Discussion paper on implementation of an overarching authority to improve sustainability in transport mega-projects

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Abstract

To facilitate the cost burden of mega-transport projects, elected governments have traditionally staged projects, contracting each stage as a new award. While this method spreads the cost loading over multiple federal and state budgets, it ultimately brings a higher total cost burden on the tax-payer. The current limited or delayed knowledge sharing, particularly between overlapping road and rail projects results in significant unwarranted additional site investigation, while construction access is often duplicated as a risk-mitigation measure. This paper delves into considerations we as an industry can promote to improve sustainability in construction. As an industry we could eliminate around 90% of intrusive site investigation in the major cities by simply having all data and models be controlled by an overarching authority. Building Information Modelling (BIM) is gaining huge traction to express the surficial and underground architecture of our cities, but currently poorly reflects the outstanding 3D geological and geotechnical models that have been developed through mega-transport projects completed to date. Digital twins are in development for Melbourne, but not publicly available for Sydney at this time. Further, the present staged approach to mega-project development results in significant site investigation, design and construction duplication to avoid subsequent stages having to take ownership of risk. By adopting an over-arching authority, who sign-off on both design and construction, this risk issue would be mitigated, and significant costs and time delays avoided.

Keywords: sustainability, site investigations, geological models

1.0 Introduction

Transport Mega-Projects are complex systems with many interacting parts and parties. While all parts and parties should interact, historically, particularly in Sydney, projects are delivered in isolation, with the formation of silos harbouring data unto themselves. This isn't something individual professionals want to see, but predominantly an outcome of contracts focused on risk mitigation and how funding is distributed.

Risk intolerance or risk aversion is a huge part of why transport mega-projects have low sustainability, particularly with respect to geotechnics, site investigations and design. There are multiple "cooks" in the mega-project kitchen but no singular cook is willing to take on the risk associated with taking over "someone else's" borehole log, let alone a complete design or construction package, not even the asset owner. Yet, to improve sustainability outcomes, there needs to be a mechanism for easy, quick sharing of information between projects and someone needs to accept responsibility. Development of an overarching authority (perhaps a government – technical society partnership) would help this. It would certainly position the Australian geotechnical industry at the forefront of attempts to achieve the United Nations (UN) 17 Sustainable Development Goals (SDGs) which the UN aimed to have actioned by 2030 (United Nations Development Programme, 2023).

Sydney Metro is leading the data sharing mentality with soil and rock logs, laboratory tests and other digital data available from the Sydney Metro West project freely accessible on MinView (Geoscience NSW, 2023) ahead of project completion, but other consortium's are not as generous.

This is a discussion paper drawing on the authors experiences and observations on how we as an industry are failing the public and the tax payer (and therefore ultimately ourselves) by continuing to develop these mega projects in a less than optimally sustainable manner. Yes, the required improvements needed to make our transport mega-projects more sustainable requires government buy-in, but that won't happen unless we, the do-ers make our voices heard.

2.0 Current Practice

In Australia's major cities, the current practice is for transport mega-projects to be sub-divided into smaller "stages". These smaller work packages enable the governments in office (often state level) a means for successful, manageable delivery – adhering to limitations in the state budget and shorter turn-around times. This presents favourable optics that the government in power is seen to be delivering on previous election promises to meet future infrastructure demand (co-incidentally right around election time). Cynical point of view? Perhaps. But who hasn't had a project cancelled mid-tender or worse, due to change in government or budget constraints? The authors first transport mega-project, the Parramatta Rail Link, became the Epping to Chatswood Rail Link mid-construction back in 2004-05. The trains have never made it past the stub tunnels at Epping now nearly 20 years on.

Joint ventures (JV) are used as no singular entity in the Australian market has the capacity to design and construct projects even at the reduced staged size on their own. While this ensures each project stage is able to access the appropriate technically skilled personnel, it does present a new challenge – how to deal with risk. The current mechanism is for each stage of a project to effectively "meet in the middle" – a typically underground reference boundary either side of which one JV is responsible. However, both parties need to access this underground boundary somehow and therein lies the need to either accept the risk and responsibility of an asset designed and constructed by another team or build your own access. Current project scopes and contracts favour the latter.

