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New Project Management Models:

Productivity Improvement for Infrastructure

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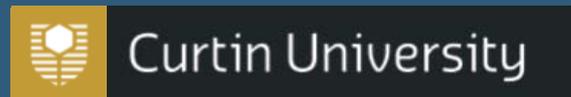
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We look forward to your converting the results of this applied research project into tangible outcomes and working together in leading the transformation of our industry to a new era of enhanced business practices, safety and innovation.

John V McCarthy AO
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New Project Management Means and Methods to Improve Productivity for Infrastructure

This research examined new approaches to the construction and maintenance of infrastructure to identify models for improving productivity. Existing solutions were identified across two categories: vertical and horizontal infrastructure. New models are proposed for three phases: Design, Construction and Asset Management.

Vertical Infrastructure

Vertical infrastructure describes built environment and infrastructure assets that are suitable for object-oriented design. These typically are local and rise vertically, having the property of a location breakdown into discrete sub-divisions, such as floors, rooms, sections. Buildings and bridges are considered vertical infrastructure.

Construction Management—LBS/WBS Matrix

Inefficiency arises in both the planning and management phases of construction because managers devote considerable effort to controlling excessive repetitive location-based data. Utilisation of an LBS/WBS matrix for construction projects, along with suitable project models and management strategies, aims to systematically improve vertical infrastructure project data management efficiency.

Design Management—BIM

Currently BIM-enabled design management is not always available to all design groups for construction of vertical infrastructure projects, slowing the pace of industry-wide productivity improvement. However, at the individual project level, identification of incompatible fixed 3d objects (clash detection) in a working model supports effective project progress.

Asset Management—COBie

It is recommended that data be organised and exchanged between construction and asset management through the use of *Construction to Operations Building Information Exchange* (COBie).

Horizontal Infrastructure

Horizontal infrastructure describes built environment and infrastructure assets that are suitable for string-based design. These typically are linear elements with alignment as the principle feature, having the property of a location breakdown into continuous centre lines, such as road lines, chainage or networks. Road and rail lines are considered horizontal infrastructure.

Construction Management—LBM

For distributed networks of projects, it is inefficient to plan works without protecting the in-use service of existing networks because sequential service interruptions may also reduce the efficiency of the whole network. The recommendation is to consider proximity as a priority factor for managing works projects. Physical proximity is required to optimise resource use for each project, but within an operating network, service efficiency must also be considered.

Design Management—BIM: IFC Alignment

The lack of accurate interoperability between string-based design and object-based design is a major obstacle to universally accepted IFC. IFC was initially developed specifically for vertical infrastructure. The proposed IFC Alignment extends IFC to include input from the Open Geospatial Consortium which is designed to support global rather than merely local geographic coordinates and levels.

Asset Management—CONie

It is recommended that a new model for Construction to Operations Network Information Exchange (CONie) be developed.

Four identified opportunities

1. Role for a location-based matrix applied to reduce data duplication within management systems for vertical construction projects.
2. The potential for IFC Alignment to support BIM interoperability in horizontal infrastructure.
3. Service focused network asset management operations based on both service and physical proximity.
4. CONie: structured means and methods for gathering and exchanging asset management information between projects and network operations.

Executive Summary

This research focused on identification of project management issues that could provide opportunities for productivity improvement during the construction of both vertical and horizontal infrastructure.

This report summarises the outcomes of the *New Project Management Models for Productivity Improvement in Infrastructure*. SBEnrc Project 2.21 Position Papers and links are listed at the end of this report.

Industry need

Construction productivity has been a continuing concern for industry since the early 1990s; yet demonstrable productivity improvement has proven elusive. In contrast, other major industries have achieved a doubling of their productivity over the same period. The construction industry clearly needs new methods that deliver productivity improvements. As with all innovation, often ground-breaking ideas need new technologies to progress before becoming industry standard. It is timely in the current environment of disruptive digital technologies (the Internet, mobile devices and cloud storage) to reassess both the fundamentals of project management and their supporting data modelling structures.

