FEBRUARY 2018



LEAPFROG WORKS

THE LIE OF THE LAND, THE TRUTH IN THE EARTH

A global briefing on technology and innovation for the civil engineering and environmental industries

Brought to you by Leapfrog, the world's smartest geological modelling solution

www.leapfrog3d.com

Hi, I'm Daniel Wallace and I am the General Manager for the Civil and Environmental industries here at Seequent, looking after our innovative solutions to solve problems that relate to geology in Civil Engineering and Environmental applications. Our flagship product is a 3D geological modelling software – Leapfrog Works, designed with those civil and environmental workflows in mind.

I'd like to welcome you to Unearthed – a special report designed to bring you innovative thinking and industryrelevant perspectives for those who have an interest in what's going on beneath the surface.

Seequent, formerly ARANZ Geo, has been leading the market in 3D geological modelling software since 2004. We have deep expertise in making sure our software evolves continuously to support geologists, hydrogeologists, geotechnical engineers and environmental scientists to name a few, to solve real challenges and help their companies save time and money. We are delighted that we can now bring a solution specifically developed for the Civil Engineering and Environmental markets. Developed with industry experts, our 3D geological models can be integrated with your engineering designs or flow models, giving you the clarity and insight you need on how the geology will affect a project.

With digital transformation being a continued hot topic in the industry, Unearthed will share some interesting insights about the role that technology and innovation are playing today. We would love to hear your feedback on our solutions and of course any interesting stories we can bring to our next edition of Unearthed!

Warm Regards and I hope you enjoy this first edition of Unearthed.

Daniel Wallace

Leapfrog Works is a revolutionary solution for understanding, visualising and communicating ground conditions. It is the only 3D subsurface modelling solution specifically designed for the Civil Engineering and Environmental industries.

THE STORY OF SEEQUENT



57 KM

The length of The Gotthard Base Tunnel, the world's longest and deepest traffic tunnel, running beneath the Swiss Alps, providing a high-speed railway link between northern and southern Europe. The \$12bn link, which opened in 2016 after two decades of work, was considered so important it originally went to a referendum of Swiss voters, who backed it largely because of its environmental promise of removing a million trucks a year from the roads. In places the tunnel is **2.3km** beneath the surface at a depth where rock temperatures reach 46C. Speaking of rock, some 28 million tons of it was excavated, in no less than 73 different varieties. The drilling machines responsible were more than 400 metres long and the amount of concrete used - 4,000,000 cubic metres - could have built the Empire State Building 84 times.

106

600 MILES

Unearthec

Length of each one of three massive canals being dug in northern China to alleviate critical water shortages. The region contains 50% of the country's population, but only 20% of its water. The South-North Transfer Project will take **48 years** to complete and will tap into several rivers – though principally the Yangtze - to supply **44 billion cubic metres** of water per annum. Mao Zedong first had the idea back in 1952. By 2014 the bill was already up to **\$79 billion** not only making it one of the most expensive engineering projects the world has ever seen, but raising the prospect that the water it delivered could actually end up being too expensive for the average Chinese consumer to use.

Why Implicit Modelling?

GEOLOGY IS A SCIENCE RATHER THAN AN ENGINEERING DISCIPLINE BECAUSE IT MODELS THE REAL WORLD INSTEAD OF BUILDING STRUCTURES WITHIN IT.

These models evolve continually with the collection of new data and the geoscientist's increasing understanding of the physical processes that govern the creation of the geological environment.

By contrast, engineers take scientific models and use them as constraints to design and build structures, devices and systems. They need tools with a greater emphasis on precision because they form the basis for precise construction.

The critical advantage of an implicit model is that it allows the user to answer a simple question: If I went to a particular point under the ground, what would I expect to find based on the data? When the data can tell us what is likely to be there, we can do a great deal...

To find out all the things implicit modelling can achieve and the solutions it enables, see our indepth report here my.leapfrog3d.com/products/works



Digital Transformation

What it means, what it can do and how it will change the civil engineering and environmental sectors

Why Givil Engineering needs to grasp the digital nettle

"Our sector is still yet to fully reap the productivity and innovation benefits of digital transformation which have been enjoyed by others."



The Institution of Civil Engineers (ICE) thinks the construction industry has a long way to go to realise the potential of digital transformation and needs to make the journey. But digital can't dethrone the 'human engineer.'

Earlier this year ICE issued a "State of the Nation" report on digital transformation (taking aim, in this case, on infrastructure in the UK).

