
ITAym
breakthrough
The ITA Young Members' Magazine
Issue 3 2017
YM
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Extending the São Paulo Metro
ITAYM's Global Network Grows
A Week in the Life of a TBM Engineer

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Welcome to 'Breakthrough'

Dear Tunnellers,

On behalf of the ITAYM Steering Board it is a great pleasure to present the third edition of Breakthrough magazine. Breakthrough is the official magazine of the International Tunnelling and Underground Space Association's (ITA) Young Members Group (ITAYM) and is made by and for people who work in the tunnelling industry.

A career in tunnelling presents a great opportunity to work in a competence driven and highly dedicated global environment. This manifests itself in the great diversity of people we meet on work sites and conferences around the world.

This unique industry will become more important than ever in the coming years and I strongly believe that the key to solving several of our society's current and future challenges can be found underground. This has been highlighted recently by a series of tweets written in frustration over the traffic situation in Los Angeles. These tweets have ultimately resulted in a new tunnelling company and a global focus on tunnelling in social media. I will not spend too much space on Elon Musk's entrance into the tunnelling world, but no matter if he will revolutionize tunnelling or not, he is helping our industry and the rest of the society to see how great the potential of tunnelling is.

Musk is also illustrating that great technological developments are needed to satisfy the global society's future needs from the tunnelling industry. In that regard, I am certain his entrance into the industry will work as a catalyst for technological developments that will introduce countless opportunities for young tunnelling professionals in the future.

In this developing tunnelling world we believe that building relations across nations and projects is more important than ever. It is therefore with great pleasure we see a high level of activity within the ITAYM and its member nation groups. Since last year we have, among other things, increased our social media presence, introduced quarterly Breakthrough e-newsletters, hosted a very successful regional ITAYM event in Switzerland, and seen several new member nations getting involved.

Lastly, I have the great pleasure of welcoming you to Norway and Bergen for the World Tunnel Conference 2017. The Norwegian tunnelling society and the ITA have been working very hard to make sure you will have a great experience in Bergen. The ITAYM will be hosting several events and we look forward to see you there!

Keep tunnelling!

Sindre Log
Chair ITAYM

Front Cover
Tobias Andersson, TBM Construction Manager for the Skanska/Strabag Joint Venture, inspects the cutterhead of a 9.3m diameter Tunnel Boring Machine (TBM) that is currently mining the second tube of the Ulriken Tunnel, in Bergen, Norway. It is the first rail tunnel to be excavated using a TBM in Norway's history (see p28). Photo by Jan M Lillebø.

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Breakthrough is endorsed by the ITA

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 and 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. The Chair and the Vice-Chair are subject to the approval of the ITA General Assembly. Steering Board members are elected for alternating periods to ensure continuity of the group. The mandate is for two years.

Sindre Log
Chair

Sindre is a dedicated tunneller that thinks underground solutions can solve a lot of society's future challenges. After gaining his Masters in Civil Engineering from the Norwegian University of Science and Technology (NTNU), Sindre started working for the TBM Manufacturer The Robbins Company. Having spent his first years with Robbins travelling to TBM projects around the world, he is now working more from the office on geological related topics and market development, but still gets the chance to go to sites and conferences around the world from time to time.

Sindre has been involved in committee work for the Norwegian tunnelling society for the last decade and has been heavily involved in the foundation of both the Norwegian Young Members group and the ITAYM. Log is currently also a part of the organising committee for the World Tunnel Congress (WTC) 2017.

Sindre is fond of outdoor activities such as skiing, fishing and football, but spends most of his free time running/climbing/playing football/drinking coffee while hanging around in playgrounds, woods, or fields trying to keep one of the future generation of tunnellers happy.

Lasse
Vester

Lasse graduated with a Masters in Building Technology from the Technical University of Denmark in 2012. From 2012-2016 he worked as a Design Engineer on the Fehmanbelt Fixed Link project and since 2016 he has been employed as a Tunnel Engineer for Rambøll in Denmark. Before his Masters degree, Lasse worked for Danish contractor E. Pihl & Søn AS on construction projects in the Copenhagen area.

Lasse is currently the 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.

Nichole
Boultbee

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

She is registered as a professional geoscientist (P.Geo) 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) as a representative for Young Members. 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.

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.

Joanne
Sui

Joanne gained her Bachelors in Civil Engineering at University College London. She has been working for London Bridge Associates since 2012 and is now an Assistant Project Manager on the Thames Tideway Project. 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!).

Doris
Frank

Doris graduated in 2012 at the Faculty of Civil and Geodetic Engineering, in Ljubljana, Slovenia. After completing her Masters degree, she started working as a Tunnelling and Geotechnical Engineer at Elea iC, a member of the iC group of companies. In the past five 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.

Senthil
Nath

Senthil gained his Bachelors in Civil Engineering and a Masters in Geotechnical Engineering from the Indian Institute of Technology and TU Dresden, Germany. He was awarded the ITA's ITACET Scholarship to pursue a Masters in Tunnelling at the Politecnico di Torino, Italy, and is currently a Sr. Tunnel Engineer at Geoconsult, in Singapore. Senthil's career is divided between India, Singapore and Indonesia. He is an active member of his local tunnelling society (TUCSS). Senthil is a passionate photographer, blogger and loves to travel.

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Contents...

ITAYM's Global Network Grows Further

In the space of three years, the ITA Young Members group has grown from a few willing young engineers to a burgeoning international network of young professionals that reaches around the globe. Breakthrough's editor, Amanda Foley, speaks to ITAYM Chair, Sindre Log, and Vice Chair, Lasse Vester, about this year's activities and where the organisation is headed.

Since it's official establishment at the Brazilian World Tunnel Congress (WTC), in 2014, the International Tunnelling and Underground Space Association's (ITA) Young Members group (ITAYM) has gone from strength to strength, becoming a burgeoning global networking platform for young tunnelling professionals. More than 35 Young Member Nations have now been recruited into the group's ranks and many of these were represented in person at the second ITAYM General Meeting, at the 2016 WTC in San Francisco, last summer. Somewhere in the region of 120 young tunnellers attended the Congress, all gathering for a highly-successful networking reception in downtown San Francisco – including 40 civil engineering students who were the recipients of a conference scholarship initiative organised by the USA tunnelling association's Young Members (UCA of SME Young Members).

The General Meeting began with presentations by ITAYM Steering Board members on aims, objectives, promotion and future plans. The Chair and Vice-Chair roles on the ITAYM Steering Board were formally passed on to Norway (Sindre Log) and Denmark (Lasse Vester), respectively, and three new Steering Board members were also elected, with representatives from the UK (Joanne Sui), Italy (Giuseppe Maria Gaspari) and Slovenia (Doris Frank) joining the Board. A short workshop was also held at the meeting, with attendees breaking off into smaller groups to identify what they wanted from the ITAYM and what the goals for the coming year should be.

"We're still here to assist in establishing young member groups, but our focus will now be more on developing a global network for the existing young member nations."

Lasse Vester, ITAYM Vice-Chair

Lines of Communication

"One of the main objectives set out in San Francisco, was to build on our social media presence and increase our use of digital mediums to open the lines of communication between Young Member nations," says Sindre. As a result, the ITAYM has become much more active on twitter and LinkedIn and has also introduced a facebook page. "There are a lot of YM Member Nations with their own social media presence, such as Canada, Norway, Sweden, and of course the British [who are now in their ninth year]," says Lasse, "and we are starting to have that interaction, because we see a lot of re-posts and posts on each other's pages. Now we need to increase awareness and to encourage more groups to get active on social media and we will begin to reach the critical mass we are aiming for."

This increased social media presence was highlighted in December, when the British Tunnelling Society Young Member (BTS Young Members) held their second #TunnelDayUK social media event, which aims to generate interest in tunnelling projects currently being undertaken in the UK and to promote the tunnelling industry (and its many professions) to people of all ages. The Australasian Tunnelling Society's (ATS) Young Members, joined in on the action, holding their first #TunnelDayOz; the Canadian and Italian Young Members also got involved, as did many companies and project teams. The ITAYM re-tweeted and re-posted many of the photos and messages, acting as a hub to bring all these events together. This has prompted the ITAYM to launch the #WorldTunnelDay event (see p10) and it is hoped that many more YM Nation groups will get involved this December.

The ITAYM has released its first 'Webinar' via its YouTube channel and future Webinars are planned for the coming year, which will be organised in cooperation with the ITA's Committee on Education & Training (ITACET).

"There are a lot of great initiatives being carried out by Young Member Nations, that experience needs to be exchanged via the ITAYM Network."

Sindre Log, ITAYM Chair

"We've also established a quarterly 'Breakthrough e-Newsletter' and highly encourage people to sign up for this on the www.tunnellingjournal.com website,' says Sindre, "this combined with the increased social media presence, is enabling us to communicate much more effectively." Proof of this improved communication manifested itself in the level of attendance achieved at the ITAYM's first Regional Event, which was organised by members of the recently established Swiss, Austrian and Slovenian Young Members groups and supported and promoted by the ITAYM (see p34). The event saw 45 young tunnellers come together from more than 10 different countries to take part in a two-day event at the Hagerbach Test Facility, in Switzerland. The event's success is apparent and the ITAYM is very keen to encourage and support similar initiatives. "Our role is to make people aware of the opportunities and to provide assistance, be it in helping to arrange speakers for an event, setting up project tours, or even providing budget assistance by helping to set up sponsors," says Sindre.

As for the upcoming WTC, in Bergen, Norway, this June, a host of events are planned. "First of all, we have the ITACET training course on Soft and Challenging Mixed Ground Conditions," says Sindre. "This is the first time that the course has been supported by the Young Members, and I think we have a great programme set up." There is the ITAYM morning run, which will take place on Monday, June 12, at 06:30am and the WTC morning run on Wednesday, June 14, at 7:00am, which take in the sights of Bergen. The ITAYM Social Event is on the Monday, at 7:00pm, at the Ole Bull Scene, after which there is a free concert. Last, but not least, is the General Meeting on Wednesday morning. Look forward to seeing you there!

#WorldTunnelDay

December 4 is the Feast Day of Saint Barbara, the patron saint of tunnellers and miners and all others who work with explosives, who venerate her due to her association in legend with lightning.

According to the legend, Barbara lived in the third century near Istanbul, Turkey, and was the only daughter of Dioscuros, a wealthy and influential pagan who sought to keep her from the influences of the outside world by locking her in a tower. She eventually escaped and when she declared herself a Christian was denounced by her father and handed over to the authorities.

According to later versions of the legend, during her escape Barbara took refuge with the silver miners of Laurium in Greece, but on leaving the mine shaft she was captured and condemned to death. Her father himself carried out her beheading but was struck dead by a bolt of lightning as punishment for his monstrous crime. Barbara's tomb later became a site of miracles.

December 4th celebrations are marked around the world, with different traditions taking place in different countries; a day-off for certain mines and tunnel projects in Germany and France, masses and dinners on tunnel sites in Italy, Spain and Greece, and parties around the world from Australia, to the UK and Canada.

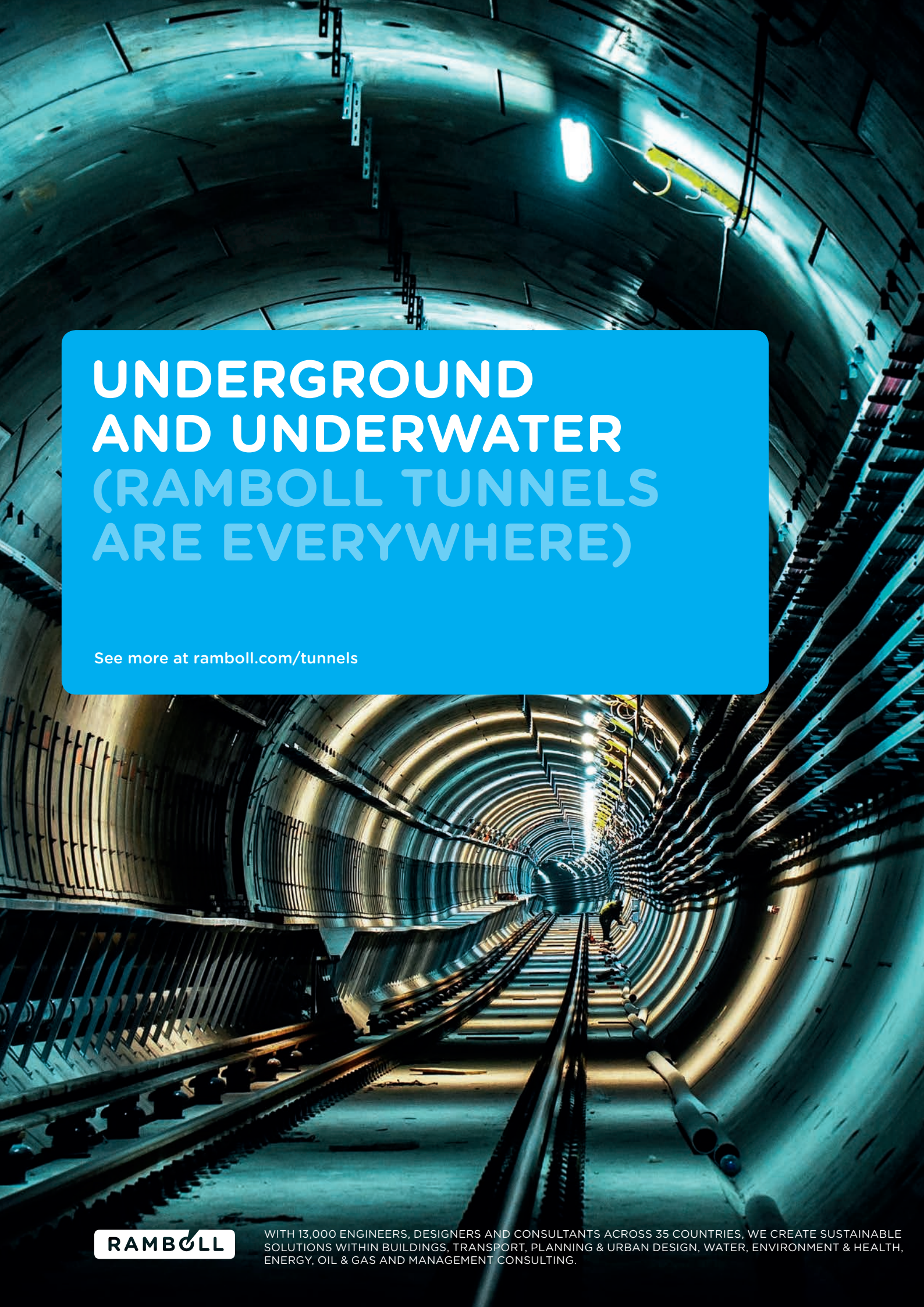
Prompted by the highly successful #TunnelDayUK social media event (see p18), the ITA Young Members are now launching **#WorldTunnelDay**, which will take place on Thursday 7th December 2017. The aim of the day is to generate interest in the great number of world class tunnelling projects currently being undertaken across the globe and to promote the industry (and its many professions) to students and also members of the general public. The day will become an annual event held on the first Thursday in December, due to its proximity of the Feast Day of Saint Barbara.

