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# breakthrough

Issue 8 2023

YIM

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Alex Nowak La Flor, Chair of the ITAym



# Welcome to 'Breakthrough'

Dear readers,

The Steering Board of the International Tunnelling and Underground Space Association (ITA) Young Members extend a warm welcome to you for the eighth edition of Breakthrough.

As individuals driving progress in the ever-evolving field of tunnelling and underground construction, we deeply understand the power of shared insights in shaping the future. This magazine reflects our commitment to expanding boundaries and addressing the latest industry trends for budding tunnellers and young professionals alike.

Across these pages, you'll encounter a diverse compilation of content that highlights the essence of being a part of the ITAym. This inspiring collection of articles is curated by our community, for our community.

We extend our sincere gratitude to the authors and contributors who have generously shared their experiences, insights, and in the process, enrich our collective knowledge. With your support, Breakthrough remains your guide on an engaging journey of networking and professional growth. We hope it sparks discussions, stimulates novel ideas, and demonstrates our unwavering dedication to shaping the future of tunnelling and underground space.

Sustainability has been a prominent theme in discussions within our sector for years. Recent global advancements and an increasing acknowledgment of the necessity for change have triggered remarkable responses from industry leaders and key stakeholders. As young professionals in this field, we hold a unique position to nurture sustainable workplaces and foster an enduring industry for the future. Significant engineering innovations and shifts in societal expectations necessitate the transformation of our knowledge and experience into practical realities. We actively contribute to the energy transition and numerous other vital initiatives.

Don't hesitate to engage in the upcoming opportunities with ITA and ITAym, and represent your member nation. To stay informed and participate, think about following us on LinkedIn, subscribing to our email updates, and exploring our YouTube channel. Let's work together to cultivate exploration and collaboration, which lie at the heart of the values upheld by the ITA Young Members community.

Our heartfelt thanks for your continued support and involvement. Let's dig deep and "tunnel" our way to a world where sustainability isn't just a trend, but the accepted common practice.

With our best regards for a sustainable future.

Alex Nowak la Flor, Eyðbjörg Amanda Petersen, Divik Bandopadhyaya, Sam Huckle, Christian Rhein

The Steering Board of the ITA Young Members



**Front Cover**  
 5 from Five's Jiri Horcicka is a Production Director for Metrostav Norge, a member of the Metrostav Group, currently overseeing tunnelling projects in Norway, Iceland, Sweden, Finland and the Faroe Islands (p39).





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### Contributing to Breakthrough

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

### Note to YM Member Nations

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

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# Meet the ITAYM Board

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



## Alex Nowak La Flor

Alex is a Civil Engineering graduate from the Federal University of Rio Grande do Sul, currently working as a pipe jacking engineer at ServBrax and pursuing a postgraduate degree in Mechanised Tunnelling at the University of São Paulo, Brazil. Passionate about the use of tunnels and underground space, he has been part of the Brazilian Tunnelling Committee Young Members (CBTym) board since 2018; initially as Vice President, and since 2021, as President. Alex's responsibilities involve helping both CBT and CBTym organise a wide array of events and has been instrumental in delivering YouTube webinars over the past year. In his spare time, Alex enjoys travelling and watching football.



## Christian Rhein

Christian was born and raised in the Ruhr region, the former stronghold of the coal mining industry in Germany. As a child, shafts and tunnels were part of his everyday life. He studied civil engineering at the Ruhr University Bochum and graduated with a master's in geotechnics and tunnelling in 2019. He began his professional career at the Research Association for Tunnels and Transportation Facilities, STUVA e. V. At the Institute for Tunnelling & Construction Management, Christian is now a Research Assistant focused on tunnel construction and waterproofing. Christian joined STUVA YEP as a student in 2017, has been a member of the Committee since 2020 and Chair since 2021. In his free time, he enjoys cooking and spending time with friends and family.



## Samuel Huckle

Travelling through the Channel Tunnel as a child is where Sam's fascination for the underground began. He joined the tunnelling industry in 2015 with a bachelor's degree in civil engineering and an MSc in Mining Engineering earned in the UK. He has experience on infrastructure projects with roles ranging from main contractor, client's engineer/ advisory and client. As a student he became involved with tunnelling societies, where he first contributed to the BTSym and more recently to the AFTESym. Sam is currently a Package Manager with FCC Construcción on the A9 Badhoevedorp to Holendrecht motorway upgrade project in the Netherlands. In his spare time, Sam has undertaken the renovation of Belgium's Tunnel d'Yvoir with a group of passionate volunteers.



## Eyðbjörg Amanda Petersen

Eyðbjörg holds a MSc in Civil Engineering from the Technical University of Denmark and is currently working as a tunnel engineer at Ramboll. With a flair for the interaction between man-made structures and untamed ground, she started diving into the field of tunnelling after a brief visit to a tunnel construction site in Iceland with rapidly changing geology along the alignment and rare rock formations. She is a board member of the Danish Tunnelling Society Young Members. Eyðbjörg is always up for some fun on the water in her spare time, be it fishing (not necessarily catching anything), swimming, dragon boat racing (or just rowing).



## Jasmin Amberg

Jasmin first visited a tunnel construction site when she was six years old. Although she didn't understand much at the time, she got the bug. In 2013, Jasmin did her Masters in Civil Engineering at the ETH Zurich in Switzerland and works now as a Project Manager at Amberg Engineering AG, where she is involved in several tunnelling projects at different stages. Jasmin is the Founder and Chair of the Swiss Tunnelling Society Young Members group (STSsym). Outside of work, she likes cooking and spending time with her family and friends, when she's not busy acting as a basketball coach and referee.



## Divik Bandopadhyaya

Divik has an MSc in Tunnelling and Underground Space from the University of Warwick, and works for London Bridge Associates Ltd. Having spent time working on major UK projects, such as Tideway and Hinkley Point C, he is currently seconded to Skanska Costain STRABAG JV as the Senior Tunnel Engineer on HS2's Atlas Road & Euston Tunnels. Divik served as the chair of the BTSYM in 2020/21, and continues to be involved with the British Tunnelling Society as Trustee/Committee Member.

# SHAPING THE FUTURE

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## Joint Young Members Austria is Formed

The ITA Young Members Austria was founded in 2016. Since then numerous activities and events have been organized and the number of participants has steadily increased. Last year the decision was made to also integrate colleagues from the parent organisations of the ISRM (Austrian Society for Geomechanics) and ISSMGE (Austrian Geotechnical Society) to create a united organisation called the "Joint Young Members Austria".

Last autumn the Young Members visited the test and research facility "Zentrum am Berg" in Styria, which consists of two parallel road tunnels and two parallel railway tunnels, connected by cross passages and galleries.

In May 2022, the Joint Young Members Austria also organized a

symposium at the Technical University of Vienna with six exciting presentations from different sub-disciplines of geotechnics. With 50 participants the symposium was fully booked.



Picture of the YM Austria Symposium 2022 in Vienna



Field trip to the test and research facility "Zentrum am Berg" in Styria, Austria

## YM Group Established in Finland

We are proud to announce that a YM Group has now been established in Finland. This has been an ongoing effort since the Finnish Tunnel Association (FTA) chose its first 'Finnish Young Tunneller' in 2019. Unfortunately, the pandemic situation made gatherings very difficult. However, by autumn 2021, the FTA had chosen its next Young Tunneller and we had the basis to begin activities. The initial plan was start gatherings in spring 2022.

In the summer of 2022, the YM Group in Finland finally came together for first time! The day's agenda involved a networking event for young members and visit two worksites in Helsinki. In total, there were 13 participants.

The first excursion was to the Patterinmäki Tunnel, which is part of the Jokeri Light Railway project. Works there were at an

advanced stage and tracks had already been installed in tunnel. Finishing works and testing were still underway in the run-up to traffic becoming operational in the tunnel.

Our next work site was

Finland's first underground water treatment plant constructed in rock. This facility has been in use since 1994 and we focused on detecting and inspecting damage to the rock and shotcrete that has appeared after decades.

In the evening a dinner was organised, providing time to meet and discuss tunnelling in Finland. This was great start for the YM Group and we now look forward to further events in years to come!



Finnish Young Members tour the Patterinmäki Tunnel, in Helsinki.

# ATSym Celebrate Achievements & Launch New Initiatives

Throughout 2022, the Australian Tunnelling Society (ATS) celebrated its 50th anniversary. The occasion was marked by a variety of activities including a Legend's Panel, a multi-location celebration on the 13 October, an event on digitisation and a special edition of the ATS Journal.

The 100-page bumper edition documented key moments in the growth of the ATS and the individuals who have contributed to it. It contains many fascinating personal

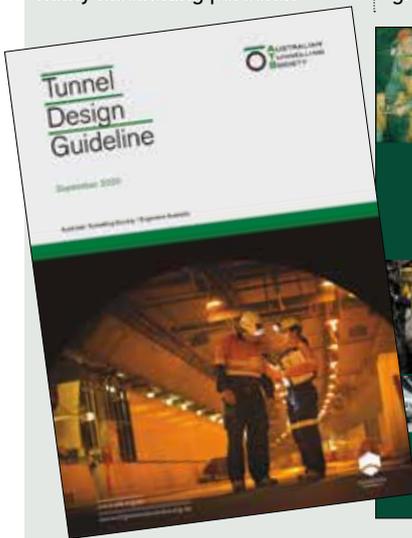
an introduction to, guidance notes on and references for each of the topics covered and is free to ATS members. For non-members, it is available for purchase.

When Engineers Australia National President and Board Chair Nick Fleming congratulated the Young Members on winning the President's Prize, he said, "The award is intended for individuals or groups who have provided conspicuous service to either the profession or the community. The work of this group of people exemplifies both

Subgroup strongly believes that an inclusive and diverse workplace is a key enabler to great work culture and high performing team.

Initiatives currently underway

include, promoting and championing the Woman in Tunnelling High Achiever Award (given out at the ATS triannual Tunnelling Conference) and running a mentoring programme. The group has some great sponsors and is also planning a series of inspirational speakers in the near future.



accounts of tunnellers – why they got into the profession, what has kept them there and how and why they got involved in the ATS – and a series of articles that touch on the history of shotcrete, rock cutting, contracts, grouting, tunnel systems and safety, in Australia.

In March 2022, the ATSym won the prestigious President's Prize from Engineers Australia for producing the ATS Tunnel Design Guideline. Although it was not intended to be a design standard or specification, the Tunnel Design Guideline is a 162-page pdf reference document that covers elementary tunnel design practice in Australia. It provides

aspects." In 2022, the ATS was also very proud to launch several new initiatives from its Diversity in Tunnelling Subgroup. This group has a committee of 11 dedicated members from across Australia and runs on the stated aim to promote, inspire and cultivate equality and inclusion in all sectors of the tunnelling industry through leadership, mentoring and engagement with the aim of attracting and retaining talented individuals.

Sabina Kost, one of the group's most energetic participants says, "When it comes to attracting more talent into the tunnelling profession, being open to a more diverse range of people is vital. The ATS Diversity and Tunnelling

## Ivan Haryono wins the 2022 ATS David Sugden Young Engineers Writing Award

Ivan Haryono was thrilled to receive the David Sugden Award on 13 October 2022 at the auspicious occasion of the ATS50 Anniversary Celebration and Dinner. Ivan received his award in Brisbane, but it was seen by all ATS members as the multi-location event was live-streamed across the country.

During his acceptance speech Ivan said, "I am extremely honoured to receive the 2022 David Sugden Award. It really motivates me to contribute more to our society and industry. Winning this award would not have been possible without the inspiration I've received from my mentors, seniors and peers; for whom I have the deepest respect – I sincerely thank each one of them."

Ivan's winning paper is called Discrete Fracture Network Approach in Ground Support Design Optimisation for Large Span Cavern in Jointed Rock Mass. You can read it here: <https://bit.ly/3sev0or>

The David Sugden Award was initiated by the ATS in 2004 to encourage young engineers to develop the art of technical writing. The competition is open to all ATS members and university students under 35 years of age.



Ivan Haryono receiving the award from ATS Young Members Chair Brodie Aitchison

The ATS Tunnel Design Guideline is available via the ATS website for AUD\$120. To get your copy, please visit: <https://tinyurl.com/mvrraj9t>

YM MEMBER NATION NEWS

# STSym Gets Ready to Celebrate 50-years of STS

After difficult times with Coronavirus restrictions, the STSym fully resumed activities in 2022. In March, the STSym visited two construction sites in the canton of Wallis in the south of Switzerland. Over 20 participants had the chance to see the work in the Vispertaltunnel, where almost all stages of the construction works could be seen, starting with excavation, to concreting works and finishing of the tunnel system that was handed over for operation soon after. After lunch the group visited the

Riedbergtunnel. Although it's a very short tunnel (just 550m) the construction works are very challenging due to the sloping alignment.

During the Swiss Tunnel Congress, in June 2022, the STSym again held their Young Members evening. Over 60 young members from all over Switzerland attended and spent a great evening with food and drinks in Lucerne.

In August, the STSym organised a site visit to the tunnel des Evouettes in the western part of Switzerland. This time the focus

of the excursion was on geology and the participants profited from the profound knowledge of the project's geologist who had to deal with the dangers of instabilities at the portals and difficult geological conditions for the excavation, which resulted in a change of support: from jet-grouting to double pipe arch roofing.

One of the biggest projects under construction in Switzerland is the second tube for the Gotthard Road Tunnel. Currently the preparation works, primarily consisting of two 5km access tunnels, are ongoing. The STSym

had the chance to visit this interesting construction site end of September and enjoyed a full day's excursion with a lot of different insights and a nice aperitif at the end of the day.

