Preparing for Transpower's BIM future

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1 Introduction

Transpower, in conjunction with Beca, as its BIM consultant, and other supply chain partners, has been looking at how BIM could deliver benefits across its supply chain through the design, construction and operation of built assets. This paper explores the approach we have taken to learning about the net benefits of BIM for Transpower by running a series of pilot projects.

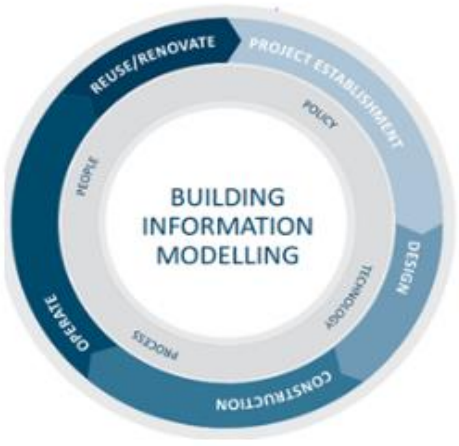
2 What is BIM and why do we care?

Building Information Modelling (BIM) is the process of designing, building, maintaining and operating built assets using well-structured digital information (associated with 3D graphical models) that multiple stakeholders contribute to, and, have access to. The creation, integration and sharing of quality information is at the heart of BIM. BIM involves the sharing and re-using of well managed information across the asset lifecycle and has the potential to deliver significant efficiencies across value chains.

Benefits include better stakeholder engagement and co-ordination, better access to and reuse of asset data, reducing design issues prior to construction, optimising in project timeframes, lower whole of life costs and improvements to safety.

For example, the 3D models created for BIM enables the use of a virtual reality environment and a very different type of early contractor involvement and collaboration between design, project, and engineering teams, and service providers. This enables all parties to consider safety, constructability and operability with a different level of spatial awareness than can be achieved through traditional 2D drawings.

BIM is not any single act or process. It is not creating a 3D model in isolation from others or utilising computer-based fabrication. It requires an awareness of the information needs of others as you undertake your part of the process of designing, procuring, building or maintaining built assets. Successful BIM implementation relies on the ability understand the current business processes and information flows within Transpower and across the supply chain. Ultimately, BIM is about creating interoperable data sets which can be modelled and viewed to suit tailored business needs of multiple users.



Operating in a BIM setting requires Transpower and all other parties across our supply chain to collaborate and share the information they create in a mutually accessible online space – a common data environment (CDE). The collection of data in the CDE becomes the 'information model' which is then available to inform all stages and all aspects of a built asset's lifecycle, from inception right through to operation and renewal (or decommissioning).

The term digital engineering is sometimes used almost interchangeably with BIM. For example, Transport for New South Wales are pursuing a digital engineering strategy which they describe as "*Digital Engineering (DE) connects emerging technologies with reliable structured data. It enables more collaborative and productive methods of project delivery and management of assets through the lifecycle compared to those traditionally utilised. By 'building our assets twice' first virtually and then physically, DE has the power to provide valuable insights, create efficiencies and deliver cost savings to every decision we make.".* This paper uses the term BIM, but the term BIM could be substituted with the term DE.

Within the power industry the adoption and use of BIM, and the technologies it enables, has been limited despite the potential to deliver significant benefits. Interest in BIM within the power sector is however picking up and in other jurisdictions some regulators are promoting or requiring a move to BIM ways of work. In New Zealand other vertical infrastructure providers such as transport and water[1], along with some councils and building owners, are investing in BIM.

