise yourselves, etc. There are no requirements for form or content – it is up to yourselves and your Member Nation officials to decide what you want.

6.



The ITAYM Group can assist with by-laws or give examples from other countries. Cooperate with the ITAYM Group to get contacts internationally.

Contact Breakthrough magazine to spread the word about your new group and to promote your activities!

5.



Work with your Member Nation on how to organize the board and the aims and objectives of your group, prepare a simple set of by-laws and start working to organize events and bring young members together.

4.



Set up a kick-off event where you invite as many people as possible. Invite an interesting speaker or give a presentation on a high profile project to attract people. Encourage participants to get involved. Organise a social function afterwards to encourage networking within the group.

**YOU NOW HAVE YOURSELF A YOUNG MEMBERS GROUP – ENJOY!**

## World Tunnel Day 2017

Following two incredibly successful campaigns and increasing international involvement from Canada to Australia, National Tunnelling Day returned in 2017 marking both the third annual #TunnelDayUK and the second #WorldTunnelDay.



In the UK, the day was marked by the launch of the brand-new #target1000 initiative; The BTSYM's goal was to engage with one thousand young people across the UK throughout the week leading up to National Tunnelling Day. Through a series of school and university visits, BTSYM members provided a peek behind the hoarding into world of subterranean infrastructure and also highlighted the importance of underground space and an insight into tunnelling as a career choice.

These outreach events were supplemented by a site visit to the key Tideway Carnwath Road Riverside site, a launch site for one of the project's TBMs and guided walks along the proposed Tideway West, Central and East tunnel routes. In the evening, the events continued with Birmingham hosting a joint BTSYM and Midlands Geotechnical Society Lecture focussing on the geological challenges of designing the 25km Doha Lateral Interceptor Sewer. In London, the annual Christmas Jumper Social took

place at Shaws Booksellers in Blackfriars to toast St. Barbara and to celebrate the BTSYM proudly hitting their target by engaging over 1,040 students.

On social media, the #TunnelDayUK campaign was as strong as ever with tunnellers and companies from across the country sharing their stories and projects with the BTSYM and the wider world. Over 1.5 million people across the globe were reached, giving the world an insight into leading projects such as Thames Tideway, Crossrail and the Northern Line Extension.

In 2018, #target1000 will return in a bid to raise the bar set in 2017 and inspire the next generation of young tunnellers.



## Italian YM's Set their Sights on Naples 2019

On December 1, 2017, the Italian tunnelling association (SIG) gathered in Naples to celebrate the festival of Santa Barbara and deliver its annual degree award. The event took place at the first SIG Young Members Workshop, held at the head offices of Metropolitana di Napoli SpA. The Workshop, which included more than twenty young members, was an important opportunity to take stock of the Group's activities in the lead-up to the 2019 World Tunnel Congress, in Naples. Several Young Members also presented and shared their experiences in the world of tunnelling.

In the introductory speeches, Coordinator Marco Ranieri, the Italian Tunnelling Society and the YM Group were presented to new engineers as well as the issues dealt by the SIG Board of Directors, in particular with regard to support requests made by the Board to YMs.

In the afternoon, activities that will be carried out by the Group in the coming months were discussed, highlighting what has already been done, what has to be done and refining the internal division of tasks and responsibilities. The following is a summary list of the activities in which the YMs Group has decided to commit: Support the indexing process of the SIG Journal "Gallerie e Grandi opere sotterranee"; Organisation of a YMs Convention at the SAIE in Bologna (17 to 20 October 2018); Management of Group Communication; Organisation of the participation of YMs in the Working Groups of SIG.

The second part of the Workshop was dedicated to presentations on work done by selected Young Members.

Feedback from the Workshop was that the meeting was an important milestone for the Young Members and in general for the future growth of the SIG as a whole.

## Danish YM Group gets new leadership

Late last year (2017) the Danish Tunnelling Society's Young Members held their General Assembly. In accordance with their by-laws no chairman can sit for more than three consecutive years and it was therefore time for Lasse Vester to stand down as Chair after three years in the position. A new Steering Committee was appointed, with Stine Kristensen of Ramboll as Chair and Ida Villumsen of Arup as Vice-chair. The new Steering Committee began 2018 by setting goals for the next two years, which include more focus on students and collaboration with universities and promoting the use of social media. At the 2018 WTC, in Dubai, the General Assembly voted Copenhagen as the host city for the WTC in 2021. This will be a great opportunity for young tunnellers in Denmark to highlight their activities and contributions in an international forum.





Ramboll has contributed to approximately 60% of all the world's immersed tunnels including the 18km Fehmarnbelt Fixed Link, which is set to become the world's longest road and rail immersed tunnel. As lead consultant on Fehmarnbelt since 2009, Ramboll is assisting with the tunnel's concept design, tender documents, approvals, and onshore works. The tunnel is a study in innovative thinking, as it challenges existing tunnel building standards.

# BREAKING NEW GROUND (IN TUNNEL ENGINEERING)

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# Tunnelling tomorrow: Five trends

Change is coming fast to the tunnelling industry. That's partly because the number of tunnels we are building is increasing at an unprecedented rate; populations are migrating to cities and, somehow, we must find more space.

There are other forces at work too. Lessons and information move faster through social media and virtual networks. Digital construction promises to streamline processes and remove interfaces. Emerging materials and technologies could allow us to build more with less. We asked four industry leaders what today's technology could bring tomorrow. Here are a few of their thoughts.



**Mark Johnson, Global Practice Manager for Tunnel and Earth Engineering, Jacobs.**

Having acquired CH2M in December 2017, Jacobs provides a full spectrum of services including scientific, technical, professional, construction management and program management for business, industrial, commercial, government and infrastructure sectors



**Colin Lawrence, Global Tunnel Practice Leader, Mott MacDonald.**

Mott MacDonald is a large, global multi-disciplinary engineering, infrastructure, management and international development consultant with a tunnelling heritage that stretches back over 125 years.



**Tom Melbye, Senior Adviser, Normet, previously CEO for eight years.**

Describing itself as a 'technology company', Normet supplies chemicals and equipment to the tunnelling and mining sectors.



**Rob Muley, General Manager for Tunnelling, John Holland.**

Owned by China Communications Construction Company (CCCC), John Holland is one of Australia's leading construction companies, operating in a wide variety of sectors in Australia, New Zealand and Southeast Asia.

## 1. Ten times bigger

**We are not talking diameters** or length here, we are talking money. Although it is the industry's ability to build bigger and deeper tunnels that has led to huge increases in contract sizes.

"We are designing and building tunnels today that we wouldn't even have attempted not too long ago," says Colin Lawrence, Global Tunnel Practice Leader, Mott MacDonald. "It almost gets taken for granted by the public, because the technology looks very similar to prevailing techniques."

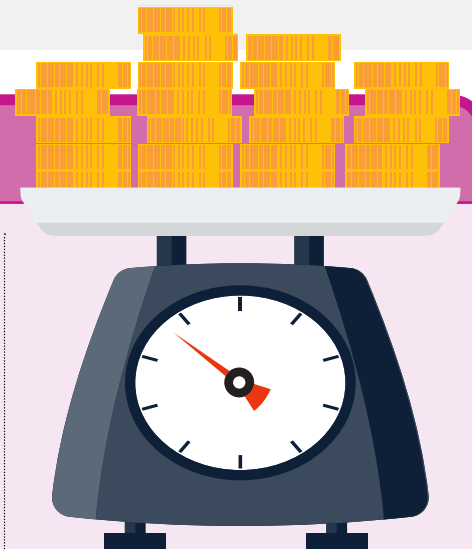
The industry has seen projects like the deep-water intake from Lake Mead in the US, where the tunnel boring machine (TBM), with all its many parts, withstood 15 bars of pressure. Or the 57km-long Gotthard Base Tunnel that carries vehicles through the heart of the Swiss Alps.

"It's a trend that's going to continue,"

says Mark Johnson, Global Solutions Director for Tunnel and Ground Engineering, Jacobs. "And that leads to bigger and bigger projects, and larger and larger teams."

In Australia, the industry has been hit with a series of high-value tunnelling projects, says Rob Muley, General Manager for Tunnelling at John Holland. The Melbourne Metro, for example, is being let as one big project, rather than being split into smaller contracts as was the case in Singapore or Hong Kong. "It becomes a challenge, first because of programme and second, because of resources," says Muley. "It's putting a real drain on resources."

Tom Melbye, Senior Adviser at Normet, sees the same challenge in his home market of Norway. "Projects are ten times bigger than they used to be. It's a booming market. And with bigger projects comes



more risk, and there are fewer and fewer people who can take on these jobs."

The result is more joint ventures, multiple companies, often from multiple disciplines joining forces to take on the scope and risk of these so-called mega-projects. But what we really need is a shift in the way all the different contributors work together (see elite teams on page 16).



## 2. Everyone pays

**For Johnson**, the biggest hurdle faced by tomorrow's tunnelling projects is affordability. "The biggest challenge is getting the money together in the first place," he says. "Projects and clients need to be as creative as possible in finding sources of funding."

Lawrence agrees: "There are many contracts in the concept or design stage that are just waiting for financing to be built," he says. "As populations keep growing, the development of infrastructure is critical but how much financing can be provided realistically is a real challenge."

Johnson cites the California Water Fix programme, involving 40 miles (64km) of water tunnels, with an expected price tag of \$15bn. "It has to be paid for by water rates and that involves pulling together a coalition of different agencies along the route, which is a difficult job."

Look to London, says Johnson, where authority Transport for London (TfL) is working with the private sector on over-station developments, factoring improvements such as new entrances or step-free access for Underground

stations into its deals.

Another way to share the cost of a tunnel would be to share its uses, says Lawrence, like the SMART tunnel in Kuala Lumpur which switches from road tunnel to stormwater tunnel during Monsoon season to avoid flooding in the city's central business district. Johnson references the Great Istanbul Tunnel, which crosses the Bosphorous strait with its triple decks accommodating both road and rail.

Public Private Partnership deals – shortened to PPP or 3P or P3, depending where in the world you are – offer a good solution in some cases. Elizabeth River Tunnels in Virginia, a programme which included both new build and refurbished tunnels, was delivered by this route, so too will be Melbourne Metro.

In a PPP, private sector funders, contractors and maintainers join forces to finance and build a tunnel and then operate it, taking tolls from the users. One huge caveat is that there must be public support for this option to be viable – or they'll de-rail the project at the planning

stage or boycott it once opened.

Because PPP models mean that designer and contractor work in parallel, with input from the maintainers, the theory is that they produce better pieces of infrastructure at a better cost. However, they tend to be more expensive – it always costs more for the private sector to borrow when compared to the public sector.

"The demands from society in terms of what needs to be built need to be balanced against what it costs to provide the infrastructure," says Lawrence. "It puts pressure on trying to make projects as cheap as possible and as useful as possible."



## 3. Bye, bye concrete

**When it comes to crimes** against the environment, one of tunnelling's most often-used materials is one of the biggest offenders: cement. Experts say that the cement industry produces 5 percent of global warming gases. "I believe that in 10 years we will see concrete replaced by other materials, such as geopolymers," says Melbye. "There has to be development and innovation, though. Normet has done quite a lot of work on that, although it's early days."



Polymer concrete has been used extensively in the chemical industry, and for elements such as manholes in waste water systems. Geopolymer concrete makes use of industrial by-products such as slag or fly ash.

Stronger than Portland cement concrete, concrete which uses a polymer binder instead of the cement, is faster curing, stronger and resistant to corrosion. It's also far more expensive. If its cost can be reduced – or owners take into account the reduction in maintenance costs – it could

become a contender for tunnel lining segments in aggressive environments, such as sewers.

