House of Representatives Committees Submission
10 July 2015

LAING O'ROURKE

Standing Committee on Infrastructure and Communications

Inquiry into the role of Smart ICT in the design and planning of infrastructure

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1. EXECUTIVE SUMMARY

Laing O'Rourke believes Digital Engineering, a combination of people, process and technology, has the ability to transform the way in which Infrastructure is planned, delivered and operated.

Digital Engineering is an all-embracing field that captures traditional Building Information Modelling (BIM), Geographic Information Systems (GIS) and associated information and knowledge. It is much more than just data, or the application of visual models.

Laing O'Rourke has long invested in a digital approach to delivering infrastructure and has refined our approach over time, with experience on some of the world's largest and most complex infrastructure and building projects.

As Australia's largest privately-owned construction and engineering company we have demonstrated the benefits in using technology to deliver:

- the necessary information to efficiently procure, operate and maximise the value of an infrastructure asset over its entire life
- increased confidence in contractors' understanding of the complex build process and associated risks of major infrastructure works
- Clearer line of sight over project performance, during planning, design, construction and eventual operation.

As a delivery contractor we believe Digital Engineering and associated technology in the infrastructure market provides:

- an increased predictability of project outcome (in terms of safety, design, cost, programme and quality) – that is, certainty for clients and the community,
- Improved understanding and management of key risks and interfaces; and therefore
- Better value for money for Governments and the taxpayer.

We believe increased use of smart ICT in the infrastructure sector further drives combined benefit through:

- a collaborative approach; and
- improved stakeholder engagement.

For an overview of the benefits of smart ICT in infrastructure through advanced digital engineering, click the image (left) or go to http://bit.ly1CsD7vK

2. LAING O'ROURKE

Laing O'Rourke is an A$7 billion global construction company dedicated to engineering excellence. With operations in Australia for more than 50 years, Laing O'Rourke delivers building construction, railway services, materials handling, marine and civil infrastructure and a range of support services to clients in the oil and gas, resources, transport, defence, health, commercial and industrial sectors.

Laing O'Rourke is a pioneer in design innovation. We were rated in the top ten construction companies worldwide by Construction Global for 2014, and rated the number 8 most innovative Australian business in 2014 across all business sectors by Business Review Weekly (BRW).

We own and implement advanced Digital Engineering (DE) authoring applications for engineering design, design management and construction planning across all markets in which we operate, with integrated, data-rich DE models that consultants and project teams use to manage efficient and timely project delivery, with exceptional quality and safety standards.

3. OUR VIEW ON DIGITAL ENGINEERING

We use the term Digital Engineering to encompass several different technologies and systems to create a technology-based asset for use in infrastructure development:

- Geographic information systems (GIS) (ArcGIS, SiteMap) – 2D or 3D tools, primarily used to organise, manage, and visualise geographic data, typically environmental, cadastral, and alignments;
- String-based systems (MX, 12D, Civil 3D) – 2D or 3D tools, primarily used for the design and management of linear projects or components, such as roads and rail; and
- Object-based systems (Revit, ArchiCAD, Tekla, Digital Project, Microstation) – 3D tools, primarily used in structures and complex projects where attributes are required.

Laing O'Rourke does not mandate a specific system as we prefer to be flexible to work with the requirements of our clients and the ability to choose the best system dependant on the project requirements.

We hold licences of many major software and – like our colleagues in the buildingSMART organisation – we firmly believe in the principles of Open BIM and neutral data format.

Laing O'Rourke believes the greatest efficiency for public infrastructure can be gained through system integration, collaborative working, underpinned by supportive contractual arrangements.

From this central data asset, further benefits like project visualisations, augmented reality walkthroughs and visual construction sequences, can then leveraged by the deliverers, owners and stakeholders.

3.1 How to drive value and certainty from Digital Engineering

No one technology can provide complete project-wide functionality for differing project types and values. That's why Laing O'Rourke uses a combination of DE systems and provides integration of digital project controls and asset packages – programme or schedule (4D), cost (5D), sustainability (6D), and asset management (7D) – to create a comprehensive federated Digital Environment, containing all the information required to deliver the project.

It is this integration of 3D with programme and cost controls, at a minimum, that maximises the value of DE to the client on a

major infrastructure project, as one of the most severe risks to delivery of infrastructure is linked to scope or program (therefore, cost and time) creep.

Laing O'Rourke has experienced the changes in the operating environment in the UK that have come from mandated BIM controls, or a benchmarked, compulsory entry-level Digital Engineering. In working within the PAS1192 standards produced by the UK Government for public sector projects, we believe these conditions offer clients increased value when procuring and delivering projects.

Clear Employees Information Requirements (EIRs), that specify which information will be transferred, to whom and at what time, drive greater efficiency through the planning and delivery of a project, because of the intense focus on the specific data that offers most benefit to the customer or asset owner.