It declared that not only the did the industry need to adopt new integrated digital approaches to managing and operating existing assets and building future infrastructure, but we all needed to starting thinking about more than the physical asset. The report pointed the industry towards the potential within infrastructure's 'digital twin' – all the associated data and information, and what it can reveal.

"The pace of change in digital processes and technologies means that those responsible for delivering infrastructure have to be more agile and adapt to change in a pragmatic way," urged the report (which acknowledged 50 organisations for their support in its preparation).

Slow progress and painful statistics

However, the ICE concluded that the infrastructure sector had been slow to engage with new digital technologies compared with other industries, rubbing it in with the statistic that a McKinsey index of key sectors, "showed construction was rated just above Agriculture & Hunting..." Ouch.

In fact, more than 60% of the firms operating in Europe and the Middle East were rated as either 'industry following' or 'behind the curve' in terms of technology adoption. "Meaning our sector is still yet to fully reap the productivity and innovation benefits of digital transformation which have been enjoyed by other sectors." But the ICE also reflected that there had been "much debate" about how automation and standardised design would transform the civil engineering profession. That could yet be putting it mildly as some areas of the industry still harbour reservations – and in certain instances rightly - about a frantic charge towards digital.

The institution recognised that there was a balance to be struck between the benefits of automated decision-making and standardised design, and the expertise of the 'human engineer'.

"While data and processes can be standardised, the effective application of information still requires judgement. Time previously spent on process-driven tasks could be applied to the innovation and aesthetics aspects which automation won't deliver." Upskilling staff, particularly in 'soft skills', would be vital to ensure that this human value would be not just retained but maximised in a changing industry.

Nonetheless, the boundaries between engineering, technological and data disciplines will blur, and digital skills development requirements will likely only accelerate over time.

The need for infrastructure to drive productivity

In the case of the UK, the report's focus was particularly on productivity. (The UK scores woefully poorly in this regard, 35% behind Germany and 18% behind the G7 average.) "The UK needs infrastructure that enables productivity and an infrastructure industry that itself is more productive," affirmed the ICE, saying that digital transformation has the capacity to increase the performance of new and existing assets "throughout their whole lifecycle." Among many recommendations the report noted that clients, contractors and Government should be using major infrastructure projects as incubators for skills and innovation. And clients should mandate data interoperability standards throughout the whole programme/project group as part of the procurement process. "Data standards to drive interoperability should be prioritised to make data appropriately accessible and usable across all platforms.

"Improved use of smart technology, data and analytics in the construction and engineering sectors, offers opportunities to address persistent challenges, leveraging previously untapped resources, improving decision making, and reducing resource wastage."

With the right approach the infrastructure sector has the potential to be an attractive industry for data analysts and ICT professionals, believes the ICE. But it needs to recognise the need and value of these skills and ensure they are embedded and not silo-ed.

A future of greater collaboration

More effective knowledge-sharing within and across organisations was also required, concluded the report, suggesting that digital transformation could be an effective tool in curing so called 'Corporate Amnesia'.

"Commercial memory is lost as teams break up toward the end of a project, or when people move on from short term contracts, meaning opportunities to reflect on lessons, which could benefit future projects are missed." A loss for everyone involved, and the civil engineering sector as a whole.

"Going forward, industry will also need to work more collaboratively. This will be driven in part by contracts, alliancing models and use of collaborative information sharing platforms, but also by a need to overcome shared risks and realise long-term outcomes."



THE CASE FOR DIGITAL



Daniel Wallace General Manager, Civil and Environmental, Seequent "

Many industries have established a long-standing way of doing things, almost like an industry culture, where paper-based processes dominate how work is done. Employees trained in a particular way then train the next generation in the same way, and that process becomes entrenched.

Today there are some key opportunities to break that cycle and change how work is done.

First, as a global population we are designing and building more complex projects in locations we might not have attempted previously, prompted perhaps by population growth or scarcity of resources.

Second, technological advancements are providing insights and improved decision-making, as well as efficiencies that are simply not achieve able with pen and paper. It's possible to completely reframe how problems are presented to stakeholders – by telling a story as well as providing an answer.

In this way 'digital' is sometimes as much about organizational transformation as it is about digital transformation, as it's the impact it has on the individuals that do the work.

At Seequent we firmly believe we are enabling that change, and we are passionate about the possibilities our products – and digital transformation as a whole – can bring to the industries we work in. As the ICE report says, Civil Engineering is undoubtedly one of those industries and we see enormous potential there. However we recognise that not every client is ready to embrace every element of digital transformation all at once... But if we can help them make a step-by-step transition, in the areas and pain points that really count in their business, I believe we can drive a 'benign disruption' that everyone will gain from in the long run.