Then there's wonder-material graphene (is there anything it can't do?).

Since it was only discovered in 2004, researchers are still finding out what we can add it to, but graphene concrete is definitely on the list of possible applications.

These new materials could change the way we line a tunnel as the TBM advances. Currently precast segments are installed to form a ring as the machine advances. "At some point, we will be able to extrude a lining from the back of the TBM as it advances which will reduce construction times and reduce the cost," says Johnson. "It's something people have been looking at for some time."

Environmental concerns will drive changes in the way we power vehicles underground, too, says Melbye. This will also work well for longer tunnels, where ventilation to remove diesel fumes becomes technically difficult and expensive.

## 4. Digital connection

**Digital technology** is already making big improvements in underground design and construction, although we are a long way from everything being seamlessly connected.

We can collect a huge amount of data, everything from the pressure inside the cutting head of the machine to the movement of the ground above it to the amount of metal that has been worn off a cutting tool.

"We are getting better data out of the machine than ever before which allows us to analyse what is being done," says Muley. "With live data coming off the machine, we can quickly analyse things like the slowest point of a cycle, or we can spot signs that show a motor or bearing going. Data reduces failures."

3D models, with information attached – sometimes called BIM (building information modelling) – are helping with planning, visualisation and

communication. Engineers can mine existing records such as surveys, borehole data and even Google maps to produce accurate pictures of the ground to be tunnelled through. Difficult details and how they fit together can be rehearsed digitally before projects are on site.

Next steps will see BIM models calling off deliveries automatically. Driven by the need to reduce congestion and improve air quality in city centres, deliveries will come from specialist construction consolidation centres sending products and materials to site on electric vehicles.

Robots are already a tool for tunnelling. Concrete spraying robots line tunnels every day, drones record progress and take inspection footage. Contractor Bouygues has a snake-like inspection robot which looks at the cutter head; TBM manufacturers are working on robots that can change the tools on a cutter head so that humans don't have to.

The next step is to get all the equipment to 'talk' to each other, says Melbye. "We could have the drilling jumbos collecting data on the rock as they drill, then passing that data on the geology onto the spraying robot. Machines have to be able to communicate with each other. The industry has to work together on this. If we pool our resources then the cost burden is less. It will happen but we do need to think differently."



## 5. Elite teams

**Increasing technological challenges,** bigger and more complex projects, greater risk, the need to engage new funders. All these aspects mean that we need the very best people and companies to be working on our projects. One big question: are there enough great people to go round?

Johnson thinks not. "Complex projects require huge teams of people to do preliminary engineering and produce tender documents. These go out to eight or 10 contractors, who then go out to subcontractors and designers. Pretty soon, we run out of firms who are capable of doing these very large projects."

The answer, suggests Melbye, is to move away from the lowest-price-wins method of procurement. "Traditional procurement is very unlikely to be the cheapest and the best solution because you are procuring on the wrong criteria: how fast can you go from A to B. if you have more performance-related criteria, then all parties take a part of the risk, and all parties have an interest in doing the best job they can."


Melbye would like to see a situation where a supplier like Normet wasn't just

selling materials to a project. Instead it would take responsibility for the whole sprayed concrete lining, for instance, perhaps charging on a cost per metre basis.

"Today I see too often the client on one side, the contractor on the other and the consultant somewhere in between. There are claims and problems because

communication is missing," says Melbye. "We have to try to solve problems together, rather than waiting until the end of a project to put in claims. When the lawyers get involved, you are not sure if the right people are winning."

Digital construction could play its part here. Johnson remarks that current working and contractual practices don't fit well with BIM. A collaborative way of working, where those involved in supplying all the constituent parts of a tunnel feed into the design and model early would work far better.

It is the next generation of engineers coming up through the industry who will drive this change. "The good news about the increasing number of tunnelling projects is that they are providing invaluable experience to those working on them," says Lawrence. "All that experience will come to bear in the future. We have never seen that before on this scale around the world." 





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# Extreme Tunnelling in the Himalayas



Missy Isaman, Project Engineer for The Robbins Company, has traveled to Japan, China, Turkey, and Germany through her work. But her most intriguing travels have been to Nepal, where an emerging economy is working to modernize its infrastructure and heal from a massive earthquake in 2015. Her work in Nepal for the Bheri Babai Diversion Multipurpose Project (BBDMP) represents the first-ever use of a TBM in the country. A 5.06m diameter Robbins Double Shield is boring the BBDMP--it is currently 2.7km into its 12.2km bore.



At the start of the Bheri Babai project, back in 2016, I was lucky enough to be able to travel to the capitol city of Nepal, Kathmandu. Although the flight was very long, getting to see a place like this is such an amazing opportunity. My role in the project is to manage the design engineering portion of the project. This also involved attending project design meetings with the owner and the contractor (the Nepalese government being the owner).

The Nepalese people couldn't have been more welcoming. This project had been in the planning stages for years. I could tell that this was much more than just a job to them. Being the first TBM in the country, this project was a major point of pride to the team. The team hopes the success of this venture will prove to the public and the industry that TBMs are a very viable option over the drill and blast method. It will help to open the doors for the TBM industry in Nepal.

The visit I took to Nepal was about a year after Nepal's devastating earthquake, measuring 7.8 on the Richter scale. There was a lot of trauma to the city even at this time. Many of the city's historic monuments and architectural treasures were permanently damaged. Most of the city was in a state of repair.

Because of the government's recovering economy, the project took much more time and effort for the team to make happen. With their continued determination, the planning, approval and procurement process ended up taking five years to reach fruition. The main reason that the owner and contractor opted for the TBM method was the geology. The plan for this tunnel



*The 5.06m diameter Robbins Double Shield*

is to divert water from a larger river (Bheri River) in one valley and divert some of the flow to a starved river (Babai River) in the next valley over. This will have a huge impact on the agricultural production and hydropower in this region. In order to do this, the tunnel will have to go through a mountain to bridge the valleys. This tunnel design did not allow for additional adits or multiple excavation faces. A drill a blast plan, for this project, would have taken an estimated 12 years to complete.

Our Robbins project team, including our local office in Nepal and president Lok Home, had multiple meetings with the Nepalese government, including the Project Office to the Ministry of Water Resources, the Ministry of Finance, and the Office of the Prime Minister. To help in the decision-

making process, project officials toured other jobsites around the world to get a sense of what a tunneling project could accomplish. These same officials made the bold decision to choose a TBM despite widespread criticism in the government over the decision.

While planning was underway, a final design review was held. In the end, in order to best combat the extreme terrain, the machine was equipped with a probe drill for ground investigation and a stepped shield, to help navigate through possible squeezing ground. For extra measures, we also added ports in the forward shield for the possible addition of forepoling or hand drilling, and radially spaced ports in the rear shield for lubricating the shield in squeezing ground. I could see in this meeting that they were excited about the progress and where this would lead their country in the future.

This tunnel is a major way to revitalize the economy.

I am so proud to be a part of a project that will positively impact so many people. A project of this magnitude has sparked the interest of the government, academics and the public. The jobsite alone has already presented opportunities. Locals have set up tea and snack shops and restaurants to accommodate the influx of workers in the area. Tourism has also benefitted from this venture. Since this jobsite is in a wildlife preserve, it has become a stopping point on tours through the area, giving everyone the opportunity to learn more about the site and the great benefits that are being accomplished. I am lucky to be a part of a project that will change a region like this for the better.



## Moving Water to Aid Nepal's Economy

The BBDMP is one of Nepal's 11 National Pride Projects--prioritized plans sanctioned by the Government of Nepal to further develop the mostly rural country. This project will irrigate 60,000 hectares of land in the southern region of Nepal, benefitting an estimated 30,000 households. It will divert 40 cubic meters of water per second from Bheri River to Babai River under a head of 150 m using a 15 m tall dam, providing year-round irrigation in the surrounding Banke and Bardia districts. The water will also be used for hydroelectricity, with a generating capacity of 48 MW benefiting the country with NPR 2 billion (20 million USD) annually.

Contractor China Overseas Engineering Group Co. Ltd.



Nepal Branch (COVEC Nepal Branch), represented by China Railway No.2 Engineering Co., Ltd Chengtong Branch, is responsible for the headrace tunnel and prepared for the challenges associated with tunneling in the tough geology of the Siwalik Range, part of the Southern Himalayan Mountains, with procurement of a custom-designed Double Shield TBM. The Siwalik range consists of mainly sandstone, mudstone and conglomerate,

requiring a TBM that can withstand squeezing ground, rock instability, possibly high ingress of water and fault zones. Maximum cover above the tunnel is 820 m.

The project owner, the Government of Nepal's Ministry of Irrigation (MOI), has chosen a TBM over the traditional method of Drill & Blast due to the faster mobilization and rate of advance offered by mechanized mining. The TBM

is also seen as an opportunity to prove the viability of the method in the notoriously difficult Himalayan geology.

The success of the BBDMP, a national pride project, is paramount for the country as well as the TBM industry. It is expected to help aide the food crisis in the mid-western region of Nepal by increasing agricultural yields and invigorating socio-economic development in the region. Even though the project is only about 20 percent complete to date, the government is planning more TBM projects. More than 100 km of tunneling planned are planned for Nepal in the next five years, of which more than 50% is considered feasible for TBM excavation. Many projects that would previously have recommended Drill & Blast only are now considering TBMs as an option.

## A Jobsite inside Nepal's Largest Wildlife Reserve


The Bheri Babai jobsite is 56 km from Nepalgunj, which is the nearest town as well as one of the largest business hubs in western Nepal. It also is home to the nearest airport—about an hour's drive away from the jobsite. Even though the tunnel is being excavated through Himalayan rock, the elevation is not too high. The tunnel portal is located in a river basin valley between 700 and 1000 m above sea level. The project site is a crossroads to highways that lead to much higher Himalayan towns and villages popular among trekkers and mountain climbers. The roads and bridges in the area, capable of handling heavy loads, were a very important factor when considering a TBM for the project. The area is prone to flooding during the



rainy season, but overall the weather is sub-tropical and quite warm in the winter, as it is close to the Indian border.