Opportunities for data management improvement arise within both vertical and horizontal construction. Project management models to some extent dictate project data structures and re-visioning could lead to breakthrough change. Similarly, smoother transition between digital model views and data needs will improve lifecycle management of horizontal infrastructure.

Research partners

For this study, 50 project management professionals were interviewed to find out about their experiences of data handling bottlenecks. The industry sample includes national and international professionals; 54% have been in the industry more than 20 years and 40% average 15 years of experience. The majority of the Australian based professionals have experience with both vertical and horizontal infrastructure projects working with all levels of government using a variety of delivery modes.

Project outcomes

This research identified major issues and proposes solutions to manage and model data for infrastructure construction projects and distributed networks. Problems for vertical structures (buildings or bridges) require solutions with excessive repetition of location/zone data in existing management systems. Problems effecting horizontal infrastructure (roads & rail) require solutions that provide for inclusion in the BIM data transfer environment and new tools to implement service-based asset management.

This report sets out the findings of the research from three perspectives: Construction Management, Design Management and Asset Management, because project management structures and data are usually interpreted with a single functional outcome imperative.
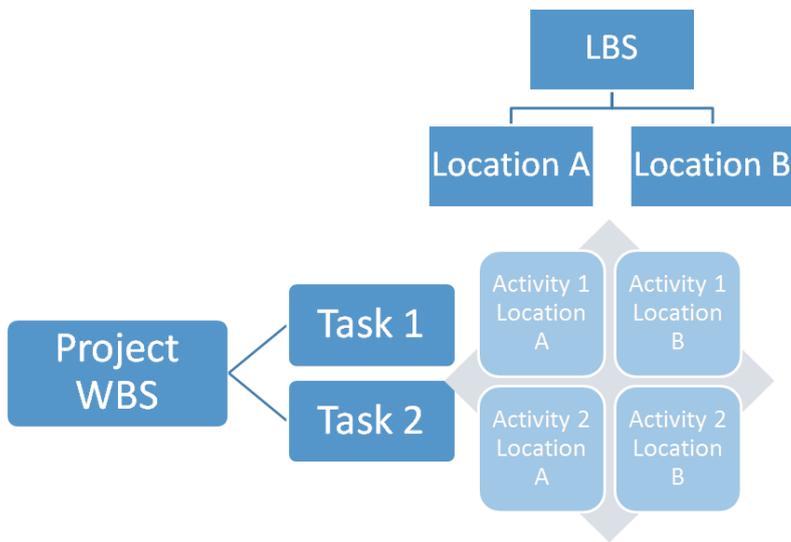
*Location Breakdown Structure /
Work Breakdown Structure
(LBS/WBS) Matrix*

Construction Management: Vertical Infrastructure

Location assumes a central role in construction management and is used by most practitioners in the planning and management of their work. However, they work with tools that are not designed to exploit location for productivity. This leads to waste in planning, managing and maintaining built environment and infrastructure assets.

50 project management professionals

This research collected information about the types of vertical projects they managed: 78% vertical capital works and 18% vertical maintenance or disaster recovery.

The majority of project management professionals used some form of location-centred construction management. For example, location was the principle aspect for deciding work priority, sequencing, and costing.

Source of inefficiency

The answers to the question concerning the use of methods to gain efficiency were disturbing. A majority of professionals, 58%, said their organisation used Location-Based Management (LBM) to gain productivity efficiencies. However, almost 70% of organisations engaged in building vertical infrastructure don't use formal LBM methods. Perhaps even more worrying is that 17% of those organisations don't use **any** production efficiency tool.

Analysis provides some indication of productivity problems. The majority of the project management professionals, 70%, answered "yes" to the question, "Does the inclusion of location in your breakdown involve repetition of detail?"

Clearly, inefficiency arises in both the planning and management phases of construction because managers devote considerable effort to controlling excessive repetitive location-based data.