As part of the day we are will be running a social media event on twitter using the hashtags **#WorldTunnelDay** and **#Tunnels**.

We would like as many people, project teams, companies and organisations as possible to tweet and re-tweet inspiring images, messages and news (historical or current) using the hashtags and get it trending on twitter!

A few things that YM Member Nations can do to support #WorldTunnelDay:

- Get support from your Member Nation Committee
- Create a poster and a press release to promote the event
- Circulate these to members of your national tunnelling organisation
- Organise events for the day and get as many people on board as possible
- Photos, video clips and messages on twitter, Instagram and facebook using #WorldTunnelDay and #ITAYM
- Spread the word about tunnelling and underground construction
- Have a great time!



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Extending São Paulo Metro's Line 5

São Paulo Metro's Line 5 Extension is due to open to the public this December. Stefania Stefanizzi, a Civil Engineer at Geodata SpA – the firm responsible for the design and construction management of the project – outlines key features of the design and some of the challenges faced on this major metro extension.

Aerial view of the completed Brooklin Station

Despite having a well-established transportation network, the subway system in the São Paulo Metropolitan Region (SPMR) remains comparatively small for one of the largest metropolitan areas in the world. Passenger density per kilometre of line is one of the highest in the world, particularly at peak-hours, due to the limited reach of the system.

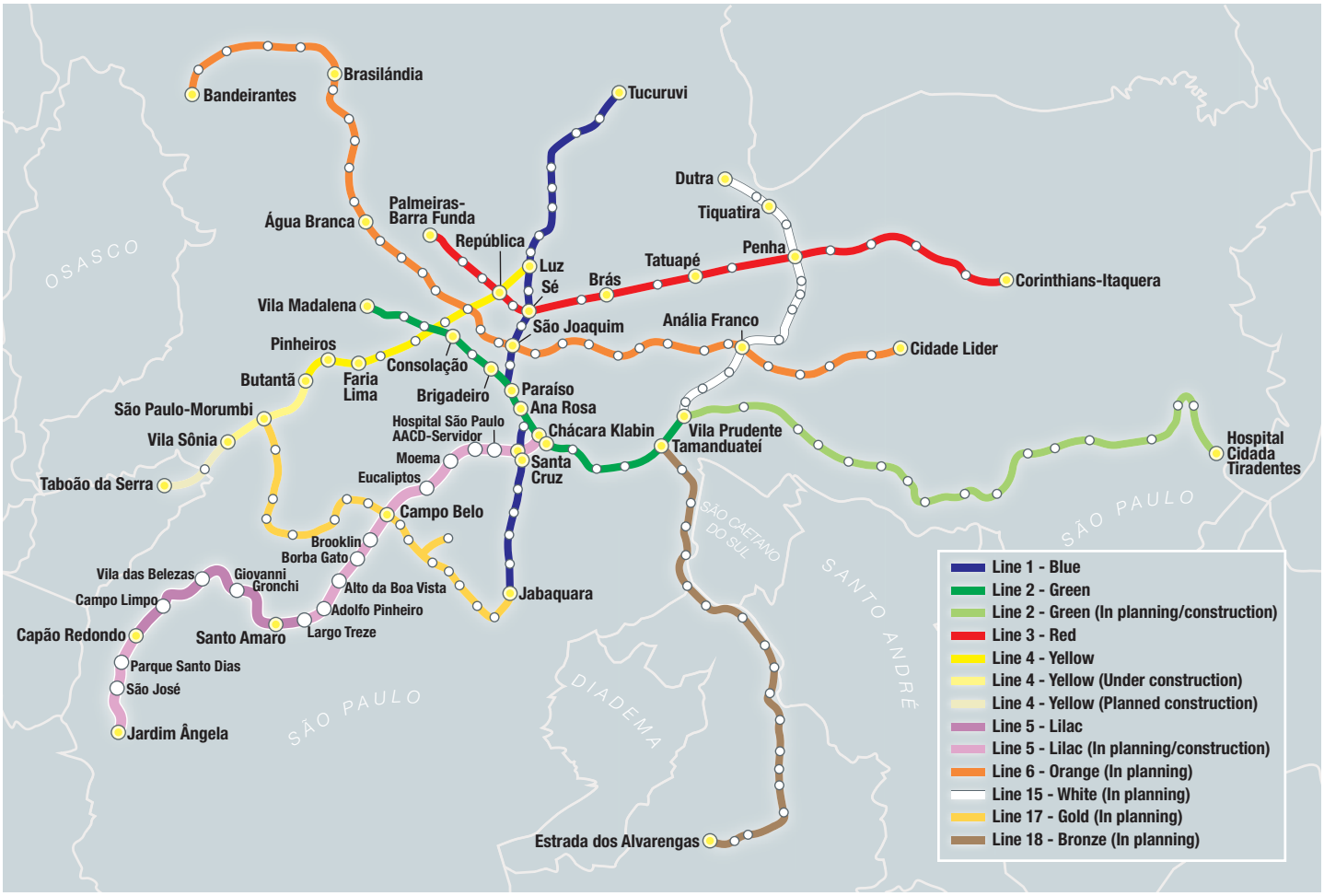
São Paulo Metro's existing Line 5 corridor, which runs from Capão Redondo to Largo Treze (see map), has been in operation since 2002. Its extension will have a significant impact on mobility within the SPMR, extending the line from Largo Treze to Chacara Klabin, thereby linking the very busy Santo Amaro area to the expanding city centre. The extension will also enable transfers to Line 1 (Blue) at Santa Cruz station and Line 2 (Green) at Chácara Klabin station. With the new link operational, Line 5 will greatly enhance accessibility within important employment areas, as well as health and education facilities for a very large population who at present only have access via road-based transportation, reducing the travel times from the city's South Zone to the centre of São Paulo by about an hour. The construction of the project is divided into 7 Construction Lots. These encompass about 11km of line, 10 stations, 10 shafts for ventilation and evacuation, 1 shaft at the train depot, 2 construction shafts (one for the launch of the two tunnel boring machines (TBMs) that will excavate the twin-tube single track portion of the line; and another for the arrival of the two TBMs and for the launch of a third TBM for the single tube-double track section), and a train depot with an area of 176,000m^2.

The construction of the Line 5 extension

Excavation of Chakara Klabin Station

Excavation of the Hospital São Paulo sStation

Excavation of Chakara Klabin Station below the existing operational Line 2 station

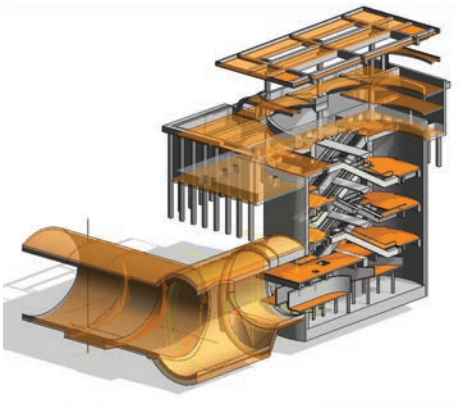


came after a highly-publicized accident that occurred during the construction of Pinheiros station, on Line 4, in January, 2007, when a large part of the site access tunnel collapsed, opening an 80m diameter crater that resulted in seven fatalities. This accident provided a harsh lesson for the entire tunnelling community underlining the inherent need to apply a rigorous and systematic risk management approach. Following the Pinheiros accident, the owner of the line, Companhia do Metropolitano de São Paulo (CMSP), decided to assign the application of Risk Management principles for the Line 5 Extension to the so-called ATO (Acompanhamento Tecnico de Obra, i.e. technical follow-up by the Designer) within the contract documents.

Construction on the Line 5 Extension began at the end of 2011, in parallel with the design, and three stations are due to go into operation this July (Alto da Boa Vista, Borba Gato and Brooklin). The remaining stations will be operational by the end of this year, except for the Campo Belo station, which is expected at the beginning of 2018. The Line 5 Extension has been completed despite the corruption scandal known as Lava Jato ("Car Wash") that has deeply affected Brazil's construction sector.

Geology

The regional geology of the São Paulo sedimentary basin can be summarised in terms of three major geological units: (1) The Precambrian bedrock composed of granitic-gneiss and residual soils with different levels of weathering, that decreases from the top to the bottom, where the weathered part is greatly associated with water circulation and inflow; (2) the Tertiary sediments subdivided into two units, the Resende formation, an alternation of a low sandy grey clay, and grey and yellow silty sand, generally little argillaceous, and the São Paulo formation, that corresponds to the meandering fluvial system deposits of the Tertiary Period (Paleocene) of the Taubaté group, composed of sandstone, sometimes conglomeratic and characterized by graded variations in both vertical and horizontal permeability; (3) the Quaternary sedimentary deposits of unconsolidated sands, organic clay and peat (with potential high settlements). The groundwater table is generally slightly below the ground surface. Multilevel aquifers exist, separated by the impermeable clayey layers.



Model of the Hospital São Paulo Station

Stations

Different construction methods have been used for the 10 stations on the line: the 'cut and cover' method (with a bottom-up configuration), mined underground stations excavated using the NATM method, and multi-secant pile large diameter shafts. The platforms have a length of 136m, with a variable depth of

21m to 49m, depending on the station type.

The design of the large mined caverns of the underground stations, with excavation areas of more than 250m^2 – in the densely populated context of the city of São Paulo – in soil and under the groundwater table, was a challenge. To model the intersections between different parts of the station, complex design tools were utilised – largely operating in the Building Information Management (BIM) environment, combining 2D and 3D numerical models with flow analysis, sensitivity and parametric analysis – to define the impact at the surface and on existing structures, as well as the potential risks and the relative countermeasures to be applied. The combination of the design with a rational interpretation of the results from monitoring and in-situ measurements permitted a real-time integration of the design and the construction, ensuring the maximum level of safety during excavation and minimizing settlement-induced damage.

The design of Chakara Klabin station has been extremely interesting, characterised by its transfer with Metro Line 2 (Green). The general layout of the station includes the construction of a circular 30m diameter access shaft and the excavation of the main tunnel with a section of about 270m^2 for a length of about 62m. The excavation was performed with Line 2 still in operation, in the zone below the existing station, protected by a diaphragm wall that was executed during the construction of the previous line and reinforced during the actual excavation with the application of tendons. The levelling points on the existing subway station showed negligible settlements.

The iconic Brooklin Station has won an award from the Brazilian ABECE association (Associação Brasilieira de Engegnharia e Consultoria Estrutural). It was created by excavating five interlocking secant pile shafts, each with an external diameter of about 36m, resulting in a total station length of about 140m and a depth of about 27m. Due to special constraints at the station site (polluted multilevel aquifers, limited space for the construction site, interferences at the surface) at the design stage we were challenged to find a reliable solution, compatible with the tight construction schedule.

According to the preliminary design of the station (projeto básico), the execution sequence was outlined using a plastic diaphragm wall (without steel reinforcement and using concrete with a low resistence) excavated with claim shell along the entire perimeter of the shafts; lowering of the water table outside the shafts; excavation of the primary shaft; construction of the shaft's secondary lining and struts; providing support during the excavation of the following shafts, which would be built in the same way.

Under the dome at Brooklin Station

Analysing the preliminary design with a risk analysis approach some potential hazards were identified (settlements on the surface due to the external drainage, instability at the bottom of the excavation with possible rupture, interference of the drainage basin with the existing polluted area located not far from the site, possible deviation from the verticality of the diaphragm wall with water-tightness of the diaphragm not guaranteed and potential reduction of the internal lining thickness) and an alternative approach was recommended by Geodata.

According to the results of the Risk Analysis, it was decided that lowering of the groundwater table should be avoided and the diaphragm wall should be substituted with a structural diaphragm wall with steel reinforced concrete, executed using a hydromill, excavating all the shafts simultaneously; and at the same time installing the struts, located in the permanent position as defined by the architectural layout.

Construction of the station following the proposed solution began in August 2012 and in October 2013, i.e. after only a year, the excavation had reached its designed depth and the concrete base slab had been poured, just in time for the two TBMs to enter and pass through the station.

According to the instrumentation data, the overall behaviour of the structure was in line with expectations, providing a high level of safety of the works. The implemented solution, compared to the original one, brought with it an incremental cost increase of about 10-15%, but also a significant gain in the execution time of about six months with respect to the contract schedule.

The configuration of multi-secant large diameter shafts had already been applied on the other lines of the São Paulo Metro (Luz station with three adjoining shafts for the line 4) but at Brooklin station it was the first time that all the shafts were excavated simultaneously.

Multi-secant large diameter shafts at Brooklin Station

TBMs and Train Depot

One of the distinctions of the Metro Line 5 Extension is the simultaneous operation of three TBMs in the city. This is a first in the history of São Paulo Metro's construction. In the first approximately 5.5km stretch, from the shaft Conde de Itù to the shaft Bandeirantes, two TBMs with an excavation diameter of 6.9m worked in parallel. In the second section, from the shaft Bandeirantes to the shaft Dionisio da Costa, for approximately the same tunnel length (5.5km), a TBM with an excavation diameter of 10.6m was deployed.