For example...

Improved decision-making. Taking tunnelling as an example, 2D means cross sections of geology but a 3D model means greater understanding of what occurs between the cross sections – and therefore better decisions, for example, on what equipment to use.

Better collaboration with other employees or stakeholders. For example, being able to have de-centralized team members with specialist functions all working on the same project together, using tools that make sense for their work, but in a federated way. Think of an engineering geologist and civil engineer both doing their work in the Cloud where every update they do automatically updates for the other party too.

Greater auditability. A digital record of who did what means, over the course of time, organizations can look back to examine exactly why a particular decision was made, and learn more from it.

Enhanced business benefits. Improved efficiencies in how work is done. Lower risk as a result of greater understanding, and trust (stakeholders are confident that the organisation has a command of the work at hand).

Being able to attract smart, digital-native employees who will identify your organisation as one they want to bring their ideas and innovation to.

When approaching digital transformation, organisations could do a lot worse than asking themselves these classic strategic questions

- What does the landscape look like in (say) 5 years?
- What problems will we be solving then?
- How different will they be compared to today?
- How does digital transformation get us there?

It may sound like the typical consultant approach, but I think it's key to understand the incumbent processes and prioritise, then 'start by starting' (as the expression goes) to begin the journey.

If you don't start you'll never end.



What digital technologies hold promise for the future?

- BIM (Building Information Modelling) is exciting and has made advances for construction. I'm excited about bringing sub-surface ground engineering to BIM.
- AI/ML (Artificial Intelligence/Machine Learning) are obviously exciting too in data-intense industries where sometimes the data is of varying quality, is disparate or incomplete. That kind of technology has the potential to be game changing.
- Also advances in VR/AR (Virtual Reality/Augmented Reality) have obvious benefits for ground engineering and will transform how people understand geology.



In Action

How Leapfrog is contributing to some of the world's most ambitious civil engineering and environmental projects.

The Vest Gate Humel project

in Melbourne, Australia

... is one of the largest diameter bored excavation projects in the world and the biggest ever undertaken in the southern hemisphere. Two huge boring machines will create twin tunnels between the West Gate Freeway and the Maribyrnong River, providing a much needed second river crossing, removing thousands of trucks from residential streets. An exhaustive investigation of the geological risk is underway, led by geotechnical services firms Golder Associates. For the first time Golder has used the ground engineering 3D implicit modelling solution offer by Leapfrog Works to assess geological risk and communicate that to a variety of stakeholders. Construction will begin following ministerial planning approval, expected soon.

The Challenge

\$5.5**B**

The tunnel passes through a complex geological and geomorphological region, and Golder Associates were tasked to undertake an impact assessment for the project.

"This was the first project where we'd used Leapfrog Works and our use has evolved since," said Golder's Principal Geotechnical Engineer, Trevor O'Shannessy. "We started by building the geological model in 2D using a very standard method and then we brought that 2D information into Leapfrog Works to build a 3D model. Going forward we'd start the project in Leapfrog Works."

> The projected cost of the construction of the West Gate tunnel. One of the biggest infrastructure investments in Australia.

The geology

Multiple layers... two different volcanic flows... varying properties, some hard, some wet... different sediments all sandwiched together changing laterally with depth... a former creek converted to a storm drain... sedimentary and igneous deposits from the Cainozoic era.

Critical inputs

Leapfrog's contribution to the project

- Highlighting uncertainty around the Southern Portal
- 3D spoil volume modelling
- Supporting the tender process by providing contractors with interactive 3D models
- 3D modelling of the aquifer geology

15.6m

- Generating 2D geological sections for geotechnical ground movement modelling
- Use as a key communication tool with the client and at the State Government meeting

15.6 metres diameter of the boring machine cutting heads



The problem at the Southern Portal

Looking at the 3D outputs from Leapfrog Works, Golder geologists immediately spotted an issue with a snaking creek that crisscrossed the tunnels as they went under the freeway. "Getting a sense of how those geometries interacted was very difficult in 2D," said Golder's Senior Environmental Engineer Scott Ambridge. "But in Leapfrog's 3D environment we could see much more and determine the risks from a geotechnical point of view." Golder was able to use the Leapfrog Viewer to let contractors see the geological models – even without access to the software – and act accordingly. "The contractors were able to slice through the model, rotate and spin it around, and see where there was greater uncertainty. The successful contractor identified the problem with the Southern Portal and went deeper with their tunnel design to avoid the high-risk areas."