Current Project Management practice centres on managing a project through the Work Breakdown Structure (WBS). The inclusion within a WBS of location causes this type of repetition, suggesting the need for location-based methods. Using a separate location breakdown structure (LBS) for location, rather than just location headings for activities in the WBS, could improve productivity by reducing the cost of managing construction projects data.

Proposed solution: LBS/WBS Matrix

The recommendation is to strip out repetitive location or zone data on vertical construction projects such as hospitals, schools and government buildings. Reducing the amount of data management is the obvious outcome of a more efficient management methodology.

Utilisation of an LBS/WBS matrix for construction projects, along with suitable project models and management strategies, could systematically improve vertical infrastructure project data management efficiency.

Vertical infrastructure projects contain location information in the following types of data:

- Building objects or components (elements and sub-systems)
- Planned and actual building component quantities
- Building system production assemblies
- Planned and actual material costs
- Building system costs.

Location provides the container for all project data, and therefore is used as the primary work division through a location breakdown structure (LBS) that is adaptable to a variety of CPM systems.

For example, the LBMS developed by Kenley and Seppänen (2010) is an integrated network of management system components potentially involving all stages of construction, from design through to completion. The system components are unified and location allows the integration of many data components into a knowledge-base for a project. This makes the LBMS rich in integrated data which parallels other initiatives such as BIM for integrated project delivery or integrated project environments.

Kenley, R & Seppänen, O (2010) *Location-Based Management for Construction: Planning, Scheduling and Control*. Spon Press, Abingdon.

New South Wales Newell Highway Corridor showing
—Physical Location as regions (green and blue)
—Service Location as the road corridor (purple)
—Works (red) in both regions and on the corridor
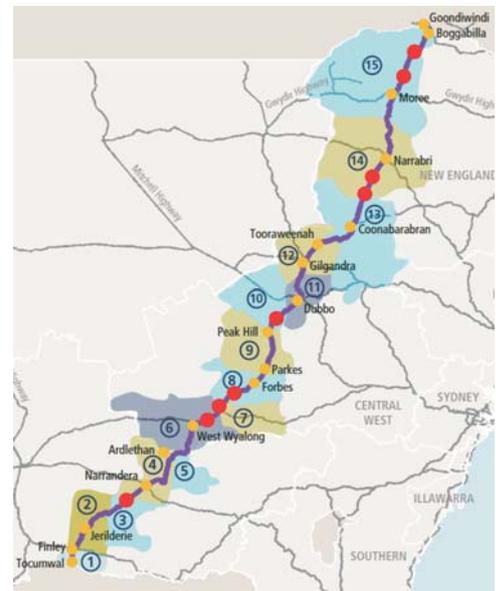
Construction Management: Horizontal Infrastructure

Roads, rail and other linear infrastructure are linked by two competing proximity factors; geography and service. Single projects can usually cope, but multiple projects across a network can create resource allocation problems. Focusing on prioritising types of proximity presents an option to limit excessive use of resources.

50 project management professionals

The study collected information about the types of horizontal projects they managed: 42% horizontal capital works; and 24% horizontal maintenance or disaster recovery. The project professionals managed roads, rail and pipeline projects.

A large majority, 80% of organisations, constructing or maintaining horizontal infrastructure begin from the premise that location is essential for work sequencing their projects. However, only 64% of these organisation use Location-Based Management (LBM) as a methodology aimed at improving productivity.

Source of inefficiency

"Location" as a principle of a management system for horizontal infrastructure is poorly documented within the construction management literature. Although location is shown to be a significant factor for planning and organising works, there are few publications highlighting location as a significant analytical factor for projects. There is a dearth of published research suggesting models for more efficient management of networks based on location.

Individual projects use proximity for managing works, typically locations such as road lines or intersections, as well as road chainage along lines. However, inefficiencies arise when a project does not work systematically through locations to minimise distance travelled. In this instance, too many resources are required.

For distributed networks of projects, a second level of inefficiency is common. It is inefficient to plan works without protecting the in-use service of existing networks because sequential service interruptions may also reduce the efficiency of the whole network.