The concept of iterative design through the use of a Plan for Advance of Tunnel (PAT) was largely used in the excavation of the running tunnel with TBMs. The data from the TBMs, from monitoring, to geology and hydrogeology, were all collected in real-time and stored in and processed using the system GDMS (developed by Geodata), in order to determine the need for adapting the – earth pressure balance (EPB) – face support pressure operational ranges defined at the design level or by the TBM's operational parameters.

No less interesting has been the design of the train depot, which covers an area of 176,000m^2.

Working Group

The design success of a complex Metro project like the Line 5 Extension was achieved through a multidisciplinary approach, rigorously managing (through the use of BIM) design interfaces among the civil works, the electrical & mechanical works, the various systems and the real-time responses from construction.

Another key factor for success was the strong commitment of the people involved. Indeed, more than 250 professionals, from Geodata's São Paulo office and Turin headquarters, worked together with dedication and enthusiasm, interacting daily with the Client, Companhia do Metropolitano de São Paulo, and with all the Contractors. All parties came together, sharing their combined experience and merging the Italian and the Brazilian cultures to reach a common goal: the success of the project.

View of the segmental tunnel lining

The 176,000m^2 Patio Guido Caloi Train Depot

Stefania Stefanizzi works as Civil Engineer for Geodata SpA, which was appointed in 2011 – with Geodata Geoengenharia do Brazil – through international tender, to undertake the Detailed Design and Construction Supervision of all 7 Construction Lots of the Line 5 Extension. She holds a PhD in Geotechnical Engineering from the Polytechnic of Turin, Italy, in collaboration with the Geomechanical Research Center of Sudbury, Canada. Working for Geodata, she has gained worldwide experience on rail, road and metro tunnels, especially in Russia and South America. She had a crucial role in the delivery of the design for the Line 5 Extension, following and coordinating the comprehensive production of more than 15,000 documents.

YM MEMBER NATION NEWS

Italian YM's Set their Sights on Naples 2019

After a year of informal coordination between the younger crowd within the Italian Tunnelling Association (SIG) during conferences, courses and site visits, an official Young Members group was established in the fall of 2016.

The first meeting of the SIG-YM Group took place in Bologna after the SIG Annual Conference/Expotunnel 2016. During the kick-off event, Young Members elected Marco Ranieri and Giuseppe M. Gaspari as their representatives for the first three years. Since then, SIG-YM has begun to plan activities and establish goals in preparation for hosting other ITA YM Groups at the World Tunnel Congress (WTC), in Naples, in 2019.

Subsequent SIG-YM meetings have been held at Italian tunnel project sites following site visits organized by SIG. Young Members have also begun to plan their own events, such as a recent site visit to the job site for the new subway line in Catania, which included a tour of the impressive 10.56m diameter EPB-TBM.

Young Members are actively taking part in the SIG Working Groups. SIG-YM also aims to organise its first "YM-workshop" for the fall of 2017.

Coordination with other Young Member groups and associations sharing similar interests, such as the Italian Geotechnical Association (AGI), was an important part of SIG-YM's initial activities in order to help the group reach a wider audience and to be attractive to new members. Several SIG-YM presented papers were given during the IAGIG (Annual Meeting of Italian Young Geotechnical Engineers) to the point that a session was specifically dedicated to tunnelling and a meeting was held during the conference within the Young Members of the two associations.

Finally, regional ITAYM events, such as the technical visit to the Hagerbach Galleries, in Switzerland, were intensively promoted and well attended by SIG-YM and a fairly good delegation plans to show-up in Bergen for the WTC 2017.

The Italian Tunnelling Society will continue its support of the YM Group activities in the near future in order to enlarge the group in numbers and capabilities and connect them to other international groups, aiming to be ready to lead the ITAYM gathering in Naples for the WTC 2019.

An inspiring year for Denmark's Young Members group

In Denmark, Young Members have had an inspirational year. They have seen presentations on future projects and had a lessons-learned session from one of the country's historic megaprojects. Of all the presentations and site visits the Danish Tunnelling Society Young Members group (DFTU-YM) have arranged, the site visit to the extension of the Copenhagen Metro, to the North Harbour, deserves to be highlighted. On this construction site the Hochtief-Züblin Joint Venture (MetNord JV) were preparing to launch their TBM for the 2nd tunnel and gave an introduction to TBM tunnelling in Copenhagen and the design considerations behind the TBM chosen for the

project. A very interesting and instructive event!

2017 was kicked off with a large presentation on lessons learned from the Øresund Immersed Tube Tunnel. It was a very interesting presentation and a good way of transferring knowledge from one generation to another. In May, a group of 12 Danish young tunnellers enjoyed the opportunity to visit the Swiss Alps as they participated in the ITAYM Regional Event to Hagerbach.

On the organisational side of things DFTU-YM has now established a Facebook page to get better interaction between its members. The DFTU-YM look forward to many new events in the coming year and hope to participate in future international gatherings!

Auspicious time in Australasia

It is an auspicious time for the tunnelling industry in Australia with the commencement of the NorthConnex (AU$3bn) and WestConnex (AU$16.8bn) projects, in Sydney. This on the back of the recent completion of tunnelling on the NorthWest Metro (AU$8.3bn) and the soon to be opened Waterview Project (NZ$1.4bn), in Auckland. As far as new projects there is the recently awarded WestGate Project (AU$5.5bn), in Melbourne, and the imminent Sydney City Metro (AU$11.5bn) and Melbourne Metro (AU$10.8bn) tender award announcements. So if you are looking for work, head to Australia, there is a bit on!

The ATSym held its first Young Member social evening in August 2016 to help foster the professional network between the current projects that are underway. The first social forms part of the wider strategy from ATS and the ATSym to increase the visibility of the ATS brand and the broader tunnelling community. The ATSym are looking to ensure that the best and brightest are looking to build a tunnel rather than a high rise or bridge. The night was attended by tunnellers young and old with undergraduates, graduates, young engineers and more senior experienced industry professionals. The night was a great success with many new friendships made across projects and generations.

The ATSym continues its engagement with universities across Australia with five visits to universities in the last year. This again is part of a strategy to improve the visibility of the industry. The latest event saw alumni from the University of Sydney return to talk to students about opportunities to travel, learn and grow with the tunnelling industry.

The ATSym continue to be a catalyst for change within the ATS in pushing the organisation for change and improvement. The major achievement in this space over the last 12 months is the scoping, planning and delivery of a revitalised website for the society. The Young Members continue to be active and involved in ATS activities including being key members of the upcoming ATS Conference. This is the peak industry event that draws together the best designers, contractors, suppliers and key clients under one roof.

Canada builds Ontario Chapter

Canadian Young Members from the TAC (Tunnelling Association of Canada) recently organised a kick-off meeting in Toronto to start building up the group in Ontario with local activities and events. TAC-YM also hosted 31 University of British Columbia students at the Boulder Creek Hydro Project. They got to see a portion of the tunnel, the powerhouse and a look up in to the turbines from the tailrace. The students also got to learn how to read the tunnel design drawing package.

Building on Success in the US

Following last year's highly successful World Tunnel Congress (WTC 2016), in San Francisco, the UCA of SME (Underground Construction Association of the Society for Mining, Metallurgy & Exploration) Young Members are having an active 2017. They began the year by encouraging attendance to the George A Fox Conference, in New York, in January, and have been busy planning several events for the Rapid Excavation & Tunnelling Conference (RETC) in San Diego, California, this June. At the RETC conference, the UCAYM will host a scholarship orientation for students who have won bursaries to attend the event, as well as the ever-popular Annual UCAYM Networking Event. The UCAYM continues to develop close relationships with colleges and universities with strong tunnelling, mining, and geotechnical engineering courses to increase the visibility of the industry.

UCA of SME YOUNG MEMBERS

In addition, the UCAYM hosts free online Webinars every month that comprise a variety of topics including case studies, recently completed or current projects, ongoing industry research, and professional development. For additional details and to view their free upcoming and archived Webinars, please visit the UCAYM website: http://community.smenet.org/ucaym

YM MEMBER NATION NEWS

BTS Young Members Enter Ninth Year Stronger Than Ever

The British Tunnelling Society Young Members (BTSYM) have had a busy year. The group welcomed in a new committee in November 2016, with Emma Hale (Mott MacDonald) taking over as Chair, David Brock (Atkins) as Secretary, Nick McCrossan (Mott MacDonald) as Media Chair, Sam Huckle (Balfour Beatty) as Professional Development Chair and Gerard Quigg (Cowi UK) as Schools & Universities Chair.

This marked the start of the 9th year of the group. Since then, they have celebrated the 2nd "National Tunnelling Day" on 1st December by holding a school event with a TBM naming competition, a site visit to the Northern Line Extension, a contracts workshop, a Christmas themed social and a boat trip along the Tideway project route. They also once again ran their online social media campaign using #TunnelDayUK achieving a reach of 2.5 million. Numerous clients, contractors, consultants and suppliers got on board and posted about their latest projects, work and products, as well as our committee and members showcasing their roles and experience. The group is already planning their 2017 event with a focus on getting the industry visible to the general public, whilst also looking forward to working with other national groups to deliver #WorldTunnelDay.

One of the key aims of the BTSYM this year is to be in a position to launch its 'Teachers Pack' in 2018. The full pack is currently being trialled at the London Academy as part of their enrichment programme and has received excellent feedback. The pack was started a number of years ago and has been developed over the years by running some of the sessions within schools and universities as they were developed. The 'Teacher's Pack' is a resource that will be available online for teachers to download and run within their schools. It will consist of material for five lessons that can be carried out independently by the school. The pack includes sessions on design considerations, tunnelling techniques and geology. This will allow our schools and universities branch to have a far wider reach than we can currently achieve with our membership base and is being supported by the Institution of Civil Engineers. As part of this trial the BTSYM has also committed to providing additional sessions to give the students a feel for the industry by taking them on a site visit to Northern Line Extension, apprenticeship presentations by Tideway and a visit to the Institution of Civil Engineers, to help inspire the next generation.

In March, the BTSYM held their 4th Annual conference in London. The day was chaired by BTSYM Chair Emma Hale (pictured below)with 12 young members presenting their projects and experience, sharing their knowledge with others in the industry. Presentations were given by Consultant and Contractor young members on topics from 'applying BIM to major projects' to 'traditional timbered hand excavation' and 'seismic behaviour of tunnels in urban environments' to 'Røssåga hydroelectric project in Norway'. Joanne Sui and Sindre Log also gave an update on the ITAYM activities to the 90 attendees on the day. The full day event was sponsored by BAM Nuttall as the gold sponsors, London Bridge Associates and Bekaert Maccaferri as silver sponsors and Mott MacDonald, Cowi and Gall Zeidler as bronze sponsors. The day concluded in some networking over canapés and drinks where the attendees continued their discussion on what the future holds. Throughout the day the Slido application was used to encourage the engagement of the attendees, giving them the opportunity to record their comments and questions as the presentations were given. This generated a far more interactive environment between the speakers and the audience and the BTSYM will be looking to run this again at future events. The BTSYM conference is open to all under 35 and very much welcomes those from overseas to come and present! For details or to register your interest for 2018 please contact Emma.Hale@mottmac.com

AFTES off to a Flying Start in France

The ITAYM are proud to announce the first meeting of the French Young Members, at the Paris at Maison des Ponts et Chaussées, in Paris, France, this April. Several initiatives have been launched since then, both to involve more young professionals in AFTES (Association Française des Tunnels et Espace Souterrain / French Association for Tunnels and Underground Space) events and activities and to share knowledge between generations, including participation in the "Mardis de l'AFTES" organisation (conference held every quarter); Young Members in each AFTES Working Group (AFTES recommendations); participation in AFTES site visits; organisation of informal meetings between Young Members; participation in international events organised for Young Members such as the YPTDP initiative and ITAYM Regional events.

The aim of this group is also to generate new ideas and encourage innovation in Tunnels and Underground Space by involving Young Members into the AFTES organisation.

BYM Swings into Action in Sweden

Since the 2016 World Tunnel Congress (WTC), in San Francisco, Sweden has established its own national Young Member-group, called BYM. The initial goal was to gather 70 members within two years, a goal that was actually reached within just a month. Today, BYM has approximately 135 members, who communicate through the Facebook page "Svenska Berggruppen för Yngre Medlemmar" where everyone is welcome to post or invite to different events.

BYM has set a goal of arranging one or two big events per year, in addition to a few smaller events. The purpose is to enable members to connect, exchange experiences and develop the network. These events may be lectures or study visits combined with a networking activity. The first event arranged by BYM was a study visit to the Forsmark Nuclear Power Plant, in November 2016. During the two-day trip, 25 delegates listened to interesting lectures and got an insight into the nuclear power plant operation, including the underground repository strategy for spent fuel and other radioactive material. Furthermore, a workshop was arranged to identify members' expectations and wishes regarding the Young Member group's future.

The Swedish Rock Construction Committee, the National Member and the Swedish Secretariat for the ITA-AITES, is going through an exciting change and will become Swedish Rock Engineering Association. As part of this change, BYM will become an official, permanent working group within the association. This will help the group develop and increase its capacity further. For example, BYM is now looking into the possibility of a mentoring programme.

Growing Network in Greece

Founded in 2014, the Greek Young Members are keeping busy with their group within the GTS (Greek Tunnelling Society). The main goal of the group is to increase the awareness of the tunnelling industry among young professionals by creating a strong network among its members. Its 50 members are mainly civil, mining, survey engineers and geologists with primary expertise in underground works and tunnelling projects. A steering board of 10 members is now responsible for directing and organising events and lectures. The YMG-GTS group is now seeking new ideas for upcoming events and workshops and is always open to collaborating and getting involved with other Young Member Tunnelling Groups worldwide, get in touch with them through their official email: ymg.gts@gmail.com

How to set-up a Young Members group

Contact your Member Nation and ask if a Young Members Group already exists

Visit **www.ita-aites.org** to check if your country is a Member Nation of the ITA

YES

NO

Join up!

NO

Work with officials to see if it is possible to set one up

Send an email to **secretariat@ita-aites.org** to see how your country could become an ITA Member Nation

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.

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.

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.

6.

35 ITAym

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!

YOU NOW HAVE YOURSELF A YOUNG MEMBERS GROUP – ENJOY!