2022 ended with get-togethers in different Swiss cities and we are looking forward to this years' activities while celebrating the 50th anniversary of the Swiss Tunnel Society – a lot of great activities have been planned!



Riedbergtunnel – Switzerland



Vispertaltunnel – Switzerland



2nd Gotthard Road Tunnel - Switzerland



STSym Evening at STC 2022

## AFTESym Grows its Membership

France's AFTES Young Members (AFTESym) now represent 13% of the total AFTES membership, with numbers consistently growing since the group's creation in 2017. This notable diversification in membership type since the group's inception has partly come from an increased number of university students and participants in INSA Lyon's specialised Masters in Tunnels & Underground Works joining the association.

The last year of activity for the group was marked by a gradual change in interaction as we got back to the in-person model that we all knew prior to the pandemic. As works linked to the Grand Paris Express project decrease from their peak during 2018-2021, other major projects, especially TELT, have come online across France. As such, there has been enthusiasm for events to be hosted in a more decentralised and hybrid way in order accommodate greater distances between the various clusters of major work in the country.

Furthermore, the AFTESym facilitated an anonymous survey gauging the views of the current membership regarding their experiences of working and evolving within the French tunnelling industry. The aim of this was to understand the leading tendencies for attraction/frustration with the industry as well as gain views on the outlook of the industry after the first major infrastructure push in France since the previous generation.

This year the association aims to further promote diversity and knowledge sharing as key points of development. To do so, events with sister associations like "Les SouterReines" (an association promoting diversity in construction) and CFMS (the geotechnical association) are planned; including roundtables on the topics of inclusivity and gender bias in tunnelling. Additionally, participation of young members in a variety of AFTES's technical working



AFTESym during an evening meeting in Paris

groups are being actively encouraged with a view to inducting the upcoming generation to the roles within interdisciplinary industrial committees.

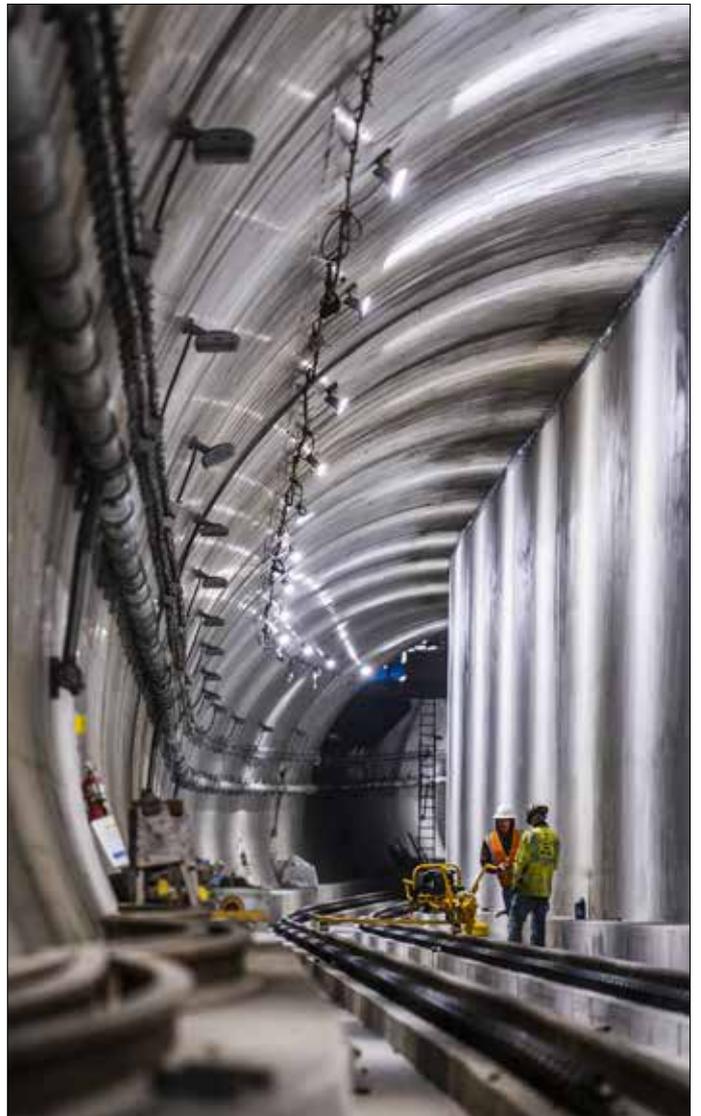
2023 is an important year for France as it hosts its biennial congress in Paris and continues to provide high-quality training programmes and scientific events throughout the year!

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## CBTym Evolves and Expands in Brazil



During 2022, the young members group of the Brazilian Tunnelling Committee (CBTym) underwent a major restructuring and now

comprises a team of about nine volunteers under the coordination of Alex Nowak La Flor (Chair) and Juliene Oliveira (Vice Chair). As part of this process, a number of new committees were created: social media and communication, relationships with universities and schools, relationships with enterprises, human capital, international relationships, events, research and development. The group has also been engaged in presenting numerous webinars, participating in congresses, spreading knowledge and building the image of the group on social media networks. A new board of direction will be appointed for the next two years (2023-24) with the engagement of Victor Lima (Chair) and Maristela (Vice Chair). We have also evolved our identity, with a new logo design to signify the renovation and growth of the group.



New members of the CBTym together with the CBT Chair at the 2022 Brazilian Soil Mechanics Congress. From left to right: Luis Zago (CBTym Head of Universities), Mariana Campos (CBTym Head of Communications), Eloi Palma Filho (CBT Chair), Victor Lima (CBTym Head of Human Capital and next CBTym Chair in 2023).

## Norway's YM: Deep in Mines and High on Waves!

The Young Members in Norway are back to normal activity levels after a couple of years of digital solutions and online meetings.

In the spring of 2022, they visited Bodø, a city north of the Arctic circle, where among other activities they visited the Hammarfall Dolomite Mines. A spectacular site with lots to learn for most young tunnellers. During these spring tours we always make sure we include something just for fun as well and a speed boat tour across the Saltstraumen, the world's strongest whirlpool, definitely got everyone's heartbeats going!

One of the main objectives for YM Norway is to recruit and inform students about the Norwegian construction industry. This is done through so called "industry nights". The student organisations at both the University of Oslo and the Norwegian University of Science and Technology, in Trondheim, help us invite students for an evening meeting with short presentations from young people in the industry with networking, pizza and beers afterwards. YM Norway does this twice a year at both universities. A popular event, where students can ask question and talk to tunnellers in a relaxed atmosphere.

The other way to reach students at the universities is to participate in recruitment fairs. NFF tries to participate in about five of these events every year. It is a demanding activity when it comes to using our resources, but it is an important measure to reach many youngsters at the same time.

The NFF young members have also made it a tradition to meet before the yearly conference for all tunnellers in Norway. During the day, this usually includes a site

visit to a construction project or a factory nearby. In 2022, the visit was to a large metro project "Fornebu-banen". This project will extend Oslo's metro system to include a connection to Snarøya, a new area for business and residential development in the neighbouring municipality Bærum and one of the largest construction investments in Norway at present.

Another tradition among our young members is to explore the Oslo-field with various volunteers. They have arranged walking trips, biking trips and in 2022 there was a visit to the Natural History Museum. With a professional guide, paleontologist Hans-Arne Nakrem, visitors came back with buckets of new knowledge.



Christian Haugen Svendsen, Bever Control, and Chatrine Gremmertsen, Veidekke, were NFF YM's representatives at a student fair at the University of Oslo (Photo:NFF).



Happy visitors at the Natural History Museum in Oslo (Photo: NFF).

# German Young Members Reunite

At the end of 2021, the German Young Members from STUVA YEP held their third official general assembly in the framework of the STUVA conference, in Karlsruhe. From eleven candidates, eight members were elected to the Steering Committee. The third Steering Committee of STUVA YEP is composed of: Christoph Caspari (Schüssler-Plan Ingenieurgesellschaft mbH), Nils Gramlich (Ruhr-Universität Bochum - RUB), Franziska Hebach (Amprion GmbH), Maren Kaiser (ZPP Ingenieure AG), Robert Lutz (Vössing Ingenieurgesellschaft mbH), Christian Rhein (RUB), Marc Steinfeld (DB Netz AG) and Anna Zehlicke (Schüssler-Plan Ingenieurgesellschaft mbH) as well as Ruben Deckers (STUVATEC GmbH) as STUVA representative. STUVA YEP would like to thank the previous members of the Steering Committee and all applicants who did not make it to the Steering Committee for their commitment.

As in previous years, STUVA YEP was again represented in Karlsruhe with its own exhibition stand at the two-day STUVA-EXPO. The YEP stand was once again the place to go for Young Members and experienced colleagues from the tunnel industry to meet familiar and new colleagues and exchange ideas over snacks and drinks and of course gain new young engineers



Tunnel construction at S-bahn's Marienhof station.

as members. As of now the german STUVA YEP consists of more than 400 members.

The third Steering Committee has now put its own signature on STUVA YEP. With most events having had to be cancelled or postponed in the previous two years, many events were organised again in 2022. The young members arranged local meetings in Cologne, Munich, Hamburg and Essen to exchange ideas in a relaxed atmosphere at more frequent intervals. The popular regular events of the past have also been revived with construction site visits and workshops.

In July, with the expansion

of underground rail and road infrastructure taking place in various areas in the region, a visit to a construction site in Munich took place. The best known project is the 2nd S-Bahn main line, which is a central element of the expansion of rail-bound public transport in the Munich region. Around 30 young members had the opportunity to first attend exciting lectures on the topic of "Challenges of large inner-city projects" and then to visit the huge construction site in the heart of Munich.

After the successful tour of this construction site the next workshop took place in October. In Cologne, young members were

invited to interesting lectures and lively discussions on the topic of "Innovations in tunnel construction". Around 50 young members came together at the TH Cologne University of Applied Sciences. The field of participants consisting of planners, contractors, clients, researchers and students exchanged views on the various lectures as well as their own projects.

The year 2022 has shown that STUVA YEP is a lively, active and constantly growing network. In 2023, numerous small and large events were planned again, at conferences and construction sites, nationally and internationally. 

## World Tunnel Day Update

In 2022, the ITAym solidified its tradition of hosting the World Tunnel Day video conference marathon. They took a slightly different approach, offering member nations more flexibility to share content they found relevant and valuable throughout the year. This self-moderated format led to a diverse range of updates, from engaging activities to insights into the origins of Santa Barbara, the patron saint of miners and tunnellers. The event remained true to its purpose, introducing people worldwide to the ITAym, facilitating networking, and exchanging ideas in an accessible environment. Each edition serves as a meaningful moment for reflection on accomplishments and a source of pride for what can be achieved.





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# Talking Sustainable Tunnel Solutions

Building tunnels helps to make the world a better place, says ITA president Arnold Dix. But we need to explain how. Kristina Smith reports.



When the International Tunnelling & Underground Space Association (ITA) elected Professor Arnold Dix as its president in September 2022, Dix had a stark message for his colleagues: Stop talking about how great your projects are and start talking about the United Nations' Sustainable Development Goals.

Dix is currently on a mission to do just that, travelling around the world to join forces with organisations who can help get the message out there. At the heart of his strategy is a plan to invent a new form of contracting that will allow tunnel construction projects to introduce

change for good, combined with a new sustainability indexing tool designed specifically for tunnelling projects.

The group responsible for the nuts and bolts of delivering Dix's vision is the ITA's Working Group 3 (WG3) Contractual Practices. The group's amateur Matthias Neuenschwander explains why contracts and the legal basis of projects is so crucial to delivering projects sustainably (see box). Below, we ask Dix to explain his thinking.

#### Are all tunnels sustainable?

Absolutely. The social and economic benefits are why

we build tunnels. We shorten the distances between places for everything from people to goods and services to energy and communications. And through making those shorter connections, we make everything we do more efficient, which is one of the core objectives of achieving sustainability.