Conditions below the West Gate Freeway

Ground conditions were considered poor here, with greater uncertainty around the potential ground movement magnitude. "We therefore needed to visualise the subsurface conditions and be confident about our interpretation of the subsurface model," explained Trevor O'Shannessy. "As this area was targeted with numerous boreholes during the investigation, Leapfrog provided a good interpolation tool in the 3D space and enabled the construction of a model in a relatively short period. It also allowed us to rotate the model, interrogate it in 3D, and experiment with assumptions such as bed level and upstream/ downstream gradient of the creek incisement."

estimate for the spoil, and also potentially be used for other

200 Number of people engaged investigation of the site, including six drilling crews

1

Cross sections are essential

When linear infrastructure projects are modelled, designed and communicated to stakeholders, cross sections are a key ingredient in that output. They contain a lot of information needed during the construction phase, and are essential to communicate important construction and design elements such as the required hard fill thickness, or the foundation depth for an overpass.

...created hundreds at once?

The user can then batch manage the sections, so that adding data or styles to the master layout will automatically update all the cross sections in the set. Then simply export them all in one easy step for inclusion in client reports.



...but you need a lot of them

The large lateral extent of most linear infrastructure projects means that many such cross sections have to be generated in order for that the information to be communicated effectively, and this information needs to be locatable by the road or rail alignment's chainage.

IN ACTION

Wouldn't it be easier?

For a representative coverage, stakeholders typically require the cross sections to be located at a perpendicular angle to the alignment, at regularly spaced intervals based on the alignment's chainage. As hundreds of cross sections are often required, this can make the process of generating them arduous to say the least.



... if one automated tool...

So for Leapfrog we built an alignment serial section tool to automate the process. It allows users to create hundreds of cross sections perpendicular to the alignment at regular chainage intervals in one easy process. Among other elements you can specify the...

- Line Section start and end
- The chainage spacing
- The width and height of the sections
- The section distance left or above the alignment
- Swap Start, specifying which end of the alignment is used as the "start"
- Start Chainage, specifying the seed chainage (false chainage) at the beginning of the alignment

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TheExperie

Each issue we ask a guest writer at the top of their field to share their unique insights with Unearthed readers.

SUSTAINING SUSTAINABILITY

Dr Mark Wade worked for Royal Dutch/Shell for more than 30 years. He is renowned for the work he did in spearheading the sustainable movement across Shell, establishing a template that would inspire hundreds of companies across the globe.

Unusually he's been involved in all sides of the sustainability mission, from the hardwired elements of governance, processes and reporting to the more human considerations of mindset, change and culture.

We asked him how businesses can maintain the impetus on sustainability, and the challenges – and opportunities – it could bring to the civil engineering and environmental sectors.

Tell us about yourself

"I'm a scientist with a background in biochemistry. I had 30 years' experience in a variety of roles with Royal Dutch/Shell, including being a founder member of the sustainable development group in the corporate centre way back in 1997. We pioneered sustainability reporting and the integration of sustainability across the group.

At the time we didn't realize it, but we were kick-starting the whole corporate sustainability reporting movement.

So how do you define sustainability?

"I still believe the best starting point is the 1987 Brundtland Report that says it's about 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'

"So as a company that means being responsible in the use of resources and in your behaviours with regards to the environment, to the societies in which you operate both locally and globally, and, of course, to the wider economic contribution and fairness that one brings to one's operations.

"We took that fundamental definition and extended it to ask what is the role of business is in society, in terms of the three dimensions of sustainability - the economic, the social and the environmental. How do you integrate these three things without trading them off? How do you treat them as equal considerations in the way you take account of them in your strategy and operations, the markets, and communities you serve? We concluded that this can only come in an authentic way through the individual mindsets and behaviours of the people within your company, and therefore collectively to the culture of the company itself."

Some companies just get it, others seem to struggle?

"Yes, there is a huge spectrum of attitudes. There are companies who do it really well and authentically, and have driven it into their core purpose.

There are those who, to borrow a phrase, just use it like lipstick on a gorilla, as PR.

Then there are those who are either in denial on the need for sustainability or who simply don't care. Let's be honest, there are a lot of companies able to make a huge amount of money in the short term without caring at all, and are therefore off that spectrum altogether.

"But thankfully there are an increasing number of companies -Unilever would be an outstanding example - that really does believe this is fundamental to their strategy. They understand where the world is going, what the needs are for a sustainable world and how they can provide sustainable solutions."

What helps a business get it right?

"It's not just about a CEO saying 'we need to do these things' or making a comforting a statement to the market. It must be embedded as a culture. Everybody in the organisation must be on board with it and live it in all that they do.