The improved use of ICT in the delivery of infrastructure will, over time, see clients and asset owners value the development of digital engineering features over the entire life of the project – from the earliest conceptual planning phase. A single-stage handover of a limited BIM model at the completion of a project (while becoming a standard, commoditised deliverable for many projects and contractors) fails to embrace the wider value-for-money and certainty opportunities that integrated digital engineering brings. In addition, it does little to foster a collaborative approach from all members of the supply chain, which is the pathway to the delivery of better, more holistic infrastructure in the longer term.

3.2 Opportunities of enhanced ICT standards on the supply chain

Digital Engineering offers an opportunity to remove traditional information 'hand-over' points where information is often discarded and then re-created by other parties – such as from client to designer, from architect to constructor, or from constructor to asset manager.

Instead, a digital engineering process relies on the early engagement of all parties, and the proper scoping of the project by the supply chain to respond to the client's digital requirements. This provides a continual building of rich data throughout the project, and an improved overall product for the asset owner – particularly important for long term asset holders.

For example, on Laing O'Rourke's delivery of the $900 million Moorebank Units Relocation project in Sydney's south-west, our digital records will assist Defence estate to manage the facilities, many of which will have a lifespan of at least the next 50 years.

On many of our public infrastructure projects, such as the Sydney Light Rail Enabling Works and the Wickham Transport Interchange in Newcastle, the capability of design partners to work in this manner is crucial to the overall success of the project. If all parties cannot work in this way, it generates gaps in the data, which makes co-ordination and clash detection in 3D impossible.

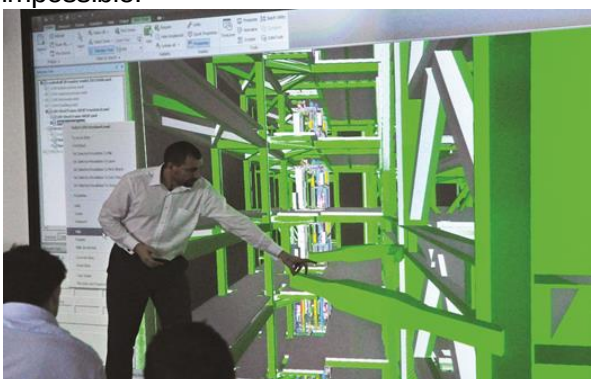


Figure 1 Design coordination meeting around the project's digital model

4. NEW CAPABILITIES SMART ICT (AND INTEGRATED DIGITAL ENGINEERING) WILL PROVIDE

4.1 Project controls

Integrated digital engineering can allow enhanced visualisation of project control data, creating easily understandable and actionable information that would normally be hidden in Gantt charts and Excel databases.

This means potential issues are identified early, permitting corrective intervention before they can materially impact project cost or schedule. Some examples of DE enabled project controls are shown below (Figure 2). We have widely used project controls linked to the Digital Engineering model on the Wickham Transport Interchange Project in NSW to demonstrate

In addition, such detailed and flexible reviews of information can be developed to allow safety procedures and challenges to be highlighted and communicated to the workforce, improving preparation and governance of high-risk tasks.

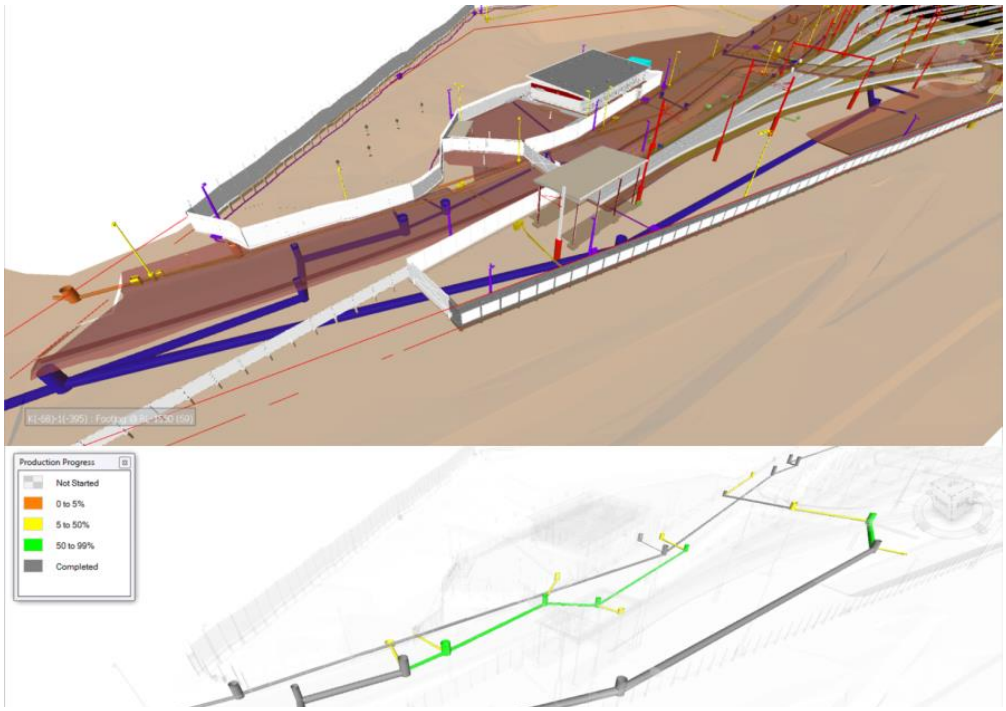


Figure 2 The DE model linked to programme gives a visual display of the complex Gantt chart programme in 3D. Below drainage on a rail project is colour coded automatically, demonstrating project controls information when integrated with a planning software.

possession sequences that provide a much wider delivery understanding for the workforce. We also used visual project controls outputs at contract review on the New Generation Rolling Stock project in south-east Queensland to ensure a common understanding of key delivery risks across the whole team.