#### What about the environmental costs of projects, such as losing trees or damaging sea life?

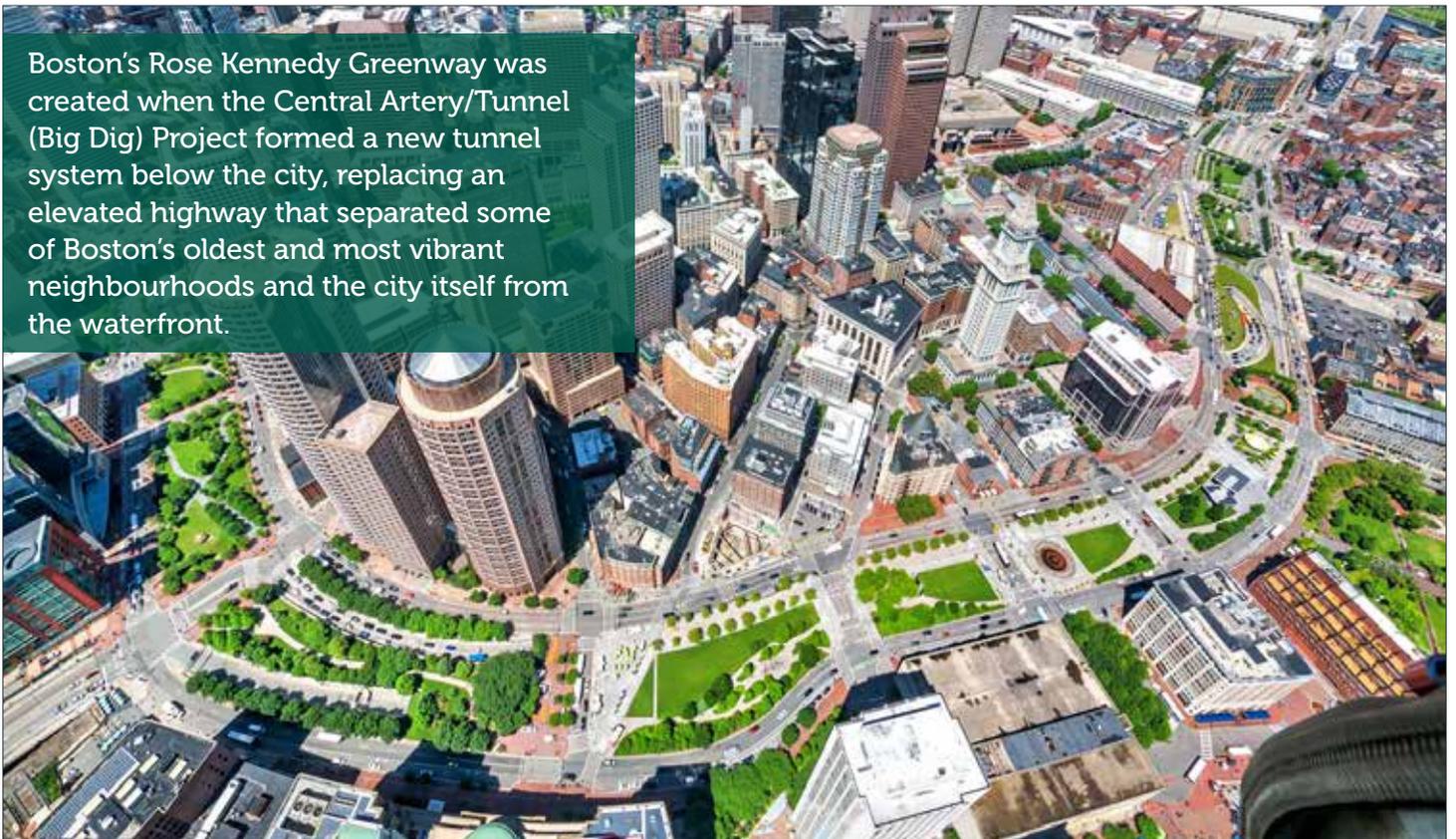
Sustainability is not a binary proposition. We ask whether, on balance, a project is bringing a benefit or a disbenefit. That is why

we are developing a sustainability indexing tool so we can be better informed about what is a good project and which projects we shouldn't do at all.

It is certain that, if we measure them properly in terms of impacts on the planet, some of the projects that we have built in the past, or perhaps even projects that we are building now, would fail. That's why we are so passionate about getting a framework in place to measure the performance of our tunnels, so that we really understand their impact.

We must assess the fundamental collective change

Boston's Rose Kennedy Greenway was created when the Central Artery/Tunnel (Big Dig) Project formed a new tunnel system below the city, replacing an elevated highway that separated some of Boston's oldest and most vibrant neighbourhoods and the city itself from the waterfront.





As part of the current Melbourne Metro development an existing parkland will be redeveloped and expanded, reclaiming part an adjacent road and car park. The parkland will include native fauna and feature BBQ and picnic areas.

we have made by building an underground space. Many countries that are now facing increased flood risks and other climate emergencies and are turning to underground infrastructure as a mechanism to better protect their citizens and the environment.

Then, there is the value of liberating space on the surface for nicer things. Think of Paris

where there are a billion underground subway journeys every year. By taking those journeys underground, we release space for parks and pedestrian movement above ground.

**Why are contracts important?**

With the climate emergency and focus on sustainability has come

an explosion of innovation, new technologies and new approaches in just about everything we do. Traditional contracts require certainty on what everyone will get, how much it will cost and how long it will take. If you are serious about responding to the challenges of today, you need contracts that are flexible and that accommodate change and even anticipate failure, which can

happen with new technologies and innovation.

Most major infrastructure projects will take at least a decade to design, gain approvals and build. If we have a contract that is relationship based, has aspirational targets in it and has an agreed way of being paid that is not linked to exactly what you thought at the beginning, then innovation that happens over that decade could be rolled out. Instead of having variations or conflict that can end in court, or worse, you end up with discussions and agreements as to how to change the project.

**What is relationship contracting?**

It is not about taking an “I am right, and you are wrong” approach. It is not about trying to make a claim to make more profit on your job. It’s a process which still has certainty but includes mechanisms and procedures within it to allow adjustment of the scope, price and specification without leading to conflict.

For instance, a contract could have an internal mechanism where everybody agrees that they will try to reduce the carbon footprint and, in doing so, they will share the cost and burden 50:50. It is walking together to try and achieve better outcomes for society at a time when everything is changing so quickly.

**How will a sustainability index help us communicate with the public?**

If we start talking specifics and details, that won’t work. But if we can use the index as part of the decision-making process, we will come to better decisions and that will speak for itself.

For me, part of the attraction of using an objective sustainability indexing tool, is that it allows you to say that the metro scheme of Contractor A is not nearly as good as Contractor B’s. Contractor B’s scheme might cost more, but they are using different concrete, a renewable energy recovery



Madrid’s Manzanares River was reclaimed as parkland when the city’s M30 motorway was placed underground. The resulting riverside park, which extends over 7.5-kilometres, has become one of the most popular spots in the Spanish capital, with pedestrians, joggers and cyclists sharing its verdant paths.



Seasonal flooding in Pakistan killed thousands in 2022 alone.

system, a natural ventilation system and a properly audited supply chain so that there's no human trafficking or slavery.

Using an indexing system will also mean that some projects will fail. And that's okay. We need to make sure that the projects we build are awesome.

### Are we too obsessed with carbon?

Of course. That's really a good example of failing to put things in context and that is why we need to properly understand the bigger picture. Having a fascination with carbon is just part of the equation. If you look at carbon alone, you will get silly results.

### Are we good enough at measuring social benefits?

If you put infrastructure underground, it liberates the surface for better social encounters and experiences as humans. Think of Paris, London or New York City, where you have this amazing life on the surface. That's a major social benefit.

In Granada, I learned how putting cars underground is wonderful for the neighbourhoods because it is quieter and that means that people get better sleep. That is

an example of tunnels directly improving people's lives and wellbeing.

A delegation of engineers from Pakistan were sent by their President to ask the ITA what could be done urgently to protect farms and rural communities from floods. That's really uplifting because you realise that underground projects have the ability to perform amazing transformations and respond to climate emergencies.

### Given the amount of green washing about, how could a graduate spot a sustainable employer?

They should not stress themselves about that because they could become paralysed as they tried to research and compare employers. They should say: "I have got a whole load of skills and intellectual tools that allow me to make a difference and that's what I am going to do". Don't try to pick the winner. There is a whole lot of faking going on so they should just accept they have got a role to play as the latest and smartest minds. So, just do your best. Do your job and help organisations digest, understand, and convert this wisdom into action.

## Contracts, risk and sustainability

"A contract is the agreement between the owner/ agency of the project and those who realise the project on what should be done, how it should be done, what it should cost and who bears what risks," explains Matthias Neuenschwander who is the Animateur – or leader – of the International Tunnelling and Underground Space Association's (ITA's) Working Group 3 (WG3) on Contractual Practices.



Matthias Neuenschwander

Because contracts are so central to the way that construction projects are delivered, they are also central to making projects more sustainable. So WG3 sub-groups are busy on several projects that feed into ITA President Arnold Dix's vision:

- Creating a new sustainability indexing tool for underground space construction with the UK's BRE, who administers the BREEAM rating tool.
- Working with contract organisation NEC on guidelines for how underground projects can use collaborative contracts NEC4.
- Producing guidelines for the Emerald Book, an underground-specific contract that was created with contract organisation FIDIC and that was first published in 2019.
- A joint project with ITA's Working Group 2 Research, aiming to create new ITA guidance on risk management.

Neuenschwander explains why getting risk allocation right is so important for sustainable development. "Large infrastructure projects such as tunnels are hugely expensive, which means they also entail huge risks," he says. For instance, if a tunnelling project runs into ground that is different from what was expected and that causes problems and delays, who pays?

Historically, project owners have always tried to pass as much risk as they can onto contractors. "This has proven far from sustainable in the sense that contractors have gone bust or walked away from projects," says Neuenschwander. With over 30 years working on civil engineering contracts, including eight years as Managing Director of Lombardi Engineering, he has first-hand experience of such situations and now provides contractual advice and mediation to help avoid them.

A better approach is to look at each risk and allocate it to the organisation best placed to deal with it, says Neuenschwander: "This is more sustainable and it will cost less too." This is what WG3 has endeavoured to do in creating the Emerald Book contract. Adapting the collaborative NEC4 contract for underground projects has the same goals. 

# Future proofing

Although tunnelling involves some amazing feats of engineering and awesome underground structures, its purpose is to make the world a better place.

Breakthrough's Kristina Smith asked a selection of young professionals how their roles are contributing to change for the greater good.

## Understanding the subsurface to help the world transition

*Aaron Hollingsworth, Customer Solutions Lead, Seequent*



I work for Seequent, The Bentley Subsurface Company, as Customer Solutions Lead in the Civil and Environmental technical team, Asia Pacific, based in Brisbane.

The biggest part of the role is teaching customers how to use Seequent's software portfolio efficiently, so they can solve problems and achieve what they need. I help customers with their workflow across software, particularly with integrations, to remove inefficiencies and double handling for users. This is really satisfying and makes it easier for users to utilise their data and work on projects effectively. Sometimes I help customers build geological models.

Having studied for a BSc in geophysics at Curtin University in Perth and then a bachelor's degree in petroleum geoscience in Adelaide, I headed to the UK to work for Delta-Simons as a graduate engineer. This role was a great mix of being on-site overseeing drilling, sampling, trial pitting, in situ testing and then writing reports back in the office. In 2017, I saw an advert for a role in Perth with Seequent (ARANZ Geo at the time) that sounded really interesting: launching Seequent into the civil and environmental sector with Leapfrog Works.

When I joined Seequent in 2017, Leapfrog was our main software solution, and mining was the key market. Fast forward to 2022, and we have a

new integrated tunnel design solution spanning ground interpretation, physical modelling and geotechnical design with smooth workflows connecting Leapfrog Works, OpenTunnel Designer and PLAXIS. We also have a rapidly growing portfolio of connected solutions for geophysical modelling, geostatistics, core imagery and geotechnical data management.

We're helping customers tackle some of the world's big problems: transitioning energy to renewables, enabling the mining industry to produce the inputs we need sustainably, bringing far greater subsurface insights to create resilient infrastructure, working on environmental challenges, and reducing cost and time overruns. One of Seequent's big-picture goals is to help its customers understand the Earth with world-leading, integrated subsurface software, and I do feel like I contribute to that in my role.

When I look back at the changes in the civil industry over the last five years I have been at Seequent, it's very rewarding to see how Seequent's software has brought together geoscientists, engineering geos, and geotechnical teams to communicate a shared understanding of their civil projects.

Even if it's in a small indirect way, I am in some way involved with providing improvements on how environmental problems are understood and enabling more sustainable infrastructure and mining. An essential part of this is helping users of our software to communicate subsurface understanding more easily to a wide range of stakeholders – whether it's a technical project team, executives or the wider community.

## Extruding tunnels

*Ilyas Seckin, Engineering Operations Lead, Swissloop Tunneling*

I am currently still in university, in my final year of a Bachelors' degree in mechanical engineering and working at Swissloop Tunneling at the same time. I was introduced to the project by a friend and started working on it in April 2022. We are currently preparing for the next Not-a-Boring Competition organised by The Boring Company, which will be held in Texas at the end of March 2023. Elon Musk is looking for ways to make tunnelling faster and more viable for his Hyperloop transportation system. At the last competition in 2021, we got second place and were given the Innovation and Design award. In the new iteration, we are building a mechanism involving polymer that we melt and extrude into a tube to form the inner lining of our tunnel in situ to allow continuous boring.

I am responsible for the organisation and engineering of the TBM periphery structures, safety, logistics, infrastructure, the integration of high-power electrics with the power grid and the development of CI/CD pipelines for the software that connects the TBM with subsystems and the control station. There are currently eight people in my team from a wide range of disciplines. In Texas we must tunnel through clayey soil, so we are going to utilise a huge sand box for the TBM to mine through. In mid-to-late February, we will ship the machine to the US, which requires a lot of organisation and is my team's responsibility.

Working on this and studying at the same time is intense. I try to do something for the Swissloop project every day and there are lots of meetings. It's a tough schedule but it's manageable and it's really fun. I think it's worth it. We are tired but we are happy and tired. If we do manage to dig the tunnel and build the tunnel lining continuously, that will be a great achievement for us. It would be a proof of concept and, after more research and development, it could mean that tunnels can be built faster and more sustainably. However, it is a difficult task.

Personally, protecting the environment and developing sustainable solutions are very important to me. I think these will be important criteria for me when I look for a job. I would like to concentrate on control systems, which can be used to optimise the sustainability of many technologies.

