



International  
Building &  
Construction  
Show

Supporting Partner



**5 - 8 DECEMBER 2022**  
DUBAI WORLD TRADE CENTRE

# The future of underground construction using swarm robotics

John Moreland-Lynn

Embracing innovation in engineering and construction /  
Mon05Dec / 2:30 PM - 3:00 PM



# Introducing hyperTunnel

- An **infraTech start-up** founded by Steve Jordan and Jeremy Hammond in 2018 (after years of market research)
- hyperTunnel represents a new, simple yet **revolutionary tunnelling concept** that borrows well established, existing technologies from a range of industries and repackages them.
- Headquartered in **Basingstoke, United Kingdom**, 45 minutes west of Heathrow Airport.
- First satellite **presence in Dubai** – since 2020
- Near-by **one-acre outdoor testing facility** which incorporates our state-of-the-art Geotech lab.
- hyperTunnel receives **R&D finance** backing from **BASF/MBS**, the German chemicals giant, and was recently awarded a **Europe wide public bid contract** to work with **Network Rail** on a non-disruptive tunnel construction, enlargement and repair methodology and a pilot study for cross passages on **HS2**
- **We've won government grant funding of >\$3 million**



*“We want to reduce the level of disruption to our passengers so we are constantly searching for new approaches to enlarging or re-lining tunnels that reduce the length of time a tunnel will be closed to trains.”*

**David Castlo**  
Technical Head of Mining & Tunnels

.....on why Network Rail, the largest tunnel owner in the UK, has commissioned hyperTunnel's® to validate its unique method of non-disruptive repair and enlargement of 650 aged & leaky tunnels

**#THEBIG5EXHIBITION**  
[www.thebig5.ae](http://www.thebig5.ae)

# Leadership team



**Mark Carne CBE**  
**Chairman**  
*Recent CEO Network Rail*



**Nick Cremin**  
**Deputy Chairman**



**Jeremy Hammond**  
**Co-Founder**



**Steve Jordan**  
**Co-Founder**



**John Moreland-Lynn**  
**Director of Corporate Development**



**Patrick Lane-ott**  
**Director of Engineering**

## People

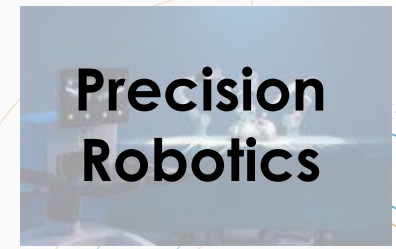
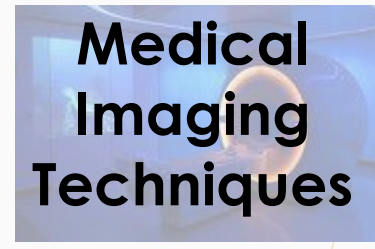
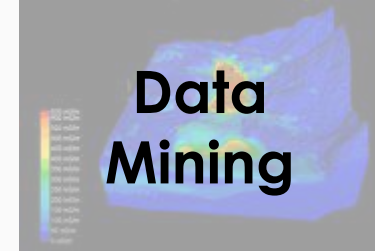
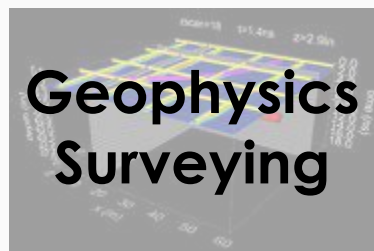
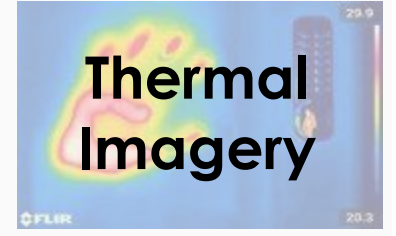
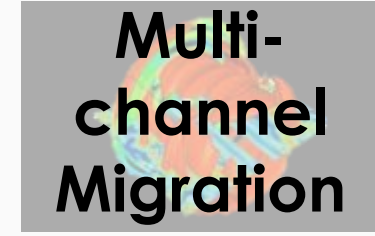
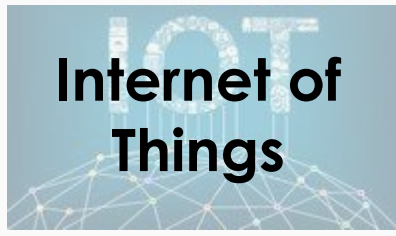


... supported by a

- Team of over thirty, mostly engineers who come from tech industries as diverse as Formula 1 and aerospace,
- Dedicated test site,
- Geotechnical lab, and a
- Bot prototype manufacturing facility.



# hyperTunnel<sup>®</sup> leverages existing technologies



## hyperTunnel<sup>®</sup> is DeepTech

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www.thebig5.ae

# Advised by a Technical Board of experts at the forefront of tunnelling



**Peter O'Riordan**  
*Chairman*  
Previously of Arup,  
Crossrail, HS2



**Bruno Combe**  
*Tunnel Technical Director*  
Bouygues TP



**Donal Coughlan**  
*Technical Director at*  
Jacobs



**Mike Devriendt**  
*Associate Director at Arup*



**Gustav Jahnert**  
*Innovations Manager at*  
Bauer Technologies



**Dr Benoit Jones**  
*Previously of Warwick University, HS2*



**Mike King**  
*Previously Head of Underground Construction on*  
Crossrail



**François Pogu**  
*Managing Director VINCI Construction Grands Projects*  
UK



**Greg Raines**  
*Vice President Stantec*



**Götz Tintelnot**  
*MBCC Group - CEO TPH*  
Bausysteme GmbH

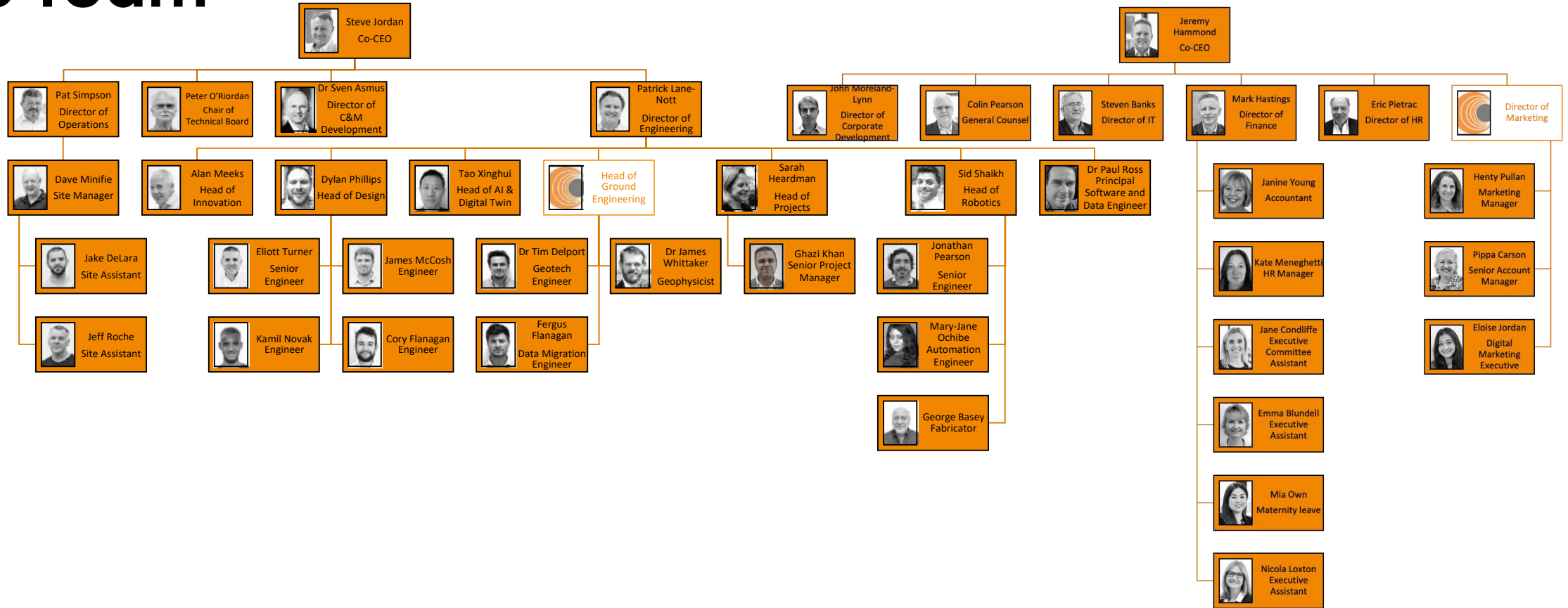


**Dr Kurt Zeidler**  
*Owner of Gall Zeidler Consultants*

... who are contracted but unpaid, critical and challenging but supportive.



# The Team



## Engineering team formerly working with/for:



# Attracting top talent at all levels



**Dr Sven Asmus**  
Director of Chemistry & Materials Development

Sven was formerly **Chief Technology Officer (CTO)** and member of the **Board** at **MBCC Group**.



**MBCC GROUP**



**Dr Kurt Zeidler**  
Tech Board member

Kurt is owner and principal at Gall Zeidler Consultants, recognised global leaders in the tunnelling industry



**Sid Shaikh**  
Head of Robotics

Sid left **Ocado**, renowned for its industry leading robotics capabilities, as Head of Engineering to join hyperTunnel in 2022.



**Dr Paul Ross**  
Principal Software Engineer

Paul is an industry leader in computer vision, data visualisation and real-time data acquisition and processing.



**Xinghui Tao**  
Head of AI and Digital Twin

Tao is acknowledged as a **leader in his field**, lecturing on cutting edge topics such as AI project landing and Edge-to-Cloud AI.



**Mark Carne CBE FREng**  
Chairman

Mark retired as Chief Executive of Network Rail before becoming hyperTunnel's Chairman in 2021.



# Captive bots operating on a physical grid system



## Site Setup

- Build environment – install grid
- Introduce Robots to grid

## Operation

- Robot is sent an address and task
- Robot navigates to the address
- Robots carry out the task
- Robots report task is complete
- Check power and location status
- Repeat cycle