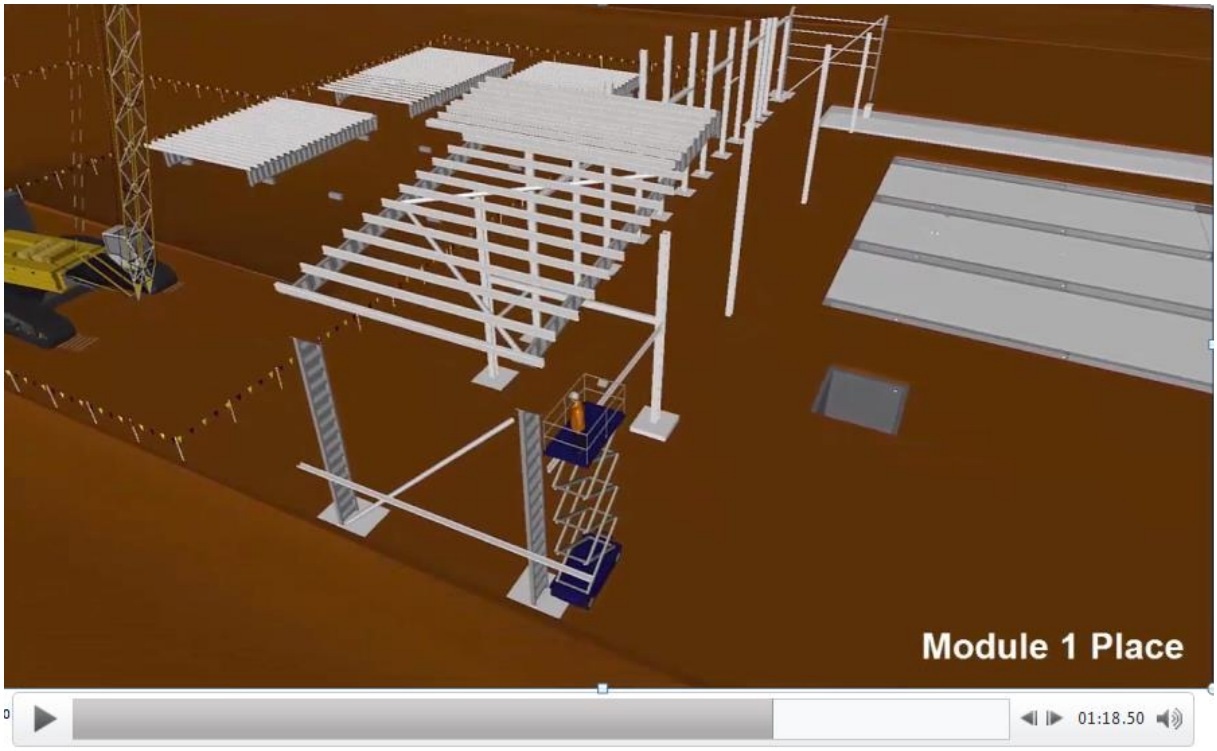


Figure 3: Movie showing the detailed sequence of work for staff induction

4.2 Macro-project overview

The entire project can also be visualised at a macro level to show the status of all work packages, either by one contractor or as an interface management tool when multiple contractors are at work.

An increasing level of detail, that can 'drill down' to even show individual nuts and bolts, is already possible on work packages managed using an integrated DE platform.

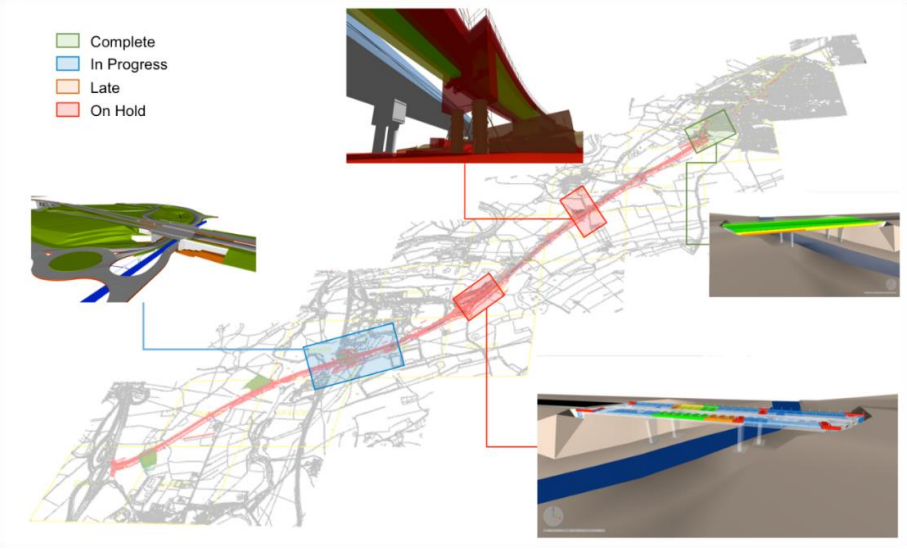


Figure 4 Macro project overview tools

4.3 Tracking and managing permits

Permit tracking and management in a digital engineering environment allows for automated flagging of upcoming permit expiration or renewal.