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breakthrough YM

Photo Competition

This year Breakthrough is launching an annual photo competition open to all young tunnelling professionals. Whether you are a budding photographer or just like to take snaps on your compact camera or smartphone, we want you to share your best pictures with us!

Help us to show off the varied and interesting world of tunnelling and underground construction by entering your photos into our annual Photography Competition, sponsored by Bekaert Maccaferri Underground Solutions.

To be in with a chance of winning, make sure you send us eye-catching images that relate to 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 photograph will feature on the cover of Breakthrough's 2018 edition, as well as websites, newsletters, Breakthrough's Flickr site, social media and more – there will also be a special prize from our sponsor Bekaert Maccaferri Underground Solutions.

Throughout the year the entries will be hosted on Breakthrough's Fickr page (https://www.flickr.com/people/breakthrough_magazine/) and will be judged by members of the ITA YM Steering Board and Breakthrough's editorial team prior to the next issue of the magazine.

The rules are as follows:

- Photographs should be submitted by email to amanda@tunnellingjournal.com or using a free large file transfer service such as Dropbox.
- Please include a caption to explain your picture.
- There is no limit to the number of photographs that you may enter. If you are not certain whether your photograph will win or you are trying to choose between several possible entries, then please just enter them all and let the judges decide.
- Ideally the photograph should be of good print quality, but if it is available only as a web quality image then please still enter.
- 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.

Leading the Way

The ITA's Executive Council (ExCo) has a big mission: to explain to the world what tunnels can do for society in a world that's changing fast.

When Tarcisio Celestino, the president of the International Tunnelling and Underground Space Association (ITA-AITES) wants to spend a day at the beach he sometimes travels along the coast of Sao Paulo State on road SP-55. Brazil's shoreline there is beautiful with small beaches and islands.

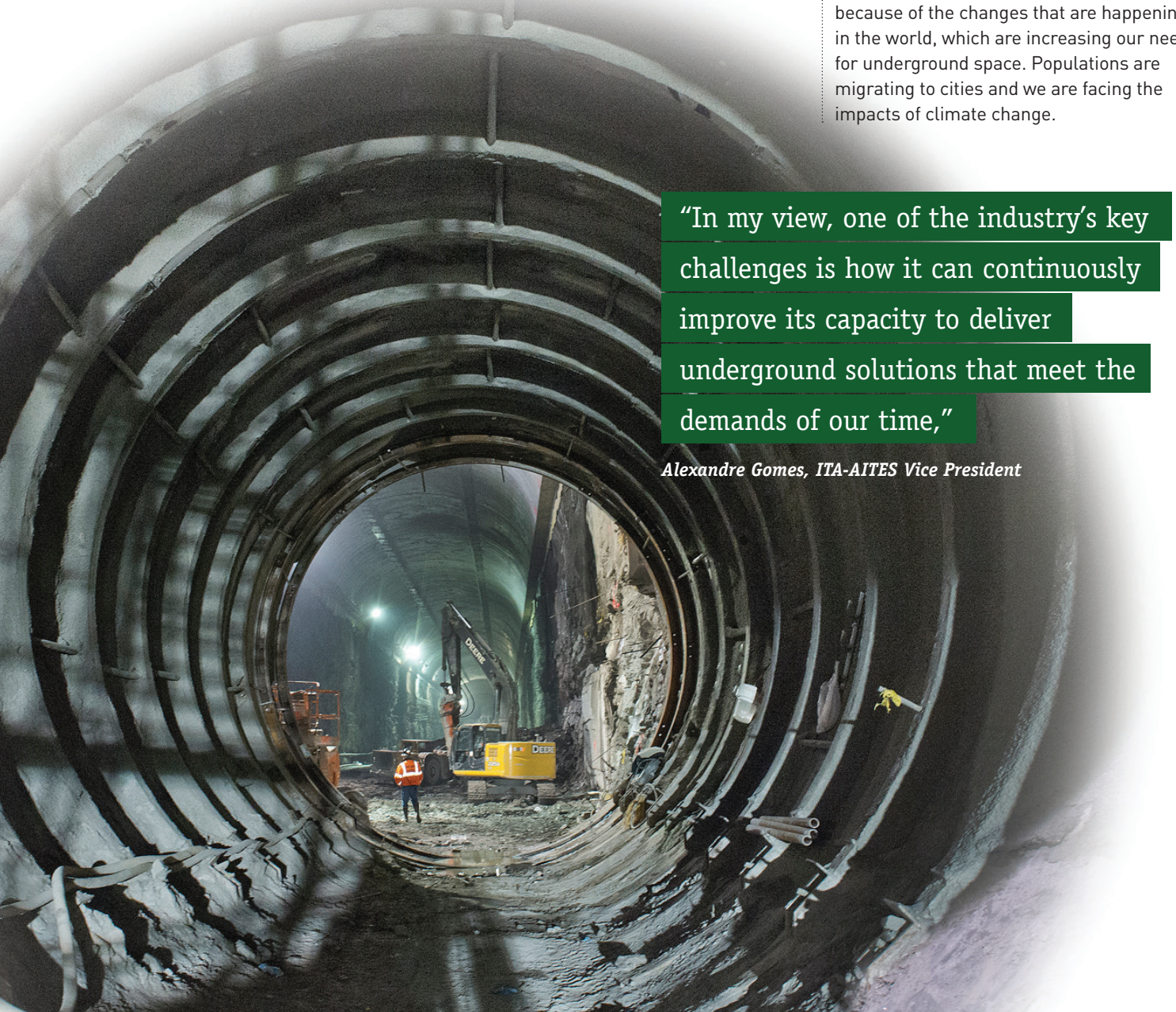
There's one part of this road that Celestino finds particularly frustrating: a section where it zig-zags up a 320m-high hillside and then back down the other side. "The engineers had a choice of building a 4km tunnel through the hill or a 6.2km at-grade road over it. Why did they make this bad decision to go over the top?" he asks.

Celestino has calculated that over the road's 40-year life a tunnel would have saved US$1.2 billion in operational costs alone, as vehicles use more fuel going up a 6% gradient than travelling on the flat. And there would have been far fewer accidents: this stretch of road has more than twice the average number of accidents for Brazilian roads.

ITA-AITES's mission is to give engineers and society the information and tools they need to make more informed decisions about roads like this one. And the Executive Council's job is to set out how the Association should go about doing that.

There's a lack of knowledge about tunnels, even among experienced civil engineers. The perception is that constructing tunnels is a high-risk activity; and many owners and their advisers don't understand how to select and pay contractors so that they get the best outcome.

ITA-AITES' challenge is intensified because of the changes that are happening in the world, which are increasing our need for underground space. Populations are migrating to cities and we are facing the impacts of climate change.



"In my view, one of the industry's key challenges is how it can continuously improve its capacity to deliver underground solutions that meet the demands of our time,"

Alexandre Gomes, ITA-AITES Vice President

"In my view, one of the industry's key challenges is how it can continuously improve its capacity to deliver underground solutions that meet the demands of our time," says ITA-AITES vice president Alexandre Gomes, who points out that we have built more major tunnel projects in the last two decades than we did in the last 100 years. "This implies that we need to keep improving not only our technologies and knowledge but also how we plan, develop and implement the projects."

In other words, ITA-AITES must change fast. And that's where young people come in, says Ruth Haug, ITA-AITES' other vice president: "My friends and I on the Executive Council have been working for quite a while; we need young members on board to help us to change faster. We need to adapt to the world we are working in, not least the way we communicate – that's a very important aspect of having a young members' group."

New strategy

The 12 members of the Executive Council are elected from among representatives of the 74 member nations that make up ITA-AITES. Each comes from a different country.

Meeting face-to-face around five times a year, with many more virtual meetings and sub-committee meetings, the Executive Council moves from country to country. Recently the meeting was held in Myanmar, one of the newest of the ITA-AITES member nations. Often the country hosting the meeting will make the most of their visiting tunnelling experts, organising a conference for them to speak at and meetings with local decision-makers.

Much of the Council's work over the past 12 months has been spent setting out the ITA-AITES' strategy for the next two years. The focus areas within the new strategic plan are all centred on better communication and knowledge sharing: between the different member nations, with students, with industry and with the public.

An important task over the next two years will be to re-examine how the ITA-AITES' Working Groups and Committees operate. If the Executive Council is the head of the ITA-AITES then the Working Groups make up its body and the four Committees are its arms and legs.

The Working Groups investigate areas of technical interest or concern and provide reports which are referred to and used widely. For instance, WG 3, Contractual Practices, has joined forces with FIDIC, the International Federation of Consulting Engineers, one of the world's most respected providers of construction contracts, to create guidance on contractual practices for tunnels. This should be completed in time for the World Tunnelling Congress, in Bergen, this June.

Members of the Executive Committee

"These guidelines are important because if contracts are set up properly, then clients can significantly decrease the unpredictability that some tunnelling projects experience," says Celestino. "It's not just about awarding the contract to the contractor who offers the lowest price: often this means the client ends up paying much more in the end because of delays and claims."

The committees are focussed on different aspects of the industry: ITACUS which interacts with urban and regional planners; ITACET which focusses on knowledge transfer and sharing; ITAtech which aims to collect and spread information about emerging and developing technology (see page 32): and ITA-COSUF which aims to improve the operational safety of tunnels and to make them more viable solutions.

Haug predicts that in this era of YouTube and TED Talks, there will be changes in the way working groups and committees spread information. "Sometimes knowledge passes around faster through discussion and presentations rather than through written reports, although we definitely need both," she says. "That's one of our challenges and something young members could help us with."

We Spoke to:

Tarcisio Celestino, president of ITA-AITES

Leader of the Geotechnical Engineering Group for the Themag Engenharia, São Paulo, Brazil and Professor of Underground Works & Rock Mechanics at the University of São Paulo, São Carlos Engineering School.

"I wish I had known how to design tunnels when I was much younger. If you are studying a civil engineering degree now and tunnelling is not part of your course, find out about tunnels."

Ruth Haug, vice president of ITA-AITES

Construction Manager for New Roads (Nye Veier), which is a construction and rehabilitation program for the Kjørholt and Bamble tunnels; past president of the Norwegian Tunnelling Society.

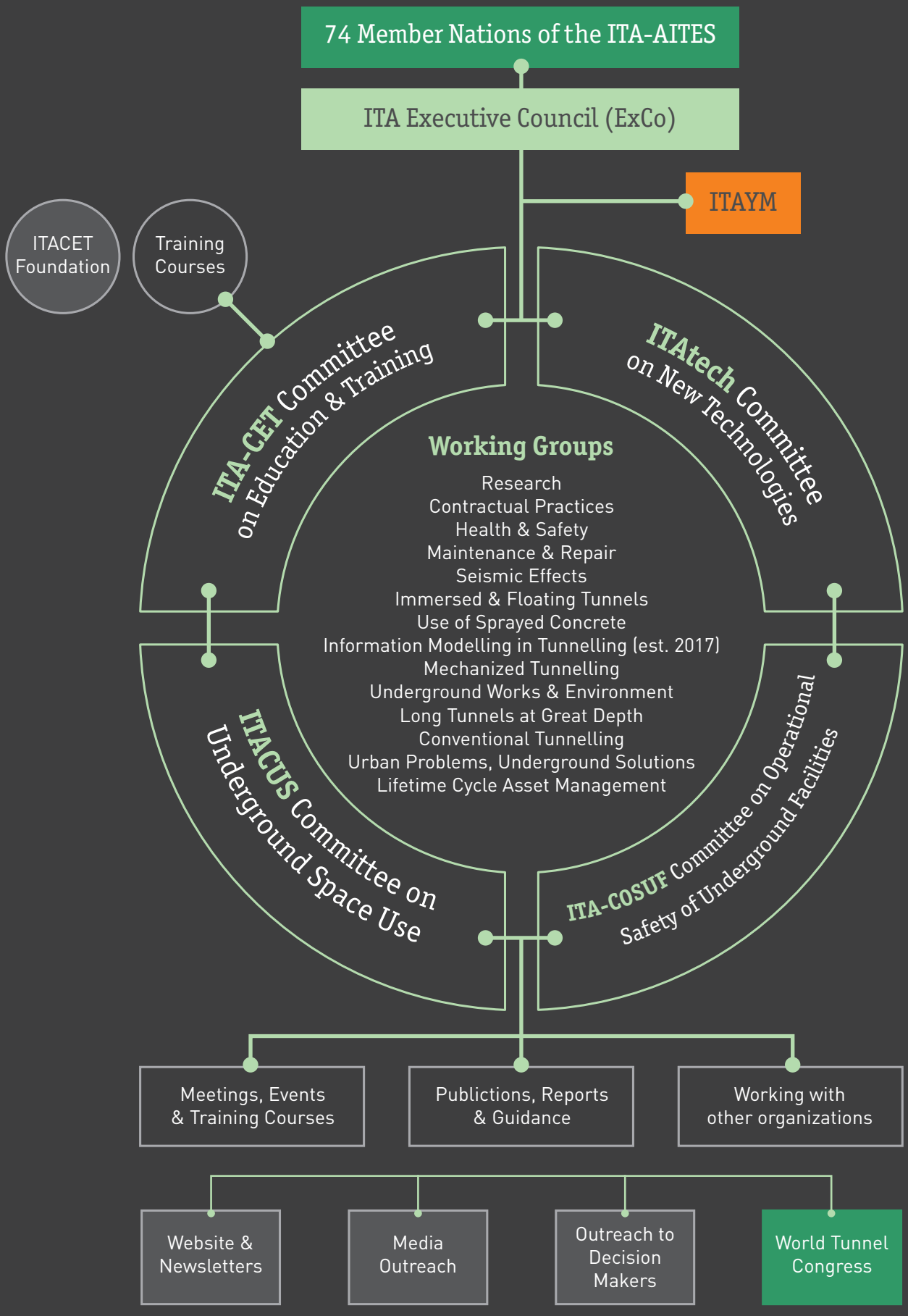
"To get a good grasp of the industry, get out there and meet other people: older engineers, people from other walks of life, get involved. Tunnelling works need good teamwork. Communicate and listen to the experience around you."