Proposed solution: Two forms of Alignment LBS

This research has identified two meanings for location in relation to works management (both planned and reactive) and each is a factor in efficient works planning:

● Physical proximity such as regions
● Service proximity such as a road line

These are both illustrated by the case of the Newell Highway Corridor showing how the physical and service proximity complicates managing these proposed works.

Moreover, physical and service proximity factors are exaggerated in the context of a widely distributed portfolio. In the two jurisdictions considered in this research, NSW and Queensland, each has a very large portfolio of horizontal infrastructure, with a diagonal distance of approximately 1,300 Km and 2,000 Km respectively.

The recommendation is to consider proximity as a priority factor for managing works projects. Physical proximity is required to optimise resource use for each project, but within an operating network, service efficiency must also be considered.

For example, on major highways there may be both many regions to be managed, and very long "service" runs. A long service run means that two works planned at the same time in different regions (say hundreds of kilometres apart) should still be considered in close proximity (Brackertz & Kenley, 2002). A road user is likely to experience disruption from both works on the same journey on the same line. This type of disruption incurs societal costs due to the negative impact on road users which, given the service provision function of the asset portfolio, represents a reduction in service delivery.

Brackertz, N & Kenley, R (2002) A service delivery approach to measuring facility performance in local government. *Facilities*, **20**(¾) 127–135.

Design Management: Vertical Infrastructure

BIM Design methodologies support 3d modelling and allow refinement of detail through design resolution, commonly called clash detection. Removing the clashes between objects during design, rather than during construction, is a primary source of productivity improvement. BIM models, typified by Industry Foundation Classes, divide vertical infrastructure into buildings, floors and rooms.

50 project management professionals

A large majority, over 80% of organisations in this study, construct and/or maintain vertical infrastructure. These buildings include both public and private infrastructure such as civic buildings, hospitals, schools, shopping centres, office and residential buildings and complexes.

For design management, complexity increases from simple single-storey buildings to multi-storey multi-use buildings. As the design complexity increases, more effective ways of managing the design are necessary. Currently, integrating 2d with approaches to 3d models has encouraged model-based (3d) design solutions including object-oriented Building Information Modelling (BIM) environments.

In this study, 45% of vertical infrastructure organisations use BIM as a means of improving productivity. This number is slightly less than the 49% reported by the *2014 SmartMarket Report* of 727 contractors from 10 countries (McGraw Hill Construction 2014).

Most of the professional project managers who use BIM in our study find that BIM is effective in obtaining productivity improvement. However, the number of organisations using BIM is still far from the aim of BIM being considered industry standard.

Source of inefficiency

One barrier to industry standard acceptance is that design development involves a complex interaction of designers from multiple disciplines (e.g. architecture, engineering, construction management) resulting in different proprietary software capability. Currently, the lack of BIM-enabled design management for all design groups working on construction of vertical infrastructure projects is slowing down the pace of industry-wide productivity improvement.

## Proposed solution: BIM and Design Resolution

An Open Source definition for BIM is recommended as the answer to enabling interoperability and a global effort is continuing to develop 3d models for common use. The International Alliance for Interoperability, buildingSMART, has developed an object class definition for BIM objects called IFC (Industry Foundation Class): a schema developed to define an extensible set of consistent data representations of building information for exchange between AEC software applications (Eastman et al., 2008).

Providing project consultants (project managers, estimators, engineers, contractors) with a digital 3d model of a vertical infrastructure project is considered a valuable tool. Productivity gains have been based on identification of incompatible fixed 3d objects (clash detection) in a working model. BIM software defines objects parametrically; that is, the objects are defined as parameters and relations to other objects, so that if one object is amended, dependent objects will automatically also change. Thus, design changes are becoming ever more efficient through use of 3d modelling for vertical infrastructure projects.

Eastman, CM, Eastman, C, Teicholz, P, Sacks, R & Liston, K (2008) *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors*. John Wiley & Sons, London.