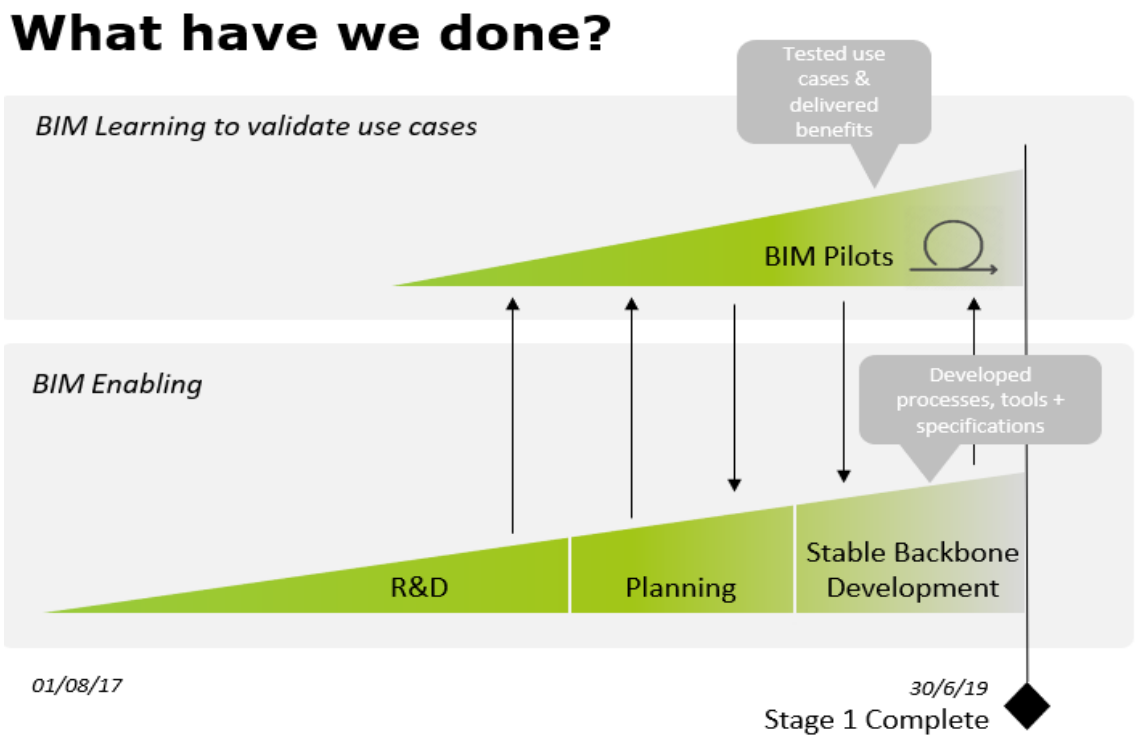
Rapid changes in technology, climate change policy, climate change itself and changing customer expectations are coming. We understand the direction of change, but not the specifics, which means we need to be ready for a variety of possible futures. Transpower's ability to be delivery focused, agile and customer responsive will be integral to meeting these future challenges. BIM or DE are likely to be key factors in our capability uplift and ability to respond at speed to changing demands. We will need good information to hand to be able to make quality decisions fast and be able to use digital technology to enable more efficient asset delivery and operation.

3 What have we done?

Stage 1 of Transpower's BIM project has focused on learning as much as possible about the net benefits and opportunities from BIM to enable the development of a BIM strategy and roadmap.

We started with the premise that BIM ways of working create significant realisable benefits from cost and time savings, discovery and early resolution of issues, improved safety outcomes and stronger, more transparent relationships with our suppliers. The project has focused on identifying and piloting use cases that will deliver immediate and tangible business benefits in the Transpower environment.

[1] New Zealand Transport Authority, Watercare, Kiwirail, Hamilton City Council and Auckland Airport



The proofs of concepts and pilot projects are informing and testing different BIM use cases and exploring the application of BIM to different asset classes. The outcomes of the pilots have informed our next steps and we expect to continue with the approach of developing proof of costs, progressing to piloting use cases and then moving to production. The table below briefly describes the pilot projects we have undertaken to date.

Pilot project	Learning Objective	Status
Kinleith substation redevelopment	Understand potential for use BIM modelling to support asset registration Test the feasibility of using BIM models and robotic total station to support site set out.	BIM models can be used to capture asset data, we have not yet built the necessary integrations to automatically update Maximo. Successful pilot, looking to move to production 19/20 year for projects using BIM. See below.
Melling – creation of brownfield site model	Understand the cost of creating brownfield site models and required Level of Development/Detail to support uses of the model. Identify and understand use cases for brownfield site models	Numerous use cases identified. Brownfield models to be developed to support project design. Learning from the creation of the Melling model has informed the development of our modelling standard.

Pilot project	Learning Objective	Status
BIM model of ODID portable building	Understand the value of creating a BIM model of an asset such as the portable building for reuse in future designs and project work.	Pilot is 'in flight'.
Parametric model of standard 66 kV VT foundations	Understand the feasibility and value of creating parametric models to represent design standards	Model is currently being reviewed but initial indications are positive. See below. Expectation is that a number of commonly used standards will be converted to models.
Lines 'exploration'	Numerous BIM lines cases have been identified. Lines exploration documented and investigated current design processes. Initial work suggested many of the use cases could be delivered by making better use of existing tools and data sets.	Work to better align data sets in Maximo, PLS CAD and GIS before further exploring BIM application for lines assets.