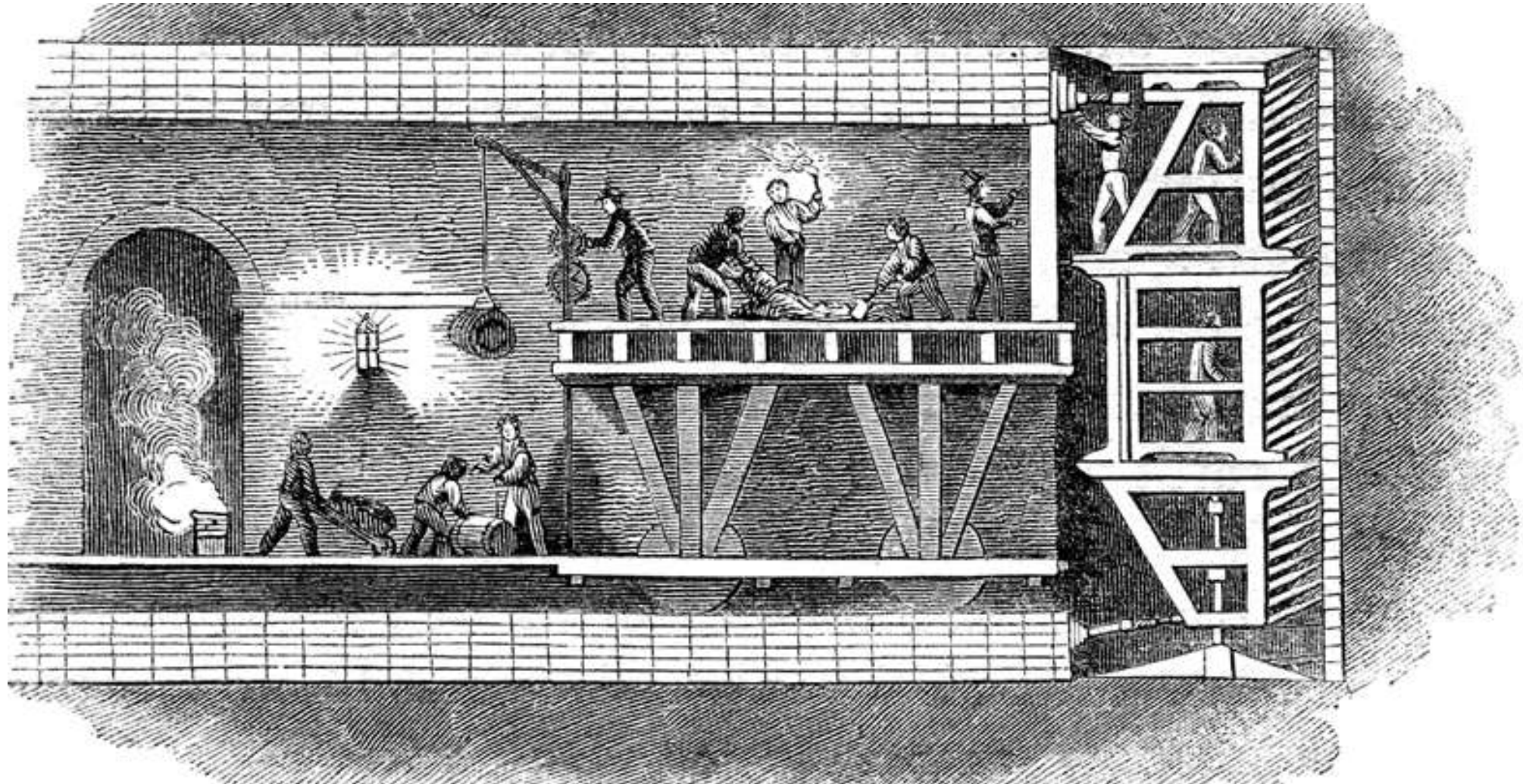
# R&D Site



# Current Methods



# Thames Tunnel – First use of a Shield 1825



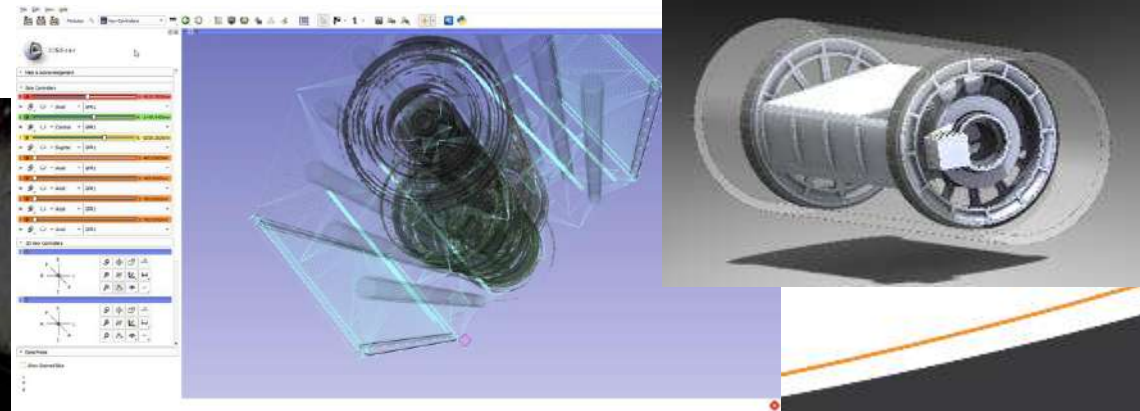
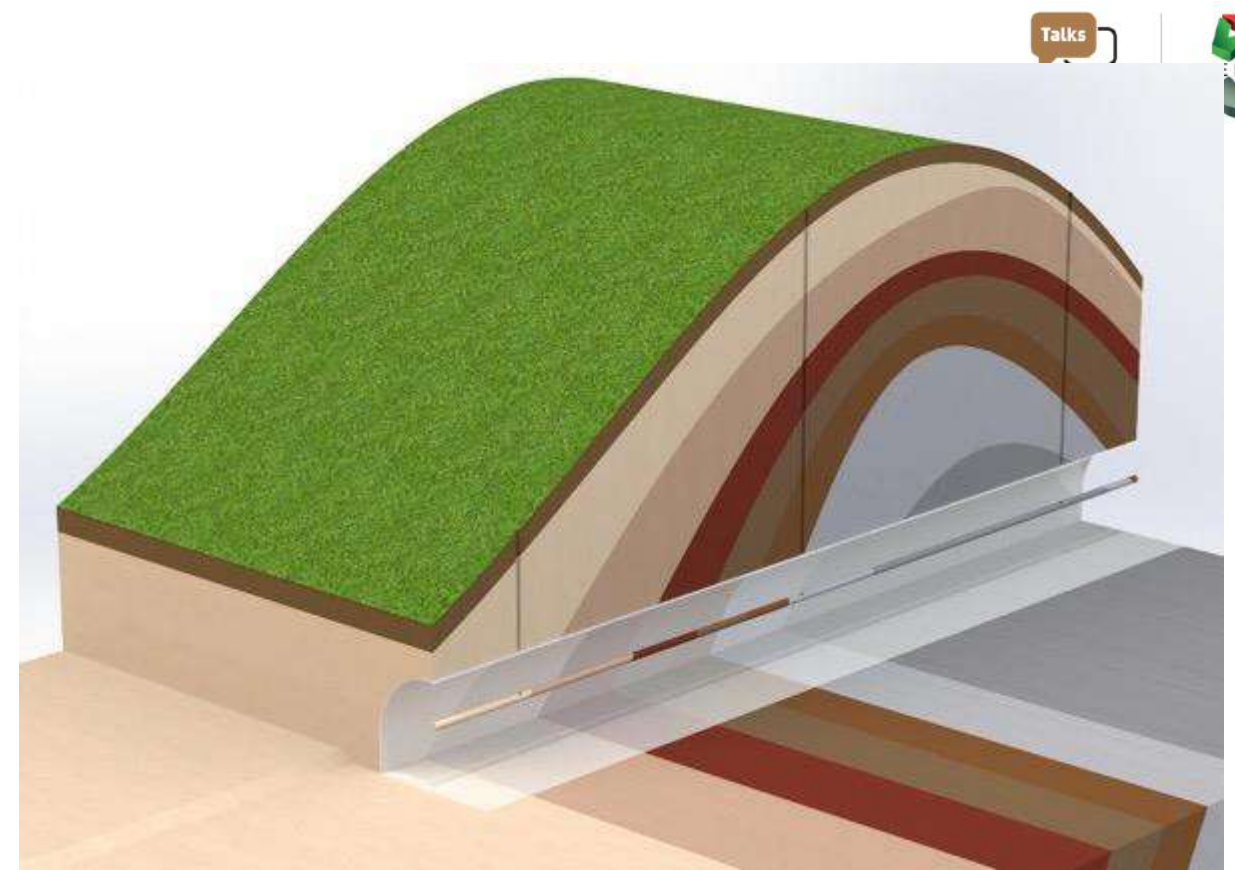
# Potential - What is the size of the revolution?



# The hyperTunnel Method

# Phase 1: Preparation

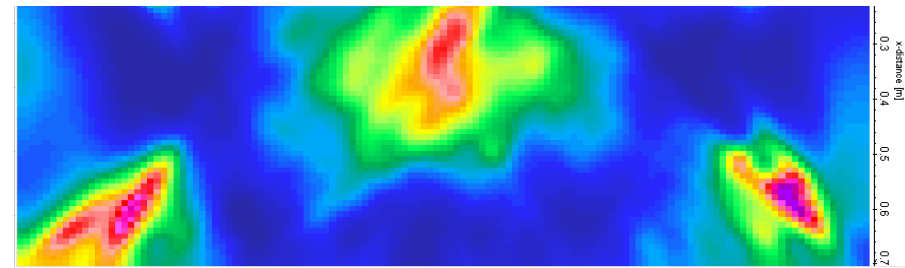
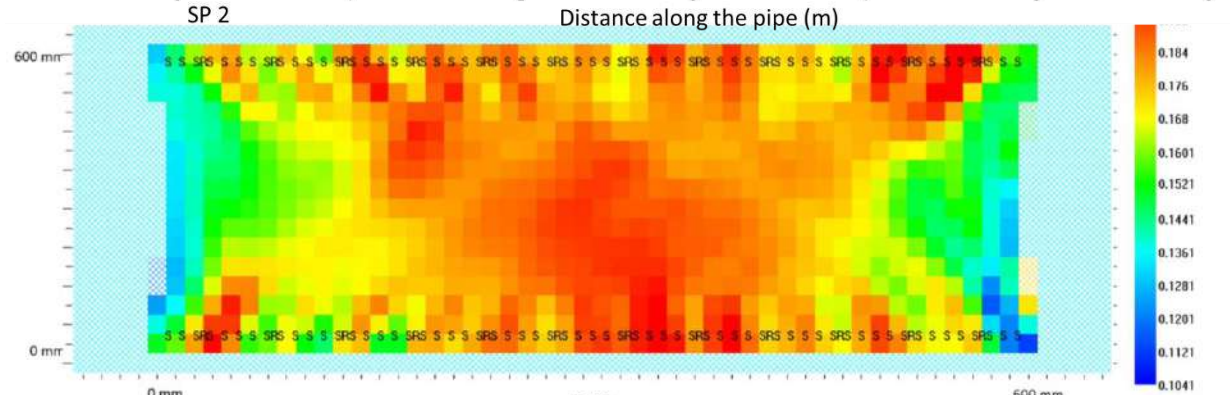
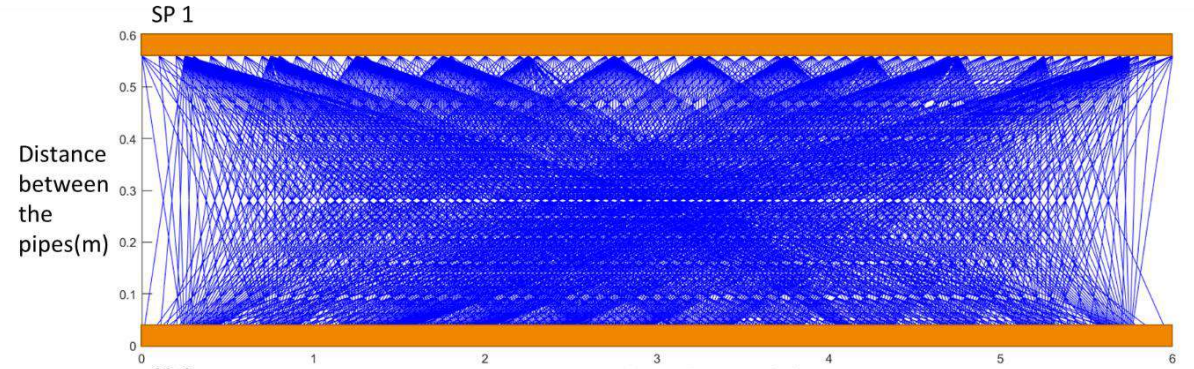
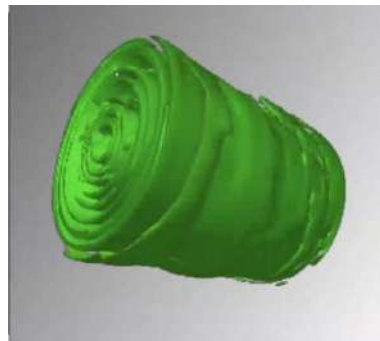
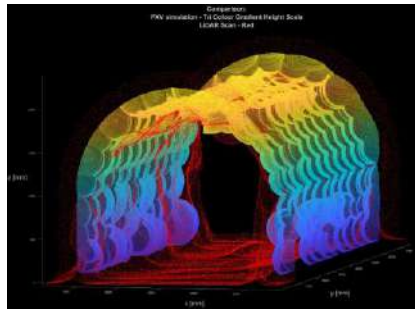
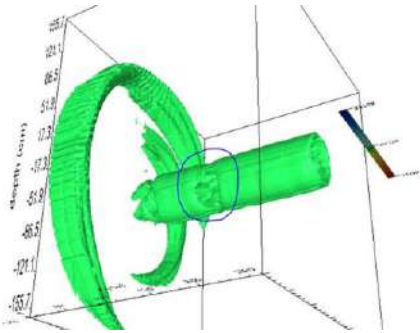
- Continuous **core sampling** provides
  - Data on and extent of rock formations and their mechanical properties, and
  - The basis upon which to estimate groundwater inflow and stabilisation requirements,



# Survey Technology

## hyperDAR

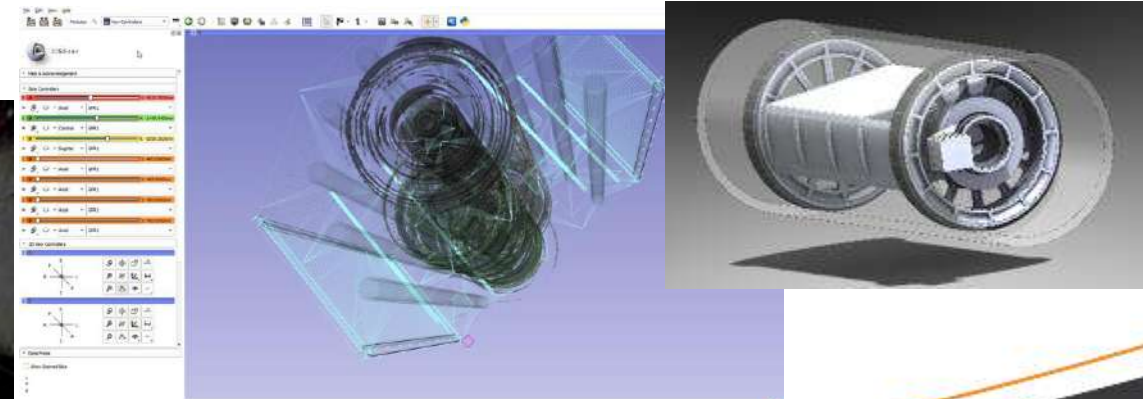
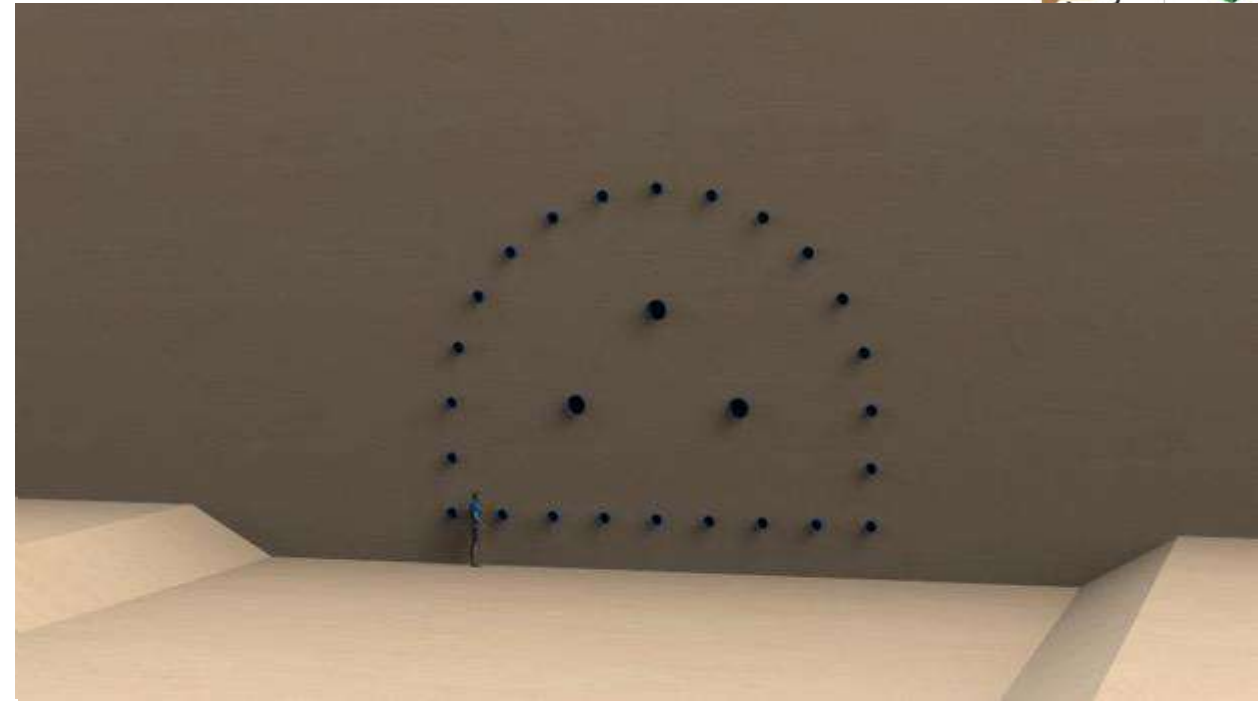
3D Views of GPR migrated data to identify geological features