McGraw Hill Construction (2014) *The Business Value of BIM for Construction in Major Global Markets*. SmartMarket Report. MHC_Analytics@McGraw-Hill.com

Horizontal infrastructure typically has string-based design models which, due to their length and continuity, are difficult to visualise. In this image, a design model is analysed for mass-haul optimisation using DynaRoad software. The representation relies on strings as objects, with distance (metres) markers located by real-world (OGC) coordinates (X,Y).
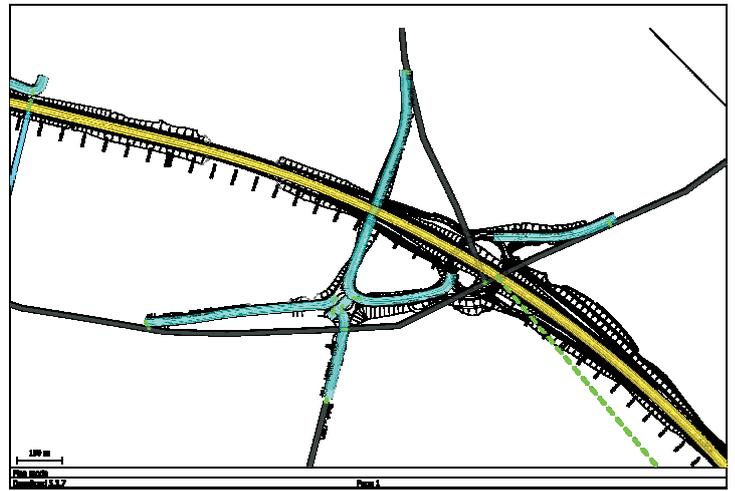
Design Management: Horizontal Infrastructure

Within horizontal infrastructure, design methodologies currently rely on string-based models which can follow complex geometry and extensive alignments. Centre lines and curves are used rather than objects as in vertical construction. As vertical and horizontal design models seek to exchange information, lack of interoperability is a critical concern. IFC Alignment is proposed as a solution.

50 project management professionals

BIM technologies have been presented as a solution to all problems within the construction industry. Fifty per cent of the organisations in this study that are involved with horizontal infrastructure projects (roads, rail, pipelines, mass transit and tunnels) use BIM as a project productivity improvement tool.

The effectiveness of BIM is often presented as an either/or proposition: it works well on vertical structures but not for all horizontal structures. Managers of horizontal infrastructure in this study indicate dissatisfaction with BIM because it lacks effective and efficient interoperability between object-based and string-based software.

Source of inefficiency

Currently, 12D is the dominant modelling system used by Australian and New Zealand publicly-funded transport authorities because it accurately models geographic features. Many transport infrastructure projects involve alignments to the curvature of earth's surface (especially over long distances). Therefore, it makes sense to use 3d modelling software that provides visualisation of geographic contours. Comments from the project management professions provide insights into their frustration; *working with BIM is painstakingly inefficient; it works sometimes; we lose data; it might work, but only on some parts of a project.*

Clearly, the lack of accurate interoperability between string-based design and object-based design is a major obstacle to a universally accepted IFC that was initially limited to vertical infrastructure.

Owen, R, Amor, R, Palmer, M, Dickinson, J, Tatum, CB, Kazi, AS, Prins, M, Kiviniemi, A & East, B (2010) Challenges for integrated design and delivery solutions. *Architectural Engineering and Design Management* **6**(4) 232–240.

Proposed solution: BIM using IFC Alignment

BuildingSMART is an international organisation of representatives from AEC firms, Owners, Suppliers and Software providers who are leading proponents of openBIM. They share a belief that the benefits of openBIM, and the greatest impact and momentum, can achieved by working together in a common community.

BuildingSMART facilitates the development and deployment of open standards for the building industry via local international chapters. BuildingSMART has developed a suite of internationally accepted standards. Together, three essentials support an efficient digital information exchange between organisations (Owen, et al., 2010):

1 Industry Foundation Class (IFC) is a common language and an unique information standard that most software applications can use.
2 International Framework Dictionary (IFD) is an object dictionary.
3 Information Delivery Manual (IDM) is a framework that describes what information should be transferred.