This allows the delivery partner to ensure all works are being performed according to approved guidelines and procedures of governance and reference groups. Such information can also be used to tag community notification when specific packages of sensitive work are reached, or completed.

4.4 Delivery status

Integrated DE models clearly articulate (by heat mapping) the current status of works.

This can be automatically displayed by any project control metric, such as schedule, cost, procurement status, or approvals status. The current design phases and works schedules for a bridge structure are shown below:

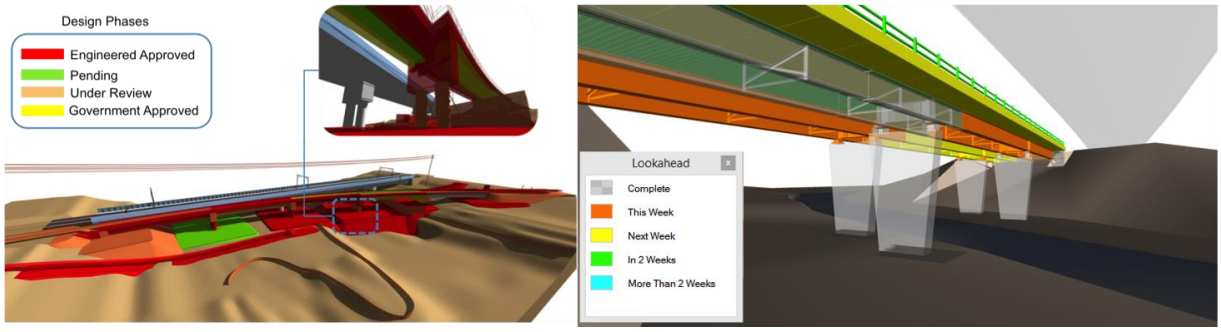


Figure 5 Status review mapped in a DE environment

4.5 Quantification and scope clarity

DE can be used in earthworks quantification, for progress tracking and ensuring that predicted volumes are being achieved from transport and cut and fill operations. In practice, this has allowed Laing O'Rourke to predict potential material deficiencies before they occur, allowing alternative strategies or supplies to be identified.

Further, this data can be linked with, and audited against, payments to earthworks contractors.

Laing O'Rourke has been using advanced digital models linked to structured bills of quantity such as the Civil Engineering Method of Measurement (CESMM4, UK) on major infrastructure projects since 2010.

Projects where we have adopted a DE approach to quantification include the Northern Line Extension of the London Underground, Custom House Station for UK Crossrail and Liverpool Street Station.

Structured and industry compliant quantification outputs linked to the information generated from the model provide increased accuracy and transparency to the client and contractor. This approach highlights potential scope gaps when packaging work for tender by the supply chain, and therefore reduces risks in the delivery of the project.