# Phase 1: Preparation

- Continuous **core sampling** provides
  - Data on and extent of rock formations and their mechanical properties, and
  - The basis upon which to estimate groundwater inflow and stabilisation requirements,
- Patterned **directional boring**
  - Horizontal Directional Drilling (**HDD**) defines the shape of the tunnel
- Ground penetrating radar (**GPR**) facilitates
  - Accurate visualisation of the geology and obstacles
  - Development of virtual reality imagery
- Building information modeling (**BIM**)
  - Digital twinning





# Productivity & reliability: Swarms & bots



in nature...



in industry...

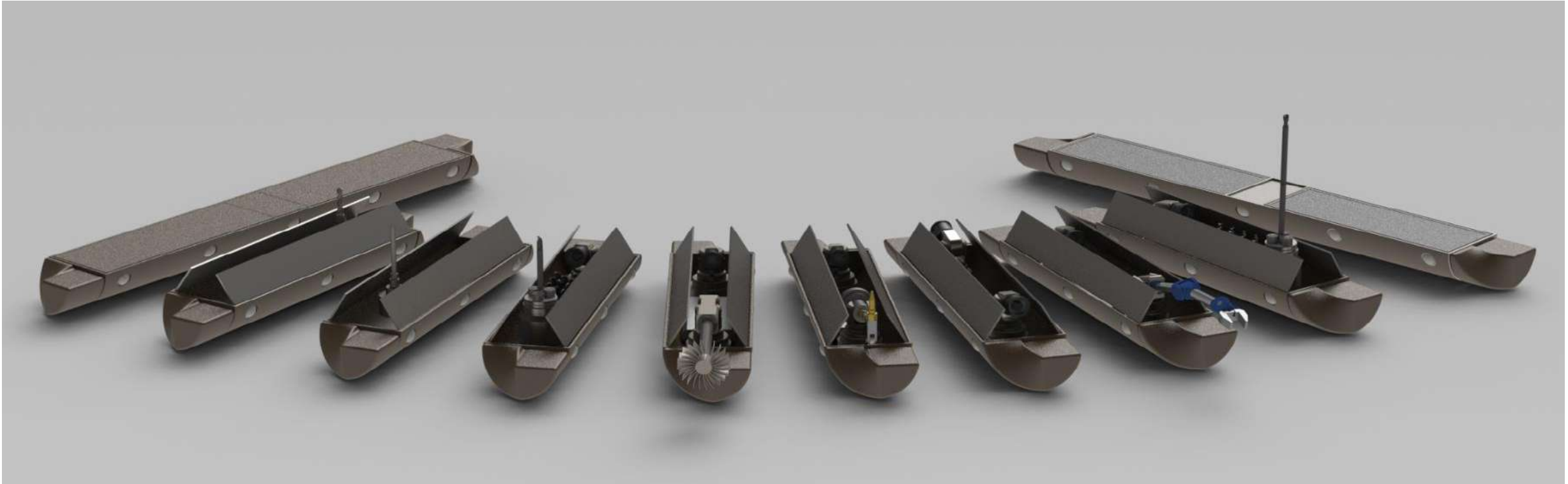


in recreation...

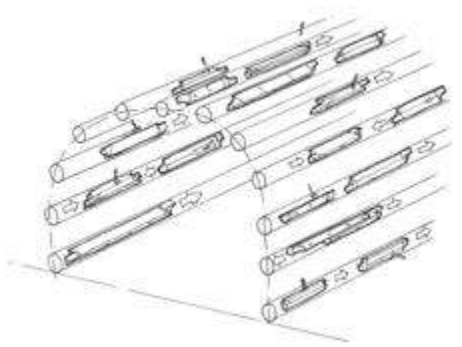
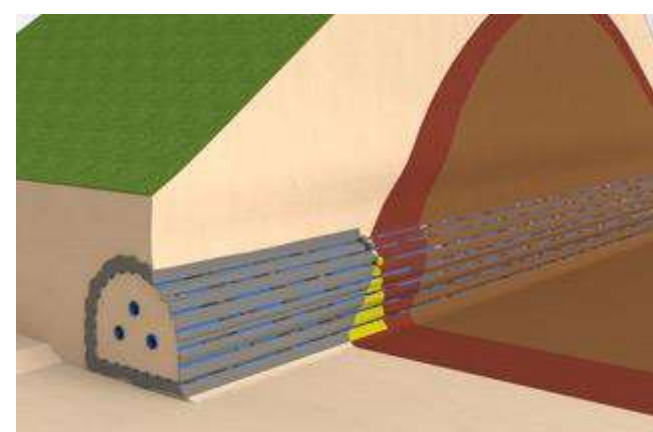
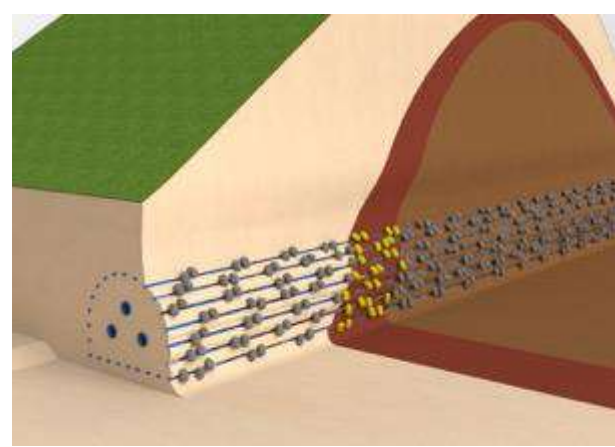
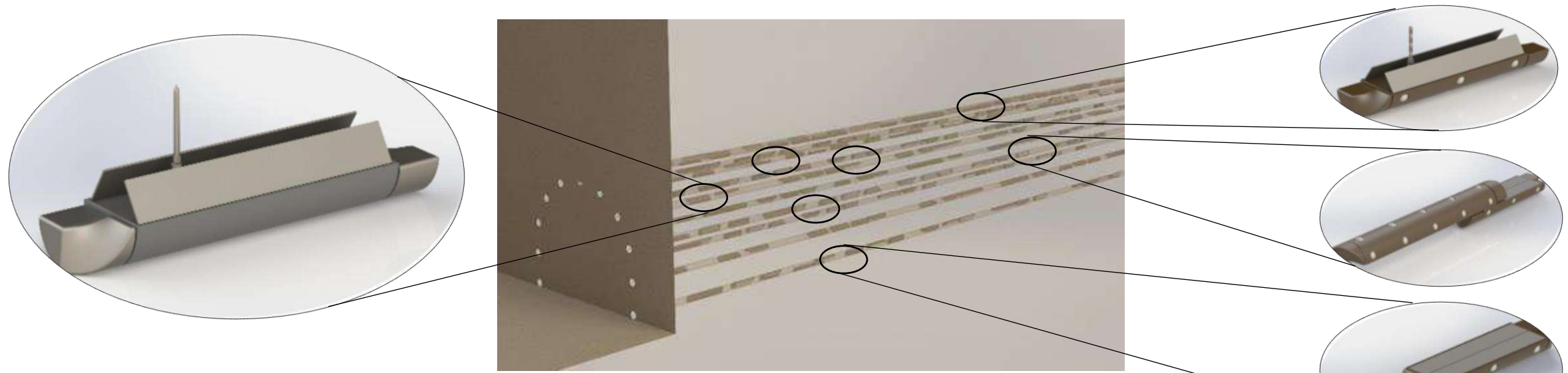


and in pipes

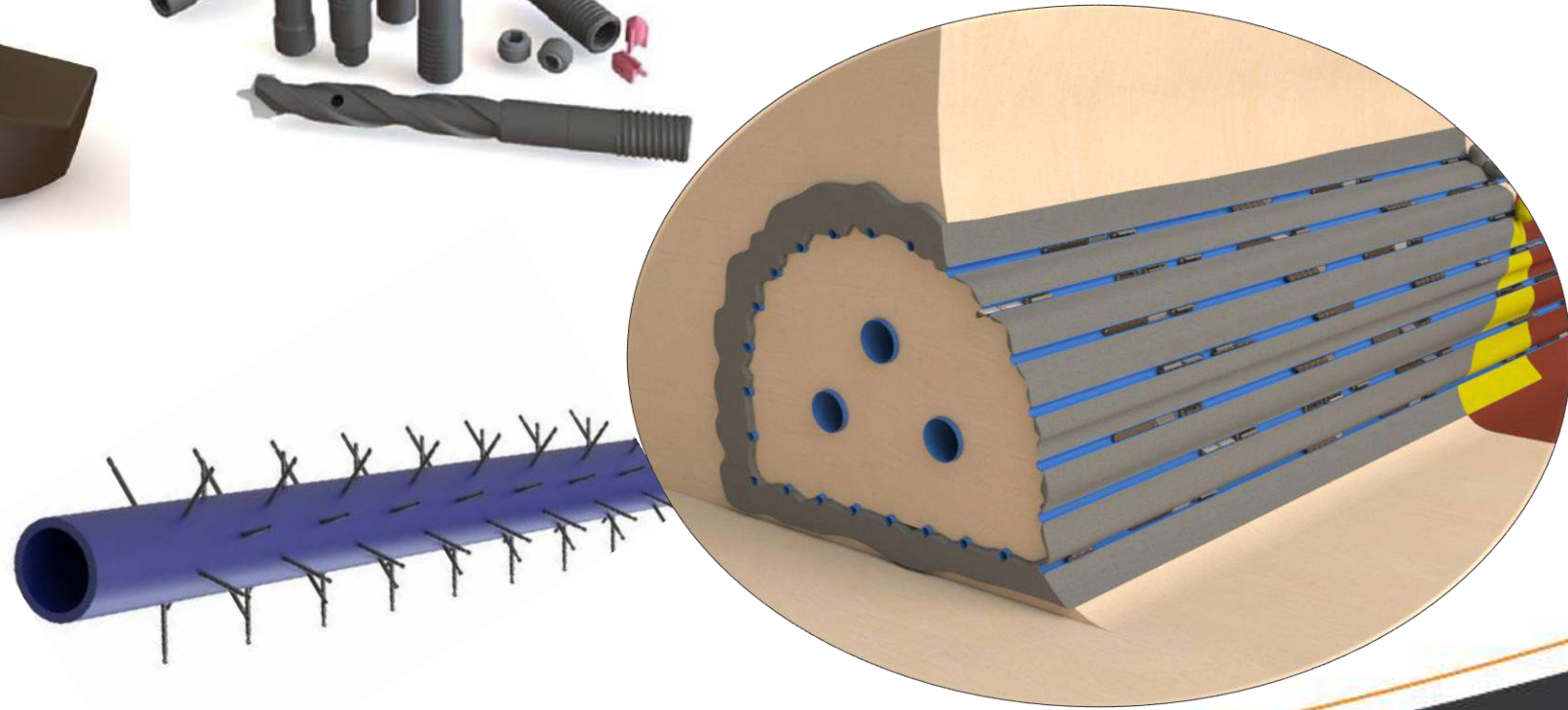
# Phase 2: Construction bots to facilitate the hyperSwarm