Alexandre Gomes, vice president of ITA-AITES

Chief Technical Principal, Tunnels and Underground for SMEC, a member of the Surbana Jurong Group

"Whatever area you choose, the most important thing to understand is that you will always need a lot of patience, persistence and dedication to have success and gratification in your career."

How the ITA-AITES is Structured



A week in my life

Tobias Andersson is a mechanical engineer working as a TBM Construction Manager for the Skanska/Strabag Joint Venture on the second tube of the Ulriken Tunnel in Bergen, Norway – the first rail tunnel excavated with a TBM in Norwegian history. Tobias has over 10 years of experience with TBM projects in Sweden and Norway. He worked on the challenging and notorious Hallandsås project in south of Sweden; and was a part of bringing TBMs back to Norway on the Røssåga Hydropower Project, close to the artic circle, where challenges such as karstic ground conditions with high water inflow, very hard rock conditions of up to 300MPa and a very low degree of fracturing were faced.

Sunday

5:50am, my kid wakes me up..."Daddy, daddy. Tractor, tractor!" Both of us rush out of bed to look through the window. He was right, a tractor is slowly passing our house this sunny early-summer morning, in the south of Sweden. The tractor made his morning, for me its time to get ready to leave for a meeting in Oslo, the capital of Norway, with my last project team. Bag packed, kiss my girlfriend and son goodbye. Ohh, I hate goodbyes, seeing the kid pushing his head against the window and waving, as he would like to follow me, while I slowly drive away to the airport. As a Swede, working with TBM tunnels means travel and staying away from home for days every week. The one hour drive to the airport goes quite quickly. I make a phone call to the TBM superintendent to update myself on the latest information from site. The client had ordered probe drilling due to a possible water bearing zone, but was not found during probe drilling and excavation had resumed.

"Daddy, daddy. Tractor, tractor!"

Arriving at the office in Oslo at 13:00, it's nice to meet up with four old colleagues and bosses, to discuss lessons learned and summarise experiences from the last project. This exercise is often forgotten or not prioritised, but it is a very good tool to become better and improve ourselves.

We end the day with dinner at a restaurant in the harbor, feeling the still chilly early-summer breeze coming in from the ocean, watching ice hockey and seeing Sweden after a long, tight and good game, beat Canada in world cup final. Then I head back to the hotel with a good feeling of victory.

Monday

5:00am, the alarm goes on my phone. A short sleep, but time for some breakfast, before I take the train to the airport and head to site. The flight was planned at 08:00am, but unfortunately it is delayed by 20 minutes. Anyway, a bit more time to go through emails and prepare some topics for the shift meeting with the tunnel crew that start tonight.

After a refreshing powernap on the plane, I arrive on site at 10:30am ready for one of the busiest days of the week.

It starts with a management meeting, where we go through the latest health and safety topics, then the production status for the whole project, upcoming activities, manpower and economy. Then time for a typical Norwegian construction lunch, a sandwich. Same every day, but with some variations like type of cheese or sausage.

The afternoon is dedicated to office work, summarising the weekly production and amount of executed work, which need to be handed over to the Client for acceptance before the end of the day.

At 6:00pm the new shift crew arrive and I take some time to go through this week's health and safety topics, production related information and then, as they all jump onto the train and head into the tunnel, I wish them a good shift. Myself, I call it a night, passing by the site restaurant to grab some food before going to my room at the camp.

Inspection of the cutterhead

Office work - Going through weekly production reports

Tuesday

5:30am, I jump out of bed, eager to go to work. Today we will inspect the cutterhead at the front of the Tunnel Boring Machine (TBM) in order determine if we have a need for additional maintenance or not. After a shaky trip through the tunnel in the manrider train, we reach the TBM, where the day shift guys are full of jokes and laughs. We perform the inspection. The cutterhead looks to be in a good shape even though we just passed a blocky quartzite zone and there is no need for any immediate action. I spend some time on the machine to talk to the guys, see the work ongoing, and best of all hear the alarm sound on the conveyor belt as it warns us that it's starting up. Then, a few seconds later, the hydraulic pumps start and rumbling sounds from the cutterhead and vibrations through the TBM start, as the machine begins to break rock again. A great feeling seeing the muck being hauled out on the belt, now we are making tunnel.

Leaving the tunnel, I meet up with the quality engineer from the shotcrete supplier, who is just about to do some slump and spread test on the last delivery.

Slump and spread test on shotcrete

He is usually not on site, but today after several tests at the batching plant, we are running a new shotcrete recipe where more crushed stone is used instead of only natural sand. If it's a success it will be a good environmental improvement.

I spend the afternoon in a construction meeting with the Client and thereafter an internal TBM meeting with our TBM superintendents.

Wednesday

I arrive at the office at 6:00am and need coffee. A local street racing team used the road and parking areas nearby for their activities during the night giving me a sleepless night. I open my mailbox to read and answer emails and handle the most recent invoices –and again some detective work to find out who ordered what and whether we have received the parts we got invoiced for. But a quick phone call to the mechanical superintendent solved the case about the spray membrane that was invoiced.

Last night's production was with high advance rates on the TBM and low advance pressure, so I decided to go together with the site geologist into the TBM to inspect the rock mass. We find some clay infill and fractured rock that calls for some extra rock support, like additional bolts and wire mesh. Before leaving the tunnel we mark up some areas to take rock samples that later will be sent to a laboratory for testing to determine the rock mass properties.

Leaving the tunnel, I am faced with a blue sky and the sun shining in my eyes, which doesn't happen that often as Bergen is one of the rainiest places in Europe. So to use the opportunity of the good weather, I decide to make a safety inspection of the yard area together with the safety representative on shift, who also works as a crane operator. During the inspection we find some areas to improve on especially around the storage of the slings and shackles for the crane.

The afternoon goes to documentation works and short small meetings around the documentation and follow up of the production.

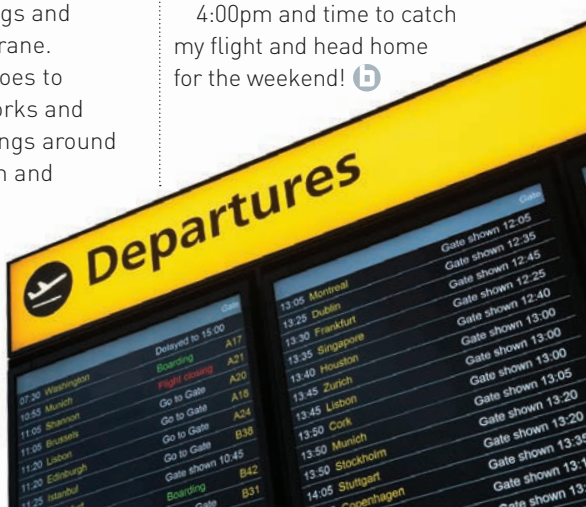
I end the day at 7:30pm in order to have time for a video call back home before the kid goes to bed for the night.

Thursday

Always one of the good days, travelling back home. But first I get together with the project management team, we have to make plans for the activities that will follow the TBM breakthrough. Many new activities will come in parallel with the TBM dismantling: drill and blast works for the cross passages, water and frost protection and concrete works. All of these need equipment and resources. After a couple of hours discussion, brainstorming and decisions, we are on the way to having it all organised.

During the final hours of the day, I work on my presentation for the upcoming World Tunnel Conference, in Bergen, were I will present a case study from the site. Looking forward for this big event that its hosted in Bergen, close to our site.

4:00pm and time to catch my flight and head home for the weekend!



ITA TUNNELLING AWARDS 2017

November 15, 2017 | Paris, France

Following two successful events in Switzerland and in Singapore, the International Tunnelling and Underground Space Association is preparing for the third annual ITA Tunnelling Awards, which will take place on the 15th of November, 2017 – alongside the AFTES Conference in Paris, France, which runs from the 13th to the 16th of November – and is calling for candidates to apply.

The awards are designed to identify and celebrate outstanding achievement in tunnelling and underground space development, and promote recognition of the industry's remarkable contributions to engineering and society.

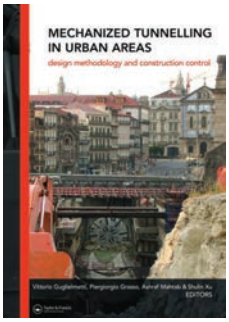
Judged by a panel of industry experts (including ITAYM Chair Sindre Log) the ITA Tunnelling Awards shine a spotlight on the individuals, companies, and project owners behind the very best projects and innovations. Entries from every corner of the world are welcome in the following categories:

- **Major Project of the Year - more than €500 million**
- **Tunnelling Project of the Year - between €50 million and €500 million**
- **Project of the Year - up to €50 million**
- **Technical Project Innovation of the Year**
- **Technical Product/Equipment Innovation of the Year**
- **Sustainability Initiative of the Year**
- **Innovative Underground Space Concept of the Year**
- **Young Tunneller of the Year**

Nominations for the nine award categories, including Young Tunneller of the Year, should be submitted by June 30, 2017, through the ITA's dedicated Awards website: https://awards.ita-aites.org
Or follow the ITA Tunnelling Awards on twitter @itaAward

Book Club

Breakthrough takes a look at some of the ITAYM Steering Board's favourite books and a series of practical rock engineering videos that are available to download for free.



1

Mechanized Tunnelling in Urban Areas

Edited by: Vittorio Guglielmetti, Piergiorgio Grasso, Ashraf Mahtab, Shulin Xu

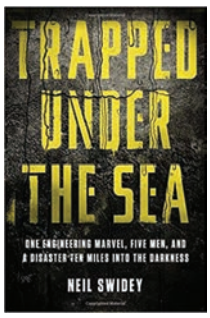
It's no news to anyone that mechanized tunnelling in urban areas is one of the most challenging forms of heavy-civil construction or that the need for public infrastructures is constantly growing in our cities. However, with the current rate of rapid global urbanization, the tunnelling industry is being pushed to expand its technological limits, while on the other hand increasing demand for skilled contractors and consultants can often collide with the limited number of experienced engineers and trained workers available in the industry.

2017 is the 10th anniversary of the publication of "Mechanized Tunneling in Urban Areas" – written and peer reviewed by leading ITA members – which is a collection of reported experiences and lessons learned, the relevance of which remains extremely valuable today.

I had the pleasure of adopting this as a handbook during my Masters in Tunnelling and TBMs to prepare for some of my exams and it also provided guidance in my professional work at the beginning of my career as a design engineer of underground structures.

This book is for me quintessential to the tunnelling industry, as it really gives the reader a clear understanding of how a TBM tunnelling project is a result of different types of technical expertise, ranging from mechanical to electrical, from geotechnical to structural without ignoring the financial, legal, contractual and safety aspects of our exciting profession as Tunnel Engineers.

Review by Giuseppe Gaspari



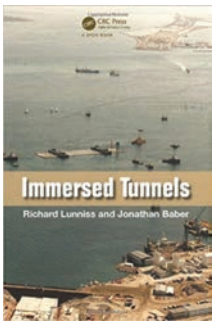
3

Trapped Under the Sea

Neil Swidey

On July 21, 1999, five commercial divers entered the Deer Island Outfall Tunnel; a key element of the multi billion dollar feat of modern engineering that cleaned up the infamously polluted Boston Harbor. The tunnel was virtually complete, save for the removal of plugs that prevented the tunnel flooding during construction. Tragically, two of the divers that went down the 10-mile long tunnel to remove the plugs would die that day and three others would barely escape the pitch-black airless atmosphere. That fatal disaster marks the starting point of Neil Swidey's "Trapped Under the Sea" a dramatic examination of the world of commercial diving and the risks that accompany major tunnelling projects.

Swidey, a reporter with The Boston Globe, weaves the histories of the divers with explanations of the engineering complexities of the project and the roles of construction companies, governmental agencies, and others in the tragedy. "This reads like a tunnelling version of the *Perfect Storm* and offers valuable lessons for anyone involved in a major infrastructure project," says Breakthrough's editor ***Amanda Foley***.



2

Immersed Tunnels

Richard Lunniss & Jonathan Baber

Immersed tunnels have been around for more than a century but remain a relatively unknown form of tunnel construction. For waterway crossings they are an effective alternative to bored tunnels and bridges, particularly in shallower waters, soft alluvial soils, and earthquake-prone areas. Successful implementation requires a thorough understanding of a wide variety of civil engineering disciplines and construction techniques. Immersed Tunnels brings together in one volume all aspects of immersed tunnels from initial feasibility and planning, through design and construction, to operation and maintenance."This is a brilliant introduction and thorough run-through of the complexities of immersed tube tunnels," says ***Lasse Vester.***

HOEK'S CORNER

Practical Rock Engineering Videos

If you are a young engineering graduate, your civil engineering degree may have included a few courses in soil mechanics and engineering geology and an introductory course in rock mechanics. But this may not be sufficient to provide the background you need to understand the complexities of tunnel design and construction. Typically, these skills are learned "on the job" but there is a little help available from a series of videos on the practical aspects of rock engineering. Dr Evert Hoek, a retired geotechnical engineer who has worked as a leading professor and consulting engineer for the past 50 years, has prepared a number of 30-minute videos that are available for free download on the Internet. Visit Hoek's Corner here: **https://www.rocscience.com/learning/hoek-s-corner/lecture-series**

Industry Innovation

When you're creating space beneath the world's busiest cities, the word 'new' can be a scary one – which is where ITAtech comes in.

Innovation and how to do more of it is a common theme for many big infrastructure programmes around the world. The aspiration is to build things better, faster, cheaper by doing things differently. There's a huge problem here though too. It's often very difficult for infrastructure owners and developers to take the risk of doing something new: if something goes wrong the results could be catastrophic. The worst case scenario could be that lives are lost, the best case is that money is wasted, and that's often money from the public purse.

The question that every owner or adviser would ask when considering a technology or method they haven't worked with before is this: who's used it before and how did it go? The purpose of ITAtech, one of the committees of the International Tunnelling and Underground Space Association (ITA-AITES), is to answer that question.

"Our goal is to promote new or state-of-the-art technologies and methods for the sustainable development of underground space," says Pauli Arenram, who chairs ITAtech's steering board. ITAtech does this by developing and publishing guidelines that deal with aspects such as terminology, how to write specifications, design issues and construction techniques.