An equivalent framework is now being developed for horizontal (alignment) infrastructure models. IFC Alignment has two important features for providers of horizontal infrastructure:

1. It extends IFC to include input from the Open Geospatial Consortium which is designed to support global rather than merely local geographic coordinates and levels. This means that it carries geometric data accurately, with the minimum of redundancy.
2. There is no choice about the way the geometric data is presented to ensure any alignment data is interoperable between projects distributed globally.

IFC Alignment had not been adopted by any existing software at the time this report was published.

Building asset management information must be collected before and during construction operations. COBie defines the type and method of data to be collected.

Asset Management: Vertical Infrastructure

Asset management information can be sourced from digital models and data collection during construction. A buildingSMART model view specification for data exchange already exists for collecting and passing this information on to the asset management system. The specification of the underlying industry foundation class (IFC) model, with required business rules, is called the *Construction to Operations Building Information Exchange* (COBie) format. COBie is recommended for asset management of vertical infrastructure designed and built using IFC based models.

Source of inefficiency

One of the most significant sources of wasted effort in construction projects arises from the tedious task of producing documentation and product manuals for the operation of vertical infrastructure—information that is critical to the ongoing operation of the facility. "Facility managers have reported that this effort may require man-years of effort to create and review and transcribe hundreds of pages of documents, validate the transcriptions and manually enter data" (East, 2014).

The construcion industry is moving toward increased use of BIM for whole-of-life functionality (Hampson, et al. 2014). One of the priorities for BIM should therefore be reducing the administrative workload in transferring information to Facility Managers.

However, it is not practical to require designers to embed all final product information within their design models. Indeed, much of the required operational information only becomes known during construction when plant selections are made.

Furthermore, in vertical infrastructure location plays an important part in defining data needs for operational management. Operators need to know "what is where" in order to effectively manage the facility.

The IFC model provides for location as an intrinsic part of the definition. Because it has arisen from the designers' perspective, this definition provides a location hierarchy (Building-Floor-Room) that well supports the data requirements for facility management.

The need is to capture operational information during both design and construction, and associate it with the location hierarchy of the model, for transfer on project completion.

Proposed solution: COBie

Bill East, of the US Army Corps of Engineers, developed an interoperable solution for capturing project data at the point of origin: COBie. "COBie is a performance-based specification for facility asset information delivery" (East 2014). COBie (*Construction to Operations Building Information Exchange)* is a buildingSMART alliance project.

It is essentially a different model view specification that is designed around the needs of facility management and operations. The components of COBie are extensions to a subset of the traditional model view specification. This means that not all object information is required for COBie (for example coordinate information is not required) but rather a sub-set of the available information. The result may then be extended with additional properties required to support operations (eg. power, type, colour). This means that being able to visualise a building and its parts in 3d does not form part of the COBie specification.

The COBie model view maintains the location hierarchy of the IFC model. Thus, objects can be located within the building with sufficient detail for efficient management during the lifecycle.

COBie also requires that all records are electronic, with original (not scanned) vector PDFs. Software is available to support COBie and asset management systems have already been adapted to receive and interpret COBie files. COBie should be implemented for asset management of vertical infrastructure.

East, B, (2014) Construction-Operations Building Information Exchange (COBie). http://www.wbdg.org/resources/cobie.php
Hampson, KD, Kraatz, JA & Sanchez, AX (2014) Integrated Project Environments. Sustainable Built Environment National Research Centre (SBEnrc), Perth.

Horizontal infrastructure, such as roads and rail, involve a mixture of discrete and continuous assets highly dependent on location. The capture of asset management information before and during construction operations must necessarily also allow for the interaction of detailed digital models with in-use LIDAR scanning.

Asset Management: Horizontal Infrastructure

Horizontal infrastructure combines alignment-based structures and fabrics (such as pavements) as well as discrete objects (such as signage). For construction, these are documented accurately. However, a network of such fabrics and objects requires too much data, presenting a major difficulty. It is neither practical, nor necessary, to manage asset information at the design level of detail and asset location information must be geo-compatible. CONie is proposed for exchanging asset information for horizontal infrastructure designed and built using IFC-Alignment models.