# Phase 2: Construction – using the hyperSwarm

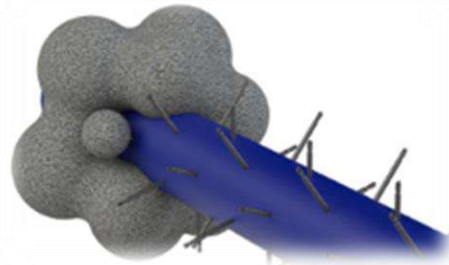
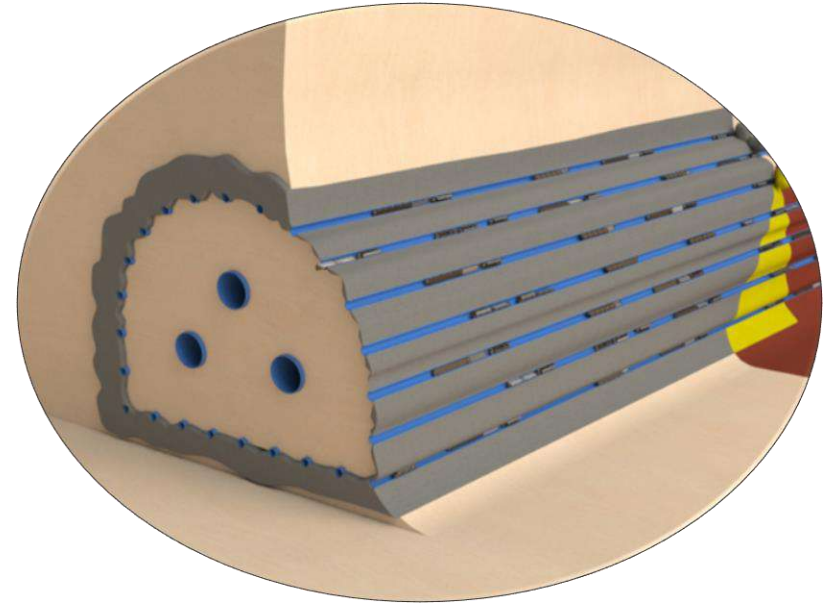
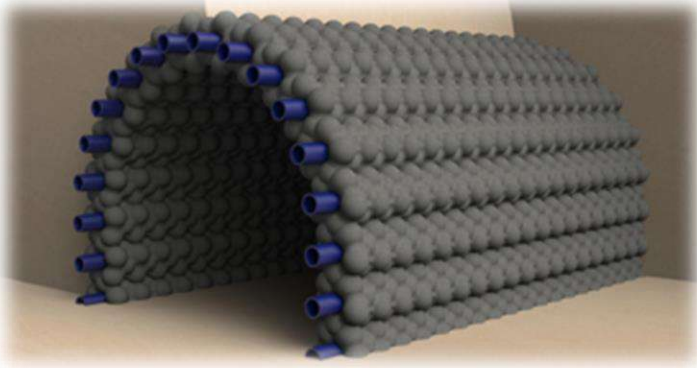


# Phase 2: **hyperBit**



**hyperBit**

# Phase 2: Flexible tool set – placing chemistry



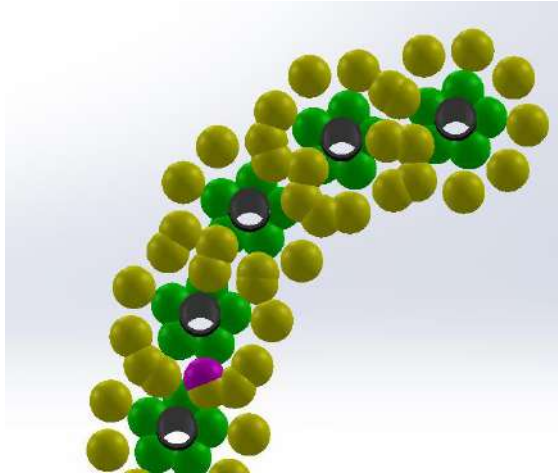
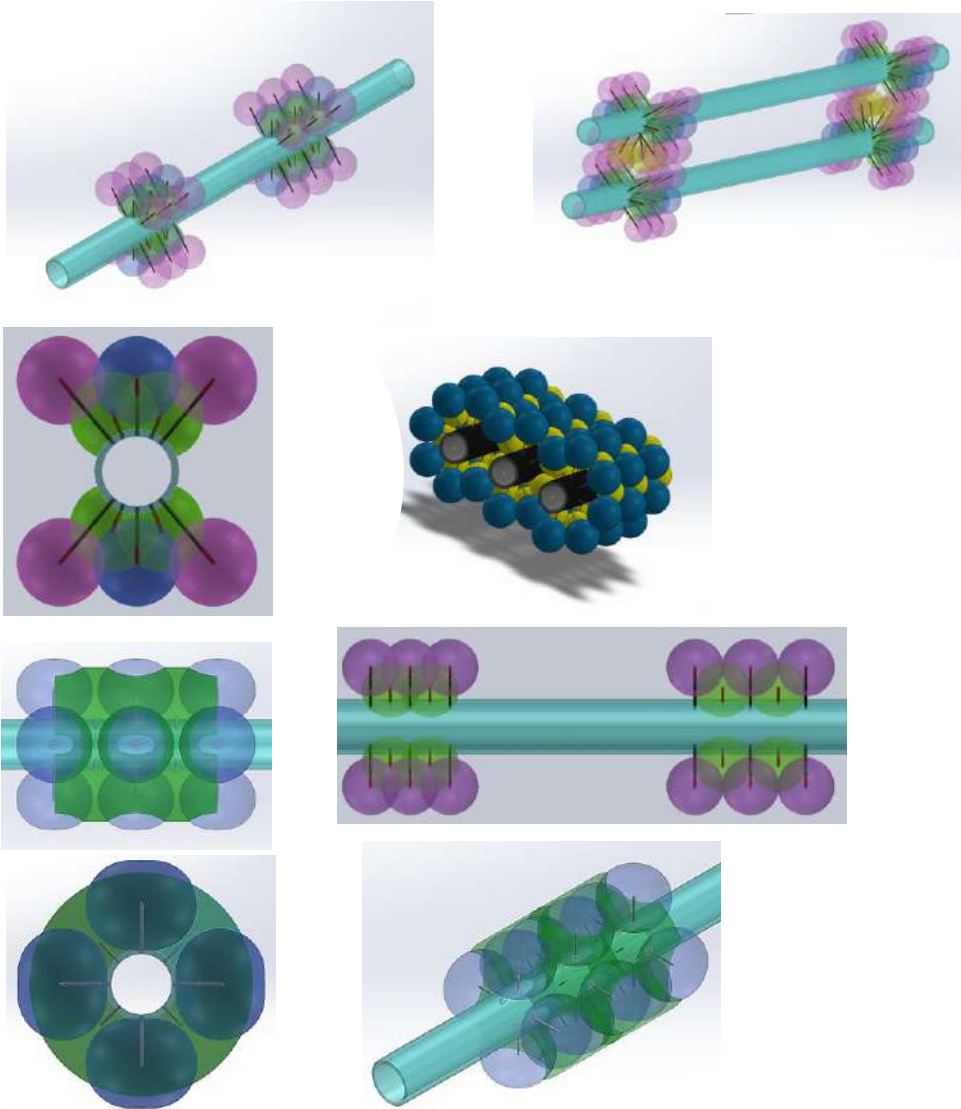
hyperBit

# Plume Samples

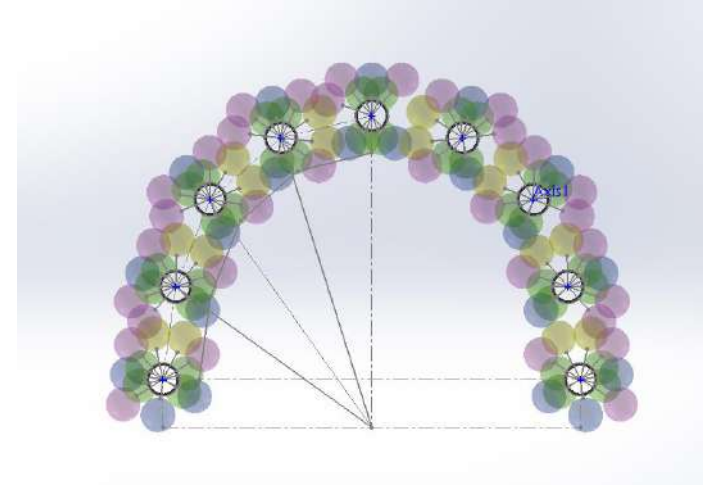
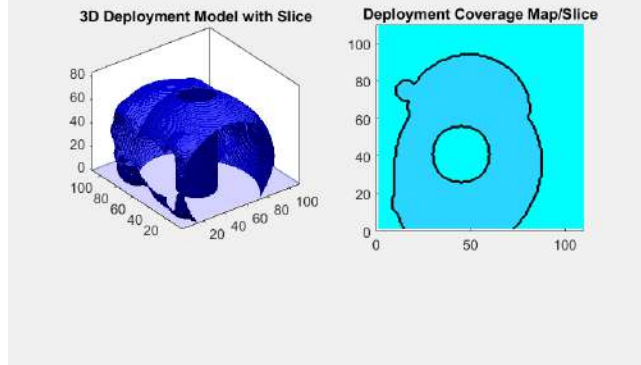


MPa 70 is >10,000 psi

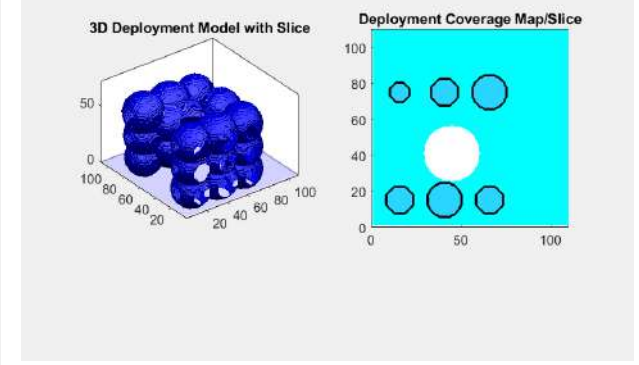
# Peak XV - Design



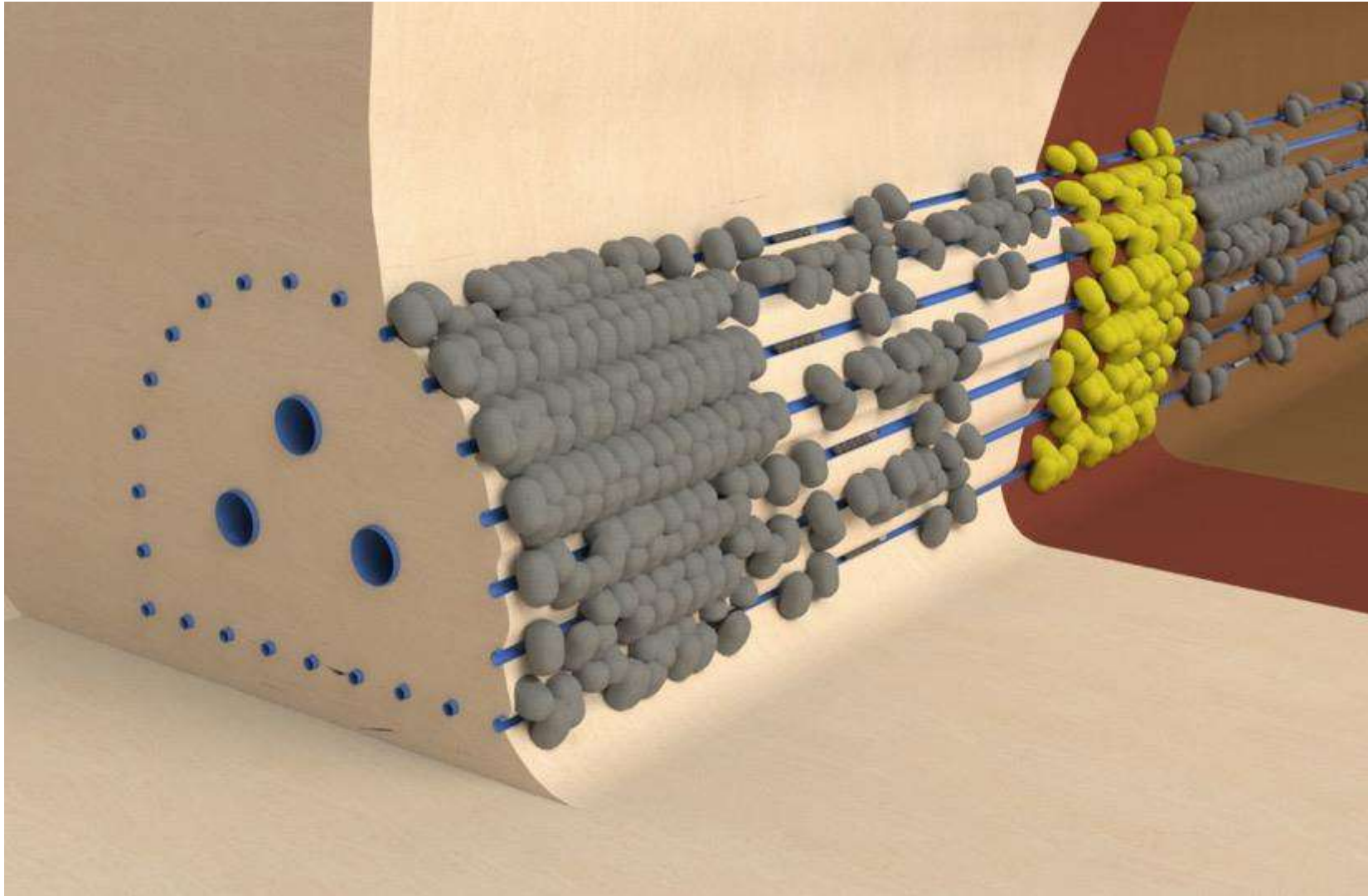
Chamber 1 Deployment Map with Chemical Spreading