Speed is important for ITAtech. They are addressing questions that people are asking now, so the sooner they can provide information to help inform decision-making, the better. "We publish guidelines, not regulations," continues Arenram. "The idea is to inform people of all the available knowledge around a subject at that time. We can and do revise the guidelines as more information is available."

ITAtech is different from ITA-AITES' other committees in that companies have to pay to belong to it. It is a way for manufacturers and suppliers to support the work of ITA and at the same time make their voices heard in the international tunnelling community and address some of the knowledge gaps that they come across every day when bidding for contracts or advising their customers.

When ITAtech was set up in 2012, there was some scepticism that competing suppliers would be able to sit down in the same room, share information and discuss issues constructively. After all, these are firms who are fighting each other every day to win work out in the commercial world.

Some topics have caused more heated debates than others, but largely things have gone well and differences of opinion have been accommodated. ITAtech's various Activity Groups (AGs) have produced a total of eight guides, with more on the way. "I think that is a good output,"

says Arenram who has chaired the board for the last two years, "Although I would like us to do more."

"One of our biggest challenges is that everybody has their day jobs and it can be difficult for people to make time to do the work," says Lok Home, who heads up the AG on Excavation and who was one of the driving forces behind ITAtech's formation.

Both Home and Arenram would like to see more involvement from young members in ITAtech's activity groups – although that does require their employing companies to be supporters or prime sponsors of ITAtech. "Young spirit is inspiring," says Arenram.

"Companies should identify their ambitious young people and get them involved," advises Lok Home.

Arenram also plans to sit down with representatives from the ITA Young Members group and ask them to identify topics for which ITAtech guidance would be useful. "Young people can be very skilled and they often come up with new ways to look at things."

We spoke to:

Pauli Arenram - Chair of ITAtech Steering Board. Vice President Business Development, Mining & Rock Excavation Technique, Atlas Copco Rock Drills

"Do not hide your new ideas, but work hard with a long-term goal of making your visions come true."

Lok Home - ITAtech Steering Board, Chair of Excavation Activity Group. Chief Executive, The Robbins Company

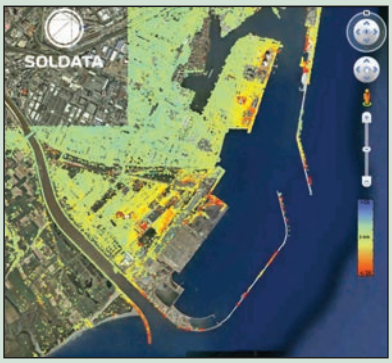
"When it comes to careers for the young and ambitious there are two 'cool' places to go: into Space or Underground. A lot goes on 'Down Under' and we don't mean Australia."

Here's a taster of some of the topics that ITAtech has tackled or is tackling in a bid to spread information about new technology faster:

Sprayed waterproofing membranes

The traditional way to waterproof tunnels is by lining them with plastic sheeting and this is still the best solution in some situations. A newer approach is to spray on waterproofing membranes that can work well where complicated geometries are involved and the amount of water coming in is not too high.

This was the subject of one of the first guidance documents ITAtech published. The guidance explains when sprayed waterproofing membranes can be used, how they impact on the design of the tunnel lining, and what the technical issues are.



Remote monitoring

Did you know that the hundreds and thousands of pictures taken by satellites can be processed to show how ground levels have changed over time? This technology is called Satellite Radar Interferometry and allows us to see how the ground has moved historically and how underground construction is impacting on it today.

Satellite Radar Interferometry was one of three remote monitoring technologies covered in an ITAtech guidance document.

Fibre-reinforced segments

Steel reinforcement bars are the traditional way of strengthening the concrete segments that are used to line tunnels as tunnel boring machines construct them. More recently steel fibres have been used to reinforce them.

ITAtech guidance on this subject looks at how fibre-reinforced segments should be designed and also touches on fibres made from emerging fibre materials such as plastics or macrosynthetics.

TBM Pilots

When TBMs are boring under densely developed cities, it is very important that the ground above the tunnel being created does not subside. For this reason Earth Pressure Balance Machines (EPBMs) – which use pressure to support the excavation – are used.

However, just as important as the machine is the person driving it. One of the outputs ITAtech is currently developing, in conjunction with the Colorado School of Mines, is a training and certification course of EPBM pilots.

Alpine Adventure

ITA Young Members from more than 10 different countries gathered for a highly successful first regional networking event, in Switzerland, this May.

On a sunny Thursday in May, 45 young tunnellers from more than 10 different countries met in front of the Post Hotel, in Sargans, Switzerland. The purpose was to participate in the first ever ITAYM Regional Event. The participants came from many different destinations varying from Sweden in the North to Italy in the South. The group from Slovenia looked a bit bleary-eyed when we met at 1 o'clock as they had been up very early that morning to drive all the way to Switzerland.

The next 1½ days were dedicated to tunnelling and kicked off with a guided tour around the historic iron mine Gonzen Bergwerk, where the historical development of mining in the region was presented. A great way to set the scene for the following day with presentations on many different aspects of tunnelling. After the tour of the mine, the first two technical presentations were given. Felix Amberg from Amberg Group gave a very

inspiring presentation of the Challenges of Underground Caverns followed by a presentation of the challenges and solutions associated with fire safety in tunnels given by Bianca Taferner from Promat.

With two presentations and a tour around a historic mine the technical part of the first day was over and it was time to start networking on a more casual basis. In the entrance area of the Gonzen Bergwerk the hosts had prepared drinks and snacks for all the young tunnellers and it did not take long before new friendships were made among the participants. People were actually so swallowed up in conversation that they almost forgot the dinner was ready to be served in the next room.

A lovely four-course local dinner was served in the underground restaurant of the mine. A perfect setting for a young tunnellers event!

Day two

Friday morning at 7:45am, a bus picked up the participants to take them to Versuchstollen Hagerbach (VSH) – the Hagerbach Test Facility. The test facility is truly a fascinating underground world twisting with galleries, caverns, testing areas, laboratories and training rooms that provide ideal conditions for research, development, testing and 1:1 experiments. The visit here started with a tour of the different exhibition and test caverns. The test facility was founded in 1970 as a research and development facility for tunnel construction. It was initially focused on testing drill and explosives technology, but over the years it grew, and with the opening of the building materials test laboratory in 1984 the range of services were expanded and today covers all aspects of underground mining, including excavation and development, sealing and installations, and operational aspects such as safety. The facility has, amongst other things, its own concrete laboratory, fire test areas and even includes a restaurant and a shooting range. Indeed a very versatile use of the caverns.

After the tour around the facility Jürg Schlumpf of Sika gave a very interesting presentation on concrete durability. This was followed by Michael Hermann from VSH presenting the fire resistance testing laboratory and the participants were then shown an ongoing fire test of a concrete sample with polypropylene fibres added to enhance fire resistance.

After a delicious lunch, the technical programme continued, but now the participants were divided into two groups, where one stayed in Hagerbach and the other was transported to Schollberg Underground Quarry.

The group staying in Hagerbach were given a presentation by Amberg Loglay of the new digital developments and Construction Site 4.0. After this Michael Lierau from Elkuch gave a presentation and demonstration of safety doors and their use in tunnels with a pressure difference between different tubes. This group was then picked up and taken to Schollberg Underground Quarry and the group that had been there returned to Hagerbach.

Schollberg Underground Quarry is a mine where stone, primarily used for coarse aggregate in concrete, is extracted. In order to minimise costs for rock support the caverns were excavated using the room and pillar method in three levels. It was very inspiring to see an innovative use of tunnelling and mining techniques for an industry that is usually seen above ground.

After the tour in Schollberg the group returned to Hagerbach, where a surprise waited for them. The fantastic hosts of VSH had prepared a test explosion in the gallery for the Young Members group. For many of the participants this was the first time they had witnessed a live explosion and felt the ground shaking below their feet.

The group returned to the Hotel Post where they had all met for the first time the

day before and enjoyed a well-deserved meal. It was amazing to see how fast relationships are built through sharing experiences and having a common enthusiasm for technical challenges. The main objective of the ITA Young Members is to provide a technical network and platform for young professionals and students in the tunnelling and underground space industry. In that light the trip to Hagerbach was a fantastic success! The programme was packed with technical presentations and the participants were very interested in getting to know each other and network across nationalities.

The event was arranged by Jasmin Amberg and Bianca Taferner from the Swiss and Austrian YM groups and Doris Frank and Lasse Vester from the ITAYM Steering Board. The participation fee for each person was €50 in and it would not have been possible to keep the participation cost so low if it had not been for our sponsors. A great thank you to Amberg Group, The Robbins Company, Sika, Promat, Pini Swiss Engineers, Elkuch-Bator, the Swiss Tunnelling Society and ITA Young Members.

A special thank you to the hosts at the Versuchstollen Hagerbach and especially Felix Amberg, who had invited us and made this fantastic visit possible. Thank you – we had a blast!

Big Data

Managing and analysing information

"Data may be the most valuable source of information in tunnelling – Make sure it is handled properly."

Patrick Schmiedeke is a software engineer working for Babendererde Engineers, an engineering and consulting company that specialises in mechanised tunnelling, specifically in tunnelling involving tunnel boring machines (TBMs).

As computer scientists are not trained in constructing tunnels, people may wonder how a computer scientist ended up in a civil engineering office. During my computer science studies, I never planned or imagined that I would end up working in the tunnelling industry. But when it became time for me to write my thesis, I was looking for a traineeship at a company in my neighbourhood. During my first days at the company I quickly realised that I had entered a really interesting workplace full of variety. Not only had I found an interesting topic for my thesis, my traineeship also gave me insight into a completely new field.

We developed a software system called TPC (Tunnelling Process Control) to manage and analyse the data collected during tunnel construction. The need for its development was due to the insufficiency of data management with MS Excel. Our civil engineers had reached the limit of what could be done with Excel in terms of data capacity, collaborative access, data protection and security.

Our software system can be used in all stages of a tunnelling project; prior to excavation by storing and managing structural reference measurements, during excavation for cost control, QC / QM, risk assessment, incident analysis and

following project completion for reporting, claims management and damage analysis. With every new development in the tunnelling sector we have to adjust our system to new aspects and to the request of our customers.

In my daily work, I receive more and more requests to implement a wide number of data sources and increased data volumes into our software. What started out with a few sensor data and manual inputs has become a complex system to access and analyse information of machine data, geotechnical monitoring data, manual data, tidal information, user inputs, etc. We compare and analyse data from various sources to improve and optimise operational procedure and performance. Analysis on excavated sections aims to improve TBM performance and the interaction of the machine with the ground and the environment. Data available from numerous sources and the possibility to combine various parameters is a source of valuable information that is the basis for the analysis.

Additionally, the frequency at which the data is gathered has increased a lot. On the one hand, it was necessary, and on the other hand it became possible, as storage space became much more cost-efficient and the computational power of the automation systems in the TBMs improved. While monitoring real-time data, it is possible to miss certain negative or positive events between recordings, if the duration of the logging interval is too long. Therefore the intervals have been significantly reduced. Recent approaches show, that in future intervals of less than 1 second may be necessary. This will lead to future challenges on both sides, the

TPC (Tunnelling Process Control) manages and analyses all data in the process of the tunnel construction.

automation system of the TBM and the software systems working with the data.

Apart from real-time data monitoring and analysis another main aspect lies in quality control and management. Many different people are involved in the tunnel construction process, from the TBM pilot that must keep the TBM aligned and operate it within the designed parameters, to the QC engineers that verify these parameters and create the relevant reports on various procedures. The reporting and documentation of the tunnelling process will always be a major aspect of the construction process. In the daily routine, our system sends emails with attached report pdfs automatically. In attempt to reduce mail traffic and to centralize reporting, we work together with cloud based storage companies to offer automated storage of reports in cloud drives. This results in multiple benefits, such as central storage, access control, security and mobile availability.

The fast pace of modern life, operational procedure and decision-making results in the need for quick and reliable access to data and information. Mobile devices, such as laptops, smartphones and tablets, have become an essential part of our daily life. Data protection and security is one of the main concerns in this development as users tend to handle devices and data less

carefully. This will always be a challenge.

Another security concern results from the introduction of the Building Information Modelling (BIM) process for all participants involved in public tunnel construction work in various countries. BIM represents all the information on a project – before, during and after construction. The output of this process is the Building Information Model, which illustrates the components of the building in digital form. As it is necessary for all participants to cooperate and coordinate their work based on the same digital model during the construction process; from the planning phase to demolition, the aspect of data security and data protection during the project will be extremely important.

Nowadays papers are full of catchphrases like industry 4.0, big data or digitization of the manufacturing sector. But years ago, companies in the mechanized tunnelling sector had already started to go digital by creating their own software to collect, combine and analyse traditional and digital data sources.

Industry 4.0 can be defined as the next big step in automation and data exchange in the manufacturing sector. It surrounds cyber-physical systems, Internet of things and cloud computing. Industry 4.0 is driven by four developments: the impressive rise of data storage, computational power and connectivity; new systems human-machine interactions like touch interfaces; development of analysis and business-intelligence capabilities; and the rise of additive manufacturing like 3D printing, which transfers digital instructions to the physical world.

In the not-too distant future, these new technologies will be used in the tunnelling industry. Augmented Reality devices like google glass will form the first step into having information available on heads-up displays during tunnel inspections. This would make work easier and reduce failures in the process. But maybe it won't be necessary to walk into the actual tunnel for inspection. There might be a virtual reality digital tunnel to walk through.

5 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...

Technical challenges, massive machines and some of the world's most unusual locations

Sindre Log, General Manager, Robbins Norway

Masters' degree in Civil Engineering at the Norwegian University of Science and Technology (NTNU)

Sindre Log is a self-confessed nerd and lover of big machines. "When I first saw a TBM I thought: 'that's crazy and awesome and I want to do it'."

So he has found the right role with tunnel boring machine (TBM) manufacturer Robbins, providing geotechnical expertise to projects around the world. Log also heads up the firms' business in Scandinavia, bidding to supply machines to projects there.

Log followed in the footsteps of his father and older sister, both of whom studied civil engineering at the Norwegian University of Science and Technology (NTNU) in their home town of Trondheim. "If you want to do a Masters thesis in engineering, that's the place you go," says Log.