"In my experience you need to get the hardwiring right - the governance, the systems, processes, standards, policies, KPIs, reporting, verification...all the stuff that you can write down. That's an important backbone. But ultimately, it's useless unless you combine it in equal measure with the soft-wiring - helping people develop the 'will, thrill, skill' of sustainability as a value and mindset."

Is this something you learned at Shell?

"Yes. We were getting a lot of compliance to begin with, but we weren't really getting a step change in behaviour, which is when I realized that you can't just say: 'do these things'.

You have to give people a deeper motivation, so they understand why it's important to themselves, their jobs and to the organisation."

You've said this is no longer an area where companies can keep their heads below the parapet?

"In today's highly connected, globalised, and internet-driven society, companies have to wake up to the fact that it's a 'no hiding-place world.' Their behaviours need to keep pace with society's changing expectations of what responsible behaviour really represents, or risk the consequences.

And it's more than just a reputational issue. It's actually a deeply important strategic one.

Companies need to address a world with climate change, constrained resources, increasing digital connectivity, growing competition and ever-increasing expectations on the role of business in society."

These are not abstract concepts but daily realities of strategic importance and operational impact.

"Climate change and the unsustainable use of resources is the meta context in which we're all operating"

Climate change is an accelerant of instability. We see this through increasing weather extremes producing floods and droughts, hurricanes, and tidal surges, exacerbated by sea rise. Disasters are occurring on an increasingly regular basis, which in turn is leading to displacement, migration, and social instability. Competition for natural resources, which is happening anyway, is further driven by disasters as people struggle to find reliable sources of water, food, and energy.

Business of all sorts operate in an increasingly volatile world - volatile markets, political and social systems.

With this comes uncertainty and lack of confidence, a challenge for companies to grasp and plan for.

Having said this – this world is also one of huge opportunity for those that can anticipate future needs and be, and be seen to be, the provider of solutions to local and global needs.



How do you mean?

"Well an example would be the way that companies are now very seriously looking at climate change as an influence on markets and their supply chains. The degree of uncertainty and the financial loss that can occur through weather extremes is very definitely keeping CEOs awake at night.

"They are asking 'are we going to have access to the resources we require to extract or make the things we want to? How are we going to adapt to all of this; how are we going to innovate to grasp the opportunities presented by the need for sustainable solutions?"

"Take the UK retailer Marks & Spencer. They are now future proofing their entire value chain – including their own operations, suppliers and now the basic activities of the use of their products by their customers. They recognise that the climate is already changing, and their business needs to be able to cope with extreme weather events. Planning is key to minimising the threats and maximising the opportunities created by evolving climate impacts.

They are working with their supply chain to understand the impact of climate change on the provision of goods and addressing issues of energy, water, and waste efficiency. They are looking at this in terms of avoidance, substitution or compensation measures."

"Having painted something of a black picture, there are, in fact, huge opportunities within this world for those companies that can anticipate future needs and be, and be seen as, providers of the solutions, both at local and global levels.

How do you see that strategic intent relating to the civil engineering sector?

I think the civil engineering and environmental industries are right at the forefront of this.

"Engineering companies may find it more difficult to get investment because of volatility and uncertainty. The social and political uncertainties will make it more difficult to plan and implement projects, such as boring a tunnel between two countries, or putting in infrastructure that governs shared water resources.

"But on the other hand, what fabulous opportunities there are here too! It will be the civil engineering companies who'll provide the mitigating and adapting infrastructure, whether it's sea wall defences, preventing saltwater incursion into aquifers, or energyproofing buildings etc. "They are the ones right at the forefront of being the solution providers. Digital transformation – which I know is an area where Leapfrog Works comes in – helps address the increasing uncertainty and complexity companies are dealing with.

"If data can be turned into information that mitigates uncertainty by providing clarity, then that builds confidence, which creates a much better platform for companies to move forward on. It also provides a 'shared reality' with stakeholders, from investors to engineers through to local communities, that can be used factually in decision-making."

Where does digital transformation fit into the quest for sustainability?

"Those companies that can navigate through uncertainty, instability and complexity, and can innovate with the insights that digital transformation brings them, are the ones that are going to be most successful.

One of the strengths of digital transformation is the role it plays in building resilience into decisionmaking and business models in ways never previously anticipated. "And for civil engineering, I think it holds one particular extra advantage – that of visualisation.

"Many of these projects cut a lot of ground and make a lot of mess; it's difficult for people to envisage the benefits during planning. But if you can visualise the surface effects, what's happening subsurface and see the connectivity between the two as well as what it's going to look like afterwards, then that brings a degree of clarity and objectivity that has never been possible before. People do respond to pictures in technology after all, and it's helpful to have a 'single truth' when you're trying to engage with multiple stakeholders.