One of the most intriguing aspects of the jobsite is that it is in the middle of Nepal's largest wildlife reserve - Bardia Wildlife Reserve

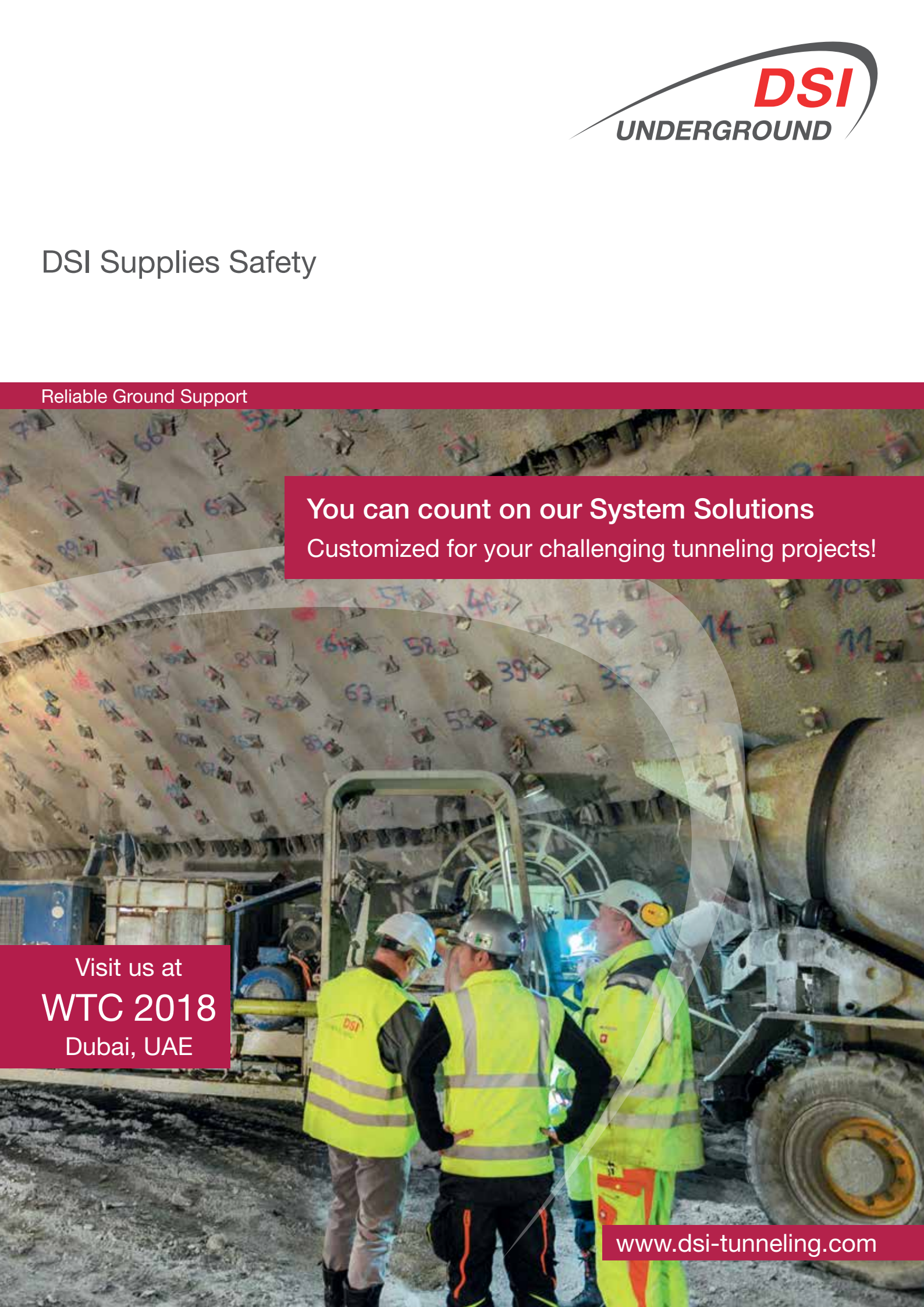
shelters Royal Bengal Tigers, two types of Asian Rhinos, Elephants, Asian Black Bears and many other types of vulnerable flora and fauna. Monkeys and foxes are an everyday occurrence around the jobsite, as well as colorful birds—laborers have even

spotted a tiger. The reserve is guarded by the Nepalese Army and there are many check-posts along the highway—anyone traveling through the reserve or to the jobsite that is not a local must show valid paperwork to pass through. 



## DSI Supplies Safety

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A photograph of a tunnel construction site. The tunnel walls are covered with a grid of small, square, metallic ground support elements. Some of these elements are marked with numbers in red and blue. In the foreground, three workers wearing high-visibility yellow vests and hard hats are standing and looking towards the tunnel. A large piece of construction equipment, possibly a conveyor or a pump, is visible on the right side of the frame.

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# PHOTO COMPETITION

Breakthrough is delighted to announce the winner of its first annual photo competition!

The prize went to Paul Challinor, a Project Manager with UK specialist tunnelling subcontractor Joseph Gallagher Limited, for his entry 'Reflection'. "The man in the photo is my former boss, mentor and friend Dickie Dexter," said Paul. "The photo was taken when we handed over a completed tunnel. It was a hard project; the ground was bad, the price was tight and our relationship with the client was occasionally strained. The project took a lot out of us and the picture shows a humbled man reflecting on all that has gone on. We delivered the tunnel and were not beaten, but we felt like we left a small part of ourselves behind."

The judging panel loved both the photo and the story behind it and sends its congratulations to Paul once again!

If you would like to take part in the 2018/19 Competition, send us an eye-catching image that highlights tunnelling or underground construction. If you've captured something inspiring, beautiful, fascinating, intriguing, amusing, or possibly all of these things, we want to see it! The winning photo will feature on the cover of the Spring 2019 edition, as well as Breakthrough's Flickr site, social media and more – there will also be a prize from our sponsor Bekaert Maccaferri Underground Solutions.

The full list of entries are hosted on our Flickr page at: [www.flickr.com/people/breakthrough\\_magazine/](http://www.flickr.com/people/breakthrough_magazine/)









**The Old and the New** by Ray Kryhul



**High Noon** by Jennifer Day

**If you'd like to enter the 2018/19 competition, the rules are as follows:**

- Photographs should be submitted by email to [amanda@tunnellingjournal.com](mailto:amanda@tunnellingjournal.com) or using a free large file transfer service such as Dropbox.
- You must include a caption to explain your picture.
- There is no limit to the number of photographs that you may enter (within reason). If you are trying to choose between several possible entries, then please just enter them all and let the judges decide.
- The photograph should be of good print quality, at least 300 pixels per inch, and a reasonable size.
- Make no assumptions about the photograph we are seeking, because the winning photograph could be of a: laboratory, project team, computer simulation, tunnel breakthrough, engineers in the field, miners in a mantrip, etc. If it's an interesting image, we want to see it!
- Photographers retain full copyright of their images, but in submitting an entry give the ITA-AITES, ITAYM and Breakthrough the right to use that image for marketing and communications purposes.



**TBM (S-719) disassembly at Farringdon, Crossrail**  
by Robert Pyne



**Light at the end of the tunnel** by Diego Sebastiani



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# A week in my life

Hannah Dix worked as a Cross Passage Tunnel Engineer on the Doha Metro Red Line South Joint Venture (RSJV) project, with QDVC, in Qatar. She has experience working with traditional excavation methods in cross-passages as well as final lining. Hannah previously worked on the Crossrail project, in London, UK; as well as an open-cut coal mine, in rural Australia. She is currently working on the West Gate Tunnel Project in Melbourne, Australia, with the CPBJH Joint Venture.

## Saturday

Saturday marks the beginning of a new week on the Cross Passage (CP) Excavation Team. This morning I woke up to my routine 4:30am alarm, got dressed in my site gear and made my way to work, ready for the 6:00am hand over meeting. These meetings are held at both 6am and 6pm with the day and night shift supervisors and engineers. These meetings are crucial for the smooth running of each shift as the handover team is updated about what activities have occurred over the previous shift, how much progress was made and if we faced any challenges.

We all prepare for the hand over meeting by grabbing our morning coffee and gathering in the site office. As we all listen to the updates from the previous shift, I notice how effective we have all become at communicating. Between the 10 of us we represent nationalities from the Philippines, France, Spain, Chile, Romania, UK and Australia. Our

diversity sometimes offers communication challenges, but with patience we have been able to become better and have all learned some new words. As the meeting continues it appears that we have another busy day ahead of us.

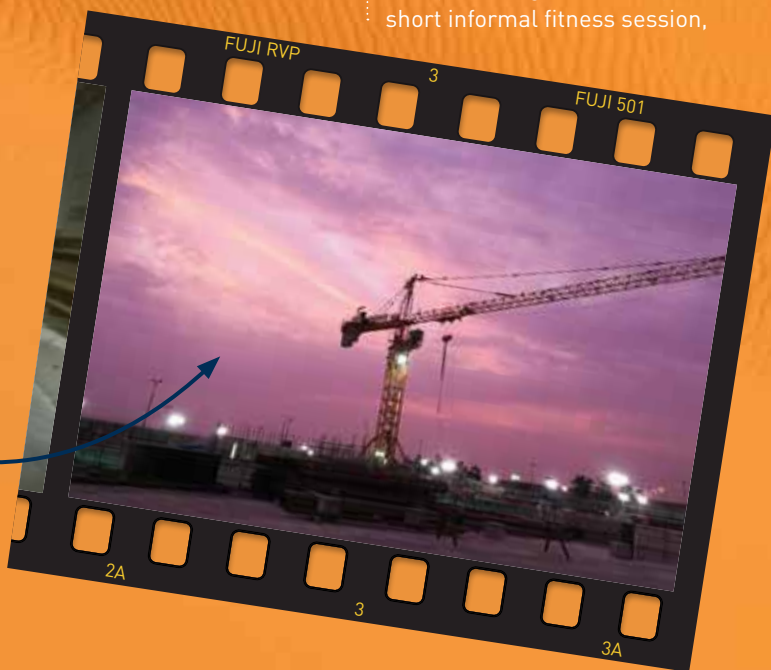
I make sure to collect all the details about the excavation progress from the night shift as well as which Cross Passages (CPs) have shotcrete orders for today. I then determine which CPs will require shotcrete for tomorrow. As our meeting progresses we are greeted by another bright pink sunrise that forms a silhouette behind the site cranes, ready for another day.

## Sunday

After the completion of this morning's hand over meeting I write up the shotcrete requests for tomorrow and send them through to the concrete batching plant. I then head over to join this morning's start briefing with the site teams. Each morning we conduct a safety meeting, followed by a short informal fitness session,



Morning sunrise





## Construction site for the new metro line at Doha city centre.



to help get everybody excited for the day's work. Often our fitness sessions end in laughter over our enthusiastic exercising and today is no exception. After our morning fitness class the supervisors describe the activities for the day and our key priorities for the shift. The various teams then head off into the tunnel. Today, we are excavating at one of the CPs. Using the tunnel checker, I help check the tunnel profile to ensure that the excavator operator and surveyor are excavating to the correct profile. I find that we are on track and progressing to our target. The excavation of the current advance should be ready to shotcrete in the next shift.

### Monday

This morning is another busy morning in production. We are preparing to shotcrete a CP

at 10am, before then however the excavation profile must be checked to ensure night shift has not missed any tight spots. The teams gather all their materials and make their way to the Alimak lift, ready to head down into the shaft. In the queue, we all greet each other before boarding the lift. The Alimak operator secures all the doors before he rings the bell and starts the descent. In the beginning, the sudden drop used to catch me off guard, but now it's just part of the morning trip. At the bottom of the shaft I put my ID tag onto the "in" side of the tally board and begin the 2km journey through the tunnel towards the CP. After I reach the CP, I check the final profile and discover there are no tight spots. The team then sets up the shotcrete pump and sprayer ready for the arrival of the shotcrete. After the shotcrete arrives the team are able to complete the spraying

## DOHA RED LINE DATA

**Start Date:** June 2013  
**Completion Date:** 2018  
**Client:** Qatar Rail Company

**QDVC 55%, GS E&C 25% & Al Darwish Engineering 20%**

### DOHA RED LINE IN BRIEF

- 5 Tunnel Boring Machines
- 5 Underground stations
- 5 Switchboxes
- 4 Emergency exits
- 35 cross passages
- 32km of tunnels

quickly and efficiently. We then barricade off the CP and leave the lining cure.

### Tuesday

This morning the Safety team has indicated that it is cool enough for the day shift works to start. It is not uncommon that the relative temperature gets above 54°C, due to the high humidity and is too hot to commence work. Everyone is

used to the temperature now with wet sweaty handshakes mandatory, but can be optionally swapped with a fist bump. Welcome to the Arabian summer. Today, in addition to the regular morning meeting, we conduct a pre-works meeting in preparation for the opening of a new CP. This meeting consists of the Site Geologist, Methods Engineer, and Shift Engineer, to discuss the conditions at the CP, taking into account

all the design and geological factors. With all technical information, logistic concerns and safety aspects taken into consideration the excavation permit is put in place, ready to begin excavation later in the week. Following the meeting, I head down the tunnel, making my way through the heat to the CPs to check on the teams.