Source of inefficiency

Design development of horizontal infrastructure involves a complex interaction of designers and contractors, from multiple disciplines, each with its own methods and priorities. Poor communication between these players can result in errors which reduce efficiency during construction. Within Australia and New Zealand, attention has been paid to the digital outputs from the design process but the emphasis has been limited to the construction perspective of the project: its design, approval and construction. While it is intended that the design data be available to and suitable for the operational life of the asset management, there is a gap between the detailed needs of project creation and the more generalised needs of operational management.

One of the key differences is data sensitivity. Currently, maintenance often relies on high-speed scans to locate assets and conditions, yet there is no connection between this broad data and the detailed project data. Asset managers are left wondering what to do with the detailed design documentation.

It is not that data is not collected or transferred, but rather that the process of doing so is inefficient and poorly informed. The information exchange process has not been researched, nor the end-user needs mapped. The network data needed for horizontal infrastructure asset management has not yet been codified.

One of the primary concerns is the lack of a suitable object model, one which accounts for the role played by alignments, and strings such as centre lines of roads. A new object model that suits this purpose has been proposed, IFC Alignment. But there is no research into the data that must be included in a construction to operations network information exchange specification.

Proposed solution: CONie

This research recommends that immediate attention be paid to researching and drafting a model for *Construction to Operations Network Information Exchange* (CONie) for horizontal infrastructure.

CONie should be designed to be as close as possible to COBie, but to commence from the proposed IFC Alignment and designed to handle life-cycle information suitable for horizontal infrastructure maintenance and operations.

Just as location is a key difference between IFC and IFC Alignment, so will it be a significant differentiation within CONie.

The IFC breakdown into Building / Floor / Room is clearly inadequate for network maintenance. And while it appears tempting to apply global geopositioning coordinates and a locator, this is similar to using project coordinates in COBie: the COBie model does not use project coordinates.

It is unlikely that a network model can ignore coordinate information. Unlike vertical infrastructure, where a room location is sufficient to locate most assets, there is no equivalent convenience within horizontal infrastructure. It is expected that while the CONie model will use distance along (road) lines (chainage) and these may be contained within higher level groupings: typically sections of road lines between intersections, coordinate geospatial information may be required. This needs to be designed taking into account both the locational data available in the IFC Alignment as well as the positional requirements for network maintenance and asset management.

Waterview project, Auckland

NZTA

The Way Forward: Theme 1—The Role of Location

There are two main research themes that flow forward from this research. Theme 1 revolves around the fundamental role that location plays in improving the management of construction production and asset management (location-based management), including location breakdown structures, geospatial coordinates and Geographic Information Systems (GIS).

Theme 1: Role of Location

Location-based management is of increasing importance in industry, and the majority of professionals are attempting to use location in the management of their projects. However, there are few and limited tools to support management by location.

Further, the different aspects of location, such as physical proximity as well as service proximity, are not supported by available software. This requires integration between GIS tools, IFC and IFC Alignment models and planning and management systems.

It is proposed that the logical development from the LBS/WBS Matrix is the design of a suite of means and methods that enrich existing technologies (such as CPM scheduling) with location-based management. Lessons learned from existing location-based tools will facilitate these outcomes.

The output will be a suite of methodologies for practical implementation in project management as well as draft specification for future software tools.

Moving forward, the research should aim to influence project management systems and processes to include location as a core component.

It is therefore desirable to engage with project management standard setting bodies, such as SAI Global and PMI to encourage recognition of the role of location in construction project management.

The research driver here is to support industry practitioners who seek to manage their projects using location, but without due recognition or appropriate systems. The necessary next step is to standardise the plethora of individual practices that use location. These can then be embedded in appropriate management systems within industry standards and practitioner guides. Standardised methods will improve location-based management practice and communication within projects to improve productivity.