## Driving fast towards electric equipment

*Tatu Makkonen, Control system engineer, Normet*

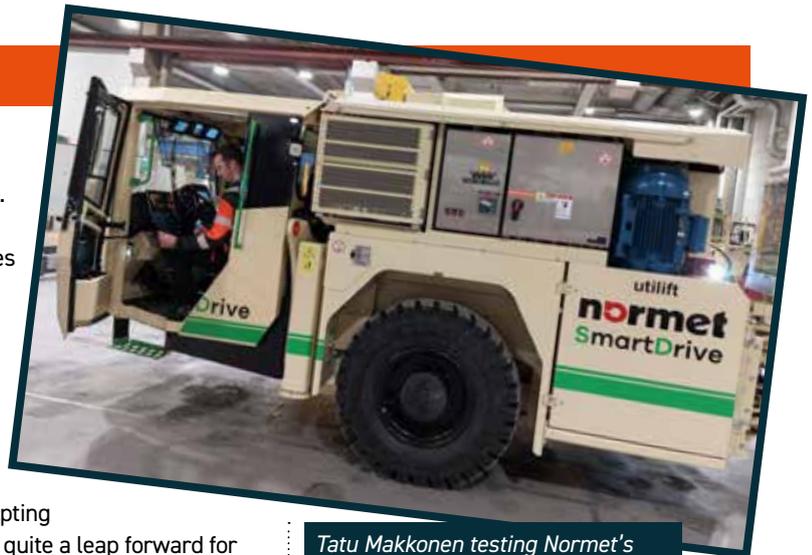
As a control system engineer in the R&D department, my main focus at Normet is the SmartDrive system, a modular battery electric vehicle (BEV) architecture that is designed to optimize energy consumption and performance in underground applications. Much of my time is spent designing new features and functionality, conducting safety analyses and functionality tests and developing detailed technical specifications. I also support our manufacturing and assembly lines with any troubleshooting they need to resolve.

This is a dream job for me. It's great to be in the frontline in implementing this new technology and it is also an excellent experience. I like the diversity of the job. I'm not just restricted to one area; I work in cooperation with other R&D departments as well. My colleagues here are very open, and teamwork is very fluent between the different parts of the company, which makes my work easier.

As we are working with new machine models and development versions, the pace

of work is intense. We have several new machine types being developed and tested at the same time. Keeping them all on schedule is a challenge, but at the same time very exciting. Adopting this technology is quite a leap forward for our customers and the interest is constantly increasing. Feedback from the field and from our customers using them is showing that the payback time for these machines is less than predicted. I think that will increase interest even further.

This technology is an excellent option for replacing fossil fuels, which will improve sustainability and have a positive impact on the environment. Of course, we will also need green electricity and to reduce emissions from battery manufacturing; but I believe this will happen, as battery



*Tatu Makkonen testing Normet's new Utilift MF 330 SD*

technology is developing at a very fast pace.

In my opinion, it is very important for each one of us to think about how our actions affect our environment. My own personal mindset has changed in the past few years. If I have the chance to improve sustainability or make a positive contribution with the work I do, I take that as a privilege. For me personally it's important and it's something I think about when I apply for a job. It's not all about the money you make.

## Navigating new territory with hyperTunnel

*Tim Delpont, Senior Geotechnical Engineer, hyperTunnel*

I lead the geotechnical operations at hyperTunnel. It is a unique role; I cover all aspects of geotechnical engineering: research, investigation, design, analysis, reviews, and stakeholder communication. I've typically found that other geotechnical roles involve only a few of those aspects.

hyperTunnel is targeting a revolution in the tunnelling industry. The company's founders Jeremy Hammond and Steve Jordan were investigating tunnel construction for tidal range energy production and noted a lack of an economy of scale when it came to constructing tunnels. Building on that initial motivator, hyperTunnel now envisions the additional innovative applications that we could realise with our technology.

I was scouted whilst completing my doctorate on geothermal systems at Oxford University. One of the company's initial goals in forming their core engineering team was to minimise the team's prior exposure to tunnel construction, therein reducing prejudice or restrictive thinking. I was fortunate to meet this criterion, having

not designed a road or rail tunnel despite a decade of consulting experience for the mining and transport industries.

I enjoy this job because of the opportunities I have to practise many elements of geotechnical engineering, and because of the pace, culture, and challenge. I've found it is one thing to understand your field's theory and practises, it is another to know them well enough to challenge yourself by applying them to scenarios they have never been applied to before - navigating new territory. Each of my colleagues at hyperTunnel are beside me and doing the same in their respective fields. That creates an amazing collaborative environment that is a real pleasure to be a part of.

We have just finished building our very first tunnel solely using hyperTunnel's robots, which deploy chemistry into the ground to build a tunnel lining before excavation. The tunnel, called Peak XV, was constructed at our test facilities in Hampshire, UK. There are plenty of possibilities for our technology beyond



just new tunnel builds, such as tunnel enlargement and repair of existing tunnels, dewatering of ground profiles and even slope stabilisation.

There will be a plethora of positive outcomes associated with a successful hyperTunnel. Tunnels will be faster, cheaper, and more sustainably built than they are using current practise. Efficiencies will bring economic gains and environmental improvements. When I joined hyperTunnel, it was clear it was a game changer. Who wouldn't want to be part of that?

**Resource efficiency and re-use: university spin-out evaluates construction chemicals**

Diego Sebastiani, CEO, Geotechnical & Environmental Engineering Group (GEEG)



The idea of GEEG was to start a company in parallel with research activity taking place at the Sapia University of Rome, where I was studying my PhD at

the time. Together with the other founders, who had the same passion as me, I wanted to build a bridge between academic research and the industry: suppliers, chemical companies and contractors.

Construction chemicals are used on tunnelling projects for many different purposes for instance to make the ground firmer or to make excavated material easier to move through a tunnel boring machine. But often there are no standards or tests that allow contractors to assess the performance of these chemicals or compare products from different suppliers. So, we created a unique team, involving several departments of the university that would usually not work together, and a unique structure. That was in 2018. By February 2023, we were five years old and are working on projects around the world.

I had to learn a lot of new things: finance administration and business planning. It was scary at first, but I wasn't alone and I have some very special colleagues. I had to hire people without ever having been for a job interview myself. In a way, that was strange, but it meant I was free to do it in a different way, without prejudice. There are 16 of us now, and we are still hiring.

The use of materials and chemicals in the engineering world is developing fast. Our small role with contractors is to help ensure that new products and chemicals perform properly and that they are used in the most effective and efficient way and that any negative impact on the environment is minimised. We also support chemical suppliers in producing affordable and sustainable products.

In addition, we are working on circular economy issues, how to reuse soil from excavations. Sometimes soil and rock is considered construction waste but at the same time we extract sand and aggregates from quarries for use in construction. It is a difficult subject, but it is something that the industry is now really working on, how



Startup di:  
SAPIENZA  
UNIVERSITÀ DI ROMA



materials from excavation can be reused. Sustainability is not just important to me, it's important period. It is simply a fact now. We didn't form GEEG because we needed to – most of us had other jobs at the time.

We formed GEEG because we wanted to dedicate ourselves to making something that is valuable to us. Making a difference to the environment is one of the things that we feel is a reward for our efforts. **B**

# breakthrough

## Reaching the Next Generation of Tunnellers

Promote your company and the work it does to the next generation of leaders and decision makers in the tunnelling industry! Breakthrough is the official magazine of the International Tunnelling & Underground Construction Association's (ITA-AITES) Young Members and is distributed (free of charge) to thousands of young tunnelling professionals, engineering students and graduates around the world.

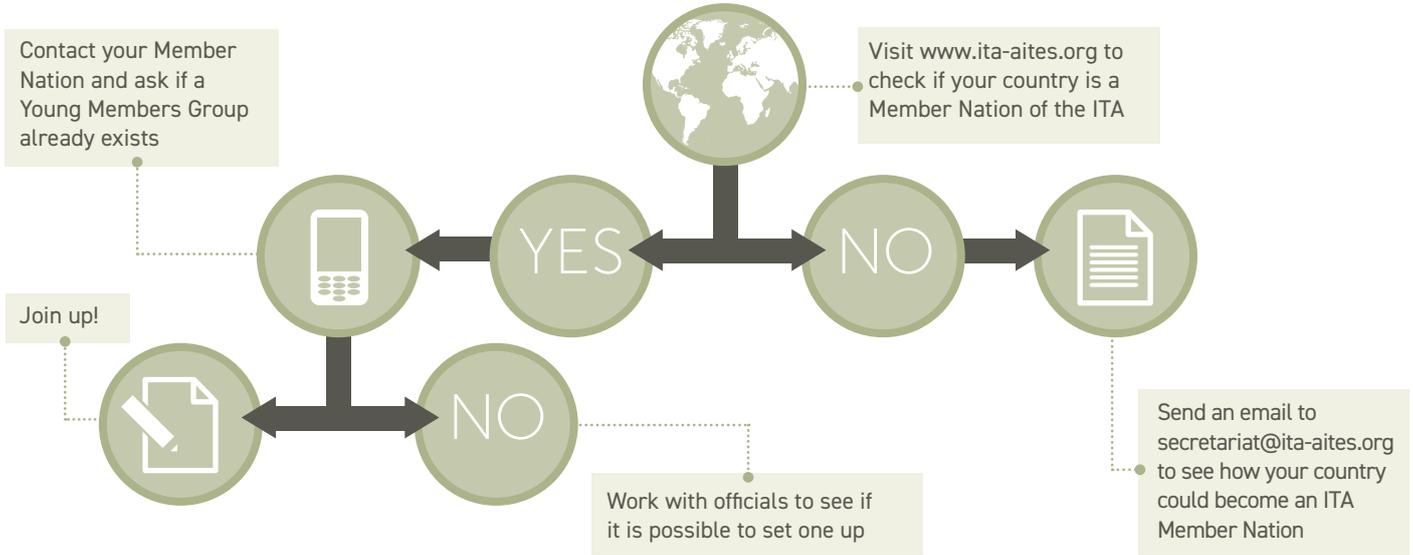
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# How to set-up a Young Members group



## SETTING UP A YM GROUP

1.



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

2.



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

3.



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

6.



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

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

5.



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

4.



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

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

# From Gold Rush to Water Rush

The Kidston Pumped Storage Hydro (KPSH) project will utilise Australia's largest abandoned gold mine to generate, store and dispatch renewable energy on demand, a world first. Kaylah Macintosh, Technical Services Manager for JV partner John Holland, describes the unique challenges of undertaking a major tunnelling project in Australia's remote outback.

**Taking-off** in a light aircraft from North Queensland, Australia, you quickly notice a distinct change in topography from the verdant fields and tropical mountains of Cairns to the savannas and shrublands of the Einasleigh outback region. My destination: The Kidston Pumped Storage Hydro (KPSH) project at the Kidston Clean Energy Hub, approximately 110km south of Einasleigh, in the Far-North of Queensland.

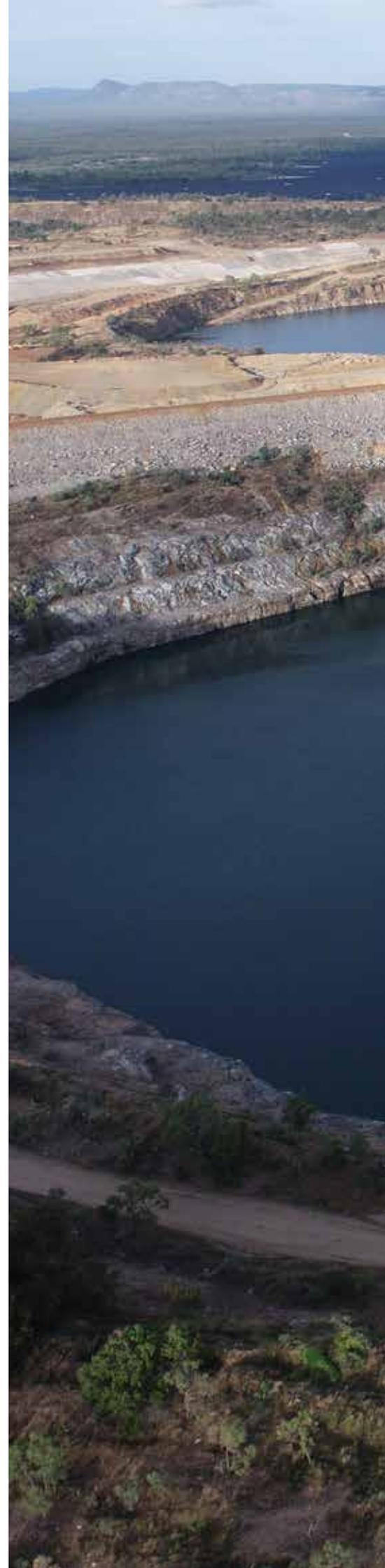
The Kidston Pumped Storage Hydro (KPSH) project is Australia's flagship pumped storage hydro project, reinvigorating renewables technology for the first time in the country in 40 years. Disembarking at Australia's largest former open cut gold mine there is an unmistakable awareness you're

arriving at a project that is distinctly different from the typical urban tunnelling projects that make up much of the work in Australia today.

Initially referred to as Oaks Rush, gold was first discovered here in September 1907, and a small town complete with post office and school was soon established – a name change to Kidston, in honour of then-Queensland Premier William Kidston, accompanied the early success. By December 1907, at least 120 ounces of alluvial gold had been obtained by working four gullies of the nearby Copperfield River tributaries with about 120 men in the field. Local mines that focused on other resources, such as copper, were soon abandoned to chase the gold found



*Drill and blast cavern heading*





## Key facts

Dam liner: approx. **125t** of HDPE offcuts, **~40%** of that to be reused to create ballasts, with the remaining to go off-site for specialist recycling.

**190,000** tonnes of site-won material to produce concrete aggregates, and moved over 3,000,000m<sup>3</sup> of site-won mine waste to construct the upper dam wall.

**38%** cement powder substituted for waste by-product (fly ash and silica fume) - infrastructure average **~25%**

**100%** non-potable water is used for all construction aspects.

at nearby Kidston.