Chamber 1 Deployment Map without Chemical Spreading



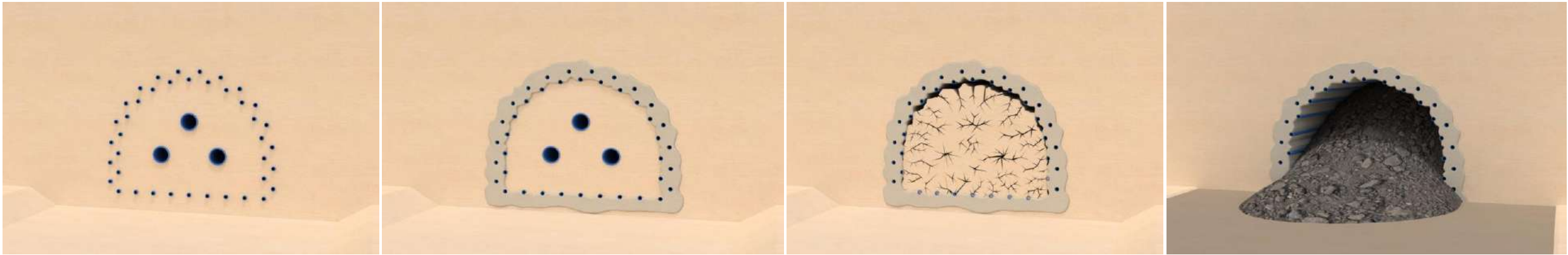
# Phase 2: Construction



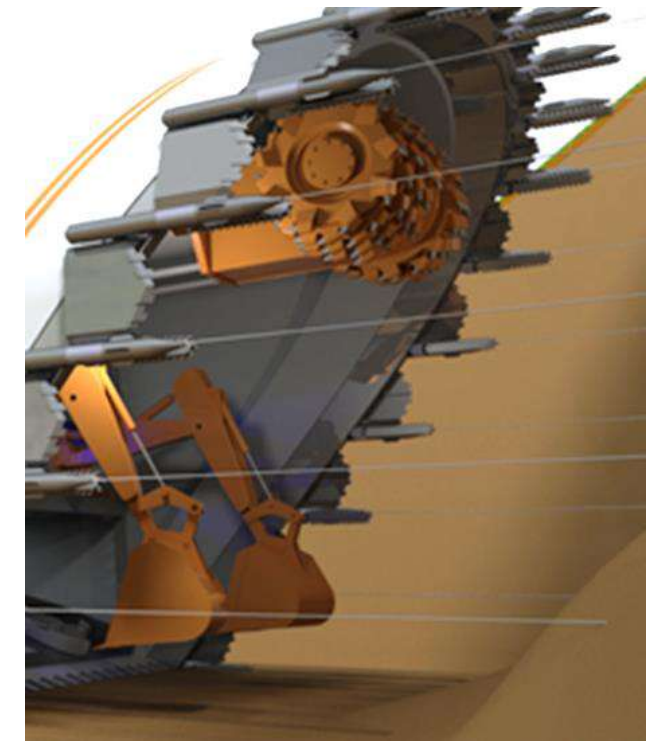
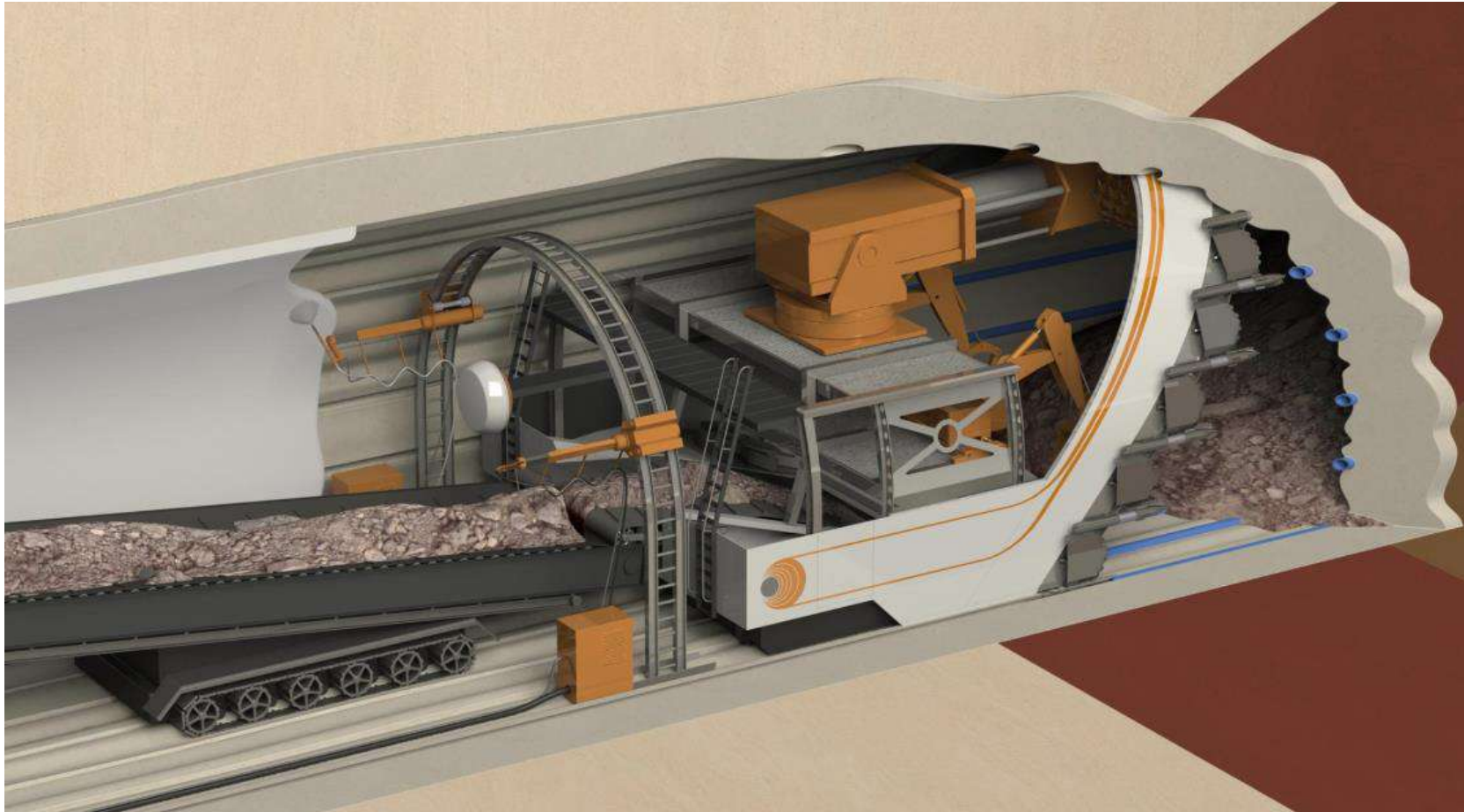


# Phase 2: Construction

Pre-excavation  
disruption of the spoil



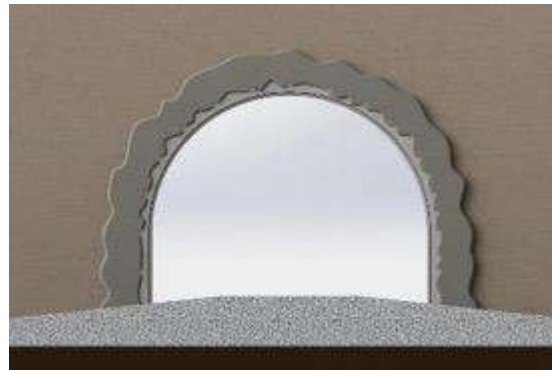
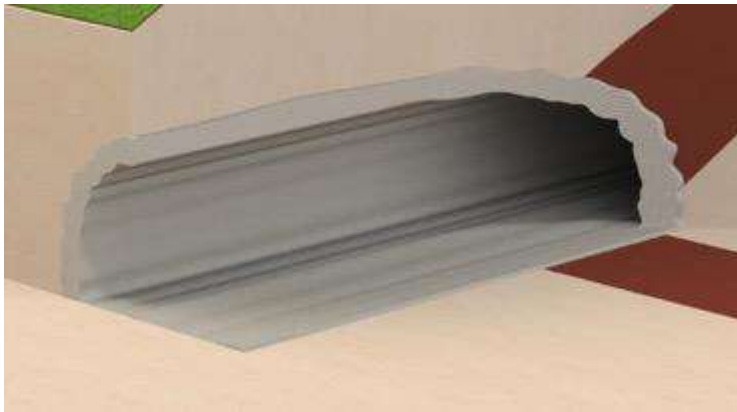
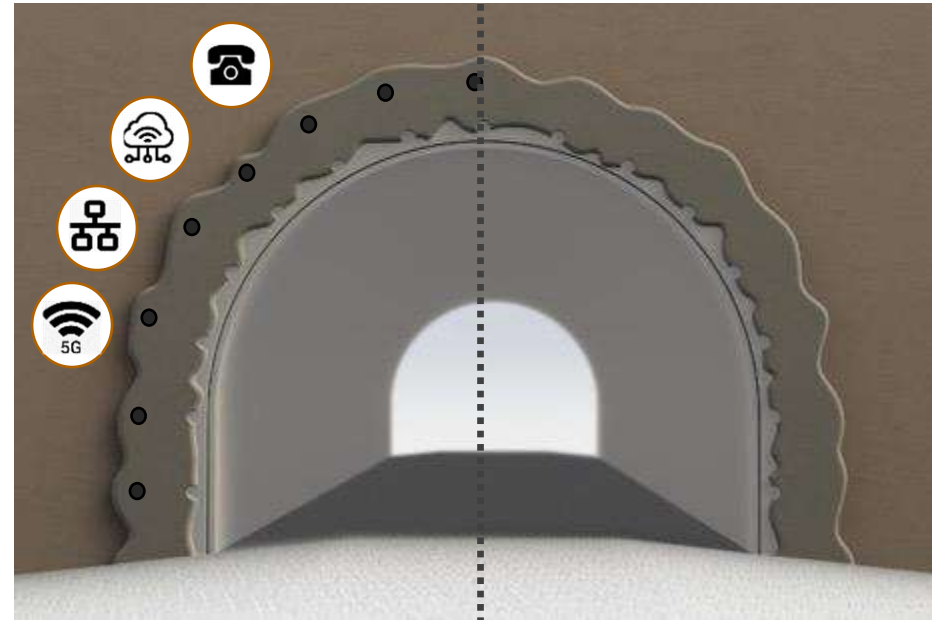
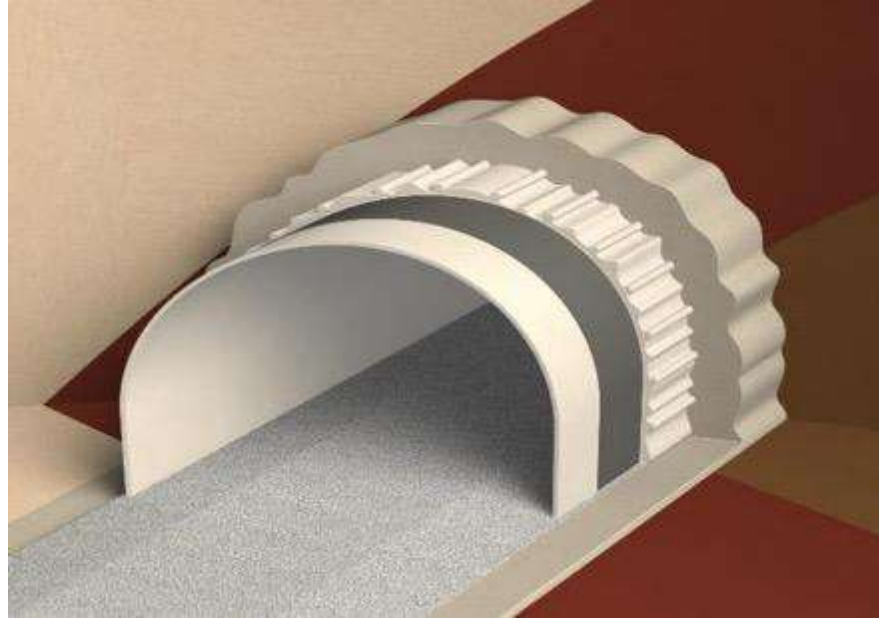
# Phase 3: Excavation (for the big jobs)



hyperTunnel dragline shield

# Phase 4: Completion

- Tunnel lining
- Digital twin (BIM)
- Continuous monitoring
- Predictive maintenance
- 3<sup>rd</sup> party services (e.g. fibre optics for data)



# Unique infraTech capabilities

## Build

- **Advanced geophysical survey** populates **digital twin** driven by **machine learning/AI** for **3D printing** and **additive manufacturing**.
- **Remote controlled excavation** for **safer** workforce and enables **custom lining** and **post-construction opportunities**

## Enlarge

- **Continuous operation** of asset during expansion works **avoids unnecessary cost** from closure

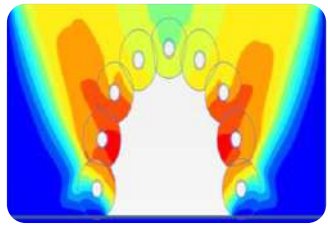
## Repair

- **Remote 'keyhole' precision repairs** for **structural failure, overburden support, water ingress, concrete repairs** and **ground improvement**

## Monitor

- Full **Digital twin integration** and **BIM** support from initial design to end-of-life.
- **InfraTech** lifecycle care with **predictive maintenance** via **IOT continuous monitoring**
- **Automated** inspection **avoiding** closures and current **labor-intensive process**

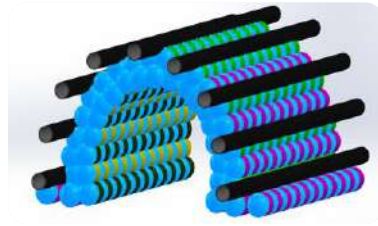
# Peak XV – World's first tunnel built entirely by robots