The remainder of this section describes two BIM use cases that we anticipate being used and further developed and moved into production in the coming 12 months – the use of robotic total stations for site set out in conjunction with a BIM model and the development of 'intelligent' parametric design standards.

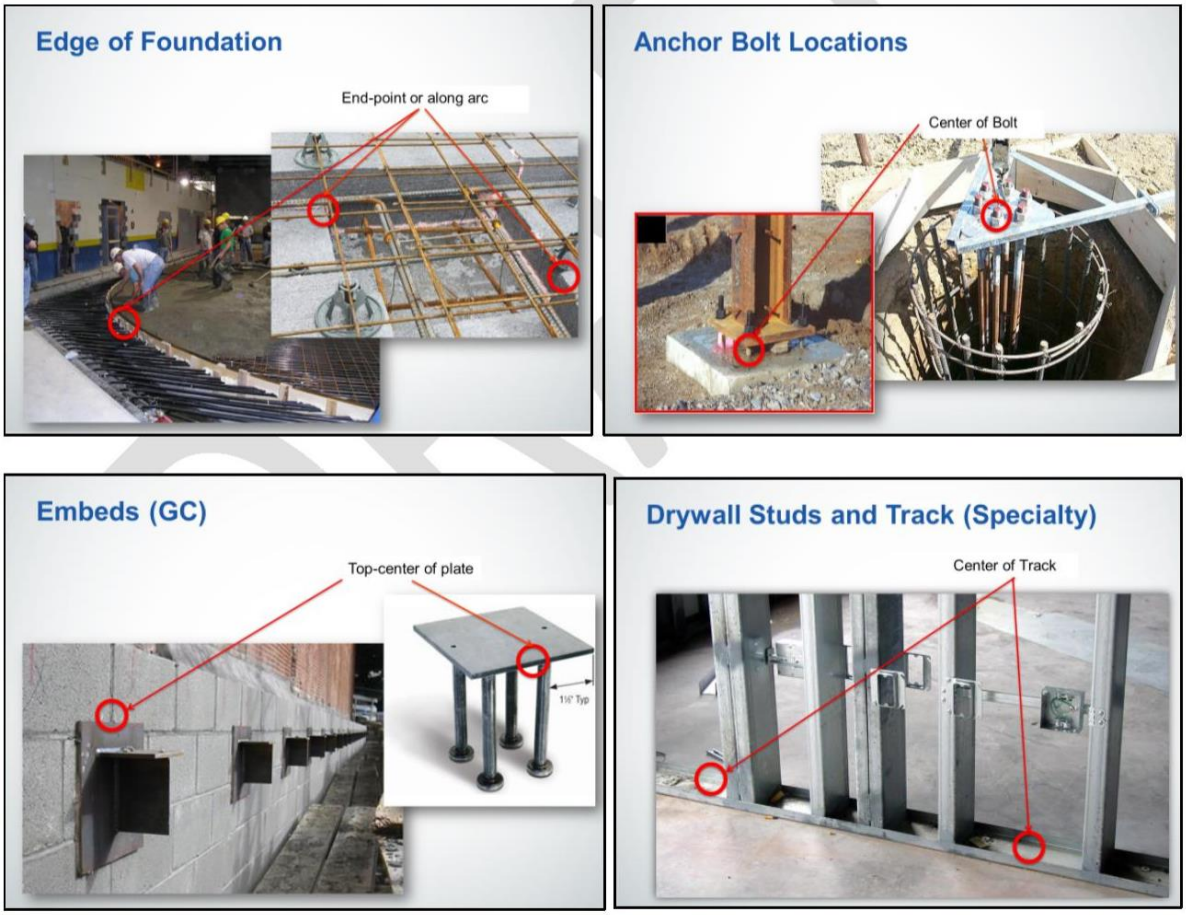
3.1 Kinleith substation redevelopment – BIM model to enable robotic site set out

The use of robotic total station hardware during construction in combination with a BIM model allows for accurate set out of construction works including foundations, ducts and anchor bolts based on data obtained directly from a BIM design model. Surveyed information is directly incorporated into the BIM model to support the return of accurate as-built BIM models. Mobility tools and the sharing of models, also allows for almost real time communication and problem resolution between field staff and engineering consultants who may be off site.

The pilot we have run as part of the Kinleith substation redevelopment project has shown benefits include greater construction accuracy, reduced rework, improved construction efficiency, improved as built record keeping and improved supply chain collaboration.

Examples of the type of works suitable for set-out using BIM are shown below in Figure 1.