Traditional surface mining at Kidston ceased during World War II, but Kidston Gold Mines applied to restart modern open cut mining operations in the early 1980s when technology caught up and enabled further work. Mining would continue until the turn of the Millennium, creating today's iconic Kidston Pumped Storage Hydro topography.

The Pumped Hydro concept stores energy in the form of the gravitational potential of water, which is gained when pumped from a lower-elevation reservoir to a higher-elevation reservoir. During periods of high energy demand, this stored potential energy is converted to kinetic energy by releasing the stored water from the upper reservoir, through electricity-generating turbines into the lower reservoir. In periods of low energy demand, the water is pumped from the lower reservoir back into the upper reservoir to begin the electricity generation cycle again. Low-cost surplus off-peak power is typically used to run the pumps.

Pumped storage allows energy from intermittent renewable energy sources to be saved for periods of higher demand; pumped storage hydro is the largest-capacity form of grid energy storage available in the current Australian market. The technique is currently the most cost-effective means of storing large amounts of energy. Naturally, Kidston's dual pits and elevation advantage made it an ideal candidate to reinvigorate pumped hydro technology in Australia.

Pioneering construction and leading from the front is a joint venture comprising Australian contracting firms John Holland and McConnell Dowell working under an EPC contract. A melting pot for engineering disciplines, the project involves; extensive non-linear drill and blast tunnelling, major earthworks and extensive mechanical and electrical fit-out to enable the project to (when operational) deliver sustainable power to the long-unreliable north Queensland power grid.

The Kidston Pumped Storage Hydro project is geologically set in the Einasleigh Metamorphics, consisting of largely granitoid, Porphyry and volcanic lithology. During active mining, a brecciated gold-supporting rock mass was the primary focus of production. The underground infrastructure of the pumped storage hydro project is set primarily in high-quality Gneiss rock. The geology, even to those with limited geological interest, is striking with its distinct black, white and pink swirled headings. To maximise the high-quality Gneiss, the

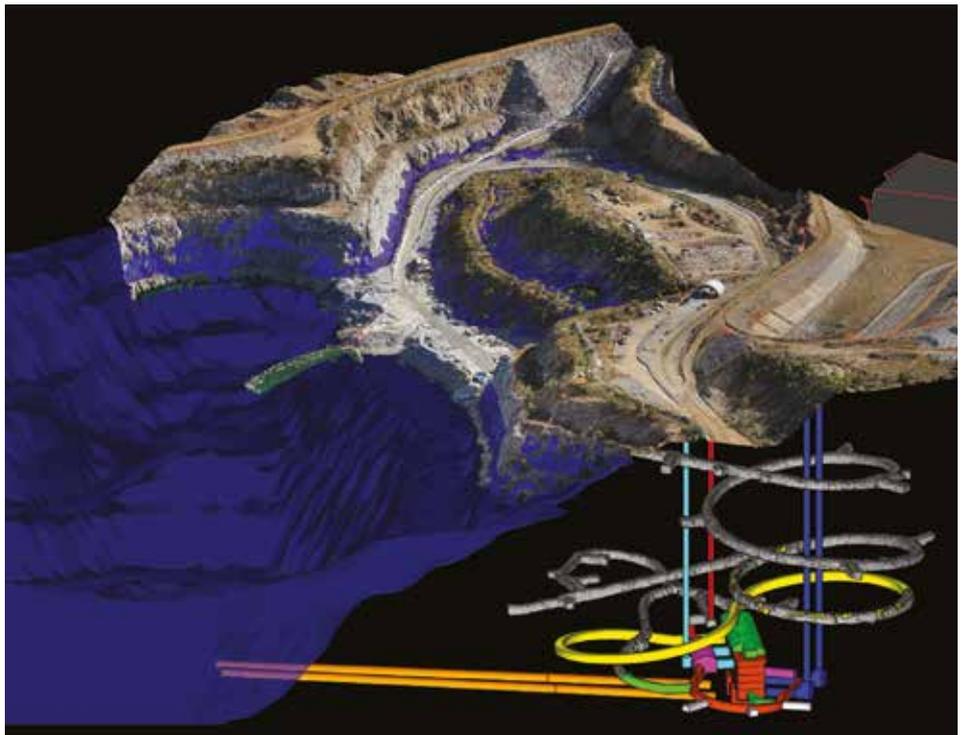


Map showing the layout and topography of the KPSH Project

## Project Scope

The project will act as natural battery storage, allowing energy to be stored and harnessed on demand and includes the following components:

1. An upper reservoir formed by a 35m high dam around the existing Wises Pit
2. A lower reservoir utilising the existing Eldridge Pit
3. A powerhouse cavern with the capacity to generate 250 megawatts
4. A tailrace allowing water to pass from the powerhouse to the reservoirs
5. A spillway from the upper reservoir to the nearby river



Section of the KPSH Project showing its spiral decline

project's design Joint Venture (consisting of GHD and Mott MacDonald) designed a helical decline rarely seen in tunnelling; however, all too familiar with mine design. This fusion of the still-young (but highly energised) Australian tunnelling industry with a galvanised mining knowledge-set makes Kidston a truly unique project.

The challenge set out by Genex Power Limited (the Kidston Clean Energy Hub's owner and future operator) was for John Holland & McConnell Dowell to develop the site as sustainably as possible with limitation of disturbance and the construction zone retained to the already disturbed mining lease area. During the construction of the dam (comprising a rockfill dam with a High-Density Polyethylene (HDPE) liner on the upstream face), the project operates a crushing and screening operation to support material needs by utilising rock from the project site. Where site-won material cannot be utilised, there is a strong focus on the responsible sourcing of raw materials.

To construct the dam liner, the project will utilise 125 tonnes of waste HDPE offcuts to create ballast tubes and, as of April 2023, sourced 190,000 tonnes of site-won material to produce concrete aggregates, and moved over 3,000,000m<sup>3</sup> of site-won mine waste to construct the upper dam wall.

The upper dam (known as Wisers Dam) will serve as the primary storage for power generation as it feeds the two intake shafts, and, subsequently, the turbines. Tunnelling of the Main Access Tunnel (MAT) commenced in December 2021 with a single tunnel heading later breaking out into three headings, all utilising drill and blast as the primary excavation methodology. The 1.7-kilometre MAT leads to the Main Powerhouse and Transformer caverns, with approximately 50,000 cubic metres of rock to be excavated to make space for the two power-generating turbines and supplementary plant and equipment to be fitted. At the end design, the main powerhouse will boast an 85 metre long, 20 metre wide and, at its deepest point, a 45-metre-high cavern approximately 240 metres below ground level. The project celebrated its milestone of completing its triple split heading powerhouse crown excavation works in May 2023.

Logistics are one of the major challenges for the project delivery due to the remoteness of the project's location; the joint venture meticulously plans inbound and outbound construction deliveries around seasonal weather, which can (at times) restrict heavy vehicle movements into the



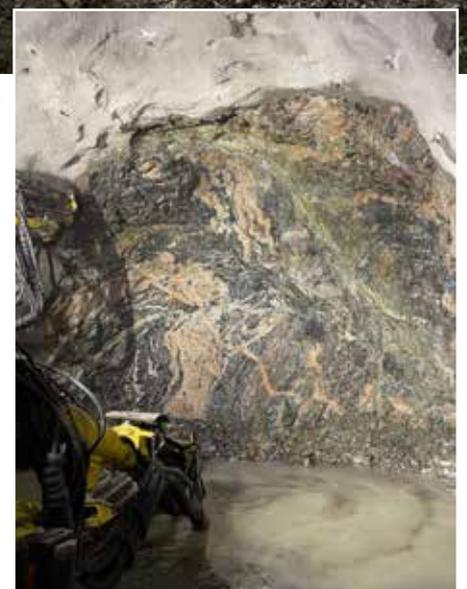
*A drill and blast jumbo moves through the KPSH tunnels*

Kidston site. The project focus is forward-thinking and agile, which is a testament to John Holland and McConnell Dowell's desire to set the standard for Australia's renewables projects.

When operational, the system will be conveniently co-located with an existing 50MW solar farm and will share infrastructure with a planned 270MW wind farm as part of the wider Kidston Renewable Energy Hub. This will enable energy generation on demand during peak periods.

The hydro project will be fed by dual intake shafts excavated by raise-boring machines to a depth of approximately 250 metres (there are also two raise-bore shafts to service ventilation and cable runs to the surface).

The dual intakes will operate with 218 metres



*Photo showing the geology of a rock heading*

of maximum head and a minimum of 181 metres of minimum drop, complimented by a less than 30-second ramp-up time for the system to start generating. The project will provide the key to the renewable generation potential of North Queensland and is contributing to the creation of 900 direct jobs. The project will also help the State achieve its Renewable Energy Targets of 70% by 2032 and 80% per cent by 2035.

The project operates an extensive indigenous engagement strategy that promotes employment and procurement with indigenous communities and suppliers. A visit to the site shows a strong local workforce (employment from within the

state of Queensland is a priority) and, where possible local to the Northern Queensland region. This will ensure that with the technology coming on board, the legacy and knowledge set for the project and renewables can be held in the regions they are built in.

This project is an important step in the rollout of large-scale energy storage capability to enable more renewable energy

into the National Electricity Market. Created from two abandoned open cut mine pits and a ghost town, the Kidston hydro project is a key step in creating the Kidston Clean Energy Hub as Australia starts its journey from traditional power source methods into a sustainable, high-tech future and is a template for other potential future mine re-purposing projects around the world.

**To find out more about the Kidston Pumped Hydro Project here:**

<https://johnholland.com.au/what-we-do/our-projects-and-specialisations/kidston-pumped-storage-hydro-project>

Special thanks to Sophie McLaughlin, the joint ventures Sustainability Graduate.

## A day on the Kidston Pumped Hydro Project

**Working remotely** provides a unique challenge on the project, "I have the added benefit of having worked with the construction delivery team for just under a year prior to this role, which has given me a deep understanding of the project challenges. The key is to know how the 2D drawings interact in the model and always ensure when providing technical advice that you consider everything from the excavation to the operational equipment as one system," noted Kaylah when asked what the key challenge is in her role.

Kaylah spends most of her time working from Brisbane, Australia (where the design Joint Venture is based) but shares that time with working on-site with the construction teams. When asked how she manages her work time, Kaylah mentioned, "Being out on site connects you to the scope, the environment we are working in and reminds you just how complex the project is, it is truly humbling to fly to the site and see the scale of the work from a light aircraft."

Day-to-day interactions with the site team are multidisciplinary (civil, mechanical and electrical), requiring agility to respond to queries from the construction team and not delay work. A large percentage of the day is spent working within the BIM (Building Information Modelling) space, ensuring the construction team has a strong digital model to work off and plan with and understanding workforce interaction as the project gears up to commence its fitting-out phase.

Once the construction phase support is complete, Kaylah will move into a completion role, applying all of the design and construction knowledge to the development of the project's operation and maintenance manuals.



## About the Kaylah Macintosh

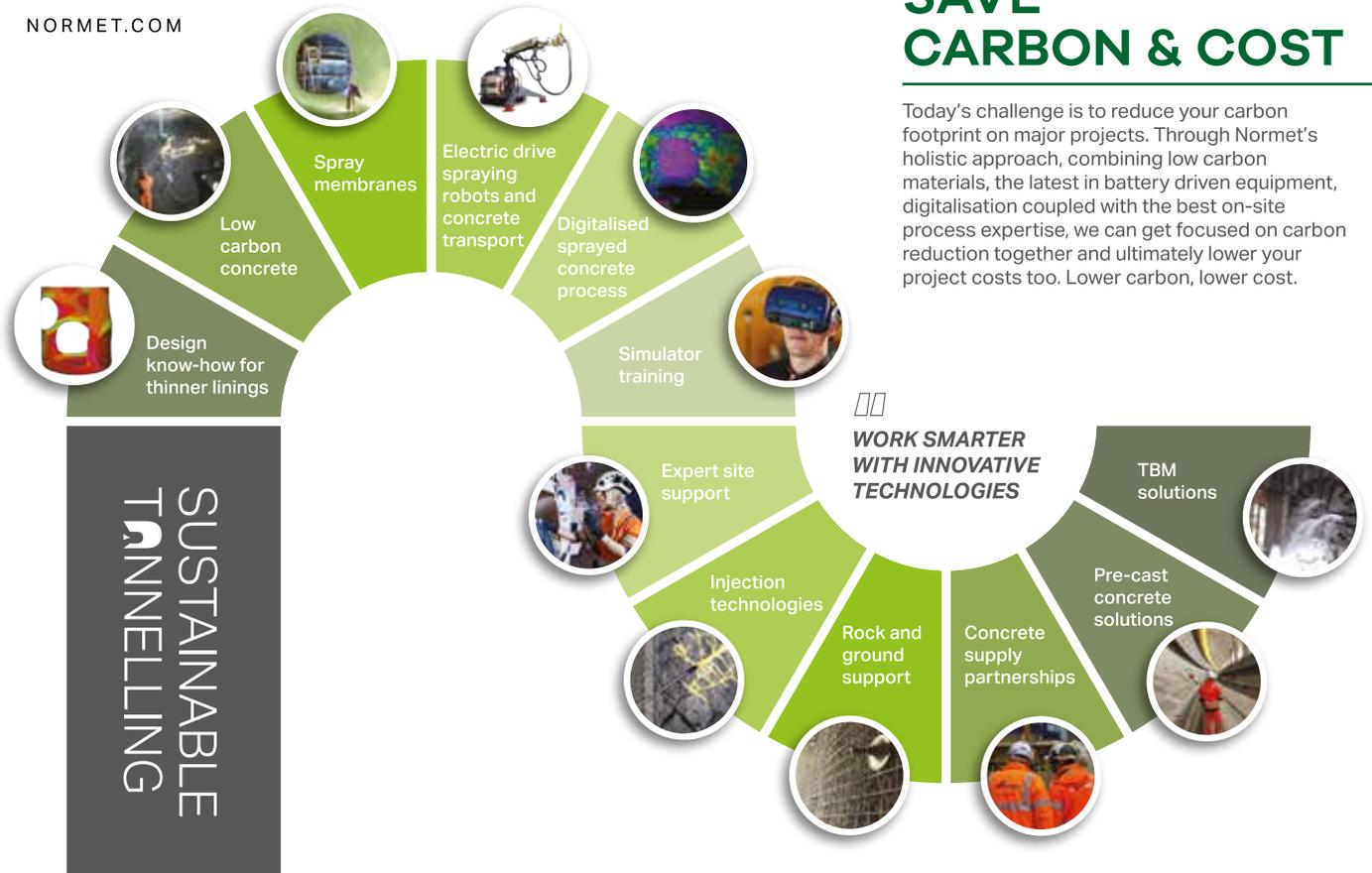


**Kaylah Macintosh** is the Kidston Pumped Hydro Projects Technical Services Manager. She undertakes construction phase design delivery with a focus on constructability and end-user planning for the project's operational phase. Her background is diverse, with experience in contractor and client-side tunnel delivery and tunnel operation and maintenance. Kaylah is a Mechanical Engineer with a master's in Geophysics, acquired in Australia, allowing a multi-faceted lens over the technical delivery of tunnelling projects. She joined the Kidston Pumped Hydro Project in January 2022 as a Geotechnical Engineer, with a recent transition to Technical