## Wednesday

One can never be too comfortable with routine. During today's activities one of the site teams has discovered a large hive of bees have decided to make themselves at home in the station box. This has caused some concern due to the inherit noise and movement within this environment, which may cause the bees to swarm. After spending some time ringing around all the local bee keepers, a bee removalist is found. Thankfully, the bee keeper is able to safely remove and relocate the bee hive off site and site activities are able to return to normal.

## Thursday

Today is the last day of the six working-day week. After my regular morning activities, today we are conducting drilling at the newly approved CP. The new CP requires the drilling of dewatering holes to locate and relieve any water pressure in one of the lower geological layers before we open the segment. We prepare the drilling team, plant and equipment at the CP and then begin drilling. After drilling to the required depth, with guidance from the geologist, we discover that the water pressure is lower than anticipated and the CP can be opened safely. Following the completion of the drilling, it is time to help with the setup of the end of year team BBQ! The Excavation Team have been making great progress on the project and with the end deadline in sight we have decided to celebrate. At change of shift tonight we are holding a dinner BBQ for both day and night shifts to celebrate our team's progress and efforts on the project. We set up all the tables and chairs



Team BBQ

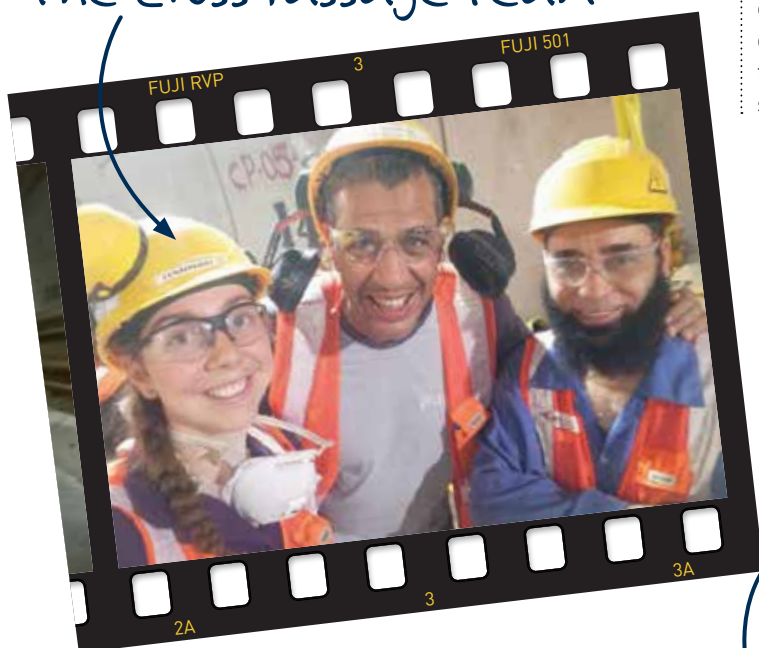
complete with BBQs ready for the celebration. Closer to dinner time the food arrives and the BBQs start grilling. As it is Ramadan, we wait until after the final prayer of the day so all our team can join us to celebrate and enjoy the BBQ together.

## Friday

Today is my day off and I have decided to share it with a group of friends on an adventure to the desert. We meet early in the morning to get a head start on the heat of the day and begin our drive out into the desert. After several hours of navigating our way to the sand dunes we see our first glimpses of sand. Though

Qatar is in a desert, much of it is rocky with little sand. Here we let out some air from our tires to begin dune trekking. Our two-car convoy makes its way over the sand dunes with the vast sandy space around us. Eventually we find ourselves at our destination, where the desert meets the Persian Gulf. It is a beautiful site with the sand dunes literally meeting the water's edge and rolling into the sea. We enjoy a BBQ lunch on the shore relaxing in the landscape. At the end of the day we pack up and begin our drive home. This isn't a day I will forget any time soon. 📍

The Cross Passage team



A day in the desert







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# ITA TUNNELLING AWARDS 2018

November 5-7, 2018 | Chuzhou-Nanjing, China



Since 2015, the ITA Tunnelling Awards has sought to reward ground-breaking innovations and outstanding projects in the tunnelling and underground space industry. The 2018 Awards will take place on 7 November, in Chuzhou-Nanjing during the 20th Chinese Tunnel and Underground works Conference (CTUC), which runs from the 5 to 6 November.

Following successful events in Switzerland, Singapore and Paris, the fourth ITA Tunnelling Awards will return to Asia for 2018. The three previous Awards events received more than 240 entries and 110 nominations, rewarded 30 projects and personalities and gathered more than 750 attendees.

Nominations for the following categories must contain projects for which the major civil engineering work was completed between 1st January 2016 and 1st April 2018. The Young Tunneller of the Year rewards an individual born after 1st January 1984 and who has brought an outstanding contribution to tunnelling.

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**Project of the Year - between €50 million and €500 million**

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**Technical Product/Equipment Innovation of the Year**

**Innovative Underground Space Concept of the Year**

**Safety Initiative of the Year**

**Sustainability Initiative of the Year**

**Young Tunneller of the Year**

*Nominations for the nine award categories, including Young Tunneller of the Year, will be announced by mid-July 2018, through the ITA's dedicated Awards website:*

*<https://awards.ita-aites.org>*

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# Dates & Events

## 24-27 June

### **2018 North American Tunneling Conference** Washington D.C., USA

Event website: [www.natconference.com/](http://www.natconference.com/)

*The UCA of SME's NAT Conference is a premier biennial event. The four-day conference provides a programme focused on current tunnelling projects, challenges and successes in North America. A Young Members' networking event will take place in the evening on June 25.*

## 13-14 September

### **Underground Excavation Symposium and Exhibition** Istanbul, Turkey

Event website: [www.uyak.org.tr/](http://www.uyak.org.tr/)

*There are 11 metro projects currently ongoing in Istanbul alone. Organised by the Chamber of Mining Engineers of Turkey and the Turkish Tunneling Society, this two-day symposium will attract a large number of domestic and international attendees to discuss the growing demand for underground infrastructure.*

## 18-21 September

### **InnoTrans 2018**

Berlin, Germany

Event website: [www.innotrans.de/en/](http://www.innotrans.de/en/)

*InnoTrans is a leading international trade fair for transport technology and takes place every two years in Berlin. The InnoTrans Convention, a top-level supporting conference programme, complements the trade fair.*

## 9-10 October

### **British Tunnelling Society Conference & Exhibition** QEII Conference Centre, London, UK

Event website: [www.btsconference.com/](http://www.btsconference.com/)

*The BTS 2018 Conference and Exhibition is the largest gathering of tunnelling professionals in the UK. The event is an essential meeting point for everyone involved in the design, construction and operation/maintenance of today's underground infrastructure.*

## 10-13 October

### **Austrian Tunnel Day & Geomechanics Colloquium** Salzburg, Austria

Event website: [www.oegg.at/en/](http://www.oegg.at/en/)

*The 11th Austrian Tunnel Day will be held on October 10, prior to the 67th Geomechanics Colloquium organised by the Austrian Society for Geomechanics (OeGG). Topics include: Geotechnical problems, TBM selection, model selection and new developments in tunnel support.*

## 15-18 October

### **Tunneling Fundamentals, Practice, and Innovations Annual Short Course**

Colorado School of Mines, Denver, USA

Event website: <http://csmspace.com/events/tunneling/>

*CSM's annual short course for industry professionals provides a comprehensive overview of tunnel planning, design and construction across all applications and all types of geology.*

## 29-31 October

### **2018 Cutting Edge Conference** Atlanta, GA, USA

Event website: <http://ucaofsmecuttingedge.com/>

*Organised by the UCA of SME and Tunnelling Journal, Cutting Edge is an annual conference that hand picks speakers to discuss the latest trends and developments in tunnelling technology. The 2018 event also features a dedicated young members session.*

## 5-7 November

### **ITA Awards 2018 & The 20th China Tunnel Conference** Chuzhou-Nanjing, China

Event website: <https://awards.ita-aites.org/>

*The 2018 ITA Awards will be held in conjunction with the bi-annual CUTC event. The biggest and most important tunnelling conference in China, the CUTC is organised by the Chinese Tunnel and Underground Works Society.*

## 3-9 May 2019

### **WTC 2019**

Naples, Italy

Event website: <http://www.wtc2019.com/>

*Organised by the Società Italiana Gallerie (SIG), the 2019 World Tunnel Congress and the 45th ITA-AITES General Assembly will be held at the famous "Mostra D'Oltremare", one of the main conference hubs in Italy. The Congress theme is "Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art".*

## 15-21 May 2020

### **WTC 2020**

Kuala Lumpur, Malaysia

Event website: [www.seacetuset2017.com/4/443/welcome-to-malaysia/](http://www.seacetuset2017.com/4/443/welcome-to-malaysia/)

*The 2020 ITA-AITES World Tunnel Congress and 46th General Assembly will be held in Kuala Lumpur.*



# Vietnam Adventure

On February 17, two adventurous Norwegian Civil Engineering students, Ola and Egil, got a plane from Oslo to Vietnam in order to conduct field surveys as a part of their Masters theses. Arriving in the coastal city of Da Nang, in central Vietnam, with temperatures in the mid-twenties, long beautiful beaches and cheap beer, was a stark contrast to the Norwegian mid-winter with its freezing temperatures. Having travelled around the world to another country and continent, we had exploit the opportunity to check out the Da Nang area for a couple of days before traveling out to the project site. The ancient city of Hoi Ann, the Marble Caves and a massive statue of "Lady Buddha" were among the main attractions Da Nang had to offer, in addition to relaxing on the beach.

Ola Hobbelstad and Egil Johansen

A couple days later, we set our course towards the project site, which is located six hours south-west of Da Nang, up in the central highlands of Vietnam. The area itself is very beautiful, with its scenic nature and steep river-dug valleys and hills all covered by vegetation. The tunnel of interest was part of the Upper Kon Tum Hydroelectric Power Plant, which will have 350MW of installed capacity and an annual production of 1 TWh when completed. About 10 kilometers of this tunnel is being excavated with a Tunnel Boring Machine (TBM), which was why the project was of interest to us. The tunnelling is being done using a 4.5m diameter Main Beam TBM from Robbins, who is also contracted to operate the machine.

The purpose of our stay in Vietnam was to collect data for our Masters theses, which have to be completed to graduate from the Norwegian University of Science and Technology (NTNU), which is located in Trondheim. Egil's thesis is focused on comparing actual TBM performance with estimations generated by the NTNU and the QTBm TBM prediction models. The

input required for the models involved mapping completed sections of the tunnel, in accordance with the rock fracture class system and the Q-Value, conducting penetration tests with the TBM, and taking core samples for Drilling Rate Index (DRI) and Cutter Life Index (CLI) testing back at NTNU and at the SINTEF Foundation for Scientific and Industrial Research, which is also located in Trondheim. Ola's thesis focuses on rock support, mainly the difference in rock support used between TBM bored and blasted tunnels – both when it comes to measures to cope with unstable ground and the amount of rock support needed to secure stability. Fieldwork conducted for this purpose was geological mapping of a section of the TBM-excavated tunnel as well as mapping of the drill and blast excavated portal. While the theoretical framework for the thesis consists of both the Q-System and the RMR-System of rock mass classification.



Hoi An ancient city



Working in a place like Vietnam is very different to the highly regulated and safety-focused construction industry in Norway. The project site itself has a permanent population of chicken and hens, cattle, stray dogs and an occasional pig or two wandering around. The work inside the tunnel is affected by the high temperature and humidity, giving us more of sauna experiences in a week than an average Finnish person gets in a year! The work environment is also very different, with workers coming from all over the world, and only a few able to speak fluent English or communicate easily with one another. Another interesting sight was the large number of locals engaged in shoveling the tunnel floor of muck to allow the water to flow out.