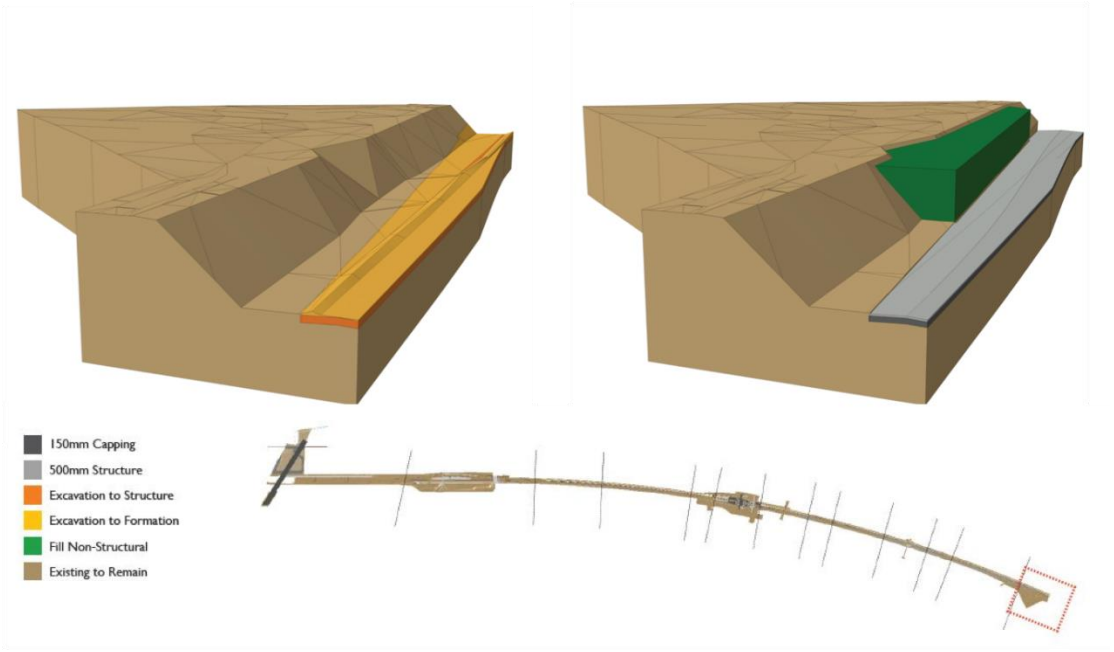


Figure 6 Material quantification and prediction

4.6 Materials tracking

One of the emerging benefits for smart ICT in infrastructure delivery is the location and status of any materials and equipment required for the project. These can be monitored using barcode and Radio Frequency Identification (RFID) technology, which is automatically updated and displayed in the models.

Laing O'Rourke has used materials tracking technology on the Cape Lambert Phase B project for Rio Tinto to successfully link the status of tracked modularised fabricated steel platforms from overseas to their eventual installation Western Australia against a live link to the model. This allowed the site team to understand delivery status of elements in a clear visual manner through the DE model.

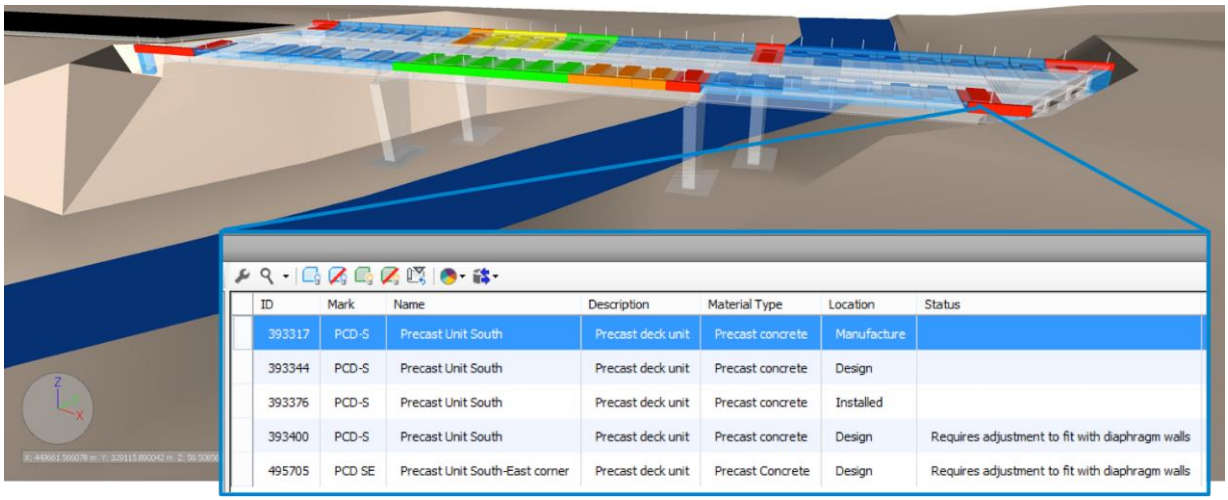


Figure 7 Materials tracking with status displayed in the model

Figure 8 The tracked components can be monitored all the way to installation in connection with the digital model

4.7 Buildability review

Laing O'Rourke use integrated digital technology for buildability audits on key risk areas, such as automated clash detection and proposed sequencing, to determine their effects on overall program cost and schedule, and therefore reducing risk and driving greater predictability.

On our Port Botany Terminal 3 project in Sydney, Laing O'Rourke uplifted the provided 2D drawings into a full digital model at detailed design phase, which led to the detection of more than 1000 services clashes, which were all resolved prior to the start of delivery.

On the Sydney Light Rail Early Works project, advanced digital engineering was used to map a spaghetti-like network of in-ground installations to enable careful planning, before any excavation of the critical George Street CBD corridor was carried out. As a result, key intersections were closed, cut up, repaired and reopened in tightly scheduled overnight sequences, minimising traffic and pedestrian impacts and ensuring a 'no surprises' result for the client.

This embodies our approach to "building twice, once virtually" where a proactive and positive approach to risk is provided. This has led us to working closely with our supply chain to ensure their design is provided in a 3D format. Furthermore, to reduce risk, Laing O'Rourke now mandates a digital engineering and smart ICT requirement in all its tenders and projects within Australasia.