2.1 Case in Point - WestConnex

Take WestConnex for example. The St Peter's Interchange is a network of surface roadways that resemble a starfish, but below the ground, it is the place where the mainline tunnels connect the M8 to the M4-M8 link. However, both the M8 stage and the M4-M8 stage, developed by two differing JVs had to design, construct and in the case of the M8, back-fill their own access tunnels to reach the same point underground. Some 5km of tunnelling was completed to form access tunnels when only about 1.5km would have been required, had the risk of using tunnels design and constructed by the first JV been acceptable to the subsequent JV. However, it wasn't the individual JV's to blame. Despite both stages of the project development being part of WestConnex, the JV's were simply following their scope of works and contract requirements. Consideration of sustainability within the wider project does not appear to have been front of mind.

3.0 Delays in knowledge sharing

We are in a world where to fit these transport mega-projects into the increasingly constrained and congested underground environment we are pushing new frontiers on technical design and construction. With that comes risk – risk that if something does go wrong it could go really wrong, and there always needs to be someone to be held accountable. While we can play happy little joint venture families during the design and construct phases, we also live in a highly litigious world, so project directors and the asset owners are hesitant to allow publication of knowledge developed on their projects until after public commissioning. Even with the necessity to sign non-disclosure and probity agreements, this also infiltrates to projects refusing to allow adjacent mega-projects being given access to their collected data (drilling logs, core photographs, mapping records) until after project completion.

3.1 Drilling data

Every transport mega-project involves drilling. It's the primary form of data collection to inform the subsurface conditions. Within urban areas, it can be difficult to undertake due to the constraints of the urban environment - underground services, overhead power lines, people's properties being inconveniently located right where you need to drill, for example. There is low public tolerance to seeing drill rigs in their local streets – no one wants the cab of a drill rig being one metre from their kitchen window (yes it happens).

So surely, if all boreholes being drilled are being logged to Australian Standards (AS1726-2017), and logs are provided to the asset owner in the required Association of Geotechnical & Geoenvironmental Specialists (AGS) format, the logs can be considered reliable and able to be shared, thereby potentially reducing the amount of required drilling by a significant degree? And surely these logs can be shared shortly after drilling and appropriate internal project quality checks, rather than waiting for a project to be completed to avoid risk and litigation issues?

Dr David Och undertook his Churchill Fellowship (Och, 2019) to understand how other nations are collectively sharing geotechnical and other logging data and present methodologies for doing similar here in Australia. Implementing these internationally recognised and successfully operated systems would surely only benefit Australia's mega-projects and the government bottom-line, and significantly improve project sustainability while also providing a positive means to respond to the drastic shortage we presently have with finding drilling rigs and personnel for use in our cities and the geological personnel to staff them.

Dr Och's key recommendations were:

1. Government involvement was needed to "assess the viability and economic benefits of capturing, processing, and dissemination of historical and current ground investigation in association with regional geological datasets to support infrastructure planning and development" and work with professional bodies to steer the appropriate course for database establishment and management.
2. Legislation changes are needed to ensure a national standardised reporting approach, boreholes are registered and data is included in a repository.
3. Mandate of broad baseline standard service briefs and guidelines for data formats and establish who are the custodians for information.
4. That it will be a two-stage process – "combine and integrate geological and geotechnical data from historical projects and……integration of new factual data obtained from the private sector, ……without recourse to the originators".

3.2 3D Models

Building Information Modelling (BIM) is gaining huge traction to provide flashy, appealing ways to showcase the key infrastructure projects, both above and below the ground to the community. It also assists JV teams to visualise current progress of site investigations and construction progress. However, the outstanding 3D geological modelling work being completed for these projects are rarely included.

These models are typically developed during the design phases of most of our mega-projects. However, only some end up having the contractual requirement to update the model with the as-built, factual mapping data; though all are required to have each new tunnel face exposure mapped and the factual data collated.

The inclusion of a 3D model is recommended but not necessarily mandated by contract requirements either. The author is aware of one major project designed in the last 5 years that still only produced a 2D long section due to the misconception that linear infrastructure projects can't be modelled in 3D.

Where the models do exist, it is difficult to understand why these models have not been merged one larger model for a city – geological digital twins exist for Melbourne (Leapfrog Works, 2018), for cities in New Zealand (following the 2011 Christchurch earthquake) and the practice in London is to collect all drilling data in a national repository as well as continuously update the city's 3D model.