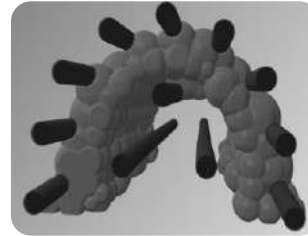
Design



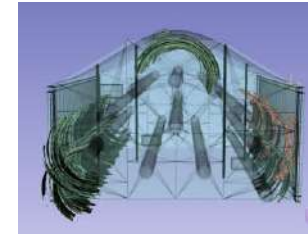
Simulate



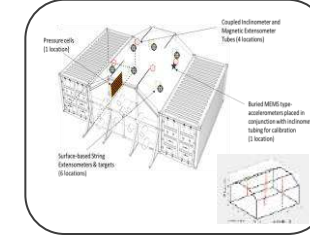
Process Plan



Analyse



LIDAR Scan



Instrument



Build



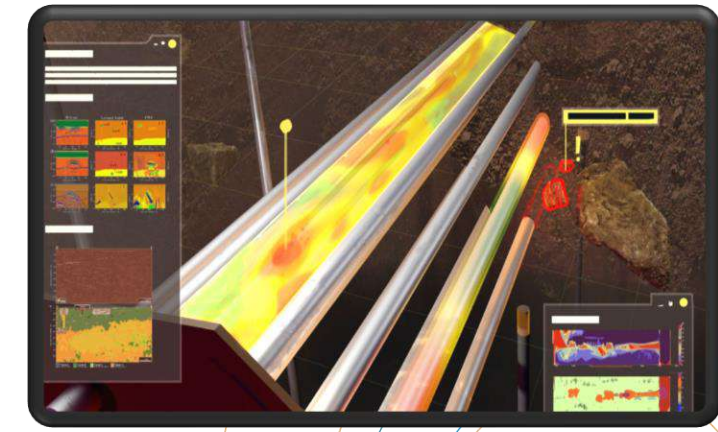
Survey



Deploy



Excavate



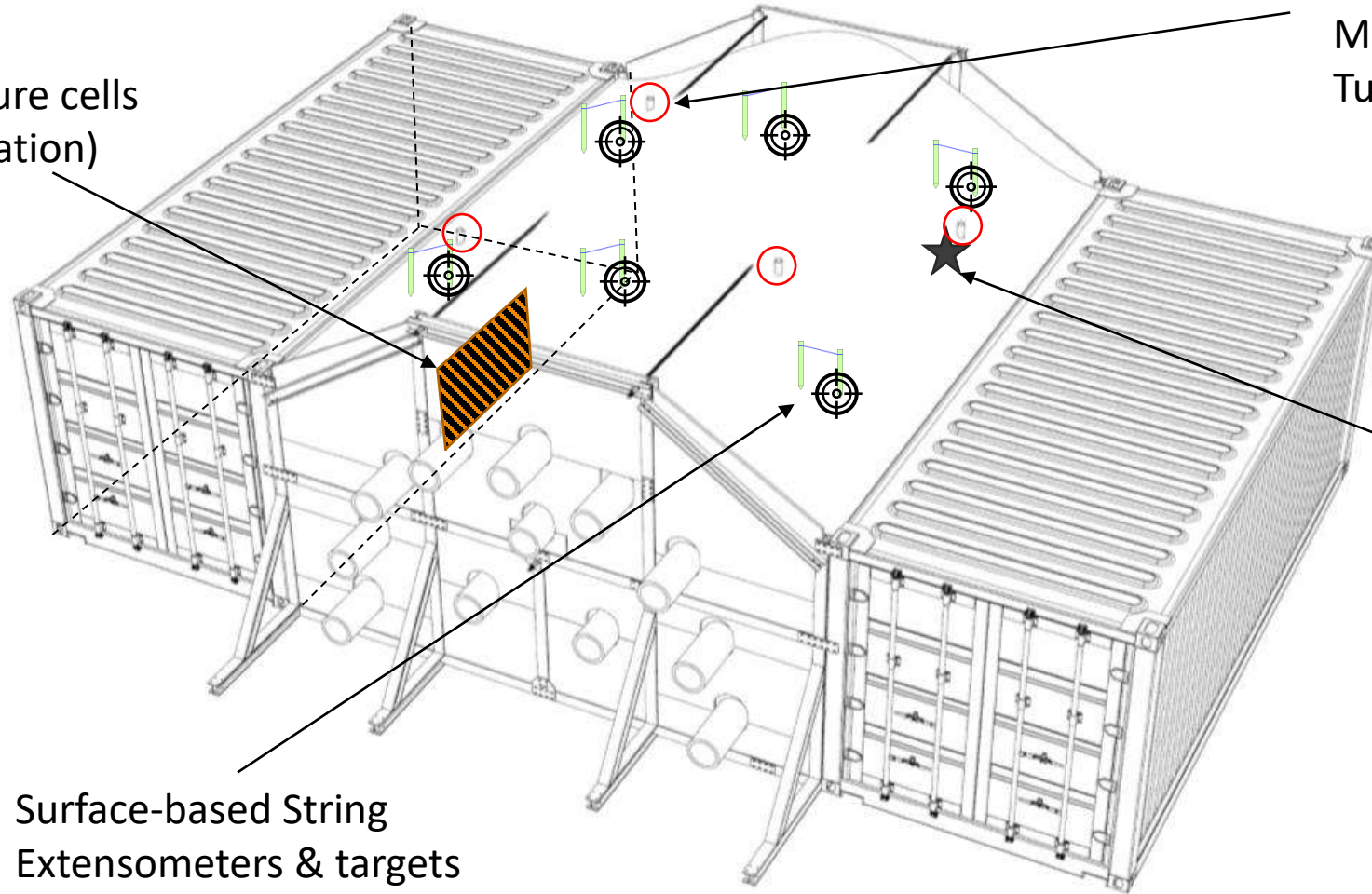
Digital Twin

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# Instrumentation Overview

Pressure cells  
(1 location)

Coupled Inclinometer and  
Magnetic Extensometer  
Tubes (4 locations)



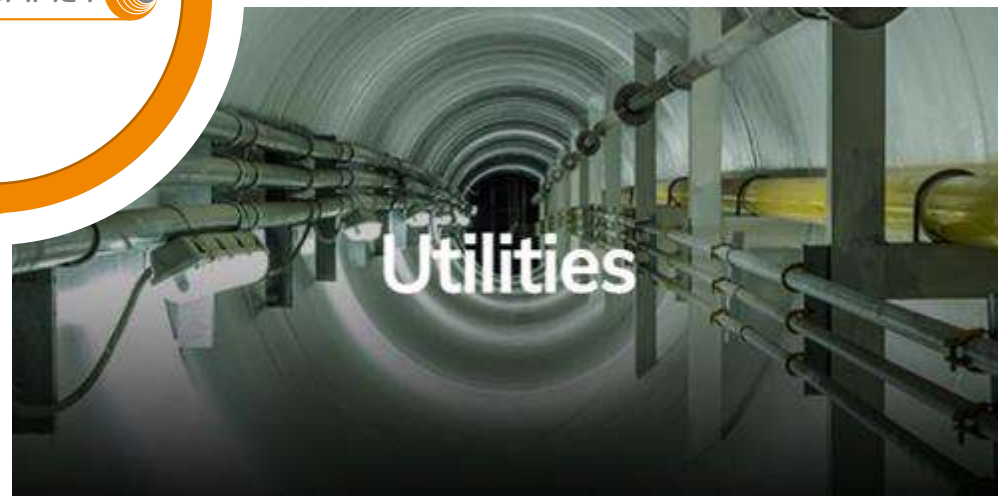
Buried MEMS type-  
accelerometers placed in  
conjunction with inclinometer  
tubing for calibration  
(1 location)

Surface-based String  
Extensometers & targets  
(6 locations)



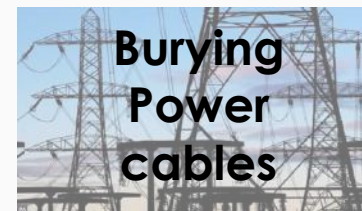
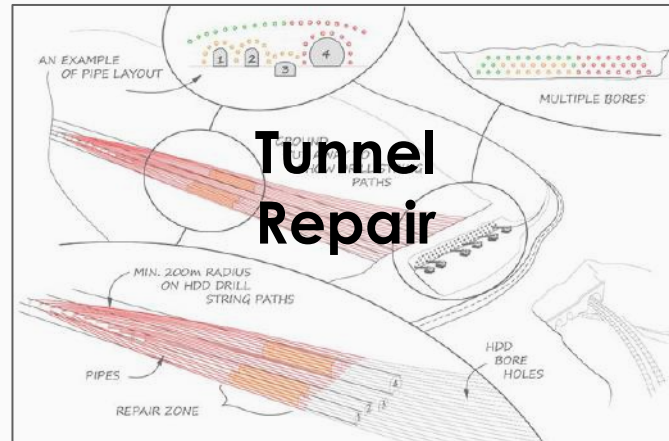


# hyperTunnel® Target market sectors





# hyperTunnel<sup>®</sup> applications



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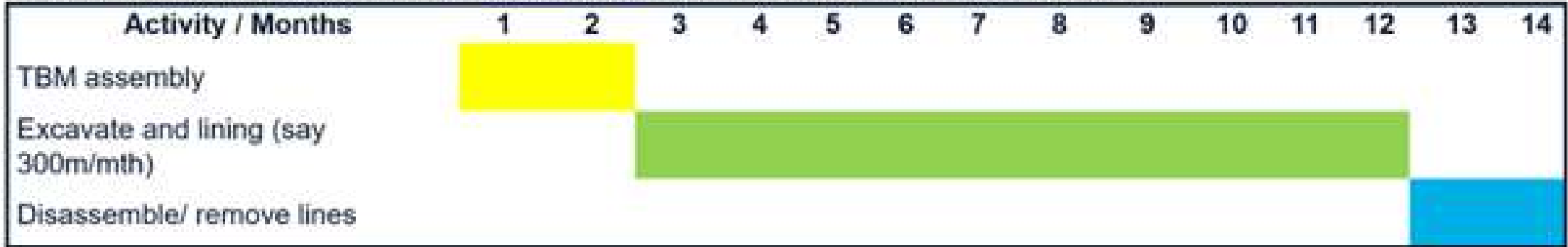
# hyperTunnel<sup>®</sup> compared to other tunneling methods

	Cut-and-cover	Drill and blast	New Austrian Tunneling Method	Box jacking	The Boring Company	TBM	hyperTunnel
Tunnel profile to suit function (not just round)	✓	✓	✓	✓	✗	✗	✓
Shaftless deep excavation	✗	✓	✓	✗	✓	✓	✓
Suitable for long, short, shallow, and deep tunnels	✗	✓	✓	✗	✓	✗	✓
Navigate tight turns	✓	✓	✓	✗	✗	✗	✓
Able to handle almost any geology (incl. sand) with a single machine	✗	✗	✗	✗	✗	✗	✓
Easily able to handle extensive ground water	✓	✗	✗	✓	✗	✗	✓
Able to transition variable geologies with a single machine	✓	✗	✗	✗	✗	✗	✓
Able to handle most voids	✓	✓	✓	✓	✗	✗	✓
Faster than Gary the snail	✗	✗	✗	✗	✗	✗	✓
Continuous excavation	✗	✗	✗	✗	✓	✗	✓
Suitable for electric construction vehicle fleet	✓	✓	✓	✓	✓	✓	✓
Excavated material preserved for a wide range of repurposing	✗	✗	✗	✗	✗	✗	✓
Low consumable costs	✓	✗	✗	✗	✗	✗	✓
Relatively low maintenance costs	✓	✓	✓	✓	✗	✗	✓
Relatively low energy consumption	✓	✓	✓	✓	✗	✗	✓
Relatively low CapEx and OpEx	✓	✓	✓	✗	✗	✗	✓

#THEBIGEVOLUTION

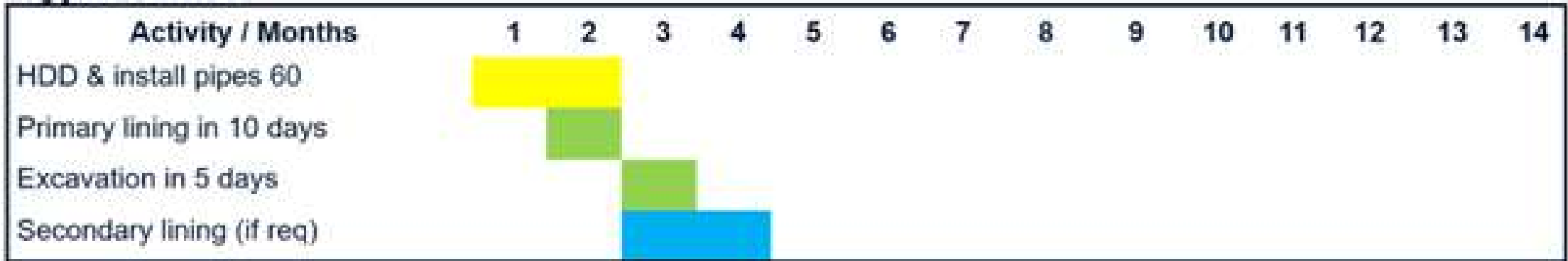
# (TRADITIONAL) TUNNEL BORING MACHINE VS HYPERTUNNEL (ESTIMATE)

A typical TBM tunnelling schedule for a 3 km tunnel, say 7 m diameter, could be as it follows:



\* Does not include: TBM Design (18+ months) TBM Launch & site preparation

## hyperTunnel



\*The schedule for hT is based on 24 hr working.