"It's not just the technical modelling of extraction or new infrastructure, it's how to communicate that 'single truth' and its relevance to key stakeholders, which will provide the basis for rational decision-making."



Where have you seen that happening in the civil engineering and environmental sectors?

Anglian Water in the UK is a good example. What impressed me was how deeply their conviction ran.

Their institutional backers are committed to sustainability; they have a board that believes in it; their executive suite is driven by it. They have a carbon manager who champions it across the entire organisation.

It is about doing the responsible things but equally it is about saving money, water and energy and building resilience into the business model. These are the elements they try to think about whenever they do anything. "One of the most straightforward examples would be when they dig a trench to lay a pipe in. They have developed a software platform, based on real life cases, that will model the most efficient ways of doing it so they don't move one single bucket of soil more than they have to. Right the way through, from the investors to the guy on the ground with the digger, they are thinking how to save energy and costs and contribute to their carbon reduction targets.

"That's the sort of granularity that the companies can embrace with the right mindset and the right digital tools."

How have you seen corporate attitudes towards sustainability change?

Now there is a much greater understanding of what sustainability is all about. Increasingly, the debate is not about 'how do we give something back' or applying corporate social responsibility as a PR sticking plaster. The conversations now focusses on why it is core to what we do and how we do it. "One of the things that we faced in the late 1990s, when we were intellectualising what sustainability meant to Shell, was the real challenge of balancing short-term priorities with longer-term strategic needs. It is still the issue today and it takes a new quality of leadership to empower people to think and act in a different way.

"It takes real leadership to push back and say we won't just do what's expedient in the next quarter.

"We're actually going to plan a lot longer than that to optimise the net benefit over a longer period, even though that might mean more investment right now.

"It requires very senior leadership to empower, to permit and to support longer-term thinking. It's not something a middle manager can do alone when they are driven by quarterly returns and shortterm KPIs. That's not an enabling environment."

FIVE STAGES OF CORPORATE RESPONSIBILITY ACCORDING TO MARK WADE



Denier

Attitude: "What's it got to do with us? It's not our fault!" Relationships: Contractual. Players: Legal Department. Culture: Act tough.



Attitude: "We'll only do what we have to do!" Relationships: Traditional shareholders and 'those with whom we do business', some stakeholder management. Players: Legal, Government relations, PR. Culture: Minimum standards.



Attitude: "We can leverage this for reducing risk and improving

for reducing risk and improving operational efficiency, and gain some PR & staff goodwill." **Players:** Sustainability experts and senior leadership encourage adoption where there is a clear rapid payback.

Relationships: Stakeholder engagement. Culture: New ways of working.



Innovator

Attitude: "This stuff gives us real competitive advantage right now and its key to our strategy and long term success."

Players: Senior leadership supported by Sustainability champions and Human Resources drive the embedding of sustainability into all functions and throughout supply chain.

Relationships: Strategic partnerships.

Culture: Innovation, empowering and inspiring, 'hearts and minds.'



Attitude: "We must show the way and encourage others to join us/ follow us."

Players: Whole company, inspired and empowered by senior leadership. **Relationships:** Actively seeking new forms of collaboration, supply chains and networks across global commons.

Culture: Core purpose – it's the how, what and why of all we do.

Where is your organisation?

What challenges does your company face in getting to the next level? How do can you equip your leaders and future leaders to embrace sustainability and lead the transition?

Fix This

Here's what the industry tells us are their biggest geological modelling pain points – and what we've come up with to fix them.

WHY IS EVERYTHING ALWAYS IN A DIFFERENT FORMAT?

THE CHALLENGE

DATA INTEROPERABILITY

For those working in ground engineering or environmental sciences, there's a need to perform detailed technical design and analysis of specific problems and their solutions, and share it with others on the site or project.

The pain point

Each stage of the workflow will require its own software package, and that invariably leads to a plethora of incompatible formats.

Ground investigations, topological surveys, GIS, engineering designs, geological and geotechnical models... each will have its own variation, because every specialist area has its particular outcome to achieve, and that will shape the data format.

The impact

It can make progressing from step to step difficult, costly and frustrating. Technical experts can waste valuable time manipulating data - sometimes manually, sometimes through multiple software packages – risking data loss along the way.

The resolution

Works aims to break down those barriers to data interoperability by supporting industry standard formats and focusing on end-to-end workflow, not just modelling.