Waterview project, Auckland

NZTA

The Way Forward: Theme 2—CONie

Theme 2 addresses the problem of exchanging information between the construction phase and the operational management of networks of horizontal infrastructure. This concerns the type of information and necessary data sensitivity required to pass from the contractor to the client via CONie.

Theme 2: CONie

CONie is proposed as a performance-based specification for network asset information delivery. CONie or *Construction to Operations Network Information Exchange* should be designed to accord with buildingSMART requirements. It is essentially a different model view specification that is designed around the needs of facility management and operations.

The aim of developing a CONie would be to support Australian and New Zealand road agencies to be at the forefront internationally in the development of information flow from design and construction to operational network asset management.

In designing CONie, particular consideration will be paid to the role of location in asset management for horizontal infrastructure. New technologies are impacting this space, including high speed mobile laser scanning from both vehicles and drones, object and feature recognition, and improved asset management databases.

The outcome will be a practical tool for asset management of horizontal infrastructure: CONie.

Moving forward, the research should aim to influence open source solution providers, such as buildingSMART to include CONie within their solutions.

Similarly, software vendors should be encouraged to incorporate CONie as both stand-alone solutions and as a path for transferring information into asset management systems.

The research driver here is to provide generic, open-source, solutions for capturing asset maintenance information during design and construction in a more efficient way. By aligning the data collection with the real needs for network operations management, there will be productivity gains in both data collection and in subsequent data use.

Australian Sustainable Built Environment National Research Centre

The Australian Sustainable Built Environment National Research Centre (SBEnrc) is the successor to Australia's CRC for Construction Innovation (2001–2009). Established on 1 January 2010, the SBEnrc is a key research broker between industry, government and research organisations for the built environment industry.

The SBEnrc is continuing to build an enduring value-adding national research and development centre in sustainable infrastructure and building with significant support from public and private partners around Australia and internationally.

Benefits from SBEnrc activities are realised through national, industry and firm-level competitive advantages; market premiums through engagement in the collaborative research and development process; and early adoption of Centre outputs.

The Centre integrates research across the environmental, social and economic sustainability areas in programs respectively titled Greening the Built Environment; People, Processes and Procurement; and Driving Productivity through Innovation.

Among the SBEnrc's objectives is to collaborate across organisational, state and national boundaries to develop a strong and enduring network of built environment research stakeholders and to build value-adding collaborative industry research teams.

Essential to SBEnrc achieving its goals is this core project :
New Project Management Models for Productivity Improvement in Infrastructure.

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Program 2 (People, Processes & Procurement) Leader
Sustainable Built Environment National Research Centre

Project references

Kenley, R & Harfield, T (2014) *New Project Management Models: Productivity Improvement for Infrastructure.* Sustainable Built Environment National Research Centre (SBEnrc), Perth ISBN 978-0-9943922-0-6.

For more detailed information about this research please refer to the Position Papers available at www.sbenrc.com.au (Project 2.21):

1. Kenley, R & Harfield, T (2014) *The Role of Location in Existing Project Management Structures*. Position Paper 1, Project 2.21 New project management models for productivity improvement in infrastructure. Sustainable Built Environment National Research Centre (SBEnrc), Perth.

2. Kenley, R & Harfield, T (2014) *Construction Production Systems: Delivering Value for Money*. Position Paper 2, Project 2.21 New project management models for productivity improvement in infrastructure. Sustainable Built Environment National Research Centre (SBEnrc), Perth.

3. West, GAW & Kenley, R (2014) *Geographic Data and Systems in Project Planning*. Position Paper 3, Project 2.21 New project management models for productivity improvement in infrastructure. Sustainable Built Environment National Research Centre (SBEnrc), Perth.

4. Kenley, R & Harfield, T (2014) *Managing Road Assets in Times of Multiple Extreme Flooding Events*. Position Paper 4, Project 2.21 New project management models for productivity improvement in infrastructure. Sustainable Built Environment National Research Centre (SBEnrc), Perth.

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