Figure 1 - Construction Works Suitable for Site Set-out



The technology selected to undertake site set out for Kinleith using BIM models is shown in Table 1 below and is split between software and hardware.

Table 1 – Kinleith BIM Site Set-out Technology

Software	Description
Autodesk Revit, AutoCAD and/or Navisworks	Development of the detailed foundation 3D design model, used Revit software as it supports other BIM features for architectural, building services and structural engineering.
Autodesk Point Layout	Inclusion of specific geometric points to inform site set-out process
Autodesk BIM 360 Glue\Layout	Software application which facilitates the interaction between the 3D model on a tablet and the robotic total station
Hardware	**Description**
Portable Tablet	Allows portable display of the 3D model on site. The current BIM 360 Layout application is compatible with Apple iOS operating platform. A new version of the BIM 360 Layout application is due for release at

Software	Description
	the end of 2019 and has been developed to be compatible with Android operating system only.
Robotic total station	Survey grade total station with the ability to communicate with BIM 360 Layout (connected via WIFI and/or Bluetooth) and a surveying prism which is tracked using a laser to provide a known location on site.

The above working solution gives contractors access to a coordinated real-time 3D model in the field via their cloud-connected smart devices. The software, e.g. AutoCAD, Revit and Navisworks, permits the engineering consultant to upload models with specific layout points directly onto the tablets of the field staff working remotely.

Connecting the BIM model viewed at site on a portable tablet to a robotic total station enables site staff to locate and crosscheck other point locations on site itself with respect to the component they are building. Cloud connectivity improves co-ordination between design and construction teams by allowing contractors to better communicate site differences back to designers (who may be off site) for quick resolution. Where changes are required updated models can be made available instantaneously to all team members resulting in reduced down time, enhanced accuracy in the field and the avoidance of potential issues further down the construction programme. It also enables real-time model navigation which enhances the performance of other project functions such as quality assurance and as-built collection on the job site.

3.1.2 What we have learnt

From the outset the BIM project has assumed the management of change would be key to the successful implementation of BIM solutions. The site set out pilot confirmed this assumption. The original onsite demonstration of the site set out technology was carefully planned and we were able to demonstrate to a reasonably sceptical contracting team the potential benefits of using the technology. If the demonstration had failed it would have been difficult to build enough confidence to run a live pilot.

Time to train new personnel and provision of responsive technical support at site should not be underestimated. Without real time support to trouble shoot it is easy for small challenges to become show stoppers.

3.2 BIM VT Foundation Pilot (Standard Design)

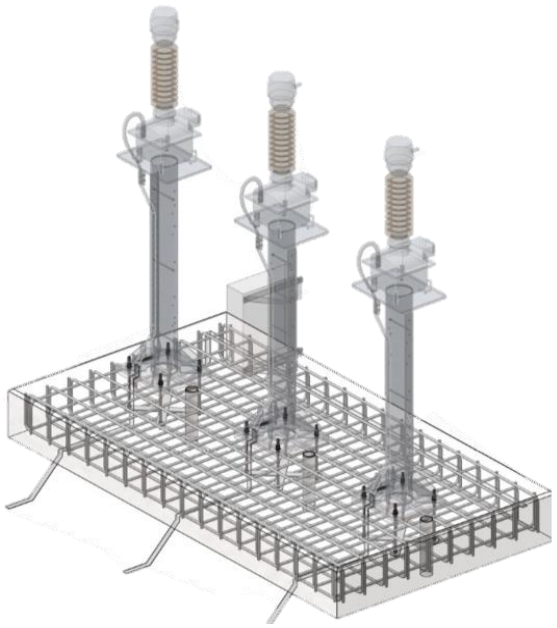
Transpower manages a set of standard foundation designs for various primary equipment such as Circuit Breakers, Current Transformers, Voltage Transformers, and Bus Supports. These designs are utilised by engineering consultants and service providers as the basis of design for many projects.