Doing field studies as a student is highly recommended if you get the opportunity. It enlightens you to all the practical aspects of construction, such as logistics, work environment, communication, safety and other issues that affect the process of

building something, which is impossible to learn from a university course. As tunneling is a highly practical form of work, you cannot get around spending extensive periods of time in the field if you truly want to become an expert.

## Further Reading

- "Using the Q-System", a handbook published by the Norwegian Geotechnical Institute (NGI), is available to download free at [www.ngi.no](http://www.ngi.no)
- A complete description of the RMR System is given in Bieniawski's book "Engineering Rock Mass Classifications: A Complete Manual for Engineers and Geologists in Mining, Civil and Petroleum Engineering", published in 1989.
- One should also read the article "Use and Misuse of Rock Mass Classification Systems with Particular Reference to the Q-System" by Palmstrøm and Broch, in *Tunnelling and Underground Space Technology*, Volume 21, Issue 6, November 2006.

# Thuong Kon Tum Hydroelectric Project

The 17.4km Thuong Kon Tum Hydroelectric project will be the country's longest tunnel once complete, drawing water from the Dak Nghe River to supply electricity to the Central Vietnam region. A 4.5m diameter Robbins Main Beam TBM and continuous conveyor system were supplied to bore the tunnel.


The project is located in Vietnam's mountainous interior region, in dense rainforest more than six hours away from the nearest city. Geological conditions were originally expected to consist of softer rock with some fault zones, but 75 to 80 percent of the rock conditions encountered

thus far are massive granitic rock tested at 300MPa UCS or more (with averages in the 270 to 290MPa range). Very little fracturing and jointing is present, but there are several major fault zones along the tunnel alignment.

Originally launched in 2012, commercial circumstances for the original contractor, combined with incredibly difficult geology, left the project at a standstill. In 2016, the revitalized project and its new contractor called on Robbins to lead the refurbishment and operation of the TBM. The results are no less than remarkable given the gauntlet of challenges set in front of

them, which include water gushing from fault zones at the rate of 600 liters per second.

In less than two years, the highly skilled personnel at the site have taken the 4.5m diameter Main Beam TBM from

a near standstill at 15 percent project completion to 85 percent complete. More fault zones are expected, but despite the challenges tunneling is planned to be complete by the end of 2018. 

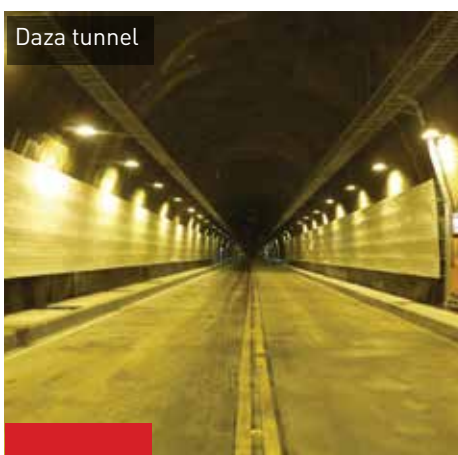


The project area

# Extreme Tunnelling in Colombia



La Linea tunnel



Daza tunnel



Occidente Tunnel

The history of underground works in Colombia is older than one might imagine. Tunnels for hydropower and irrigation, rail tunnels, urban drainage tunnels and road tunnels all currently exist. However, when Colombia launched its 'Infrastructure Master Plan 2015-2035', in 2015, tunnel engineering gained a much higher profile, due to the challenges that engineers will face to execute the plan.

Following a decades-long gap in infrastructure development, Colombia will heavily invest in upgrading highway infrastructure in a bid to develop the country's economy. Many reasons can be listed for the infrastructure gap, but regardless, it is important to note that in terms of geology and topographic formation there is a predominant difference between the east and the west of the country.

The former displays sparse mountainous relief formed by ancient rock, while the latter is characterized by imposing young rocks of the Andean mountain ranges. Colombia is the only country that hosts three subdivisions of the Andes (western, central and eastern), presenting great differences between rock formations in terms of age and petrographic type. This results in a varied and complex geology encompassing igneous, sedimentary and

metamorphic rocks, in addition to the high rainfall rates that are observed.

A great number of tunnelling projects are needed to successfully interconnect regions, to reduce the distance, time and cost of transporting people and goods, as well as to reduce trade barriers. However, due to the conditions mentioned above, Colombian engineers, academics, national and international firms are facing tunnelling challenges, not only at the design phase but also during construction. The role of young engineers will be crucial in the development of such projects, which will contribute to a brighter future for Colombia.

## Importance of tunnelling in Colombia

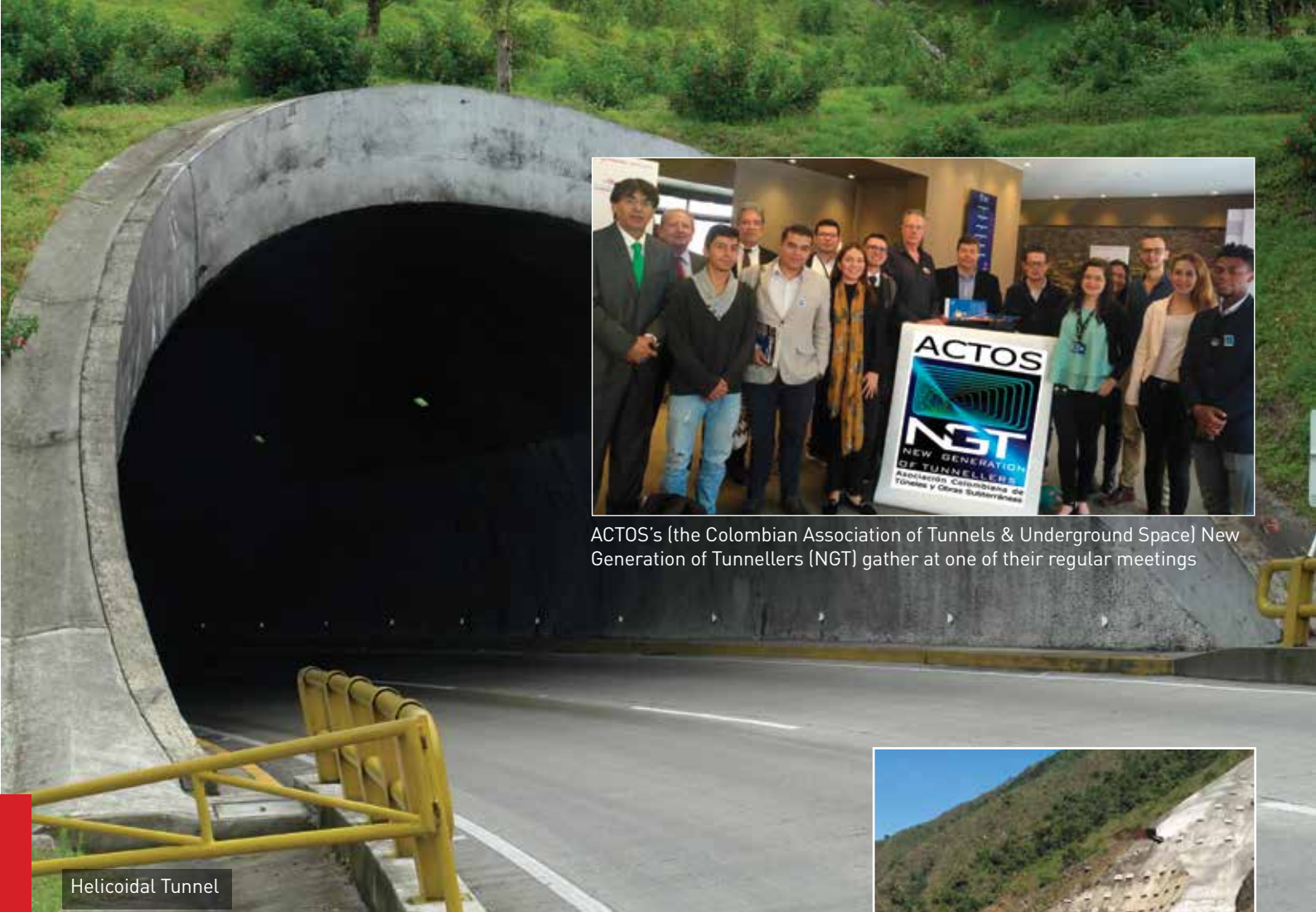
The 4th Generation Toll Road Concession Programme is one of the most ambitious projects in the history of Colombia's infrastructure, consisting of 40 projects that will comprise 8,000km of toll roads, including 159 tunnels with a total investment of around US\$18 billion.

The 4G Program is expected to reduce unemployment, creating more than 180,000 jobs. This is when young engineers must enter the labour market, meeting the needs of the country. Unfortunately, the number of tunnels in design and construction phases is greater than the number of young

## Longest Tunnels in Colombia

Tunnel Name	Function	Year of Completion	Location	Length (m)
Via Guateque Tunnel	Road Tunnel	1966	Western ranges	1600
El Boqueron Tunnel	Road Tunnel	1999	Central range	2405
Buenavista Tunnel	Road Tunnel	2002	Western ranges	4519
Occidente Tunnel	Road Tunnel	2005	Eastern ranges	4603
Tunnel del Sumapaz	Road Tunnel	2010	Eastern ranges	4200
Toyo Tunnel	Road Tunnel	2025 Expected	Western ranges	9840
La Linea Tunnel	Road Tunnel	2019 Expected	Central range	8600





ACTOS's (the Colombian Association of Tunnels & Underground Space) New Generation of Tunnellers (NGT) gather at one of their regular meetings

Helicoidal Tunnel

professionals and national companies at the moment, it will be difficult to face these tasks created by tunnelling works that are key for the development (with a total length of approximately 250km in tunnels).

Tunnels, especially in Colombia, are considered an environmental solution as they negate the need for deforestation and erosion of hillsides. However, such tunnel projects call for rigorous design and construction at the same time, and an effective monitoring is also required in order to reduce risks by controlling water in-flows to obviate environmental damage. Therefore, one of the three key conclusions at the XII Andean Seminar of Tunnels and Underground Works, held in November, 2017 was the importance of having competent engineering graduates who are able to develop the operation and maintenance of the coming tunnels projects.

Henceforth, it is essential for the new generation of graduates to be well prepared, particularly in the use of computer tools. Over the last few years of tunnelling experience in Colombia (Table 1), it has been analysed that in tunnel design, with the advancing of computers, the required design parameters also demand great care. That is why our young

engineers need to analyse and make good use of all the information gained during the geotechnical research. It is our responsibility to classify and process the results in order to properly assess the analysis and ensure accurate results.

#### Noteworthy Projects in Colombia: El Toyo and La Linea

In order to understand the importance of tunnelling in Colombia, the Toyo Tunnel project can be taken as a reference. It will cross the western part of the Andean mountain ranges in the region of Antioquia, and will be the longest road tunnel in South America with a length of 9.84km, cutting travel time by more than half from Antioquia to Cañasgordas and reducing the distance by approximately 300km. The El Toyo tunnel will contribute to the interconnection of Colombian regions, main cities and ports, leading to a better future and solving the issue of regional isolation.