The available 3D modelling software packages all have robust export capabilities that would enable integration of individual models into whatever system/program was ultimately adopted. Further, the implicit modelling functions of such programs could allow the models to be suitably merged at the project interfaces.

The significant costs associated with tendering could be substantially reduced and the site investigations tailored to gap filling exercises if data sharing between projects became normalised.

4.0 Way Forward

Why a central authority?

To put it simply – because we, as an industry, don't like to share. We don't want to give data to others which may see them win a project we are also bidding for. It's human nature to keep critical information to oneself for one's own advantage.

We need to be better than that, and in that sense Sydney Metro is leading the way. However, it's a lone entity in NSW doing the altruistic thing at the moment. So, how would a centralised authority to collect and maintain data work? How to we ensure projects include scope (and funding) to handover standardised data sets at regular intervals?

The data element is the simplest concept to grasp. It's factual and can be standardised. Collection of logs and core photographs is occurring globally – Dr Och's Fellowship is a 101 page testimony to this. Actioning Dr Och's recommendations for a core data repository is plausible – at either a state or national level. Yes, historic data may need converting to current standards, perhaps even to metric. But do we, as an industry intend on being proactive in finding sustainable ways to continue developing infrastructure in our major cities like London or will we wait for a national emergency to implement a unified plan like New Zealand. Should we look at adopting the working groups mechanisms of the International Tunnelling Association (ITA) to move such plans forward?

My interest however, most definitely lies with the 3D geological models. Who verifies, merges and updates the 3D geological models developed for each project? Do we need purely factual 3D models (boreholes in 3D space, tunnel and other mapping only) and separate interpretive mega-models?

Collation of factual mapping data into a 3D model is, in concept, something that also shouldn't be too difficult to achieve. The tunnel mapping is there for all of these projects, and for many smaller ones too – like the numerous networks of sewer tunnels that traverse the city. But who funds collating and validating this historic work and how is the harder question.

How we deliver a merged 3D interpretive model for a city is more challenging. After all, if you ask five geologists for their opinion, you'll likely get six or more answers. Does this become a task for the state geological surveys, with the models to be updated just as the Surveys 2D maps are?

The ITA Working Group 22 – Information Modelling in Tunnelling document BIM in Tunnelling – Guideline for Bored Tunnels -Vol 1 (Karlovsek, et al., 2022) discusses inclusion of geomodelling within a project BIM and recognises separation of factual from interpretive modelling may be required. To keep the BIM package less technically exhausting (and therefore more widely used) the ITA suggests inclusion of simpler geological models of borehole data and interpretive features like lithological boundaries. This is a different scope for geo-model inclusion in accessible means to what we need with a fully developed geological digital twin to fast-track tendering processes and reduce overall site investigation demands. However, taking that working group experience and applying it to merging of project scale geo models and how to deal with the various complexities between projects has merits.

The data collected for the WestConnex project has unearthed, literally, so much additional understanding of the structural geology south of Sydney Harbour that the loss of this data into personal hard drives or hard copy reports is unconscionable. The Sydney Metro and Western Harbour Tunnel projects criss-cross the WestConnex network, further filling the gaps in the overall understanding and demonstrating Sydney is far more geologically complex than previously thought. We can't just simply hope our already stretched and overworked key project personnel have the self-drive (and personal time) to publish this data. Waiting for publication also won't help current or future projects.

The Western Sydney Metro design phase post-dates the construction and public hand over of WestConnex M4 tunnelling, yet the time to receive mapping data from the M4 was so long, it was faster to undertake intrusive site investigation than wait.

Smaller projects would benefit from active collation and sharing of data and models. The need to drill for a basement excavation may be able to be reduced. Likewise having basement drilling (and excavation data) in a 3D model could be a huge advantage to mega-projects. Understanding of water recharge at one significant deep tunnel project was hampered by knowing nearby deep basements were present, having an idea from the data that at least one of them must be pumping water out of their basement regularly causing local recharge but not having a means to accurately understand exactly where and when it would occur.

Our current practices aren't sustainable. For our cities, our residents and most definitely for the limited personnel who work this space every day.

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