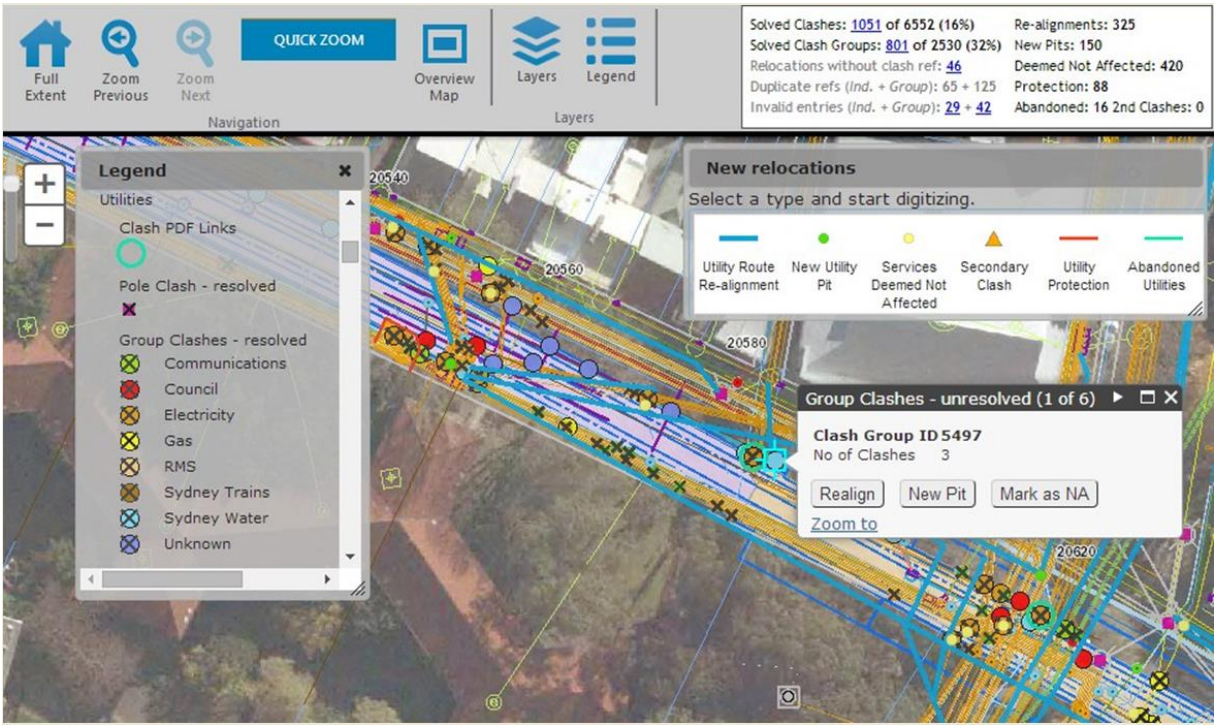


Figure 9 Automated clash detection

4.8 Productivity in delivery

To increase efficiency onsite Laing O'Rourke is using digital workpacks, which are an online and mobile collection of all digital data related to the project, mapped out in specific work sequences for the construction crews to follow. These are also shared with the client, so all members of the team know who is doing what, how, at any given time – and progress can be clearly mapped and monitored.

Electronic versions of drawings, quality and assurance records, safe method statements and specifications are held in the workpacks, allowing site engineering teams to plan, construct and hand-over discreet packages of work in the field.

This information is available in a digital format on a tablet computer, improving accessibility to accurate information and reducing the possibility of mistakes through decisions being made on the basis of a superseded printed document or a saved file stored on a static drive.

This is particularly effective on large, remote projects. Our Wheatstone LNG civil works project in remote Western Australia has implemented workpacks across the delivery phase, recording outstanding levels of productivity.

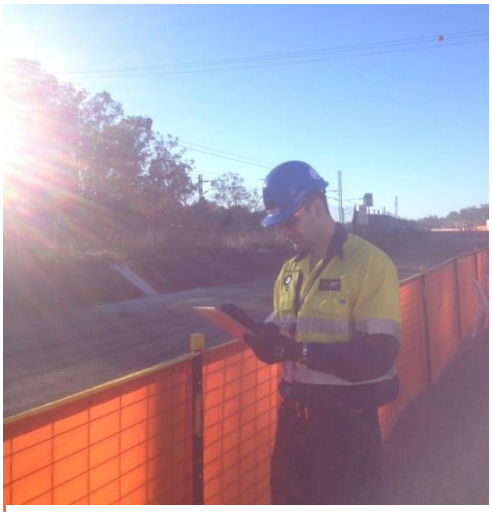
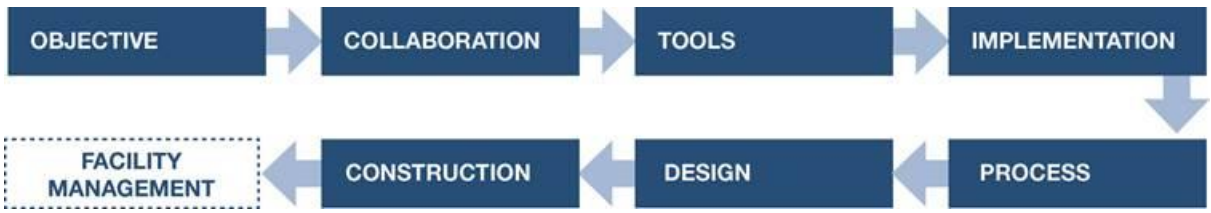


Figure 10 QA/QC being carried out in the field on a tablet, through use of a 'digital workpack'

Figure 11 Having a dedicated DE station in the site office will ensure all team members and sub-contractors can interrogate the model at any time

4.9 Asset Management opportunities



The building of a digital asset during a project can offer a valuable insight into design information such as installers, date of installation, key decision points, optimization decisions and outturn costs linked to the model interface.