Another relevant undergoing project is La Linea Tunnel, which dates back to the 1920's, when it was first proposed as a rail tunnel to connect the Pacific and central railway. Individuals began hand excavation of the tunnel portals, but unfortunately this did not last for long and the visionary idea was left behind. It was almost a



Paola Castillo at work in Colombia

century later that the guild of infrastructure warned governmental authorities of a high degree of uncertainty and possible geological risk in the central mountain range, leading to the start of excavation works for a pilot tunnel, with the aim of determining the geological conditions and thus minimizing future construction risks. Today, the central tunnel of the La Linea Project is projected to be 8.6km in length. For the total project completion, 25 bridges and 20 tunnels are required. It will reduce congestion and travel time, allowing daily savings of approximately 4 billion COP for

transporters, represented by gasoline, equipment wear and time.

Unfortunately, the La Linea Tunnel Project has had contractual problems from the beginning in 2008. Since the last contract, the project has been delayed by two years and is currently expected to complete by the end of 2019. ACTOS-NGT Chair, Paola Castillo, supported the arbitration of this project. The main problems encountered are: contractor's budget problems, unsuitable machinery or machinery in poor condition, and contractual disorganization. In addition to the geotechnical challenges encountered during construction such as rock bursts, high overburden (over 830m), water ingress and rock squeezing, there was also a problem in the rock mass classification, which led to cost overruns. Notwithstanding, if the project cannot be completed, it will bring about 400 billion COP of losses per year.

### Prospects of Tunnelling in Colombia

The challenges faced by young civil engineers in Colombia consist of three main pillars: i) sustainable construction, ii) QHSE management, and iii) improve society's quality of life.

At this point, Colombia is calling for a new generation of engineers capable of



demonstrating good tunnelling knowledge, which integrates geotechnical, engineering geology, hydrogeology, tunnel design, structural design, traffic engineering, ventilation, fire hazard control and other disciplines relevant to the design and construction of tunnels.


In addition, the essential skills a good engineer must have includes teamwork, and above all ethical behaviour both personally and professionally. Therefore, colleges and universities need to recognize the importance of identifying, developing, and providing opportunities that bring about adequate improvement in the competence of our engineering graduates.

The tunnel industry also plays an important role in the future of Colombia. It is important to embrace concepts on

sustainability during construction and operation, and in all stages of development and operation of tunnels.

Again, ethics and good engineering practices are of fundamental value and should be promoted along with the sustainable development of tunnelling projects. Last, but not least, regarding the political situation of Colombia, poor management of resources is an evident factor in inadequate development of civil infrastructure. The lack of political participation of civil engineers also restrains our decision-making contributions both in evaluation of projects and during the implementation of them.

Governmental authorities need to clearly identify the benefits and risks of such projects. They also need to put forward regulations, policies and standards that guarantee sustainable underground construction with very few environmental impacts.

This is the reason why the new generation of tunnellers need to strive to be able to achieve active participation in political processes and it is supposed to be the next challenge that must be approached from different perspectives with key tools, and this will contribute to the continuous learning and the training of young civil engineers. 

## Authors: Paola Castillo and Diana Diaz

**Paola Castillo** is a 21-year-old Civil Engineer, who graduated from the Pontificia Universidad Javeriana, in Bogotá, Colombia. In April 2017, Paola was given the opportunity to do an internship with a tunnel consulting company and as a result was hired as a Junior Tunnel Engineer once her internship was completed. During this time, Paola got actively involved in ACTOS (the Colombian Association of Tunnels and Underground Works), helping to organise seminars, congresses and forums on roads, mining, hydraulic and water supply tunnels, both at a national and international level. In July 2017, the ACTOS Board

appointed Paola to establish and lead a Young Members group, named ACTOS-NGT (New Generation of Tunnellers).

This experience has awakened her interest in the exciting field of tunnelling and has provided more value than she could have imagined. Working in this field has allowed her to develop her academic knowledge into abilities applicable to her career.

**Diana Diaz** is a Masters candidate in Tunnel and Underground Engineering at Tongji University, in Shanghai, China. Diana is 24 and is part of Prof. Yun Bai's (a former Vice-President of the ITA)



Paola Castillo

Research Group, where she has contributed to the "One Belt, One Road" project and the "China-Nepal Trans-Himalaya Railway Link"; she has also taken part in research on sustainable underground space development. Since 2017, she has worked with ACTOS helping to lead the Young Members group ACTOS-NGT with Paola.



Diana Diaz

Diana developed her passion for tunnels and underground engineering during an internship with one of the biggest design institutes in China (SMEDI), where she was given drawings and specifications for a new metro line that was built to connect Shanghai Disney World to the existing metro system.





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# Working Together

From figuring out how to re-use muck from tunnel excavations to mapping out the new technology skills engineers need today, the mission of the ITA's Working Groups is to capture, define and share best practice. Kristina Smith reports.

A video of the very first Alstom train on a trial run through the new Metro Line 1, in Chennai, India, posted on LinkedIn earlier this year received opposing responses. Some people offered congratulations on the progress made while others criticised the untidiness of the site.

The video is a reminder of how hugely working practices on tunnelling projects around the world vary, and that can be for a whole variety of reasons. Some countries have years of tunnelling practice behind them, others are just starting out. Skills and resources vary, as do politics and legal frameworks.

There isn't a 'one size fits all' approach. But it is possible to transfer knowledge and experiences gained from projects in one region to others. And that is what the International Tunnelling & Underground Space Association (ITA-AITES) aims to do through its Working Groups.

"The aim of the Working Groups is to go into a topic in depth and provide information on what is state-of-the-art," explains Olivier Vion, ITA-AITES' Executive Director. "We produce guidelines rather than standards, but they are recognised and respected around the world. We see them used in tenders or to help inform dispute resolution."

Some of the subjects currently being explored by Working Groups include what skills tunnelling engineers and others require to work in an age of digital technology; a new form of contract which could revolutionise the way risk is shared on tunnelling projects; and how we could make better use of the muck excavated from new tunnels (see opposite).

## Commitment

There are usually around 13 or 14 working groups active at any one time. The ITA's ruling body, the Executive Council, oversees and approves the creation of new groups. A recent addition was Working Group 22, chaired by former ITA Young Members' Chair, Jurij Karlovsek, from the University of Queensland, which will look at information in tunnelling.

Every group meets at least once a year at the World Tunnelling Congress (WTC), this year in Dubai. Many of them have a second face-to-face meeting somewhere else part-way through the year. The number of people in the groups

has been growing steadily, says Vion, so whereas they used to be between 10 and 25-strong, there can now be up to 40 people.

The outputs from the working groups are guidance documents that are published on the ITA-AITES website and presented at the WTC each year. The findings from

the Groups also help inform some of the training courses offered and approved by the ITA-AITES.

One of the problems faced by all the Working Groups is that they are all made up of volunteers, and often volunteers with very busy day jobs. "Trying to collect all the information is a time-consuming process," says Jan Rohde, a Senior

Advisor at Sweco Norge, who heads up WG 15 Environment. "People are enthusiastic at the meetings, but once they get back to their normal work situation, they have to focus on other things."

There are two routes into the Working

Groups. One is for people to be proposed by their country's tunnelling association. Another is to turn up and volunteer, although Vion and Working Group leaders note that they need ongoing commitment, rather than one-off appearances at a meeting."

All the Working Group 'Animateurs' say that they would welcome more involvement from young tunnellers. "Listen, put your hand up, get involved," says Brian Fulcher, Principal Tunnel Engineer at McMillen Jacobs Associates, who chairs WG14 on Mechanical Tunnelling. "If young people show up, we take a very special interest in that and there is often more dialogue and excitement. Young ITA members are quick to get involved and make a difference."

Rohde says that his research has been boosted by contributions from students at the Warsaw University of

Technology, Poland, led by the Working Group's tutor, Professor Anna Sieminska-Lewandowska.

Fulcher acknowledges that it is difficult for people to persuade their companies that they should have the time and budget to attend events such as the WTC, particularly if they work for a contractor. He himself attends in his vacation, alongside his wife who is a tunnel design engineer.

He urges young people to make a case to their employers for attendance: propose de-briefing sessions with peers after the event, emphasise the values of technology and information exchange, networking and learning social skills. "Large, complex, jobs need people with these types of skills," says Fulcher. "Companies are looking to employ their A-Team on these jobs. Young people should take every opportunity they can if they want to get onto that A-Team by developing essential skills beyond a solid base of technical knowledge."



Olivier Vion



Brian Fulcher



Jan Rohde



# Here's a taster of some of the new guidance we can expect soon from ITA's many Working Groups:

**WG3, Contractual Practices** is producing the world's first tunnelling-specific contract, working with the International Federation of Consulting Engineers (FIDIC) whose contracts are recognised and used globally. Tunnelling contracts often overrun on time and cost because owners try to transfer all the risk onto the contractors.

"For the first time, employers, contractors, designers and engineers will have a clear-cut definition of a balanced allocation of the risk related to the sub-surface conditions at their fingertips," says Matthias Neuenschwander, of Neuenschwander Consulting Engineers, who heads up the Working Group. "This will lead to cheaper projects, better cost stability and less need for disputes."

**WG5 Health & Safety** is updating important guidance it published in partnership with the British Tunnelling Society (BTS) relating to high-pressure compressed air working. Working under high pressures involves the use of non-air breathing mixtures and occasionally the use of saturation exposure techniques along with transfers under pressure.

"High-Pressure Compressed Air (HPCA) work is a high-risk tunnelling activity which has developed rapidly over the past 10 years," says Dr Donald Lamont, leader of WG5 and a world expert on the subject. "The ITA/British Tunnelling Society guidance has been the only internationally available guidance on the topic and has already been used as the basis for enforcement by one national regulator."

## Working Groups

Research  
Contractual Practices  
Health & Safety  
Maintenance & Repair  
Seismic Effects  
Immersed & Floating Tunnels  
Use of Sprayed Concrete  
Information Modelling in Tunnelling  
Mechanized Tunnelling  
Underground Works & Environment  
Long Tunnels at Great Depth  
Conventional Tunnelling  
Urban Problems, Underground Solutions  
Lifetime Cycle Asset Management

**WG14 Mechanised Tunnelling** has set up four sub-groups tasked with finding out the latest information about tunnels, related equipment technology, new materials and training for operators, engineers and managers. It is also working on joint projects with a number of other Working Groups.

The skills of a tunnel engineer are definitely changing, says Fulcher. "Shaft engineers and heading engineers tend to be quite general, but the role now is very techy. There is lots of instrumentation and data collection, but some of them have little idea about the data that they are collecting and the often-critical benefits that come from that data."

**WG15 Environment** is compiling case studies of projects that have been able to use the excavated muck that comes out of tunnels for other purposes – rather than it being dumped somewhere and landscaped.

Working Group 15 Animateur, Jan Rohde, has many examples from his own company's tunnelling projects and is seeking further case histories from elsewhere. "We are looking around the world to find out how people are dealing with the opportunities and challenges of using tunnel muck as a construction material," he says.

# Italy welcomes you to WTC 2019

Italy hosts some of the longest and deepest tunnels in the world. It is also one of the best learning grounds for tunnel engineers, as in a quite restricted territory it is possible to face challenges such as intense rock swelling, active tectonic faults, huge gas pockets and marine/fluviol inconsistent deposits.

Nowadays, the Italian tunnelling market is as active as ever with several new investments supporting tunneling projects and attracting new energies and players worldwide. Tunneling activities are ongoing in the Alpine Base Tunnels, including the record breaking 55km-long Brenner Basis Tunnel and the Turin – Lyon, Mont Cenis base tunnel, which includes two 57.5km long tubes, 45km on the French side and 12km on the Italian side. The top-of-the-line Italian High-Speed railway project is continuously expanding with the Milano-Genova route 37km tunnels and the Napoli-Bari 6 billion € sections mainly underground.