While these designs have been produced using a historically typical engineering and drafting approach, through our investigation into the use of BIM, we had the opportunity to improve the designs to provide greater benefits through design and construction. The table below outlines the differences between the current CAD and proposed BIM approaches:

Current CAD Approach	Proposed BIM Approach	Benefits of BIM vs CAD
▪ Modelled/drawn in AutoCAD	▪ Modelled/drawn in BIM compatible Revit	▪ Improved visualisation for designer/key stakeholders early in the project life to inform design reviews and decisions
▪ Base design model in 3D, with many details such as rebar, ducts, earth strap etc drawn as 2D overlay.	▪ Design fully modelled in 3D.	▪ Single source of truth through the design and construction stages ▪ Avoids potential errors associated with switching between 2D and 3D designs
▪ Design generally caters for worst case scenario i.e. Heaviest possible piece of equipment plus a margin	▪ BIM Model is parametrical driven – I.e. The design changes based on design parameters (Seismic Zone, Equipment Weight, Hold Down Bolt Spacing etc.)	▪ Produces be-spoke designs to meet requirements of the proposed installation which reduces construction cost and programme
▪ In some cases, dimensions are hard coded, meaning some dimensional changes to the 3D model may not be reflect in the corresponding drawing	▪ All dimensions are driven directly from the BIM model	▪ More accurate designs produced reducing misinterpretation of drawings and construction errors on site
▪ The current standard designs do not provide/detail a Bill of Materials (BOM)	▪ BOM can be generated from model, with rebar details now added to the drawing.	▪ Reduced time required for tendering/estimation process due to additional BOM info ▪ Improves accuracy of cost estimating for new projects
▪ No support for construction set out	▪ BIM model will include predefined set out points that, when used on a project, can be used with a robotic total station by Service Providers to facilitate set out of foundations	▪ Reduction in construction time for establishing site grid co-ordinates and set-out activities ▪ Facilitates accurate as-building of services during the construction phase

3.2.1 What we have learnt

The initial parametric design for the 66 kV foundations has been created and is currently being peer reviewed. Initial indications are that the model has a number of improvements over the current standard design approach. These include potential reduction in material by up to 55% (and the associated reduction in environmental impact), reduction in construction costs, reduction through the 'semi-automation' of design documentation, the creation of a rebar schedules (not previously included in standards) improving procurement and supporting 'prefabrication', and the basis of a digital library object that can be utilised in BIM models going forward.



4 Transpower's BIM 'stable backbone'

Along with piloting BIM use cases we have identified what we are calling the BIM 'stable backbone'. The idea of the stable backbone is that to support a consistent approach to BIM and the creation of reusable information assets there are processes, standards, information, technology etc which need to be relatively stable and used across the supply chain to support the development of consistent. The table below shows some of the artefacts we are developing and work with the supply chain to refine over time.

Stable backbone elements	Value
3D/BIM modelling specifications	Modelling standards will enable consistency and compatibility between models created by different suppliers and models generated in project design and in a brownfield substation environment.
Digital object specifications	To support the creation of a digital object library and consistency and compatibility between digital objects created by different suppliers.
Point cloud modelling standards	Point cloud modelling forms part of standard design practice but there are no point cloud modelling standards in place to make sure that there is consistency in how point cloud data is generated.
Supply chain recommendation on model software authoring tools	Existing software limitations make interoperability between models authored using different toolsets challenging. Transpower is therefore likely to recommend a closed approach to BIM authoring tools. In time, as technology improves, and interoperability issues are resolved it is likely that a transition to an open BIM approach would be favoured.

Stable backbone elements	Value
Level of Development Specifications	Level of Development refers to the level of detailing, information and geospatial accuracy required for BIM objects within a model and will enable a consistent approach to modelling
Asset data standards	Existing asset data standards have largely been designed to support Maximo functionality. Over time we will move to asset data standards based on the Common Information Model (CIM) which will span the asset life cycle and enable interoperability of data sets between systems. Usability is also a growing focus.
BIM execution planning procedures – version 1	BIM execution planning procedures describe the processes followed to deliver projects (design, procurement and construction) in a BIM way. The BIM procedures are being designed to complement our existing Investigation-Delivery Project Framework.
BIM documentation – version 1	BIM procedures are supported by templated documentation which provides a standardised way of communicating and working with the supply chain.

5 Where to next?

The BIM pilot projects have confirmed there are significant benefits available from a staged BIM implementation. We also know that working with BIM tools and approaches involves changing some of what we do and how we do it both for Transpower people and the supply chain. Effectively adopting BIM ways of working requires a planned and managed approach. Ongoing benefits and change management is important.

For now, Transpower's focus will be on capturing the BIM benefits available during design and construction while at the same time ensuring that projects deliver quality information to support the asset lifecycle and the development of our information assets (e.g. re-useable design models, site BIM models and a digital object library). Our approach will be to use BIM tools and ways of working for those projects which we can confidently say will benefit from a BIM approach. We are looking forward to continuing to work with our supply chain on the opportunities offered by BIM ways of working.

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