In the UK Laing O'Rourke has provided the client on Europe's largest science and research facility with a highly detailed asset management model linked to handover data, such as air pressure tests and detailed product information.

We believe major infrastructure clients and emergency services will benefit from this accessibility to key data when operating the facility, or if called to major buildings for emergency events.

Our Australian business has evaluated multiple software options, such as Ecodomus and WEBFM that can provide enhanced asset management data that links directly to the as-built model.

5. ASSOCIATED AND SPECIALIST BENEFITS

From an accurate and complete central digital assets the ability to leverage associated and often non-technical outputs at low cost is a major benefit to asset owners and operators.

On a train stabling facility project in Queensland, Laing O'Rourke's DE model has been used to demonstrate to train drivers, who will use the complex, how they will go about their daily routines in a virtual 3D environment before construction is complete.

This has allowed the capture of crucial end-user comments, which would have not been elicited by 2D drawings, to influence design and provide a more user friendly and practical facility.

Figure 12 Signal Sighting using the confederated DE Model

Signal sight-lines for train drivers have also been tested using the DE model, creating a far more efficient process in the pre-delivery environment.

5.1 Visualisation

Visualisation is BIM output which is well understood in the industry, however, as we look to the future of smart ICT in the infrastructure sector, we should ensure that visualisation is a leveraged output from the central DE model.

Figure 13 Wickham Transport Interchange high-resolution renders, direct from the DE model

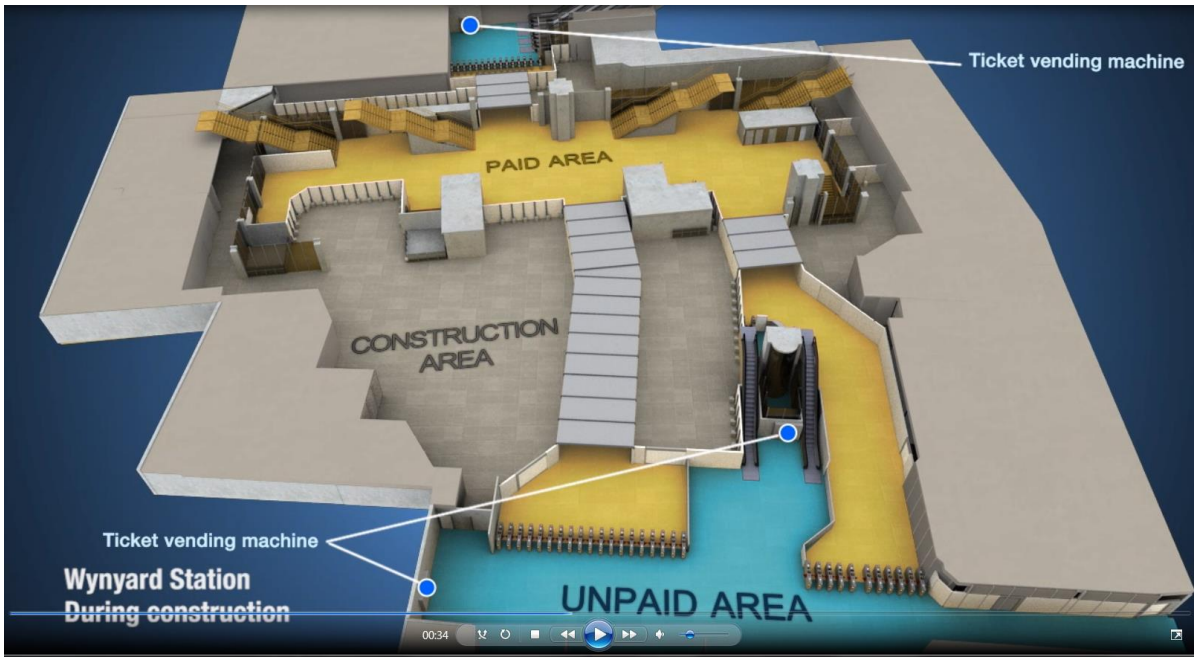


Figure 14 Wynyard Station public facing construction sequence movie

Visualisations should be true to the design and be built directly from the digital engineering model, allowing it to be explored, modified, viewed from all angles, and tested against a range of criteria.

While many clients demand a high-resolution, rendered digital flythrough of their project – this is not the same.

There is strong client benefit from DE visualisations supported by the 3D model, and Laing O'Rourke has recently worked with Transport for NSW to provide visualisations on the Wickham Transport Interchange Project and a movie for commuters of the staging sequence of the refurbishment of Wynyard Station. Both of these use the central DE model as a base, which increases efficiency, ensures the plans are factual and transparent, and reduces the cost and resourcing of re-work.