One of the highlights of Log's five-year course was a trip to China just before the Olympics. He also began to get seriously interested in the detailed workings of TBMs there: the university has a huge TBM-testing laboratory where Log worked part-time as a research assistant, learning first-hand about rock behaviour and TBM performance.

Log made contact with Robbins' Chief Executive Lok Home when he was preparing to work on his thesis. "Lok sent me to India for three months to study the use of 20-inch cutters compared to 17- and 19-inch cutters," he says. "I also carried out an analysis of the job site, cutter wear and penetration depths."

The thesis project lead to a job offer and a first posting in Germany before Robbins opened up its new office in Norway where Log is based now. From there he literally travels around the world – China, South America, Vietnam, Malaysia, US, Europe - visiting all Robbins' rock jobs to look at the geology and solve problems.

"I love travelling and with this job you get to visit places that you wouldn't see as a tourist," he says. "I still enjoy that part of the job, although it's a little bit different now that I have a young family."

Log has also been involved for many years in the Norwegian Tunnelling Society and has worked to establish young tunnellers' organisations in Norway and internationally. He is currently chair of the ITA Young Members group – and heads up the editorial board for this magazine.

"I get very enthusiastic about things and want to get engaged," he says. "I see the tunnelling industry as something that can help solve a lot of society's problems and we need to tell the rest of society about that. I sincerely believe that this is one of the best industries to work in."

Log points out that while many young engineers in Norway aspire to work in the oil and gas industry, tunnelling offers far more opportunities. "If you work hard in this industry, you will be properly rewarded," he says. "That isn't always the case in other industries.

> I think tunnels will be a big part of the future. It's good for young people to get involved now because a lot of things are going to happen and they will have a chance to be part of that.

Young Tunneller of the Year – on a mission to change lives

Derek Eng, Assistant Manager (Tunnel), MMC Gamuda

Bachelor's degree in Civil Engineering at Universiti Sains Malaysia; Project Management certificate at Hochschule Bremen

"What we do on earth is all about changing lives and engineering is life-changing," says Derek Eng, Assistant Manager (Tunnel) for MMC Gamuda on the Klang Valley Mass Rapid Transport (MRT) project in Kuala Lumpur, Malaysia.

Eng was awarded the International Tunnelling and Underground Space Association's (ITA-AITES) Young Tunneller of the Year in 2016, and after half an hour in conversation with him it's easy to understand why. Passionate and modest in equal measure, Eng wants to make a positive impact on society through his work, learning from those around him and encouraging school leavers to consider engineering too.

Eng chose to study civil engineering at Universiti Sains Malaysia. "I always thought I wanted to be a builder because I wanted to give something to my nation. I've always been awestruck by structures like the twin towers or suspension bridges and I wanted to know how they work and how they are created."

Since tunnelling projects are rare in Malaysia, Eng didn't think about going underground until he went to Germany to study Project Management, an extended programme offered during his bachelors degree. There he learnt about the existence of the tunnelling industry – as well as the basics of how to plan and run a project.

Returning to his home country, Eng started work on his first project with contractor MMC Gamuda on Line 1 of the Klang Valley MRT. Initially, he worked on the tender, helping to prepare paperwork, plan the site set up and how to launch the machine, look at the procurement strategy, manpower and plant needed. "It was a very steep learning curve," he says.

Once MMC Gamuda had won the contract, Eng worked as a Shift Engineer with one of the ten TBMs, on 12-hour shifts, working six days on and three off and alternating between blocks of day shift and night shift. "You have to work hard and you have to get your hands dirty," says Eng. "You cannot expect to be a manager without knowing what's happening down there."

Eng is now working on Line 2 of the MRT and has been promoted to Assistant Manager. "My new role involves managing people. That's what I really like doing; I am quite extrovert," he says. "This role means I will get to meet a lot of people and learn from them, working with external parties on interfacing works."

The message that Eng tries to convey to school children through his outreach work with MMC Gamuda is that a career in tunnelling makes a positive impact on the world.

"You will be creating structures that last for 100 or 200 years, something that will contribute to society," he says. "But you have to be mentally and emotionally prepared because it will not be a smooth journey; there will be ups and downs and you have to be willing to move around to different countries. That's the best way to learn."

My Power is Construction

Joanne Sui, Tunnel Engineer, London Bridge Associates

Bachelors degree in Civil Engineering at University College London

It's safe to say that few tunnel engineers have appeared in cosmetic company advertising. But London Bridge Associates' Joanne Sui has; she was selected for Lancôme's 'My Shade of Power' campaign, which featured influential women of all ages from a variety of professions.

Lancôme's researchers had found Sui, whose photo was captioned 'My Power is Construction', because of her success in several awards schemes. She was one of Management Today's 35 women under 35, shortlisted for the First Women Awards and highly commended in the Asian Women Awards.

Sui was drawn to a civil engineering degree at University College London because of the subjects she enjoyed at school. "I quite liked physics and maths and learning how things worked so I ended up doing an engineering degree," she says.

Like many people who work in tunnelling, she came to the industry by chance. "I had a look around at what projects were underway and applied for a placement with Morgan Sindall on the Kings Cross Station upgrade," says Sui. "Tunnelling is not an obvious career choice because people don't know about it. I didn't realise when I was at university what a community there was in the tunnelling industry."

Sui has worked on a number of high profile UK projects including the Lee Tunnel, Silvertown, Hinckley power station and the HS2 feasibility study. Following a secondment from contractor Morgan Sindall to designer Mott MacDonald, she spent a six-month sabbatical travelling around southeast Asia before taking up her current position with London Bridge Associates.

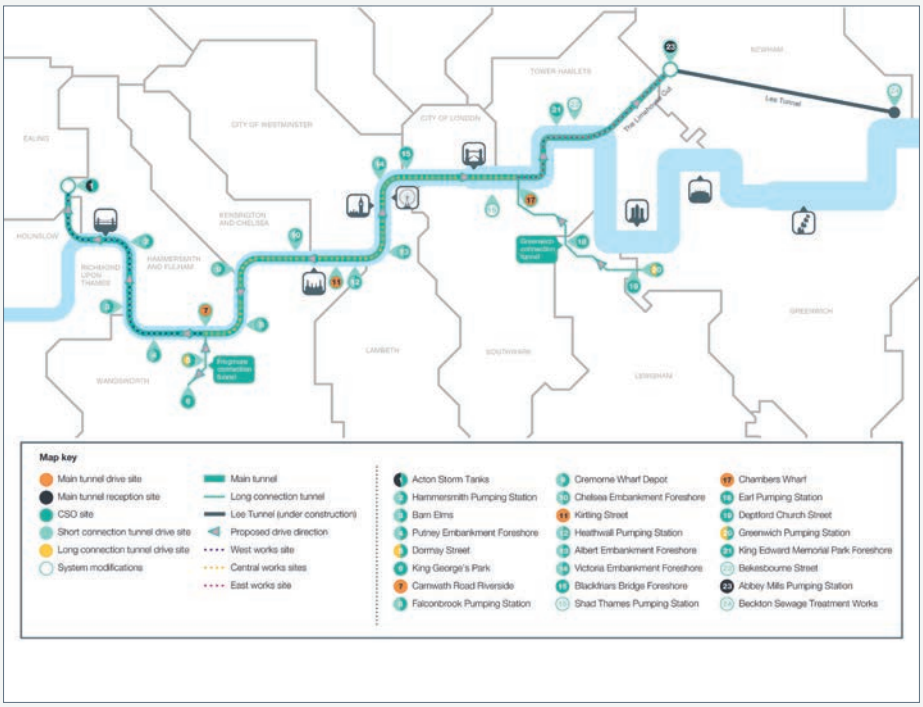
Her current role is on London's super sewer project Tideway, working as a Construction Engineer on one of the sites. Employed on the client side, her current tasks include assurance, checking health and safety, programming and cost planning.

"The best thing about my job is being part of a bigger picture," says Sui. "Tideway is cleaning up the River Thames and making London a better place." As a Londoner born, bred and educated, Tideway will have a very direct impact on Sui's local environment.

Sui has chaired the British Tunnelling Society's Young Members and currently sits on the Steering Committee for the International Tunnelling and Underground Space Association's (ITA-AITES') young members' group. "It's about promoting tunnelling and encouraging other people," says Sui. "It's good to be able to pass on some of what I've learned to other people."

Her advice for those at the beginning of their career is to look for lessons learned everywhere: "You can learn from every situation, whether positive or negative," she says. "Every day is a learning day. Don't be afraid to ask questions."

> The best thing about my job is being part of a bigger picture. Tideway is cleaning up the River Thames and making London a better place.



World-wide experience to fast-forward career

Giuseppe Maria Gaspari, Tunnel Design Lead and General Manager, Geodata Engineering – Canada branch

Bachelors in Civil Engineering and Masters in Geotechnical Engineering at the Sapienza University of Rome; Masters in Tunnelling & Tunnel Boring Machines at the Politecnico di Torino

Since Giuseppe Gaspari graduated he has made it his mission to work in as many different countries as possible.

"That was one of the goals I set for myself," he says. "After getting some of the best education in the world, I wanted to go abroad to see how the industry was developing outside Italy. It's a way to boost your experience and accelerate your career, facing real-time trouble shooting at job sites and working on design solutions with owners and contractors face-to-face."

Now based in Toronto, heading up Geodata's North American business, Gaspari has worked on tunnelling sites in Istanbul, Bangalore, Singapore, Europe and Canada. "It has helped me to understand that different cultures apply technologies and skills differently," he says. "The way you build a tunnel in India is different from the way you build in Canada or Singapore; constraints, available technologies and risk perception are not the same."

Having studied a BSc in Civil Engineering and an MSc in Geotechnical Engineering at the Sapienza University of Rome, Gaspari was faced with a decision between going on to study a PhD or starting work. "The Italian tunnelling industry was booming at the time. We were building high-speed train lines connecting the North and South of Europe, we were designing the longest Alpine tunnels to unify Europe, and several companies were starting to work abroad."

Gaspari chose to start work with consulting engineering firm Geodata Engineering, which had strong connections with his university and tutors. After a year, Geodata selected Gaspari to attend Turin Polytechnic's specialist Masters course in Tunnelling and Tunnel Boring Machines (TBM).

"The best thing about the course was its connection to the industry," says Gaspari. "We got to meet board members of the ITA, as well as the technical directors from all the TBM manufacturers, the main consulting firms, contractors and geologists. It meant that we saw multiple sides to a problem: how to plan, how to design, how to build and how to maintain."

The practical course at Turin perfectly complimented the more academic studies that Gaspari had completed in Rome. "You need both," he says. "The important thing is to analyse yourself and find out where the gaps in your experience are. I see a lot of people studying because there is no work. You shouldn't just study for study's sake."

Gaspari's roles with Geodata have included designing underground caverns for the Istanbul Kadikoy-Kartal Metro Line, coordinating the design of earth retaining and stabilising structures for one of Singapore's Eastern Regional Line contracts; coordinating designs for pre-cast segmental lining tunnel projects in India, recruiting and training engineers for the office there; and interim project management for the Bangalore Metro project.

Gaspari's latest challenge sees him combining technical work with management and commercial duties. "I wanted to have experience in America as that was missing; I had worked mostly in Europe and Asia. The Americas market is very interesting and challenging."

Heavily committed to young members' groups in Italy, Canada and the ITA-AITES, Gaspari firmly believes that the next generation can help accelerate the industry's take-up of new technologies such as 3D mapping, drones, robotic inspections and virtual modelling.

> You have to learn from everyone and teach everyone. The industry can only grow if we all share our knowledge, share our mistakes and learn from them so that we can go further, faster.

Why rock engineering rocks

Rebecca Karlsson, Team Manager, Rock Mechanics, WSP

MSc Civil Engineering at the Luleå University of Technology, Sweden

When Rebecca Karlsson started her five-year Masters Degree in Civil Engineering at the Luleå University of Technology, her plan was to become a structural engineer. However, after studying rock engineering courses during her first year, she was hooked.

"I think rock engineering is interesting and exciting in a different way to structural engineering," says Karlsson. "Nothing is ever the same, you never know what you will find underground. You can't say that in the same way about above-ground structures."

Now Karlsson heads up a team of engineers based around Sweden for WSP. "The best thing about my job is the people I work with and collaborate with: the team here in Sweden, clients, contractors and our colleagues in WSP around the world."

A combination of reputation and climate attracted Karlsson to the course at Luleå, which at the time was a five-year Masters; now there is the option to study a shorter Bachelors degree only. "I chose the university because I had heard good things about it and it was a place I had never been to before," says Karlsson. "And the chance to ski was a big attraction for me: there is a lot of snow there."

Once on the course, Karlsson found that the accessible style of teaching combined with many study trips and close links with industry was a winning combination. The university's links with business were instrumental in finding Karlsson her first role at WSP: she spent seven months there on an internship at WSP's rock engineering department at WSP's Stockholm office.

Karlsson's thesis, which looked at the impact of overbreak and damage zones in rock tunnels on surrounding areas, was also carried out with WSP and she began her first paid role there six years ago as an engineer. "My time at WSP has been really exciting," she says. "I started at a great time because there were so many projects starting up." She has worked on many projects from wastewater and railway tunnels to underground carparks and an underground bus terminal in Stockholm.

In February this year, Karlsson was promoted to a leadership position. "I enjoy challenges and I'm always looking for them, whether in projects or in my own personal development within each role," she says. "WSP is a great company to work for because they can offer a lot of different career paths."

With many underground projects coming up in Sweden, one of Karlsson's biggest challenges is finding enough rock engineers for her team. "

We are really trying to promote this career to young people early because many don't even know it exists," says Karlsson. "It's a really interesting market and we will need a lot of competence and resources in the future. The lack of space at ground level means it is important to find new possibilities to create space underground and this need will only increase with the mega trends of urbanisation and globalisation.

> It's an interesting time to be in this industry because we are just at the beginning of something new.

Dates & Events

3-7 July

BTS Design & Construction Course
University of Warwick, Coventry, UK
Event website: www.britishtunnelling.org.uk
This British Tunnelling Society supported annual five-day course provides a comprehensive introduction to all aspects of tunnelling.