Not only railway, but also highway: the Bologna-Florence Highway A1 “Variante di Valico” consists of 66.6km with about 50% of the alignment excavated by TBM or conventional tunneling, while “Gronda di Ponente”, in Genoa, foresees the construction of over 70km of road, of which 53km are in tunnels, along the existing A10.

Last but not least, the metro tunnels, the most interesting of which will be Naples Metro Lines 1 and 6, with 93km of track and a further 30km of new light rail connecting 114 stations together, Rome Metro C and Milan M4.

If not enough yet, here we



give an overview of why Italy in general and Naples in particular makes a such a great venue for tunneling and why you should start planning your trip to the WTC in May 2019.

## The Italian Tunneling: over 2000 years of experience!

The tunnelling sector in Italy sinks its routes deep into the past, as the Romans were some of the most amazing and innovative Engineers in History. The groundbreaking underground project was probably the Cloaca Maxima, a massive wastewater system, partly still in use, constituted by tunnels ranging from 1.5m to 8m internal diameter connecting all major monuments of Rome underground. Not only urban tunneling, but also important milestones in the long and deep tunnels were achieved by the Romans, like the Fucino Lake drainage tunnel, the longest world tunnel up to the Frejus Tunnel completion in 1871. Naples is the perfect venue to blend modern tunneling and history, thanks to its unique underground network that goes back to the Roman age but has been widely expanded and modernized in the 19th Century: the most amazing and exciting is the so called “Tunnel



Borbonico”, an underground viaduct built in 1853 that, passing under Monte Echia, joined the Royal Palace with Piazza Vittoria, near the sea and the barracks with two parallel tunnels, one for carriages and the other one for pedestrians. We do suggest you visit it when in Naples!

## WTC 2019 in Naples

Therefore, we are delighted to invite you to the next World Tunnel Congress, which will be held in Naples, Italy, from May 3 to May 9, 2019, hosted by the International Tunnelling and Underground Space Association (ITA-AITES) and the Italian Tunnelling Society (SIG).

The conference will offer the traditional topics on design and construction of underground works, focusing on tunnelling, engineering

and innovation. All of this combined with some unusual topics suggested by the true Italian trademarks, such as history (Archaeology), design (Architecture) and genius & creativity (Art).

The special Triple “A” Sessions and Technical Visits will be unique opportunities to appreciate how either in both ancient and new underground infrastructures, history, design and creativity (Archaeology, Architecture and Art) are integrated in the Neapolitan underground space, leaving the delegates astonished and fascinated!

Italy, the country of Leonardo da Vinci, will complete the WTC offer. Technical and cultural visits are planned, including the Rome’s new Metro C line and the Brenner Base Tunnel, in the charming Alps mountain,





that will be the longest railway underground connection in the world.

Even the great social program we are working on – we are sure – will leave participants astonished and will be an opportunity to experience the beauties of Naples and its surroundings.

### The Young Member Involvement

The Young Member Group of the Italian Tunnelling Society (SIG) is actively working within the WTC 2019 Organizing Committee in order to plan dedicated initiatives for young professionals. Have a large number of YM attending the WTC in Naples as well as giving them the opportunity to actively participate and build network is definitively a main goal of the Italian Tunnelling Society (SIG) and of the WTC 2019 Organizing Committee. The Italian Young members group and ITA young



members will have their own exhibition stand, which will be a natural gathering point for young professionals during the conference.

### Why Naples?


The choice of this city is not by chance, Naples represents the 'Italian lifestyle' with Archaeology, Architecture, Art, its touristic attractions and, of course, Tunnelling. The WTC



2019 in Naples is therefore a unique opportunity to overlook the Mediterranean basin with all its history, culture and art, where past and traditions are blend with innovation and future.

Mostra d'Oltremare is the main conference hub in the South of Italy. Its size, architectural features and services make it a large multi-purpose centre, a reference

point for the Italian trade show site. Mostra d'Oltremare also hosts a small but priceless archaeological site with a short stretch of the "Via Antiniana" (an ancient Roman road), and provides several charming locations which will turn your attendance into a glamorous, unique and unforgettable experience.

Naples is the place to be in 2019! 

# from Five

Aspiring tunnellers can get a head start on their peers by studying one of the specialist undergraduate or postgraduate tunnelling degrees around the world. Breakthrough spoke to five young tunnellers to ask them why they chose the course they did and where it has taken them. **Kristina Smith reports...**

## Aiming high to inspire the next generation

**Dr Chrysothemis Paraskevopoulou**

- Lecturer (assistant professor) at University of Leeds
- MEng in Mining and Metallurgical Engineering and MSc in Design and Construction of underground works, National Technical University of Athens (NTUA), Greece; PhD, Queen's University, Kingston, Canada

In February 2017, at the age of 29, Dr Chrysothemis Paraskevopoulou was appointed lecturer (assistant professor) at the University of Leeds in the UK, teaching BSc and MSc level courses in rock mechanics and tunnelling engineering. The competition was stiff; she was pitted against people with more experience and higher qualifications.

"I knew the chances of getting the job were limited due to the competition, but I believed in myself and I aimed high," says Paraskevopoulou. Looking back on her path to Leeds, aiming high is a common theme.

Paraskevopoulou was inspired to become an engineer by her parents, who were both civil engineers. "If you are an engineer, you have to love what you do," she says. "This isn't a nine-to-five job. Every day you put the theory and background that you have learned and studied into practice. That's what excites me about engineering."

Living in Athens in Greece, she wanted to go to the National Technical University of Athens (NTUA). Competition for places is very strong and most people have additional tutoring, but Paraskevopoulou wanted to test herself, refusing tutoring and working hard to win a place.

Having studied Mining Engineering at



■ ■ If you are an engineer, you have to love what you do. This isn't a nine-to-five job. Every day you put the theory and background that you have learned and studied into practice. That's what excites me about engineering. ■ ■

NTUA, a five-year professional degree (MEng), Paraskevopoulou decided to continue her postgraduate studies at the same university attending a two-year Masters in Design and Construction of Underground Works. Her NTUA professors, many of whom have been actively involved in Greece's infrastructure and internationally the last quarter of a century, helped grow her enthusiasm for engineering:

"If I had not been taught by such great minds and inspiring professors, I am not sure I would have followed this path of tunnelling and geomechanics," she says.

Hard-working as ever, she decided to complete the two-year MSc in one year, so that could pursue a PhD at Queen's

University, Canada. Paraskevopoulou had met Mark Diederichs, an eminent rock engineering professor at Queen's, during a field trip in Greece, shared between students from NTUA and Queen's.

Paraskevopoulou's PhD looked at the time-dependency of rocks and the implications associated with tunnelling, working on a project for Canada's Nuclear Waste Management Organisation (NWMO). Two of the five years were spent doing laboratory testing at ETH, the Swiss Federal Institute of Technology, in Zurich.

"I travelled a lot during my PhD," she recalls. "Professor Diederichs gave me the opportunity to participate in lots of events. If you have good social skills, or you are willing to develop them, you can establish a good network in our industry. I feel lucky to have met in person all the 'big' names, these legends whose work you have read, studied and applied, (emeritus) professors like Evert Hoek, Charles Fairhurst, Richard Goodman, Nick Barton, Paul Marinos, Mark Diederichs."

PhD in hand, Dr. Paraskevopoulou's next move was to look for a position in Europe, either in academia or industry as she had worked for the public and private sector while studying at NTUA. Hence her application to Leeds.

As well as teaching at MSc and BSc level, her role at Leeds includes running a research laboratory, collaborating internationally with other universities and organisations and carrying out consultancy at a national and international level.

"I now teach the course that I was inspired by as a student, and I am consulting too, the best of both worlds," she says. "As my professors were a personal inspiration for my career path, I hope to become an inspiration to my students."



## New horizons in Singapore

### Russell Connors

- Project engineer, John Holland Group
- Studied BEng Civil Engineering and Infrastructure, RMIT University, Melbourne

Tunnelling, for me, is a career that I sort of fell in to!" says Russell Connors, a project engineer for John Holland Group, now based in Singapore. Had it not been for a career guidance councillor at school, he would never even have thought of civil engineering.

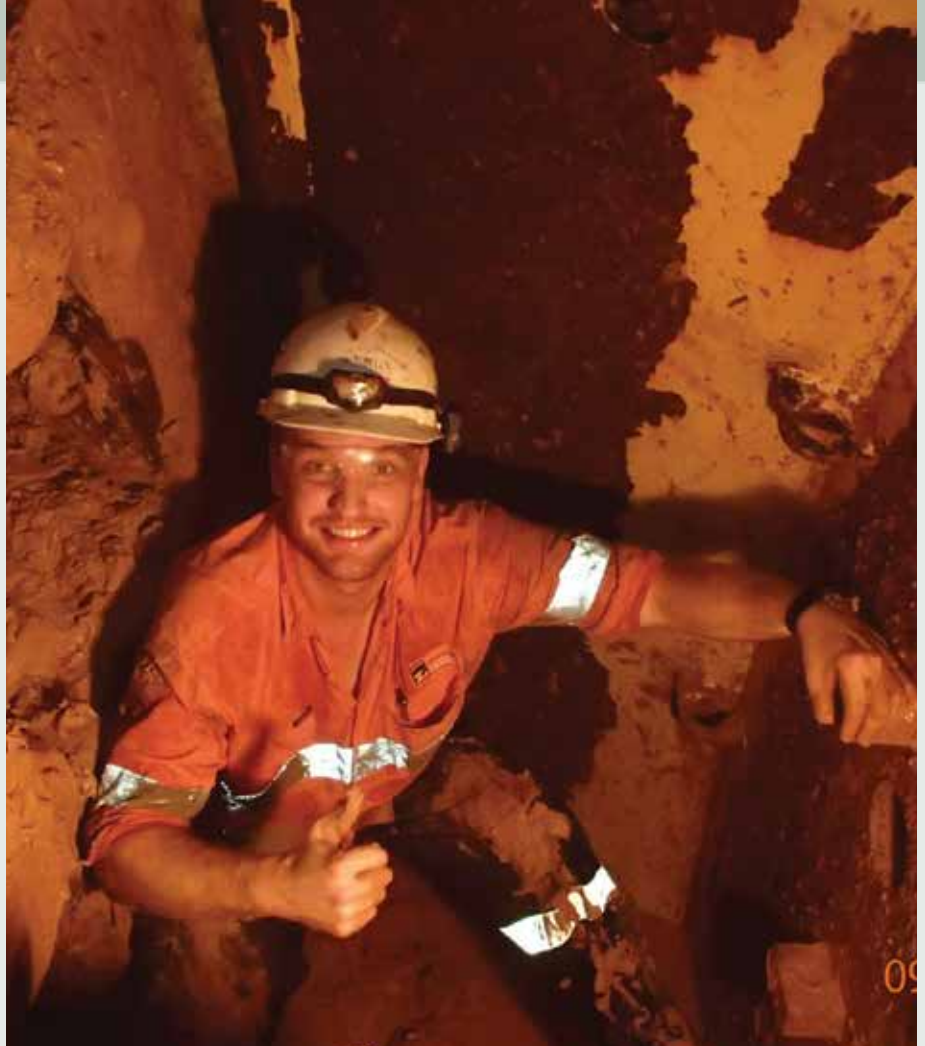
"At the time it was more likely that I would take up a trade", says Russell, who is now 31 "When the letter of an offer came back from the university, I was hesitant and nervous at first, however my family was very supportive and I stuck it out for four years. Fast forward to now and I have enjoyed every minute of it!"

Russell studied civil engineering and infrastructure at Melbourne's RMIT University, focussing on geotechnical and structural engineering with elements of construction management and hydrogeology.