Services to see out the delivery of the project and to support the wider delivery team. When asked what she was most excited about looking ahead for her career, Kaylah advised: "The renewables industry in Australia (and in particular Hydro Schemes) are a real opportunity for seasoned tunnellers like myself to bring our knowledge into a developing industry and combine that with existing experience in the renewables space. I'm excited to see where my role with John Holland takes me; no doubt the company has a strong future in this space, and I'm certainly up for the test to go on that journey'."

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# Sustainable Spaces

With a bit of ingenuity, abandoned mines and disused underground tunnels can be put to some amazing uses. Breakthrough looks at just a few sustainable examples.



There are well over a million abandoned mines around the world (with some sources claiming this is more likely in the several millions), in all sorts of environments and locations, many of them underground. In the US alone, the Bureau of Land Management says there are some 500,000 abandoned mines. There are over 60,000 in Australia, whilst it's estimated Canada has at least

10,000. The UK and China have at least 1,500 and 12,000 old coal mines respectively without even considering other types of abandoned underground mines and tunnel systems.

While many old mines contain hazards, such as heavy metals and dangerous chemicals, or noxious fumes like carbon monoxide, and methane – with a bit of planning and ingenuity, some of them can be put to amazing uses.

## Renewable resources

Although not a particularly new concept in itself, pumped storage hydro projects – where at times of low electrical demand, excess electricity is used to pump water into an upper reservoir and, during higher demand, water is released back into a lower reservoir through a turbine, generating electricity – like the Kidston PSH Project, which makes use of Australia's largest abandoned gold mine, are currently pioneering the way for the renewables industry and numerous projects and ventures are underway around the world to explore the use of mines or mine shafts as the basis of pumped storage and other gravitational force systems to generate electricity.



## Food for thought

Researchers and scientists around the world are also looking at ways of turning underground mines into food mines as arable land on the surface becomes increasingly precious. In some countries, where winter conditions can be harsh, growing fresh produce in purpose-built geothermal buildings is nothing new. Nor is hydroponics, the

art of growing fresh produce indoors in nutrient-rich water. However, miles and miles of disused tunnels that currently exist around the world could be equipped with hydroponic planters, coloured LED lights (for photosynthesis) and used to produce an abundance of fresh food for the world's expanding population.



'Growing Underground' is a repurposed bomb-shelter 33m below London.

## Funderground adventures

A number of abandoned mines around the world have been re-purposed as leisure facilities. In the US, what once was a limestone mine that opened in the late 1800's is now a once-in-a-lifetime experience for ATV enthusiasts at Mines and Meadows in Wampum, Pennsylvania. The company offers an ATV tour that takes riders into the mine, with parts lit only by the vehicles' headlights.

In Louisville, Kentucky, a limestone cavern was turned into an enormous 320,000 square foot underground bike park that included over 45 trails, including Dual Slalom, BMX and Cross-Country tracks.

In northern Wales, UK, a 200-year-old slate mine in Snowdonia National Park is owned by Zip World. It has become an adventure-tourism destination with ziplining courses,

trampolines and a network of netting walkways, tunnels and slides. Meanwhile, in Romania, the Turda Salt Mine in Transylvania is a popular underground amusement park and includes a cinema, bowling alley, contemporary arts space, Ferris wheel and spa. Visitors are also able to hire boats to use on the underground lake.



## Secure Storage

Back in 1936, a mushroom magnate in New York called Herman Knaust purchased an old iron ore mine and turned it into a mushroom farm, proving even then inventive minds could find interesting ways to repurpose old mines. However, by 1950 the mushroom market had fallen flat and Knaust looked for other ways to use his mine, which he had named "Iron Mountain". He saw a business opportunity, amidst widespread Cold War fears, in protecting corporate information from nuclear attack and other disasters. So, he turned his farm into secure underground storage vaults. Today, the Iron Mountain company has locations all around the globe but its best-known storage facility, used by the likes of Bill Gates, Universal Music, and the US Office of Personnel Management, is an old limestone mine at Boyers, in Pennsylvania.

Of course, this is just one example. There are many repurposed secure underground storage facilities around the world. In 2008, Sweden's biggest internet service provider Bahnhof turned a former nuclear bunker, located 30m below Stockholm, into one of the most secure data centres in the world. It became famous in 2010 when WikiLeaks hosted their servers in the data centre. The entrance of the facility is fortified with a 400mm-thick steel door and can only be reached by a tunnel. Due to this, the facility has the capacity to withstand a hydrogen bomb. Other components of the facility are underground waterfalls, greenhouses, simulated daylight and a 2,600-litre saltwater fish tank. 



The built environment  
accounts for 39% of gross  
annual carbon emissions  
world wide The United Nations Environment Programme

# Soldiering for Sustainable





# Sustainability

**Katherine Westerlund, an Engineer in Training with Mott MacDonald, in Vancouver, Canada, has already made a mark on the North American tunnelling industry, despite only having graduated from university a few years ago. With the support of her company and mentors, she has impressed industry leaders with impassioned presentations on the need for sustainability in underground construction and her work on embodied carbon estimation at tunnel conferences and talks here about her experiences and lessons learned so far.**

**My professional** engineering career started in June 2020 with a knock on my front door. It was a courier, there to deliver a laptop for my first day of work.

It was certainly not the first day I had in mind when I signed an offer in January 2020 to join Mott MacDonald's tunnels team after graduation. The world had turned upside down two and a half months earlier and frankly I was just happy to still have a job despite the turmoil of Covid.

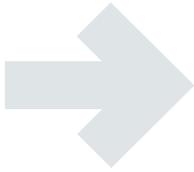
As an undergraduate I studied geological engineering at the University of British Columbia, here in Vancouver, Canada. The department first attracted me with the promise to "escape the office" (complete with a cool photo of someone field mapping in the mountains with a helicopter), but I quickly learned there was much more to the industry than helicopters and high-visibility vests.

I fell in love with the complexity and uncertainty that arises when engineering with natural materials like soil and rock. The field is as much an art as it is a science and every project poses different and interesting challenges. We didn't learn much about tunnel engineering while I was in school, but I was always intrigued by tunnelling and underground projects. The large scale of these projects attracted me, combined with the chance to work on fantastic projects like the subway expansions happening in Vancouver. I was excited to dive into the deep end.

As a company, Mott MacDonald is forward-looking, rising to meet future challenges of the industry with cutting-edge techniques. As someone interested in the future of the industry and how that might change with the new tools offered by artificial intelligence, it seemed like a natural fit.

Over the last couple of years, I have grown to understand the incredible benefits of working with a truly global team of tunnelling professionals. Everyone I've worked with has been one of the smartest, most interesting, and kindest





people I have ever met. I always explain it to other young engineers by saying, “it never feels like you’re working on a group project at school and nobody else is pulling their weight.” Instead, there is positive pressure to be your best in an environment where everybody is working hard on challenging projects.

I have learned so much from our teams of interdisciplinary engineers and designers. Tunnelling projects are much more complex than I could have ever imagined and I wake up every day excited for the new challenges that await me!

I am fortunate to be starting my career during a particularly exciting time in the tunnelling and underground construction industry in North America, as many large-scale underground projects are currently underway in major cities across Canada and the United States, with great diversity in settings and configurations.

For example, Vancouver, Toronto and Calgary are all undergoing major programmes to upgrade their subway systems and encourage more sustainable forms of transportation. Other Canadian cities are upgrading large water mains or other large underground infrastructure. I personally have worked on seven different tunnel projects across Canada in the last three years, ranging from hard rock road tunnels to drinking water mains. My mind has been opened to the underground world that exists below our feet and it has been utterly fascinating.

It is also an exciting time to be a part of my company, Mott MacDonald, where there are initiatives and opportunities for young people to get involved. In 2020, I joined several regional committees of our Early Career Professionals organisation. Eventually, I met enough co-workers who were interested in sustainability and underground projects and together we started the North American offshoot of the Global Sustainability Working Group for the company’s Tunnels Practice.

I began to learn more about embodied carbon estimation and how carbon-intensive many of our tunnelling projects are. Armed with this evolving understanding of sustainability in the underground construction industry, I sought out opportunities to move the industry in a more sustainable direction.

While the actions of a single individual or company can be admirable, real progress on the issue of climate change can only come from collective and systemic action from our industry. So, I got to work. Through conference presentations, emails to like-minded or influential industry professionals and countless hours of research, my colleagues and I have made some really exciting progress towards a vision of a more sustainable underground construction industry.

I am now responsible for co-authoring the new “Guidelines on Sustainability in the Underground” for the UCA of SME. With a target publication date of early 2024, this is a guidance document that intends to educate the underground construction industry on different topics related to sustainability. The document will establish standards for how different project stakeholders can influence a project in a more sustainable direction and provide guidance on North American underground-specific sustainability challenges.

I am joined by three dedicated co-authors and an ever-growing review panel, representing different areas of the industry, all motivated to see a more sustainable future. I am encouraged every day by the enthusiasm from everybody – from junior designers to senior titans of our industry. People seem to be grappling with the scale of the challenge ahead of us, but not letting the scale prevent them from taking meaningful actions.

These guidelines are our first attempt at tackling this issue as the underground industry in North America, but we hope they will be followed by other publications. The future is complicated, but I am relentlessly optimistic that together we can make a meaningful difference.

When I reflect on my past three years in the industry, there appears to be serendipity in the opportunities I have had. However, I would not have been able to benefit from these continued opportunities without the positions I have put myself into and the strong mentors and role models who surround me. If you’re wondering if it’s worth it to attend that networking session or lunch and learn – do it! You never know if that opportunity will snowball into something much more substantial in your career.

There have been challenges, though. As one can imagine, the pressures of working as a young engineer in a busy tunnelling market aren’t always compatible with spending lots of time thinking about these bigger industry challenges. The pace at which I was working over the past year and a half was quite hectic. Eventually I realised I had to step back and re-evaluate my priorities to ensure I was approaching my work in a way that was sustainable for me personally.