18-21 September

Tunneling Fundamentals, Practice, and Innovations 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 geologies.

25-26 October

UIUA 2017
Wroclaw, Poland
Event website: http://uiua.pwr.edu.pl/
Organised by the Faculty of Civil Engineering at Wrocław University of Science and Technology and the Polish Tunnelling Group, this two day conference will focus on Underground Infrastructure in Urban Areas.

30 Oct – 01 Nov

16th Australian Tunnelling Conference (ATS2017)
Sydney Harbour, Australia
Event website: www.ats2017.com.au
This well respected industry gathering, organised by Engineers Australia and the Australasian Tunnelling Society, brings you the best opportunity to hear from Australasia's current and future tunnelling projects with a content-rich, three-day agenda.

15 November

ITA Awards 2017
Paris, France
Event website: https://awards.ita-aites.org
Judged by a panel of industry experts (including ITAYM Chair Sindre Log) the ITA Tunnelling Awards shine a spotlight on the individuals, companies, and project owners behind the very best projects and innovations.

13-15 November

2017 Cutting Edge Conference
Seattle, USA
Event website: www.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.

13-16 November

AFTES International Congress " The Value is Underground"
Paris, France
Event website: www.aftes2017.com
The congress will highlight the latent value of underground space as a means of developing our living spaces, especially if urban planning harnesses it to establish a symbiosis between ground-level and underground.

13-16 November

World Tunnel Day (#WorldTunnelDay)
International
Check out what's going on with your national tunnelling society's Young Member group on #WorldTunnelDay. If nothing is planned, get organising! Don't forget to post photos and messages on twitter! (see page 10 for info)

20-26 April 2018

WTC 2018
Dubai, UAE
Event website: www.wtc2018.ae
Organised by the Society of Engineers - UAE, the 2018 World Tunnel Congress and the 44th ITA-AITES General Assembly will have the theme: "The Role of Underground Space in Future Sustainable Cities" (see p45).

3-9 May 2019

WTC 2019
Naples, Italy
Event website: www.wtc2019.com
The 2019 World Tunnel Congress and the 45th ITA-AITES General Assembly will be held at the famous "Mostra D'Oltremare". The Congress theme is "Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art".

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UAE welcomes you to WTC 2018 in Dubai

The tunnelling sector in the UAE began development many years ago, and continues to achieve milestone after milestone, in line with other industries in the UAE. Mega projects implemented in the UAE tunnelling industry encompass many world-class accomplishments, including Dubai Metro, one of the key tunnel projects in the Emirates; and the Hyperloop UAE, an under-construction development that will link Dubai to Abu Dhabi in 12 minutes. Other ground-breaking underground projects have also been implemented throughout the UAE and have helped overcome challenges in transportation, electricity and water grids. These and other upcoming projects have led the UAE to become an ideal host for the 2018 World Tunnel Congress in Dubai. Below is a brief overview of all the reasons that make Dubai a fantastic platform to host this event and we encourage you to start planning your trip to attend this global congress.

Why Attend?

The UAE Society of Engineers and the organizing Committee of WTC 2018 Dubai are committed to encouraging young talent to attend and take part in the activities of the Congress. As an incentive to attend, the congress will hold ITACET training courses and awards for best papers. The congress will also offer discounted prices for attending sessions and other events, a unique networking opportunity, and post-event tours in Dubai.

Young Emirati talent and members of the International Tunneling and Underground Space Association (ITAYM) will participate at the event in a dedicated platform that will attract young tunnelling professionals from the region and around the globe.

We are honoured to invite participants to be at one of the most exciting tourist landmarks in Dubai, Burj Khalifa, the tallest building in the world. As we still have one year on hand to the Congress date, we are studying a line-up of initiatives for field trips to related sites and other activities that will be announced accordingly.

Why Travel to Dubai?

Dubai - the exotic jewel of the United Arab Emirates; Bordered by deserts and beaches, provides stark contrasts, from intriguing Islamic culture to the ultra-modern, high-tech metropolis of the 21st Century. The city is a magnificent expression of an incredible vision and an uncompromising statement of success and opportunity... Dubai has something for everyone.

Dubai hosts world class resorts, amazing beaches including Kite Beach and Sunset Beach, a variety of water sports, as well as heritage and cultural destinations, including Saruq Al-Hadid Museum Located in Shindagha Heritage District that introduces traditional crafts to visitors. For culture and art enthusiasts, Dubai presents the Opera House, Alserkal Art District in Al Quoz, and Al Fahidi Museum that introduces Emirati folklore, such as Al Ayala and Yolla arts. Visitors will be amazed in the Desert safari where they are introduced to authentic Arab hospitality, coffee, and sports such as falconry and camel riding. On the other hand, Dubai Canal and Dubai Marina provide stunning waterfronts, while Creek Park boasts great green scenery suitable for family and friends gatherings. Visitors should not miss the opportunity to enjoy amazing shows at the Dubai Fountain located between the Dubai Mall and Burj Khalifa. You will be introduced in Dubai to a traditional tale that is still being written in the present to shape the future.

Looking forward to seeing you!

We promise you a remarkable visit to Dubai, whether you are going to the beaches, heritage sites, cultural destinations, or simply attending WTC 2018 Dubai. See you there!

On behalf of the organising committee of WTC 2018 Dubai.

3D vision

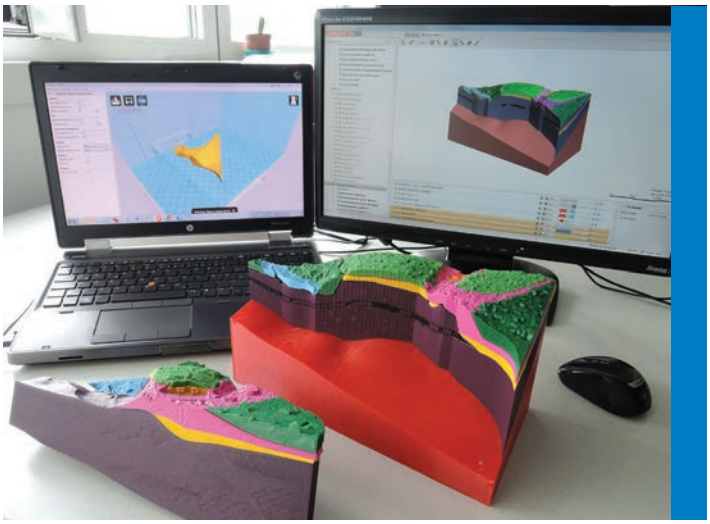
Jonas Weil completed his geology studies at the Universities of Bochum and Vienna in 2010. From 2006 to 2011 he gained experience in geothermal and geotechnical projects (Geomatrix, Austria) and mining (Endeavour Mine, Australia). In 2011, he joined iC-group where he is now involved in engineering geology and exploration, with a focus on 3D modelling and digitization.

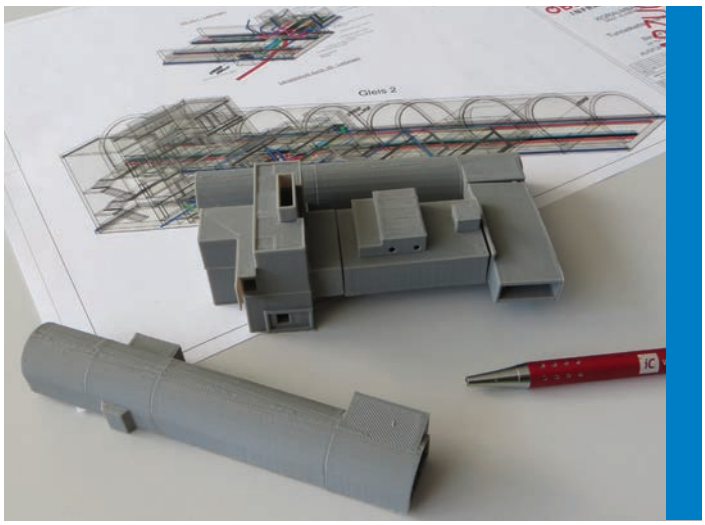
3D-printing is a fast evolving technology, fascinating because it is a tool to materialize things that used to exist only virtually and on computer screens.

iC group has been using digital geological 3D-models for more than 10 years, originally from mining and exploration projects where these applications have been state of the art for a long time. More recently, similar software and methods were applied to tunnelling and other infrastructure projects as well. Geological 3D-models can be used and are highly valuable in all periods of a project, from the early stage of prognosis and site investigation planning, to updating and adjustment

during construction, and finally to the analysis and evaluation of the documented geology after construction, especially with respect to possible claims and court cases.

The introduction of BIM (Building Information Modelling) in tunnelling and underground construction enforces the use of such 3D digital geological models during the design and engineering stages as well as during operation and maintenance.





Traditionally, geological conditions are presented in 2D maps and sections, often accompanied by the typical geologists "hand waving", explaining the orientation of structures like faults or layers. Interactive digital 3D-models on a big screen or, even better, in a show room with hologram technology as widely used in the petroleum or mining industry, help to make complex geologic conditions understandable for all project participants.

Analogue geological 3D models have a long tradition, from "sandbox models" used in research to detailed "classical" models made of wood, ceramic or plastics that display geological conditions in museums or exhibitions.

3D-printing is a logical application, because it brings the existing virtual models out of the computer into the real world. It can be seen as the opposite of survey techniques like laser scanning or photogrammetry, that bring the "reality" into the digital model.

In iC group, 3D printing techniques were first used for topography models of infrastructure and mining, visualising excavation pits or open cut mine geometry. At the next stage, detailed geological layer models were printed as "3D-puzzles", for example the geological model used in the planning of the Vienna subway extension, in Austria, conducted by the owner Wiener Linien.

This was done using a standard Desktop-Printer with the material PLA (scale is 1:5000 with 10x vertical exaggeration). Eight different geological units where printed separately in different colours, and the model is vertically split along the alignment so that the "geological long section" can be viewed in 3D. A second version of this model was produced at a 3m length by a company that specialises in the production of architectural models, and is displayed in a visitor centre for the planned subway extension.

Another application is 3D printing of complex subsurface structures like the ventilation building shown above, especially due to the growing use of Building Information Modelling (BIM), enforcing the design.

Printed 3D models make complex geometries of geological or subsurface structures quickly and easily understandable, especially for those who are not so familiar with sections and geological maps, may it be audiences in public relations or decision makers.

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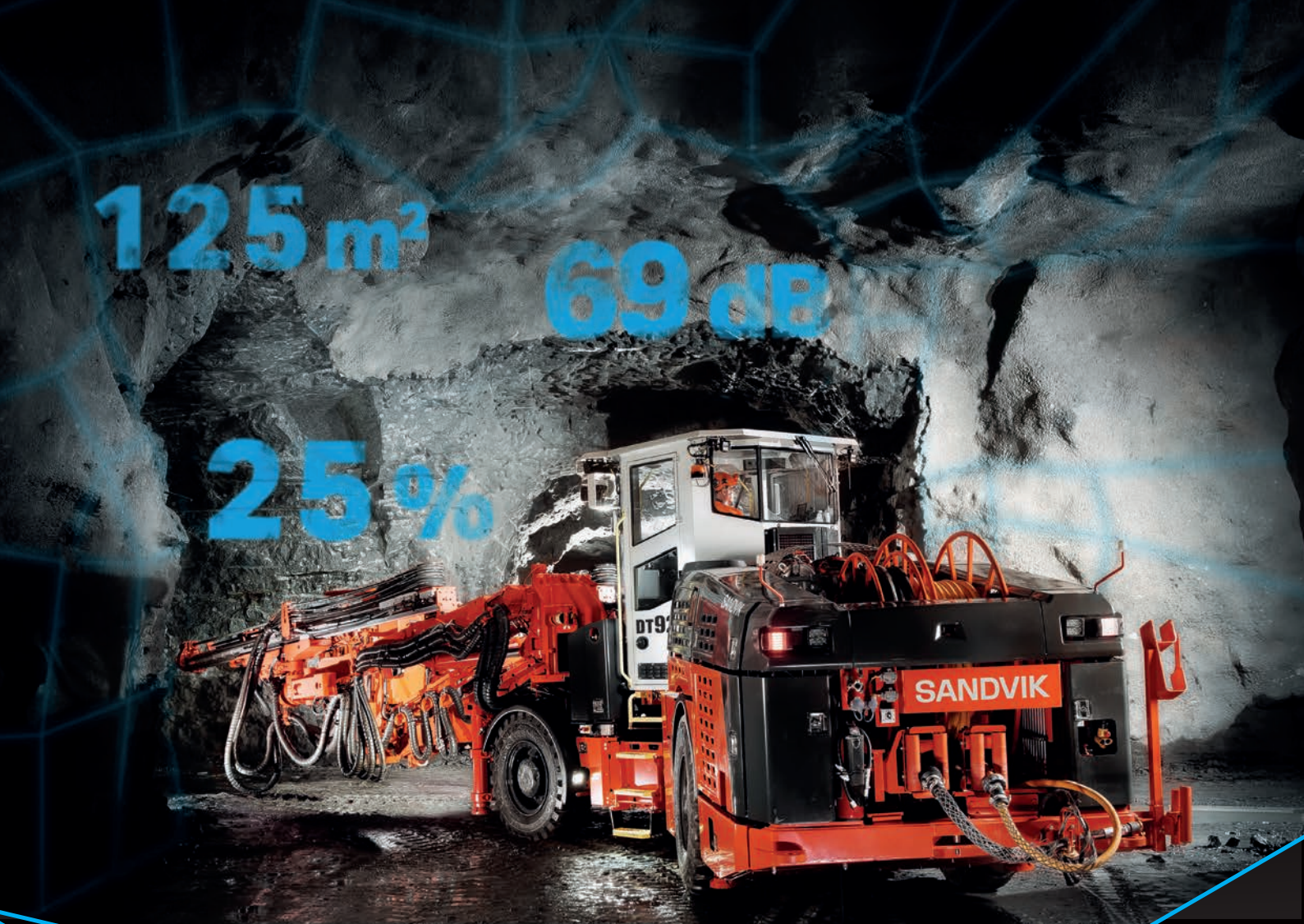

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