Note that the primary lining and excavation durations are in days. The hyperBot fleet is 1750

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# Wide portfolio of intellectual property

**Patented**

Intellectual Property Office  
Europäisches Patentamt  
European Patent Office  
Office européen des brevets  
Government of Canada

**hT Concept**  
hyperTunnel

Intellectual Property Office  
**hyperShield**

Intellectual Property Office  
**hT Divisional**  
hyperTunnel

**Patent-Pending**

Intellectual Property Office  
WIPO PCT  
The International Patent System

**hT Concept**  
16 National Applications  
**hyperCast**  
hyperTunnel

**hyperPull/Push**

**hyperFix**

**hyperDAR**

**hyperBot**

**hyperBarrier**

**hyperBit**

**Burgeoning IP Pipeline of component technologies**

**hyperCore**

**hyperMesh**

**hyperSeis**

**hyperHoles**

**hyperSwarm**

**hyperPrint3D**

**hyperPulse**

**hyperShuttle**

**hyperLocate**

**hyperConvoy**

**hyperTool**

**hyperView**

[www.thebig5.de](http://www.thebig5.de)

# Industry engagement

Deal Progression

Commercial Deals	
MOUs	
Commercial Discussions	
Tech Discussions	
Presentation	
Contacted	
Identified	

# Pilots and Projects: 2022-25 potential



# Already financially backed by industry leading players ...



*“This technology can be truly game changing in improving safety and sustainability of underground projects and aligns with our goals of a rapid response to the climate emergency.”*

**- Guillaume Bazouin**

Technical Head of Start Up and Intrapreneurs Programme

*“We want to reduce disruption to passengers and constantly searching for new approaches to enlarging or re-lining tunnels that reduce the length of time a tunnel will be closed to trains.”*

**- David Castlo**

Technical Head of Mining & Tunnels

*“We are proud to be a strategic partner of hyperTunnel®, whose approach towards tunnel construction is truly visionary. They use innovative technology which challenges the status quo.”*

**- Götz Tintelnot**

MBCC Group – CEO TPH Bausysteme GmbH

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# Further industry support

**AMCO·GIFFEN**

*“We are keen to commence trials and satisfied you are at the appropriate stage to do so. We anticipate to conclude repairs in half the time of current techniques.”*

**Dave Thomas**  
Operations Director

**ferrovial**

*“Our experts in tunnelling agree with your assessment to potentially reduce costs with the further advantage the Digital Twin can revolutionise maintenance in the future.”*

**Rafael Fernandez**  
Innovation Director

**PARSONS**

*“Your visionary approach and technology allows us to help our clients in the Middle East in building and repairs on tunnels and other underground assets in the future.”*

**Max Clark**  
VP Delivery Services

**HNTB**

*“You have presented a mature and credible plan to launch a truly disruptive, market-creating technology.”*

**Ian Chaudri**  
Senior Vice President

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# International awards



*Paris*

VINCI

*Dubai*

*Brussels*

European Innovation Council

eic **INNOVATION** Council

*Miami*

*Paris / London*

IMPULSE PARTNERS  
Strategy | Innovation | Performance

*London / Montreal*

Artificial Intelligence  
Global Business Innovation  
Programme with Canada

*Madrid / Monterrey*

TOP 50 CoNTech STARTUPS 2021

www.thebig5.eu

# A step change in sustainability

## Carbon Footprint



- Aligned to UN and net zero goals
- Electrical energy for robots 50% lower
- Concrete use 65% lower plus low carbon concrete suitable
- Reusable robots/circular economy

## Environmental Impact



- Less raw materials, waste
- Less water in extraction process
- Smaller worksite requiring less land
- Repair and surveying extend tunnel life and avoid closures

## Societal Benefits



- Shorter journeys benefit society
- No human enters underground
- Building underground reduces pollution and allows green space
- No maintenance closures

# Exclusive Distribution Agreements

## Key element of hT's GTM strategy

- Description

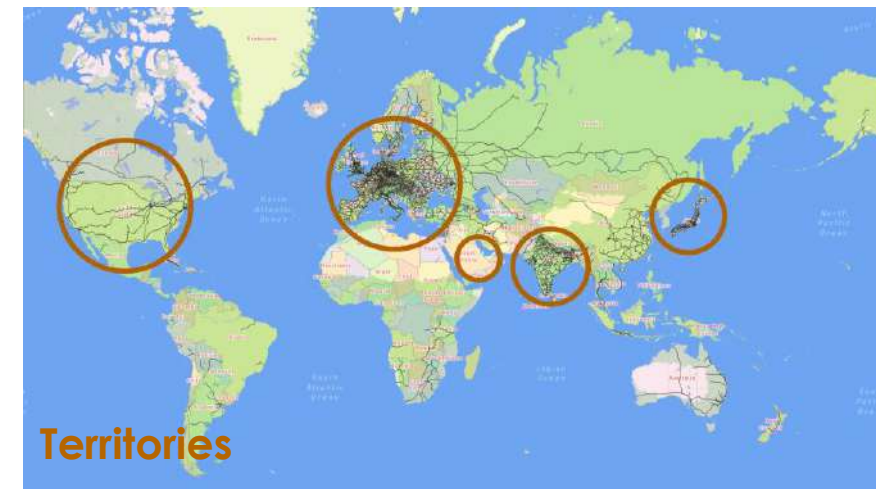
- An **annual licence fee** payable monthly in advance, subject to
  - **Discounts** to reflect the level of hT Technology development and
  - Distributor spend on hT Technology and hT Consulting Service
- Scope **exclusivity** within the relevant sector of each territory

- Distributor benefits

- Early **low-cost bet** that secures future territories, provides the opportunity to lead the Industry, and exclusivity **removes the risk** of losing current revenue streams to competitors with hT technology
- Access to the hT **distributor portal** (for marketing support, technical support, and tools for designing and costing schemes) and relevant **sales leads** generated by hyperTunnel
- Enables distributor to bring **cutting edge technology** and innovation to their customers and markets
- Delivers real added value, creates **differentiation & competitive advantage** to grow **market share**, enhance **margins** and improve **sustainability**

- hT benefits

- Contractor has **Skin in the game**, thereby encouraging **in-market investment**
- Forces **commitment** from contractors and forces the market to talk about hT
- Early and consistent **revenue stream**
- Acceleration of technology development with a customer focus



AMCO·GIFFEN



Started process of appointing hT's global distribution network

# GCC Tunnelling Centre of Excellence

- Beneficiaries

- Government Agencies who have problems that need to be solved
- Landowners who may benefit from increased values as a result of projects.



- Facilitators

- Who can provide expertise and/or open doors to beneficiaries.



- Financiers

- Such as UK Export Finance (UKEF) to support the asset owners.



- Contractors

- to undertake the work



- Consultants

- to assist develop the CoE proposal.



- Academia

- Provide contacts, deliver mutual credibility and build a legacy.



# Thank you



Concrete



Facilities  
Management



Geotechnical  
& Engineering



HVAC R



Offsite  
& Modular



Project  
Management



Solar



Stone Design



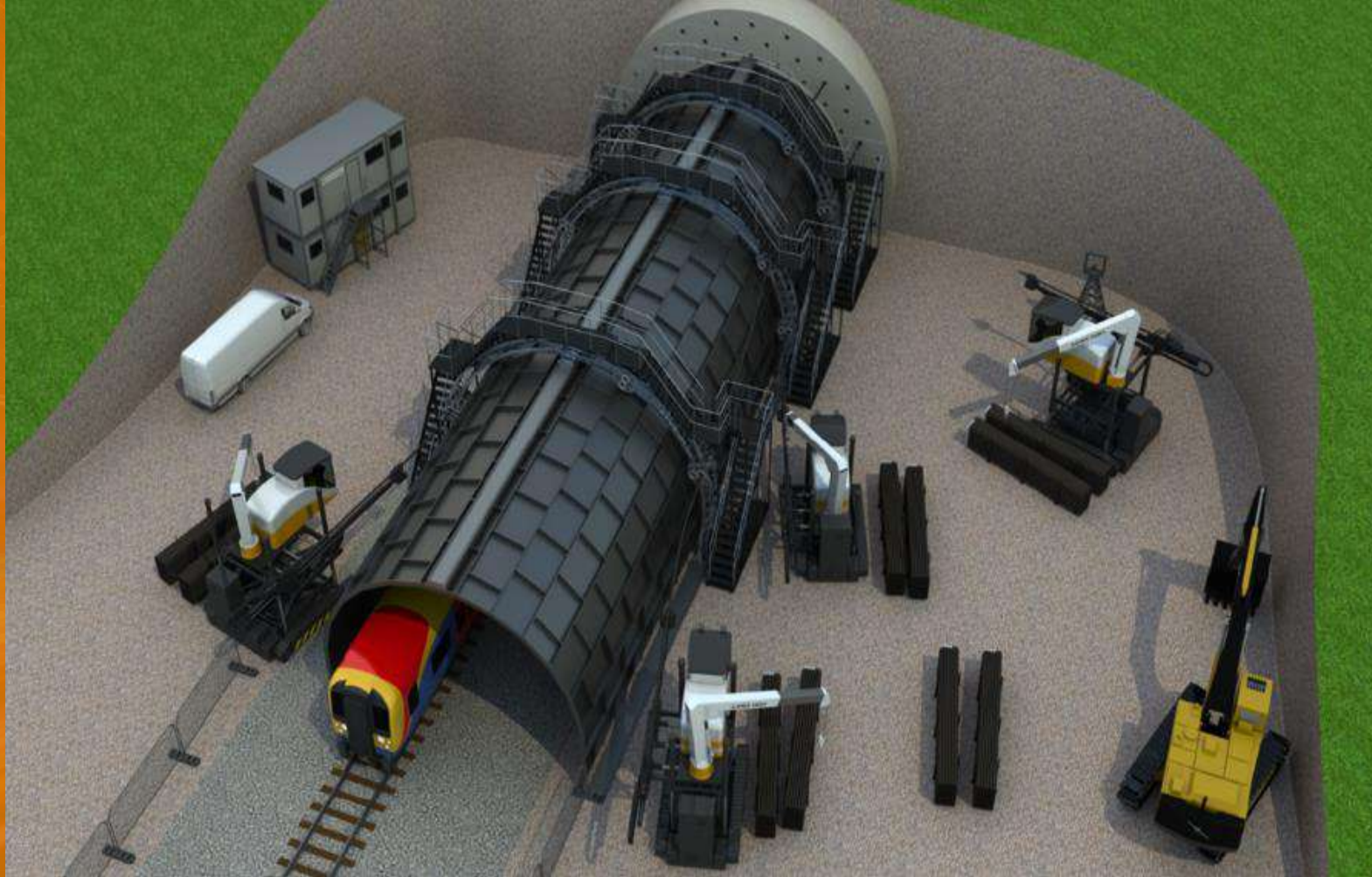
Technology



Urban Design  
& Landscape

Private & Confidential

# Appendix



# Exclusive Distribution Agreements

## Key element of hT's GTM strategy

- Description
  - An **annual licence fee** payable monthly in advance, subject to
    - **Discounts** to reflect the level of hT Technology development and
    - Distributor spend on hT Technology and hT Consulting Service
  - **Scope exclusivity** within the relevant **sector** of each **territory**

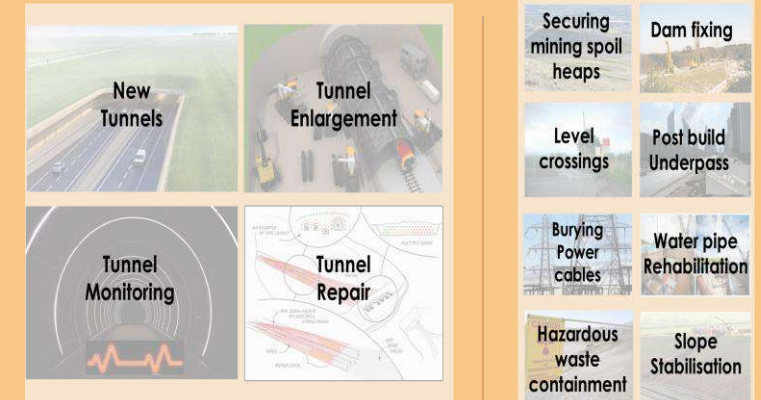
### Territories



### Sectors



### Scope



- Distributor benefits
  - Early **low-cost bet** that secures future territories,
  - Access to the hT **distributor portal**
  - brings **cutting edge technology** to their markets
  - Creates **differentiation & competitive advantage**

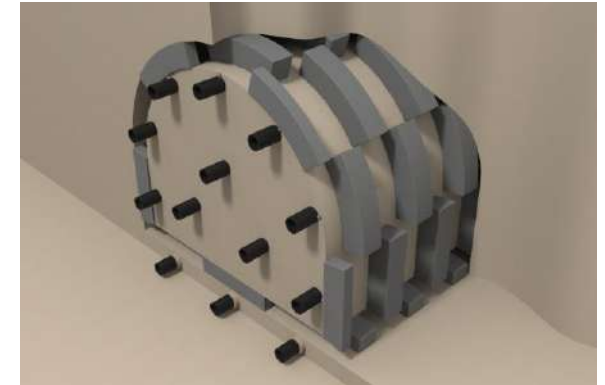
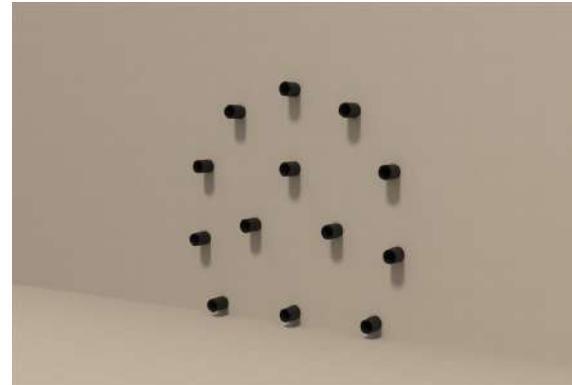
- hT benefits
  - Contractor has **Skin in the game**,
  - **commitment** from contractors and forces the market to talk about hT
  - Early and consistent **revenue stream**
  - development with a customer focus

# Captive bots operating on a physical grid system



## Site Setup

- Build environment – install grid (pipes) using HDD
- Introduce robots to grid




## Operation

- Robot is sent an address and task
- Robot navigates to address
- Robots carry out task
- Robots report task complete
- Check power and location status
- Repeat cycle