Issues like climate change will require long-term work to make positive changes. The key to doing that is ensuring I am approaching that work in a sustainable way. From my perspective, that’s a key strength my generation

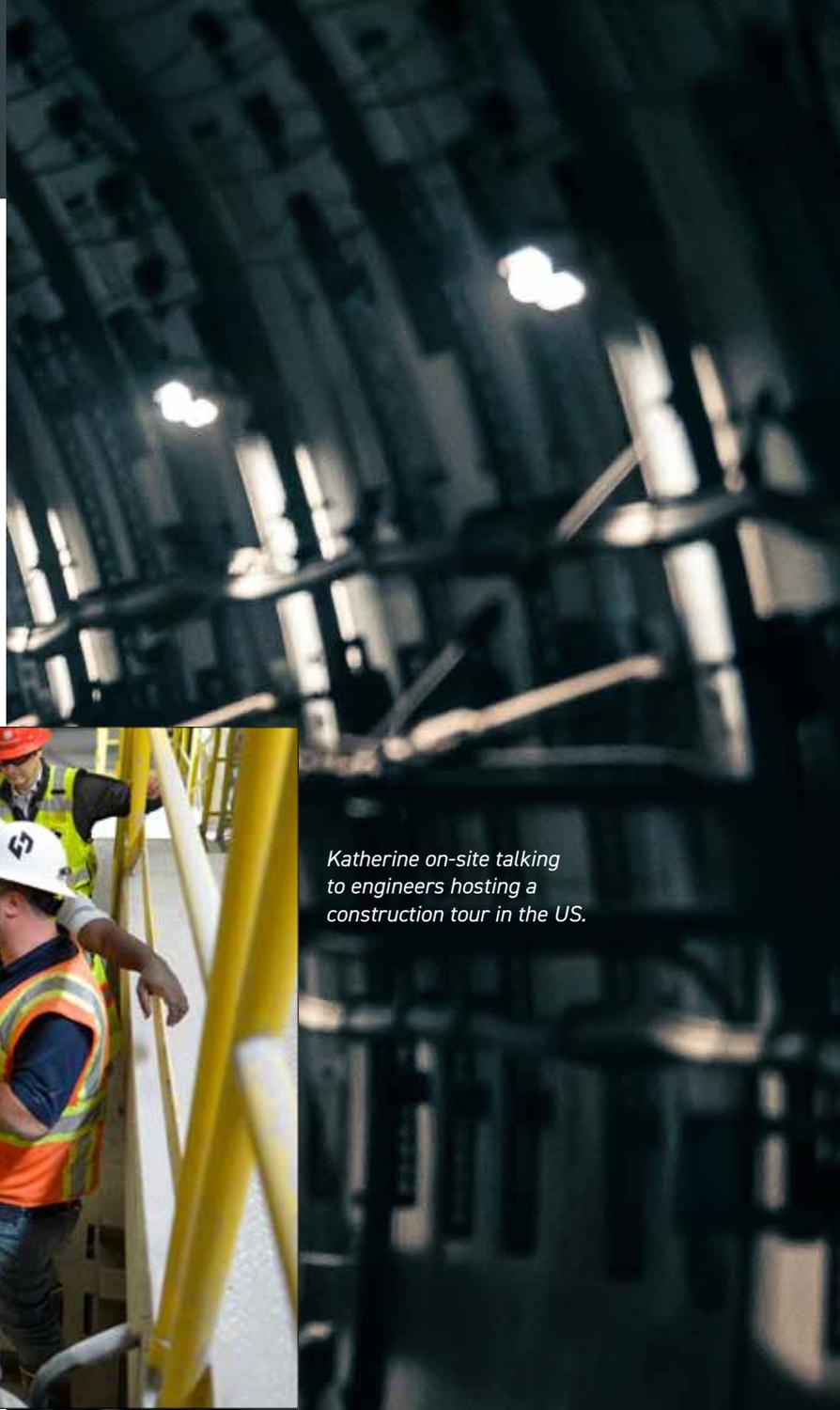


*Katherine speaking at the Cutting Edge tunnelling conference in 2021*

of engineers seems to be bringing to the field – an understanding of the need for sustainability in personal working habits.

With the increasing complexity of urban tunnelling projects, it has become more important than ever to establish and maintain healthy boundaries between one's personal and work lives. I'll be the first to admit I haven't always aced this balance (and my phone still has the Microsoft Outlook and Teams apps on it), but it's a work in progress!

In summary, the future of the North American tunnelling industry is strong. There are many opportunities for people at all stages of their careers to contribute and make a positive difference to the industry. I would highly encourage everybody to find the part of the underground industry that excites them the most and, if you'll pardon the pun, dig in!



*Katherine on-site talking to engineers hosting a construction tour in the US.*

Worldwide, **countries and companies** are committing to reducing their carbon emissions.

Tunnel engineering currently depends on a number of **carbon intensive** materials

**Concrete accounts for about 8% of global CO<sub>2</sub> emissions**

Chathamhouse.com, 2018

**Steel accounts for about 11% of global CO<sub>2</sub> emissions**

Globalefficiencyintel.com, 2021

## Underground connections

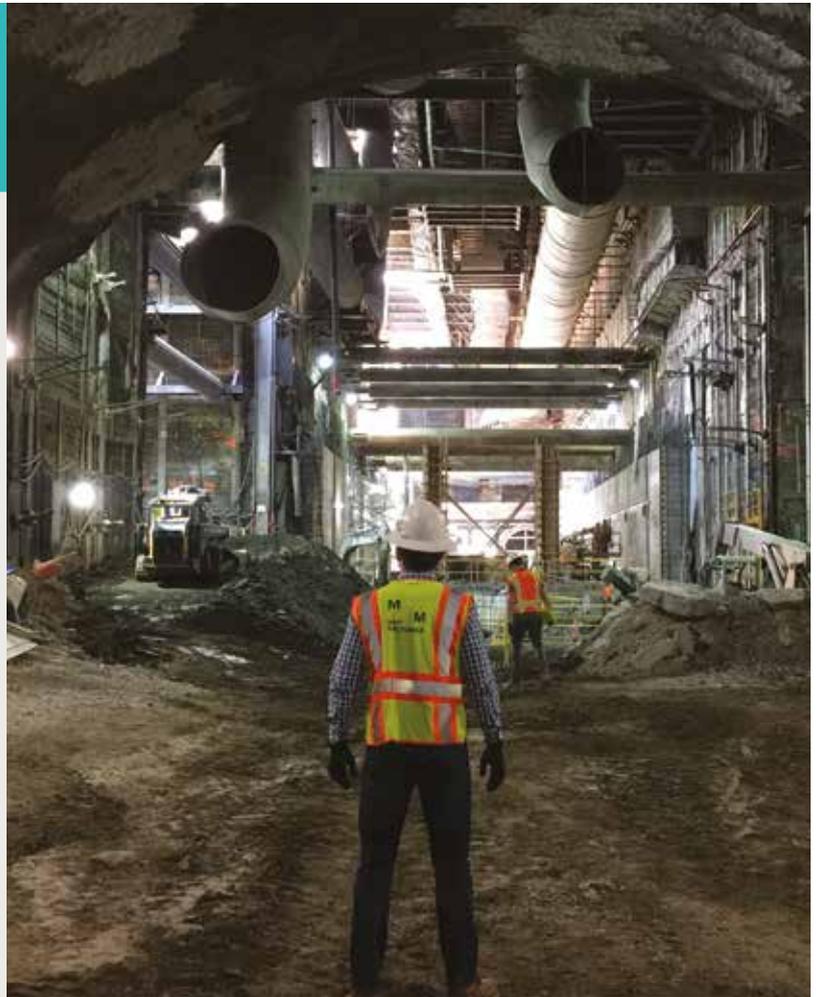
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### Four of the fifteen BTSYM Chairs to date work for LBA. We asked them 'Why LBA?'



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*'Working for LBA you are amongst highly skilled and diverse professionals and always able to tap into that experience.'*

*'LBA is entirely owned by the employees and we all own a part. It certainly feels like my company.'*

*'We are supported to help reach our personal and professional career development goals as well as adding value to the industry.'*

Quotes from Divik Bandopadhyaya, Anita Wu and Joanne Lambert



# BIM for Sustainable Drainage in LISBON

**Tiago Andrade Gomes** is a member of CPTym (the Portuguese Tunnel Commission's young members group) and is currently working on Lisbon Municipality's largest ever tunnelling project, part of the Lisbon Drainage Master Plan. Here Tiago discusses his role on the project as BIM Manager.

**Following** an increase in the intensity and number of extreme storm events in Portugal over recent years, the Municipality of Lisbon, decided to address a problem that has plagued the city for too long, flooding. The cost of these events not only affects the local population and the tourism industry, but more importantly causes long-lasting detrimental effects to the City's property and heritage. The need for a plan to evaluate and update the current drainage systems therefore became urgent. That was the reason why the Lisbon Drainage Master Plan 2016-2030 was implemented. The plan consists of several solutions that address four main goals: i) Origin control; ii) Basin transfer; iii) Reinforcement and rehabilitation; and iv) Knowledge improvement.

Although the plan includes a number of structural interventions in the city, the most significant in terms of size and cost consist of two new drainage tunnels and ancillary facilities, which are expected to mitigate between 70% to 80% of the flood problems in Lisbon. The tunnels will collect excessive upstream flows and redirect them to the Tagus River to protect riverside areas downstream.

Both tunnels will be built using state-of-the-art Tunnel Boring Machine (TBM) technology. Following a detailed analysis of the geology, the machine chosen for this project was an Earth Pressure Balance (EPB) TBM. This type of machine uses the excavated soil in the excavation chamber of the machine, mixed with ground conditioning polymers, to provide a soil consistency and resistance needed to hold back the groundwater pressure. This type of TBM can excavate various types of soil, in this case rock/stiff soil (basalt and limestone) and soft soils (clay and alluvium) and thus is capable of adapting to the various geologies that are expected to be encountered during the excavation process.

The first tunnel, TMSA, will have a length of 4.6km, and the second, TCB, will be 1.1km. Both will have an internal diameter of 5.5m. These tunnels will facilitate the drainage of flows that statistically (historically) occur once every 100 years.

In 2017, after finishing my civil engineering studies at the faculty of engineering, Instituto Superior Técnico de Lisboa, I joined the team who had the mission to realise the Lisbon Drainage Master Plan. At that time, the team was preparing a public tender for the construction of the Lisbon tunnels. I had the luck of starting my career working on the largest project ever launched by the city council, which is not only challenging in itself, but also extremely motivating as it's a project that will help protect the city, the people, and the environment. I became a civil engineer to build something, to apply my penchant for exact sciences and mathematics to something tangible. This project not only allowed me to do that, but also to improve the lives of the city's citizens, and by extension myself.

Being a high-cost project, there was a need to launch an international public tender. Due to its specific nature, where there are several constructive methods available, for which the contractor has a greater management capacity, the tender was launched as a Design/Build public tender. I had the opportunity to be at the genesis of the tender, helping to establish the various elements and specifications.

An important specification that was implemented, was the obligation to use BIM



(Building Information Modeling) methodology on this project. Since I was a BIM enthusiast and had studied these matters, I played an important role in the definition of this specific requirement. Later, with continued studies in the area, I became the BIM Manager representing the owner of this project.

Being involved in such a big project, led to the need and desire to expand the areas of knowledge intrinsically linked to it, like geotechnical engineering, hydraulics, BIM, and even public procurement. Being an engineer is constant evolution, studying and learning new things. On this project that has been a constant reality, not only derived from training and courses, which I have taken, but mainly due to the proposals and solutions presented

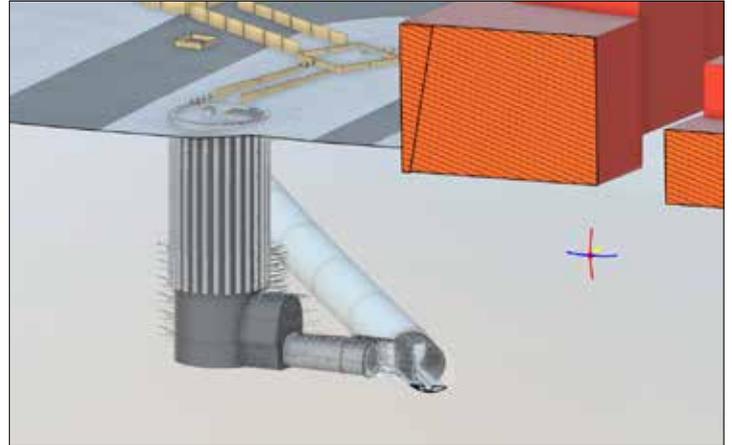
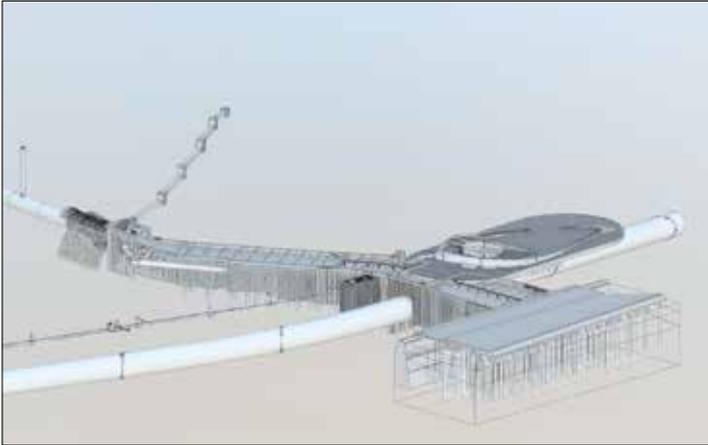
### *Flooding in Lisbon*

by the various contractors, which we received and had to technically evaluate. Also, due to the development of the construction project, or even derived from the several challenges and situations that naturally occur on a project of this scale.

My involvement on this project also led me to engage in working groups and communities like the Portuguese Tunnelling & Underground Space Commission, the Portuguese Geotechnical Society, and the nucleus of Young Water Professionals. These technical communities allow us to work towards a better understanding and development of



Testing of the TBMs at the factory.



*BIM models developed for the TMSA and TCB tunnels*

good practices, to lobby on important technical issues, and above all to share experiences and problems, which let us learn and develop with the mistakes and victories of others.

As mentioned before, I'm currently the BIM Manager of this project. BIM was brought to the project mainly due to its operational span. With a 100-year lifecycle, the maintenance and operation of the assets gained specific relevance and, when combined with the inevitability of construction digitalisation, led to the use of this methodology being of natural interest for the municipality. Nevertheless, the Owner's interest in using BIM wasn't only due to maintenance and operation. The optimisation of management, design, and execution, for instance through the optimisation of monitoring, control and planning in multiple dimensions, were also factors in the inclusion of the BIM requirement on this project.

With BIM becoming a reality on this project, and myself the official BIM "Owner Manager", overseeing and helping in the development of the BEP (BIM Execution Plan), the management of the Common Data Environment (CDE) and

the management of all project data became part of my job and responsibility. Of course, these tasks aren't only my responsibilities, having had the help, whenever necessary, from my team and having a great collaborative environment with both the inspection team and the contractor's team.