"The course had a very hands-on approach with an emphasis on industry exposure, and the ability to adapt and work effectively in small teams," says Russell. "It was well suited to those who either wanted to focus on one or more of the sub-disciplines of civil engineering, or for those wanting a broader approach."

Russell came to tunnelling through a six-month placement with John Holland Group, working as a student engineer of the Melbourne Main Sewer Replacement project, a 2km segmentally-lined tunnel. When he graduated from RMIT, he continued with John Holland, working on a number tunnelling projects including the Northern Sewerage Project in Melbourne and the Brisbane Airport Link.

In 2013 Russell had a big decision to make: did he want to re-locate to Singapore? After some thought, and with encouragement from his family, Russell



■ Tunnelling, for all its challenges, the various personalities, the heartache and the stress, is addictive! There is no greater feeling of a sense of pride, accomplishment and teamwork after a successful breakthrough. ■■

made the move and has since worked on two major projects in Singapore, Downtown Line 3 and Thomson East Coast Line.

Currently he is part of a team working on a tender for another Singapore contract: "I am enjoying applying my knowledge of the industry and past experiences in the hope that we can put forward a successful bid," says Russell.

His course at RMIT prepared him well for the industry, he says. "Communication in tunnelling is critical. You must be able to work effectively and efficiently within small teams to deliver results," he says. "I also learnt during my studies that it is important be able to adapt, learn and overcome the constant challenges that tunnelling throws at you. A good tunnel engineer is compelled to evaluate what has happened, so that they can apply what they have learned. Underground, we got to push it. That's our job."

With the benefit of many hours spent

working on tunnel boring machines (TBMs), Russell thinks that would-be tunnel engineers would benefit from an understanding of the Programmable Logic Controller (PLC) which is the 'brain' of the TBM. This would mean that the engineer could work with the PLC technician to diagnose faults faster and thus reduce downtime.

TBMs are only going to become more complicated, says Russell, as automation increases. Robotics, already being trialled by some contractors, will become more widely used increasing efficiency and reducing the risk of accidents.

Russell advice to young engineers is to make sure to get time underground, learning tunnelling methods first-hand. But he issues this warning: "Tunnelling, for all its challenges, the various personalities, the heartache and the stress, is addictive! There is no greater feeling of a sense of pride, accomplishment and teamwork after a successful breakthrough."

## Tunnel love began at 17

**Daniela Herzig**

■ Project manager, Gähler and Partner  
■ MSc and Bsc in civil engineering, ETH, Zurich

Daniela Herzig's first thoughts about civil engineering came during a school visit to the Zurich western bypass, close to her home city. Part of this project was the 4.4km-long Uetliberg Tunnel.

"I got my first impressions of a tunnelling project," she says. "I didn't know anything about civil engineering. That was the beginning for me."

Herzig was lucky to be able to study civil engineering at ETH in Zurich, although she admits that its location and the chance to be near her friends was more important to her than its good reputation at the time. Looking back, one of the best things that her ETH education gave her was the ability to solve problems:

"At ETH, they don't just focus on the technical subjects, they teach you how to think and solve problems," says Herzig. "I learnt logical thinking and how to identify problems, how to distinguish between what's important and what's irrelevant."

After gaining her Bachelor of Science degree, she worked on a number of traineeships to help her decide what specialisms to choose for her Master's degree. Among these was four months spent in Abuja, the capital of Nigeria, with Bilfinger and Berger subsidiary Julius Berger.

For the Master's course at ETH, students choose two specialisms – Herzig chose geotechnical and water engineering – and can then study a wide range of other courses, including economics, developing countries and languages. The only subject that Herzig wishes she could have studied in more depth is law, which was only a small module.

"Once you are working, you learn that technical solutions are only part of the



picture. It's important to understand cost and how the contract works and to find the best technical solution within those constraints," she says. "Knowledge about contracts would have been great. We are engineers but we are also lawyers, in a way."

After visiting a careers fair at ETH, Herzig sent her CV off to a few firms and, following on from some interviews, had four job offers to choose from. "It was pretty easy to find a job," she admits.

Herzig chose Gähler and Partner, starting as a project engineer working on various infrastructure projects around Switzerland. Now, age 32, she is a project manager in the tunnelling team, responsible for two big projects; the Albula Tunnel in Southern Switzerland and the Ruckhalde Tunnel near the city of St Gallen.

"It is the variety I enjoy the most," says Herzig. "I work with lots of different people, on different subjects and on different projects. There are always new challenges. Take the Albula Tunnel. It's close to a UNESCO World Heritage Site and there is the risk of avalanches."

Herzig sees big changes for the

■ ■ As a young engineer, you have a new approach to projects. Tell people about your ideas, and always ask. People think that asking questions is a sign of weakness, but it's a sign of weakness if you don't ask, especially as an engineer. ■ ■

tunnelling industry ahead, as it adapts to changing modes of transport. "In Switzerland most tunnels are part of the railway or highway network. What about logistics tunnels? Mobility will change. There will be self-driving cars so we may not need the same kinds of tunnels."

True to her ETH grounding, Herzig says that the most important thing for young engineers is to ask questions. "As a young engineer, you have a new approach to projects. Tell people about your ideas, and always ask. People think that asking questions is a sign of weakness, but it's a sign of weakness if you don't ask, especially as an engineer."





■ The best thing about my job is that you get challenged every day. I have to take care of the excavation of the dam and the advance of the tunnels. Right now, in a moment there were 10 or 15 tunnels advancing at the same time. You have to be involved in everything and always be prepared to resolve things. I like that. ■

## Seeing Colombia's monster hydro project coming to life

**Juan David Herrera Caicedo**

- Geological and geotechnical co-ordinator, Integral, on Ituango Project
- BSc in civil engineering, Universidad Nacional de Colombia; MEng in rock mechanics, Universidad Escuela de Administración y Finanzas y Tecnologías – EAFIT, Medellín

The US\$2.8bn Ituango Hydroelectric Project will be Colombia's biggest every power station, generating up to 2,456 megawatts of electricity for this growing nation. Juan David Herrera Caicedo knows this mega-project well: he first worked on feasibility studies for it back in 2006, soon after he joined Integral, returning to oversee construction back in 2012.

"I always wanted to create things, to be able to see my work materialise," says Herrera. "I am really enjoying seeing the drawings and designs that we worked on actually being put in place. It's so different when you are in the field compared to when you are at your design desk. Things that you think might be easy on paper, are sometimes not so easy."

Herrera studied civil engineering at the National University of Colombia in his home town of Medellín, one of the best places to learn civil engineering, he says. In the final year of his Bachelor's degree, one of his professors introduced him to Integral, which designs and supervises



energy, infrastructure and mining projects, and he started work for them in 2005.

It wasn't until 2008 that Herrera started his Master's degree, doing it alongside his day job. It was hard work, he admits, but he had the advantage of already having worked in the field and so had a better understanding of what was being taught.

"I always recommend to younger people that they get a Bachelor's degree first and then work a little bit and try to work out what they want to do, rather than going straight from a Bachelor's degree to a Masters," he says. "At least, that is what I think works best here in Colombia."

Herrera's first two years with Integral were spent working on a range of geotechnical projects in Medellín including building foundations, ground investigation and slope stability. After working on Ituango's feasibility planning, he was sent to another huge tunnelling project: the 8.2km Oriente Tunnel which will connect Medellín to the José María

Cordova airport in Rionegro.

Then came something completely different: working in Integral's office in Peru for a year-and-a-half. Here, Herrera learnt new skills. "Until then I had only worked on design and in the field, I hadn't had any commercial experience," he says. "In Peru, I looked after our clients, made presentations, got to understand the commercial side of the business."

Back on the Ituango project, there is a huge amount of work underway. There are more than 12 km of tunnels in the main works, says Herrera, but another 10 km are needed to get to those tunnels.

"The best thing about my job is that you get challenged every day," he says. "I have to take care of the excavation of the dam and the advance of the tunnels. Right now, in a moment there were 10 or 15 tunnels advancing at the same time. You have to be involved in everything and always be prepared to resolve things. I like that."

Herrera wishes that his civil engineering course at university had contained at least some information on tunnelling. One of the best ways to learn and gain new information is by making contact with other tunnelling professionals, says Herrera who is involved with Colombia's tunnelling society, the ITA and in setting up a new young members' group in Colombia.

"There's a lot of knowledge out there if you are in touch with the right people," he says. "Be confident about your own knowledge but also respect the fact that other people have a huge amount of experience that you can learn from."

## Thinking beyond engineering to make metros do more

Nicolas Ziv

■ PhD Candidate at Egis  
■ Bachelor's degree, Classes Préparatoires aux Grandes Ecoles, Janson de Sailly ; MSc civil engineering, Ecole special des Travaux publics, du Batiment et de l'Industrie; Cycle in International Management, Ecole des Ponts Business School; Masters in transportation/mobility management, Ecole Nationale des Ponts Chausses; PhD civil engineering at Université Paris-Est

Tunnelling engineers are often accused of being too focussed on their tunnels. They think about how to build them faster, cheaper, but forget to look above ground to see how tunnels interact with the cities and communities they serve.

Nicolas Ziv certainly can't be accused of that. His extensive studies have included a Masters in transportation and urban planning and a Cycle in International Management (CIM) which encompassed politics, economics, business, human resources and marketing.

"In my day-to-day job, I need a general understanding of civil engineering, but I don't need to go very deep into the field," says Ziv, who is 27. "But I do need the bigger picture - economy, politics, finance, urban planning - which is very useful in helping me understand how to integrate innovative concepts for cities."



Ziv has been working for Egis Rail since 2015 on a training-through-research contract (CIFRE). He is in the final stages of a PhD which has seen him explore how tunnels can be used for more than one purpose, how projects are becoming more and more complex and how that complexity can be managed.

During an initial six-month internship at Egis, set up through links between the company and his engineering school, Ziv was asked to research how metro tunnels could be built more cheaply. That work led to another question: how can we share the cost of building new tunnels by using them for other services such as communications, utilities and transportation of goods?

Involving more parties means more complexity, so Ziv has also developed new methods and software to help manage these complexities on large, multi-stakeholder projects. People and

■ What I like best about my job is the variety of tasks, being able to work on different projects. With Egis I have done so many things: developed tools, worked on projects, worked with R&D teams and participated in conferences. ■■

communication skills are vital too, he says, to break down invisible barriers: often different parts of the same organisation never communicate with each other

"In my view, tunnelling projects will get more and more complex, although not necessarily bigger and bigger," he says.

"With environmental constraints and many different uses, it will become more complex to design new infrastructure.

"You cannot design a complex system with existing methods and tools, you need new materials, new methods and new ways to manage projects." Part of Ziv's PhD is a new tool and method: software to help organise and manage complex projects.

While working for Egis, Ziv has had the chance to test his ideas and tools on live projects including metro lines in Medina, Saudi Arabia, Line 16 in Paris and a planned metro in Lyon. Prior to working at Egis, his studies included stints in Cape Town looking at stakeholder issues on a Bus Rapid Transit project, four months tunnelling in Turin and a transportation project in the historic city of Korçë in Albania.

"What I like best about my job is the variety of tasks, being able to work on different projects," he says. "With Egis I have done so many things: developed tools, worked on projects, worked with R&D teams and participated in conferences."

Ziv's advice to would-be tunnelling engineers is to arm themselves with an understanding that goes beyond the underground. "Don't just study tunnelling and structural engineering, have a broader view of what is tunnelling is and why we build tunnels. Are there possibilities other than tunnels to deliver those functions? Why are we building these tunnels?" ■



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