5.2 Augmented Reality and Immersive technology

Stakeholder engagement through augmented and digital technology on infrastructure projects will one day be a smart ICT feature that will be an expectation of client and community alike. We are currently using augmented reality on public infrastructure works in a trial of Smart Hoardings, where the public can use a tablet or smartphone with a Laing O'Rourke App to "look behind the safety barrier" and see real time updates on the project, construction progress, time-lapse or images of the finished structure, or other key information.

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Figure 15 Immersive and augmented reality at Laing O'Rourke

We have used Oculus immersive technology on Wickham Transport Interchange and on our Hong Kong underground metro infrastructure, to allow internal and external stakeholders to "walk around" the project and to interact with the design model.

As with visualisations, these not created independently, but are leveraged outputs from the creation of one central digital model.

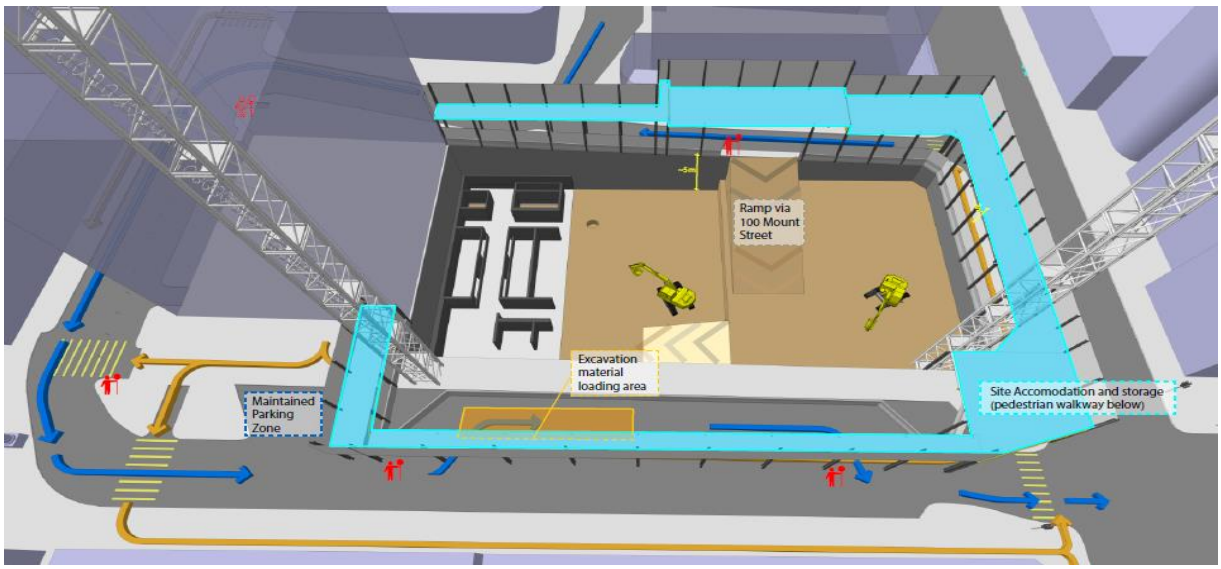

Figure 16 To ensure minimal disruption to the public, integrated traffic management and logistics plans help communicate to the entire team designated construction traffic routes, materials laydown, waste storage, site access etc.

6. CONCLUSION

Integrated digital engineering combines GIS and 3D tools with electronic schedules, cost, sustainability, and asset management data.

It is an emerging but extremely powerful smart ICT tool to centralise data and convert it into rapidly actionable information, reducing risk and uncertainty around the delivery of infrastructure projects.

Its value has been widely recognised in design, construction, and operation of projects around the world, and is consequently being adopted on the majority of complex mega infrastructure projects. It is more than just data, to successfully implement a Digital Engineering Approach the right people, process and technology have got to be bought to the fore.

Unfortunately, not all digital engineering resources or applications are created equal. There is a wide gap between best practice and emerging technologies in this space, and minimum-level low cost digital outputs that are patchy across the supply chain.

Our belief is that an integrated digital asset, that builds through the life of a project from its first conception through design, tendering, construction planning, delivery, commissioning, handover and operations is the necessary future for the efficient and innovative construction of the built environment. The tools are currently available, however broader understanding, transparency and collaboration are required to put them to work effectively in the best interests of the supply chain, contractors, clients, governments and stakeholders alike.

> "We at the Department of Transport and Main Roads have been impressed by [the team's] approach to project delivery using their innovative digital engineering capabilities.
>
> It is evident that these technologies have driven enhanced value through optimised design, improved the construction coordination between parties, provided the platform for more efficient stakeholders' engagement, and improved collaboration right through into operations and maintenance.
>
> As a result we consider that the project is now an exemplar for the use of digital engineering in Queensland, and a key contributing factor in making the project a showcase for the ... G20 summit."
>
> **Paul Setchell**
> Maintenance Facility Program Manager
> New Generation Rolling stock Project
> Queensland Department of Transport and Main Roads

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