To organise the scope, objectives and BIM uses, define the information management requirements, minimise coordination problems and to guarantee its quality and efficient use, the BEP is a transversal and essential document to the work. Due to its importance and the need for its use, the BEP had to be finished and approved in the first third of the construction project schedule. The fulfilment of this first objective was essential for the good and efficient functioning of the remaining process. The definition of information flows, deadlines and structure, among others, present in this document, play a very relevant role in day-to-day developments. However, the proper use of BIM methodology demands that this document be dynamic, to accommodate knowledge gain that naturally occurs with the development of

the project. So, the BEP has a fixed component (where the transversal process guidelines are defined) and a flexible one (that is in constant review).

The Common Data Environment, which I manage and is used by almost all the players on a daily basis, is another key piece of BIM and of the project. The CDE, at its core, consists of a collaborative platform that allows the Owner and Supervisor to always access updated models and files. In this specific case, we use the Docs functionality of the Autodesk Construction Cloud platform (ACC), which allows us, among other functions, to centralise information, view and interact with models, use analysis tools, interact with project members and to have flexibility in permissions levels (either by the user, by "role", or by the company). However, it should be noted that, as in all choices, there are some limitations in the adopted solution. The impossibility of tracking folder activity, limiting itself to listing the documents present in the folder at the time of export, the difficulty in managing complex folder structures, the impracticality of viewing PDFs, page by page, or the inadequacy of document approval tools, are issues that could and should be improved.

For me, the use of this methodology, especially in this project, is highly motivational. Not only because I consider BIM an asset but also because its use isn't generally wide. This fact allows me to be on the cutting edge of technology and procedures evolution, worldwide, and contribute for instance to the IFC standard on Tunnels of BuildingSmart International.

We are currently in an extremely exciting phase of the project and have already started works on some sites. I'm looking forward to seeing the development and materialisation of all the work we've designed so far and I'm sure that the near future will be extremely challenging, but also fulfilling. 



*Team members from the project*

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# 5 from five

How do young engineers find their way into the tunnelling industry and how do their studies help with their working lives and careers? Five people from around the world share their stories with Breakthrough.

Kristina Smith reports...

## Spanish winner

### Alfonso Navarro

- Civil engineer (tunnelling department), Sener
- Degree in civil engineering at Universidad de Castilla-La Mancha with an Erasmus year in KTH, Stockholm; Masters in Tunnelling and Subterranean Works, AETOS (Spanish Tunnelling Association) and BIM management (Zigurat)

In September 2022, Alfonso Navarro became the first person to win the Young Tunneller of the Year award from the Spanish Tunnelling Association, AETOS: "I was very happy and proud to be the first," he says.

Navarro's education and working life has taken him from Madrid to Stockholm, London and Reading and back to Madrid again. He has been back in Spain since 2014, working for multidisciplinary consultancy Sener in the tunnelling and geotechnical department.

Sener works on projects all over the world, currently designing tunnels in US, Mexico, Australia, Panama, UK and Spain. Navarro enjoys numerical modelling and his early years with Sener were spent developing such models for tunnel projects. Today his role is more like a coordinator, organising junior colleagues, liaising with other departments and communicating with clients.

Navarro was drawn to civil engineering because he always loved engineering structures, he says. He remembers as a child asking his father to drive him through a tunnel near his village to the South of Madrid.

He chose to study at the Universidad de Castilla-La Mancha because it was close to home, which is common practice in Spain. It was a new course, just five or six years



old when he joined the university, which meant small classes and good rapport with professors, he said. For his final year, he got the chance to study in KTH in Stockholm on the EU's Erasmus Programme.

Returning to Madrid, he chose to study a Masters' level course with AETOS and, at the time, was introduced by a university colleague to Halcrow in London, now Jacobs. His friend was working there, and the company was looking for others like her.

"They came to my university in Castilla-La Mancha when I was doing my Masters in Madrid. They were looking for people to work in the tunnelling department. It was like destiny," he says.

After a three-month internship with Halcrow, where Navarro worked on his Masters, he was offered a job and worked in

■ ■ To help people make that jump from university to professional life, it would be good to get more professionals involved in universities. ■ ■

London for two years before moving west to work for Mott MacDonald in Reading. Family issues brought him back to Madrid and he was lucky enough to find another tunnel engineering job with Sener.

While university teaches people how to find information and solve problems, says Navarro, it doesn't teach you what real professional life is like. "When you finish university, you think you know how to do everything, but you don't know anything," he says. "To help people make that jump from university to professional life, it would be good to get more professionals involved in universities." ■

## A hands-on approach

### Carlos Martínez Zarazua

- Senior Tunnel Engineer, Traylor Bros., Purple Line Project, LA Metro
- BEng Civil Engineering and Masters in Geotechnical & Geo-environmental engineering, Universidad Nacional Autónoma de México (UNAM)

If you saw Carlos Martínez, covered in dirt at the cutterhead of a tunnel boring machine (TBM), you might think he was one of the TBM crew. But you would be wrong. With a Master's in geotechnical engineering, Martínez is an engineer who doesn't mind getting his hands dirty.

"I am a field engineer and I enjoy working in the field," he says. "I like to get involved. If I need to get up in the cutterhead and change a tool, I can do that."

Martínez is working for US contractor Traylor Bros on the Purple Line Project for the LA Metro, overseeing two TBMs. His Mexican roots mean that he can communicate easily with the crews, 90% of whom come from Latin America and speak Spanish.

During his bachelor's degree, Martínez initially studied mechanical engineering, but switched to civil engineering. After working on above-ground construction projects for a few years, he went back to study for a master's because he wanted to work on major infrastructure projects "The impact that underground projects have on cities is huge," he says. "The project that we are working on now is going to help a lot of people in this city. And putting transport and utilities underground makes space for other things on the surface."

Having gained his master's, Martínez was recruited to work on the Guadalajara Metro on a 12m-diameter Earth Pressure Balance (EPB) TBM. "A master's qualification like mine is quite rare in Mexico," he explains. After three years there, he moved to the US, first to work for contractor Lane on the Northeast Boundary Tunnel project in Washington DC and then to Los Angeles.

Moving between countries and cultures was challenging, says Martínez. Having been an established tunnel engineer in Mexico, it



■ I am a field engineer and I enjoy working in the field, I like to get involved. If I need to get up in the cutterhead and change a tool, I can do that. ■■

was almost like starting again.

His geotechnical studies do come in useful he says. "It makes it easy for me to understand things like water pressure and to identify the ground, what type of soil it is and what condition it is in."

If he had to add anything to his engineering courses, he would include management and financial aspects, he says. "In public universities in Mexico they prepare people to be technicians and problem solvers. In private universities they prepare people to be managers," he explains.

Working underground is not for everyone,



Martínez agrees. Few people are interested in the long hours and dirty conditions. But there is huge satisfaction, he says: "One of the things that motivates me is that the tasks I do are helping the guys to get their work done. "I always say 'thank you', thank you God, and thank you to my guys. Without them, we would not go anywhere." ■

## Resilient and sustainable infrastructure for tomorrow

### Xi Jiang

- Research Scientist, University of Tennessee, Knoxville
- PhD in Tunnel and Underground Construction, Tongji University, PhD in Civil Engineering, University of Tennessee, Knoxville

Xi Jiang was inspired to learn about tunnelling by Professor Yun Bai, at Tongji University's College of Civil Engineering in Shanghai, where Jiang studied for a doctorate. As well as working on tunnelling projects around the world, Professor Bai is a leading figure in the tunnelling industry, having been a Vice President of the International Tunnelling and

Underground Space Association (ITA).

"Professor Yun Bai is a prominent figure at the university having gained recognition around the world," says Jiang. "He is my idol."

As well as encouraging Jiang to attend several World Tunnelling Congresses, Professor Bai and Xi's advisor at the University of Tennessee, Professor Baoshan Huang supported him in applying for his current role as a researcher at the University of Tennessee in Knoxville. Jiang also works for US sister organisations the National Transportation Research Center and Oak Ridge National Laboratory.

Jiang's current focus is on sustainable construction materials. For instance, he has been working on a geopolymer concrete, which has a lower carbon footprint than a standard concrete mix, and he is looking at a new pavement structure design that minimises the quantity of asphalt material used but has no compromise in performance. "All the projects I am working on are about improving the resilience and sustainability

## Building a career on firm family foundations

### Citlali Vargas Monreal

- Project Manager, Amberg Engineering, Grand Paris Express
- Double Bachelor's degree in civil engineering, National Institute of Applied Sciences (INSA), Rouen and National Polytechnic Institute (IPN), Mexico City; master's degree in tunnels and underground works, National Institute of Applied Sciences (INSA) and National School of Public Works (ENTPE) in Lyon

With a passion for mathematics, and a deep appreciation of what civil engineering could do for her home country of Mexico, Citlali Vargas Monreal elected to study civil engineering at the National Polytechnic Institute (IPN) in Mexico City. Here, she was chosen to join a double degree programme that would also take her to Rouen, in France, to study at the National Institute of Applied Sciences.

She chose to specialise in geotechnics. "My love for geotechnics came when I understood the story of natural materials, applying this knowledge to create stability and durability of structures," she says. "As civil engineers, we have to understand the behaviour of the

of our urban infrastructure, which is a very important topic," says Jiang.

Jiang heads up the ITA young members' group in China and is working to set up a technical committee on tunnelling and underground space under the umbrella of the American Society of Civil Engineers (ASCE). "If you are doing something you are interested in, you have unlimited energy," he says.

Jiang's extensive and varied education has helped prepare him for problem-solving in his current projects. "The most important aspect during my study was not the detailed knowledge, it was developing critical thinking."

Jiang's advice to any student is to get on and do things. "Don't wait until you feel you are 100% prepared. In my first and second years, I always felt I was not ready to conduct experiments or write papers, but my professors encouraged me to just get started. You will meet different problems and questions along the way, but if you don't get started, you will not go anywhere." ■



■ ■ Being inside a tunnel during its construction and seeing these huge TBMs at work, is like seeing the evolution of civil engineering, what we have managed to achieve as humans, to be within the ground and within nature without affecting the natural equilibrium. It's really impressive. ■ ■

earth so that we can balance structures and work within the equilibrium of nature."

After her first degree, she worked as a laboratory technician and then at a consultancy designing deep and shallow foundations and slope stabilisation projects. Inspired by a conference about the Grand Paris Express project, Vargas Monreal elected to return to France to study for a

master's degree in tunnels and underground works at the National Institute of Applied Sciences (INSA) and the National School of Public Works (ENTPE) in Lyon.

During her master's degree, Vargas Monreal was offered an internship and the chance of employment afterwards by consulting engineer Lombardi. "It then became a life decision: whether to return to Mexico or not," she says. It was a big decision, with many uncertainties and Vargas Monreal wishes that she had known back then that everything would be okay, and that she would meet great people professionally and personally.

Staying in France also meant working on the Grand Paris project, initially with Lombardi and more recently with Amberg. "Participating in a big project like Grand Paris Express, was a dream for me and now it is a reality," she says. "Being inside a tunnel during its construction and seeing these huge TBMs at work, is like seeing the evolution of civil engineering, what we have managed to achieve as humans, to be within the ground and within nature without affecting the natural equilibrium. It's really impressive."

Vargas Monreal credits her success to the dedication of her family. Her grandmother could not write but worked to send her 11 children to school. Vargas Monreal's mother became a teacher who could send her daughter to school: "There can be no construction without a great foundation," says Vargas Monreal. ■

■ ■ The most important aspect during my study was not the detailed knowledge, it was developing critical thinking. ■ ■



## Competitive spirit

### Jiri Horcicka

- Production Director, Metrostav Norge
- Bachelor's and Master's degrees in civil engineering from Czech Technical University, Prague

Having spent seven years on the Czech national cross country skiing team, Jiri Horcicka knows a thing or two about focus and dedication. Now, working for a large civil engineering company, he is applying the same approach to his professional career.

At 32, Horcicka is already a Production Director for Metrostav Norge, a member of the Metrostav Group, currently overseeing three tunnelling projects and two bridge projects with more in the pipeline. His branch of the group covers the Scandinavian countries of Norway, Iceland, Sweden, Finland and the Faroe Islands.

Civil engineering runs in the Horcicka family. His father and both grandfathers were civil engineers. "I never thought about anything else. It has been my passion since I was a child," he says. "I remember seeing my first big construction site, and it totally amazed me. We were travelling North from Oslo and part of the E6 highway was under construction."

He chose to study both his bachelor's and master's degree in civil engineering at Czech Technical University in Prague because of its good reputation and also because the national cross country ski team was based there. "When you want to be a civil engineer in the Czech Republic, that is the best place to go," he says.

On graduating, Horcicka ran his own small civil engineering company for three years, but he wanted to stretch himself further, and an internship with a tunnelling company in Norway gave him a taste for the underground. "My dream was to be part of something really big. And with my role now, as a board member and the only one on the ground in Scandinavia, I have the opportunity to build up this part of Metrostav."

Horcicka's civil engineering course in



Prague contained more applied tunnelling knowledge than might be expected. "I was lucky that I had the opportunity to learn from Professor Jiří Barták who is a tunnelling father. He was able to motivate his students with the way he talked about drill and blast and even did practical sessions. I can still apply some of my education in my current job."

■ ■ I was lucky that I had the opportunity to learn from Professor Jiří Barták who is a tunnelling father. He was able to motivate his students with the way he talked about drill and blast and even did practical sessions. I can still apply some of my education in my current job. ■ ■

Horcicka loves to be out on site, although nowadays his role is more organisational, attending meetings and talking contracts and negotiations. "I am still able to put my work clothes on and touch the rock and chat to the workers," he says. "Yesterday I was on the construction site because there was a situation that needed handling and I had to do it." **B**

# breakthrough

## Contributing to Breakthrough

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





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