The case study

For example, before Leapfrog brought in AGS data and gINT support, clients like Motts would have needed to spend time setting up macros to pull multiple Excel outputs together, and stitch them into a format that could be consumed by us as a borehole database. Now we read the format they get from their subcontractors directly – and a massive pain point is removed.

How we do it

- Works offers direct support of ground investigation data standards like the Association of Geotechnical and Geoenvironmental Specialists (AGS) and widely used ground investigation databases like gINT from Bentley.
- Works also supports standard engineering design formats like Drawing eXchange (DXF) and AutoCAD Drawing (DWG) from Autodesk
- That means detailed tunnel, motorway earthworks, bridge, dam and building foundation designs can be bought into the context of the ground model and visualised by everyone on the project.
- With View one of our latest features that even means they can be shared directly, with everyone, via a web browser.



BUT WHICH OF THESE VERSIONS AM I WORKING TO?

THE CHALLENGE

VERSION CONTROL

New data will often change the prognosis of a project, sometimes significantly. How can you ensure everyone involved knows there's a new interpretation and is working from the right one?



The pain point

Version management can be just as complex a process as wrestling with data interoperability – and might carry more risk. There's the danger that separate teams are pushing ahead, but with outdated models. Perhaps the ground engineer is working from the wrong version of an engineering design? Maybe a road alignment, cut slope or retaining design has been changed due to a recalculation of safety margins, costs, or public consultation?

The impact

As the construction progresses, how can you ensure that what you discover updates the model of what's coming up on the next phase of excavation? How can you be confident you have the latest authorised version of the engineering design when that might be produced by another office, or even another company altogether? If you design something based on the wrong information, and perhaps order incorrect materials, the impacts could be cost overruns, scheduling hits or expensive machinery sitting unused.

The resolution

Leapfrog Central easily and accurately keeps track of every model published, and all the elements that have gone into it. Because Leapfrog models are dynamically linked, they are easy to maintain and refine over the lifecycle of a project. Central's audit trail and full version history lets you manage your experimental models vs approved models, and control access at the right level for different members of the project team.

The case study

IC Group will be using Leapfrog Central during the construction phase of the upcoming Vienna subway expansion to manage the delivery of all their geotechnical elements to the project team. The project is for the extension of Vienna's U2 and U5 lines which will help close a major gap in the inner city network, and prepare the city for a population expect to grow to more than two million by 2030.

How we do it

- Cloud-based Central project repositories mean your published projects are backed up and available from anywhere in the world, at anytime.
- Central maintains a comprehensive project history that shows how the model has changed over time and lets you branch the model and manage updates on different branches. Its visualisation capability lets you step through 3D scenes of the model over time so you can see progress and decisions made.
- Central works with your organisation's processes, colour coding the project's stages to mirror its various phases. Project-based permissions give you flexibility of control around who can see which permutation of the model. You'll have the confidence and control to send an experimental interpretation for review with internal experts, or formally publish an approved update to the project team.
- Collaboration is key to project success and annotations let users collaborate around the central model across companies or geographical locations. They can include information that helps build a complete picture or point out features that require further investigation.



WE NEED TO DO EVERYTHING FASTER

THE CHALLENGE

TIME

Projects with long lifespans may be years in development - but not every undertaking has that luxury.

The pain point

Fast turnaround projects can need rapid iteration of models to meet construction deadlines. The pressure will be on to develop multiple hypotheses from the data you have, often in a very short space of time. That won't be helped by using software not truly designed, ground-up, for building geological models – the sort of software that can only do the job with the support of a series of plug-ins.

The impact

Those plug-ins can be slow, difficult to use, and may actually be tools co-opted from another industry altogether and not intended for the 'artform' of geological modelling. When new data comes in – as it will, frequently – it may takes days, even weeks to update the geology. Meanwhile the project is already underway, and costing money.

The resolution

Leapfrog was built to cater to the needs of geologists, honouring data from multiple sources, while allowing the flexibility to add interpretation and form a model into a realistic representation. Importantly it's also based on a data hierarchy, which means that as new data is added or updated, the entire model downstream will adjust to account for the changes – a huge advantage over having to manually update every entity within the system.

The case study

PJ Hollenbeck, Leapfrog expert. (PJ covers a wide range of roles, including product manager, senior technical services representative, and technical sales.)

"One of my first mining projects was to design a relatively simple vein; but simple or not, it took me a week to digitize (poorly) in a general mining package. I was able to get a comparable result out of Leapfrog within about 10 minutes. My first reaction was 'damn that was awesome!'. My second was 'Arrgh. What's this going to do to my billable hours???'