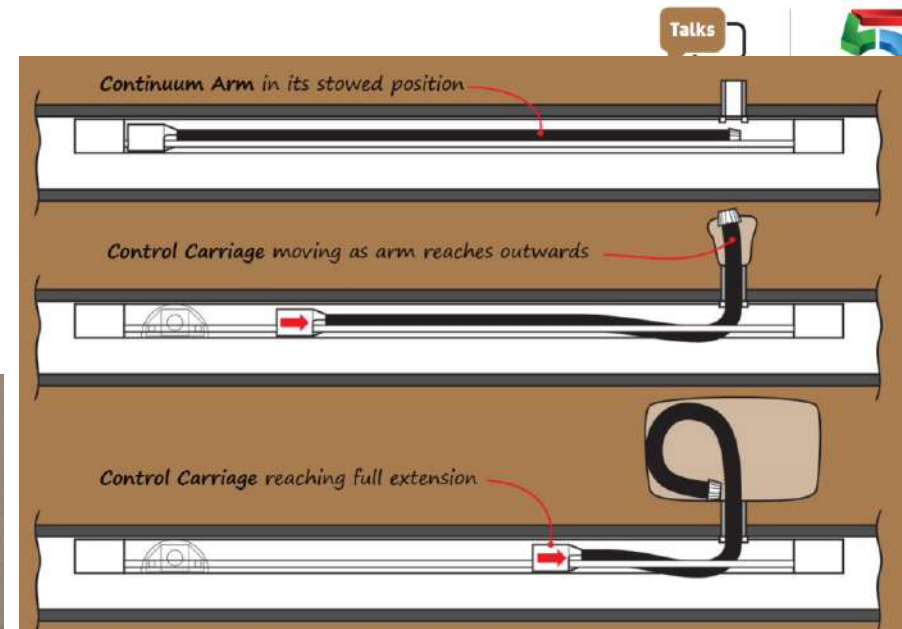
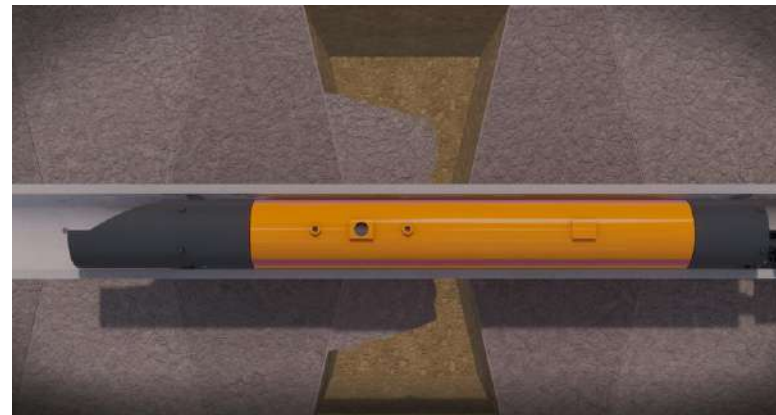
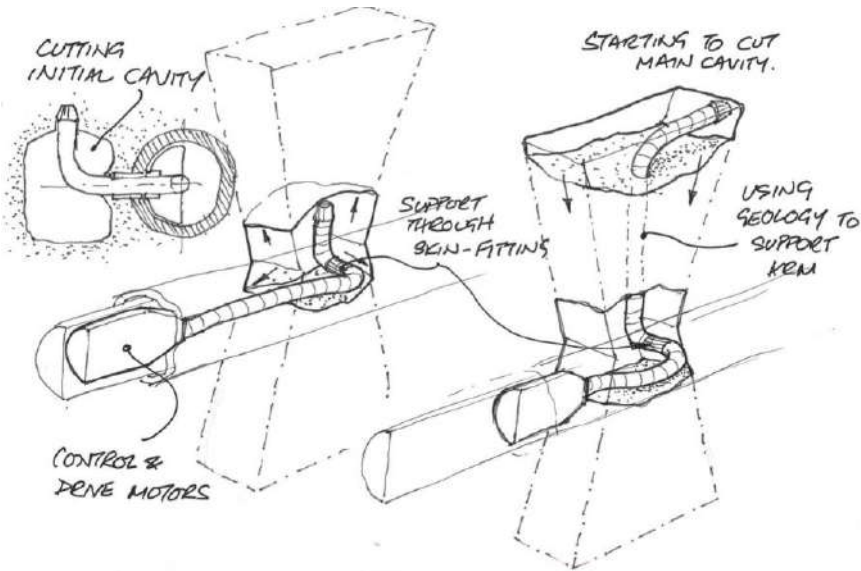
5 The 'bot carves precise chambers in the geology and these are then filled with suitable construction material.

# The hyperTunnel Method

[From hyperTunnel Video](#)

# hyperCast

- Structures in impermeable ground
- Block built structures
- Choice of chemistry



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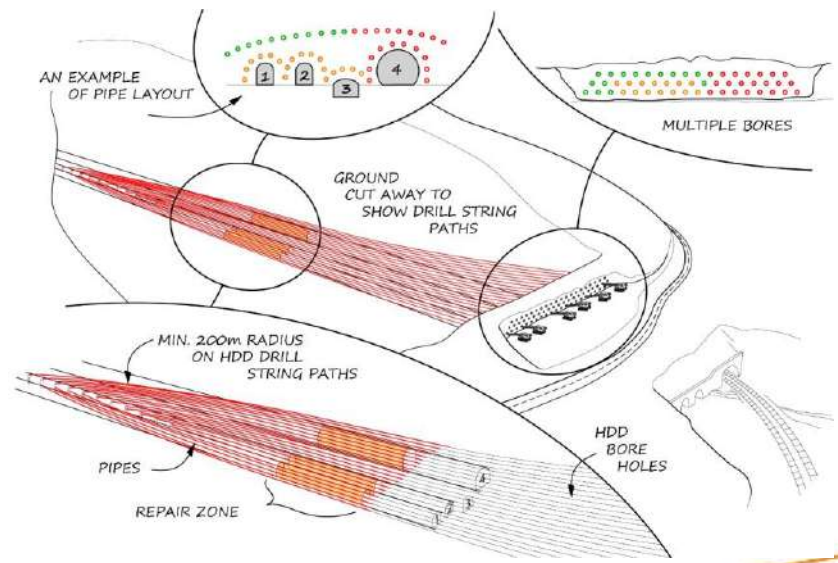
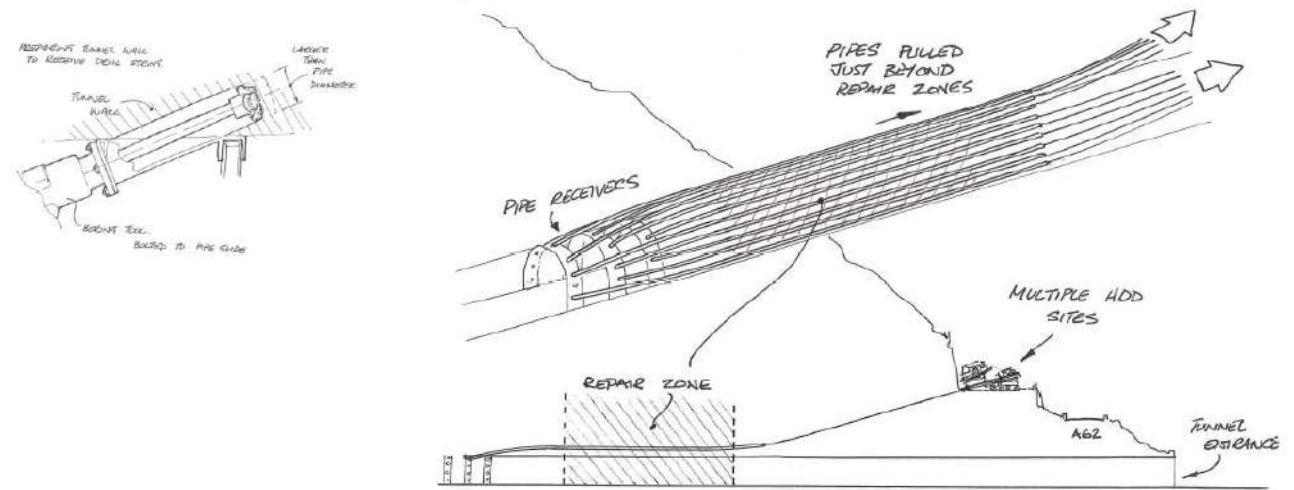
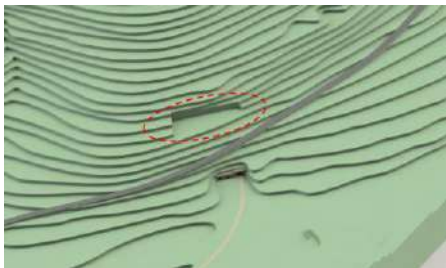
# The hyperTunnel Method



6 The cast in situ blocks interlock to create a permanent structure, block by block.

[From hyperTunnel Video](#)

# Example toolset application: Rail tunnel repair



# Example toolset application: Hazardous waste containment



Home / News / Best States / Washington News

## US: Nuclear Waste Tank in Washington State May Be Leaking

Officials say an underground nuclear waste storage tank in Washington state that dates to World War II appears to be leaking contaminated liquid into the ground.

By Associated Press | April 29, 2021



## Nuclear waste tunnel collapses at Hanford site in Washington state

Science | May 9, 2017 2:32 PM EST

The U.S. Department of Energy issued an emergency alert Tuesday morning at the Hanford Site north of Richland, Washington after a tunnel containing rail cars full of radioactive material was breached.



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# Example toolset application: water pipes rehabilitation

## Birmingham Resilience Project – Elan Valley Aqueduct (Bleddfa) (2017)

Ensuring continued water supply for Birmingham through three new bypass tunnelling sections connected into the existing Elan Valley Aqueduct

By: Severn Trent Water, Barhale/North Midland Construction Alliance (BNMA) and GHD

Published: October 01, 2017



(left) By combining the tunnel drive pits and connection cofferdams, the team made significant savings while simplifying construction and reducing the delivery programme and (right) the three sections will bypass key locations of the aqueduct to improve resilience of water supply to Birmingham using this 100-year old asset - Courtesy of GHD



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# Example toolset application: burying power cable



July 21, 2021  
11:57 PM BST  
Last Updated 6 months ago

United States

## California's PG&E to bury 10,000 miles of power lines to prevent wildfires

3 minute read  
By Noor Zainab Hussain



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Tags: california | pacific gas electric | 10000 miles | power lines | wildfire prevention

### California's PG&E to Bury 10K Miles of Power Lines to Prevent Wildfires



## National Grid unveils plans to bury cables underground

By Roger Harrabin  
BBC environment analyst

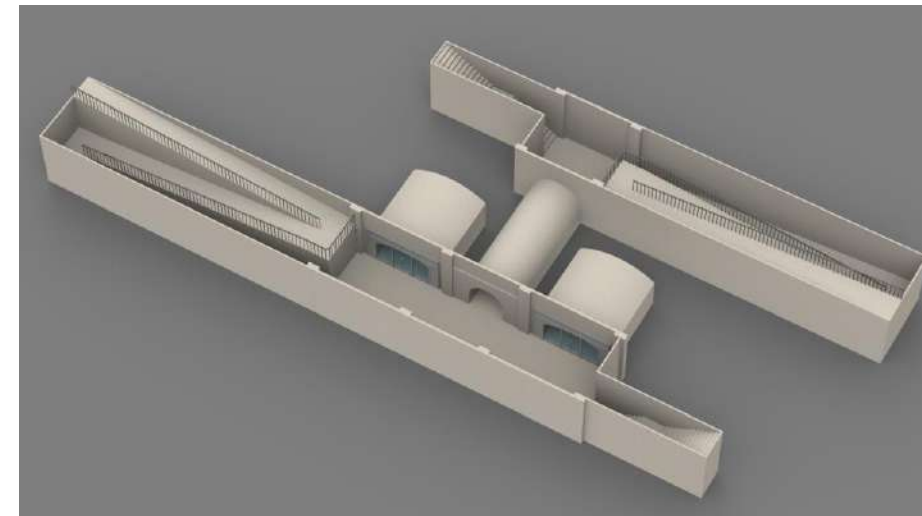
10 November 2014



Pylon cables will disappear from some of the most beautiful areas of England and Wales as part of a move by National Grid to reduce the impact of energy transmission on the landscape.

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# Example toolset application: Underpasses





# Example toolset application: Dam fixing



# Example toolset application: Level crossing



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# Example toolset application: Slope Stabilisation



**Kent railway reopens following cutting stabilisation closure**  
BAM Nuttall fits 17,000 working hours into nine-day railway cutting stabilisation project

SLOPE STABILISATION & ... 19 AUG 2021



**Major section of Chiltern railway line secured from landslips**  
Earth beside the Chiltern main line in Warwickshire, UK, has been secured from landslips to provide more reliable journeys for passengers.



**Slope collapse above busy railway gives Murphy more than it bargained for**



# Example toolset application: Securing Coal tips/ Slag heaps

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**Wales needs £500m-£600m to make abandoned slag heaps safe**

Devolved government asks for UK help to deal with dangerous legacy of coal mining



Nearly 300 of 2,456 slag heaps in Wales are categorised as being at 'high risk' of landslides © Matth



Law Commission  
Regulating the Law

Law Commission  
Consultation Paper 355

**Regulating Coal Tip Safety in Wales**  
A Consultation Paper

9 June 2021

THE SPECTATOR

Coffee House Politics Economy World Culture Life Magazine

Wales is terrified of a repeat of the Aberfan disaster

Theo Davies-Lewis

21 November 2021, 7:50am



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