"As it turned out, my billable hours didn't go away, because I was able to spend that additional week's time refining my model into something fantastic, incorporating additional data (surface mapping, faulting, etc.) that would have been difficult or impossible to do by hand modelling.

"Likewise, I could quickly generate multiple models to test different scenarios. Is there a fault here? What happens if I split the vein at this spot where it gets oddly wide? And I could still do that in less time than it took to make one rough first-pass model manually!"

How we do it

- Implicit Modelling reduces the time to get to a first pass product by automatically connecting the dots from input data. This brings the days or weeks required to handdigitise polygons for a first pass model down to – literally - seconds.
- Once the initial surface or volume is generated, it is now up to the geologist to sculpt and form that shape into something that is geologically reasonable while still honouring all of the input data. With Leapfrog this is typically done in **full 3D space** rather than in crosssectional view. This allows the entire model to be considered at once rather than small portions within the cross-section.
- Multiple modelling approaches or hypotheses can be considered by simply making multiple surfaces to represent the same geologic unit. These surfaces can be compared with one another and with the overall system, and the best surface will be used for the final volume calculations.

Or you could always...

INSPIRING USES FOR LEAPFROG, #1

Peering into the past of life on earth

Dr Ferhat Kaya from Helsinki University is a vertebrate paleontologist and is using Leapfrog to research the distribution of mammals in the distant past. Dr Kaya contacted us to reveal he had performed a Leapfrog 3D block diagram to see spatial and temporal distribution of mammal faunas during 'deep time'.

His research revolved around studying the fossilized teeth of extinct mammals alive two to 23 million years ago. Once the data on size was isolated, he imported it, along with maps and study area information, into Leapfrog Geo, and was able to see a 3D representation of how high and low crowned teeth specimens related to arid and open or humid and forest conditions.

"Some of these extinct mammals were the ancestors of today's extant mammals species like rhinos, elephants, antelopes, primates, buffalos, wildebeests... etc." The research will help to understand how, when, and where these mammal communities adapted to their environments.

"I submitted one of my latest works to the Nature Ecology & Evolution journal, and we are very close to getting published. Keeping finger crossed!"

MY FANTASY PROJECT The Bering Strait Crossing



Aaron Hollingsworth

"I remember first hearing about this on a tv show when I was a kid and I've always remembered it ever since. It's a 'hypothetical' link between Alaska and Russia – effectively joining East and West. It's been a proposal for years, so who knows if it will ever happen.

"It would involve significant tunneling and bridges spanning the ocean to link the two continents – an incredible and admirable concept. I admire the impressive amount of logistical and engineering work that would be needed to make it happen, considering the remote location on either side of the strait. On top of this, it would need to overcome the unique complications such a location would give rise to - like geological issues, climate conditions, and environmental impact on the local ecology, such as the Pacific walrus. The viability of such a project also remains to be proven. But it's such a cool idea!"

THE BACKGROUND

"

Cost

In 2011 the Kremlin supposedly "approved" a £60bn 65mile Bering Strait tunnel that would pass beneath the Big Diomede and Little Diomede islands, straddling the international dateline and linking Uelen in Russia with Nome in Alaska. No word on whether any work has started. It also remains to be seen if the benefit of such a project would ultimately outweigh the costs.

History

In the west the concept was first voiced in 1892 by Joseph Strauss (project engineer of the Golden Gate Bridge). In the east Tsar Nicholas II approved a then \$65m dollar bridge in 1905. There have been a variety of different proposals ever since, variously named The Intercontinental Peace Bridge and the Eurasia-America Transport Link. Nothing has ever come of them.

Technical challenges

The water is not the problem. The relatively shallow continental shelf in the region is typically less that 50m below sea level, and the currents are manageable. However the cold is a major issue. The temperature can drop to minus 50 and winters are long and dark. Exposed steel and concrete would need to be enormously tough to resist the weather, not to mention the stresses from the constant motion of ice floes at certain times of the year, all of which would need to be accounted for in the designs. And the varied nature of the geology in the Bering Strait presents its own technical challenges. It includes a range of sedimentary, metamorphic, and igneous rock, with faulting present across the Bering Strait region.

Aaron Hollingsworth is Customer Solutions Specialist for Seequent and was previously a geotechnical and geo environmental engineer.

Most likes about Leapfrog: "The ability to quickly and easily bring together and visualise the subsurface and its technical parameters, be it the lithology or geotechnical testing data. You can look at and manipulate the 3D models and make sense of the situation. And it's always interesting."

WHAT THE BERING STRAIT CROSSING COULD MAKE POSSIBLE...





If you have feedback, questions or any thoughts on what you'd like us to cover in future editions, please contact:

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