Sustainable Built Environment
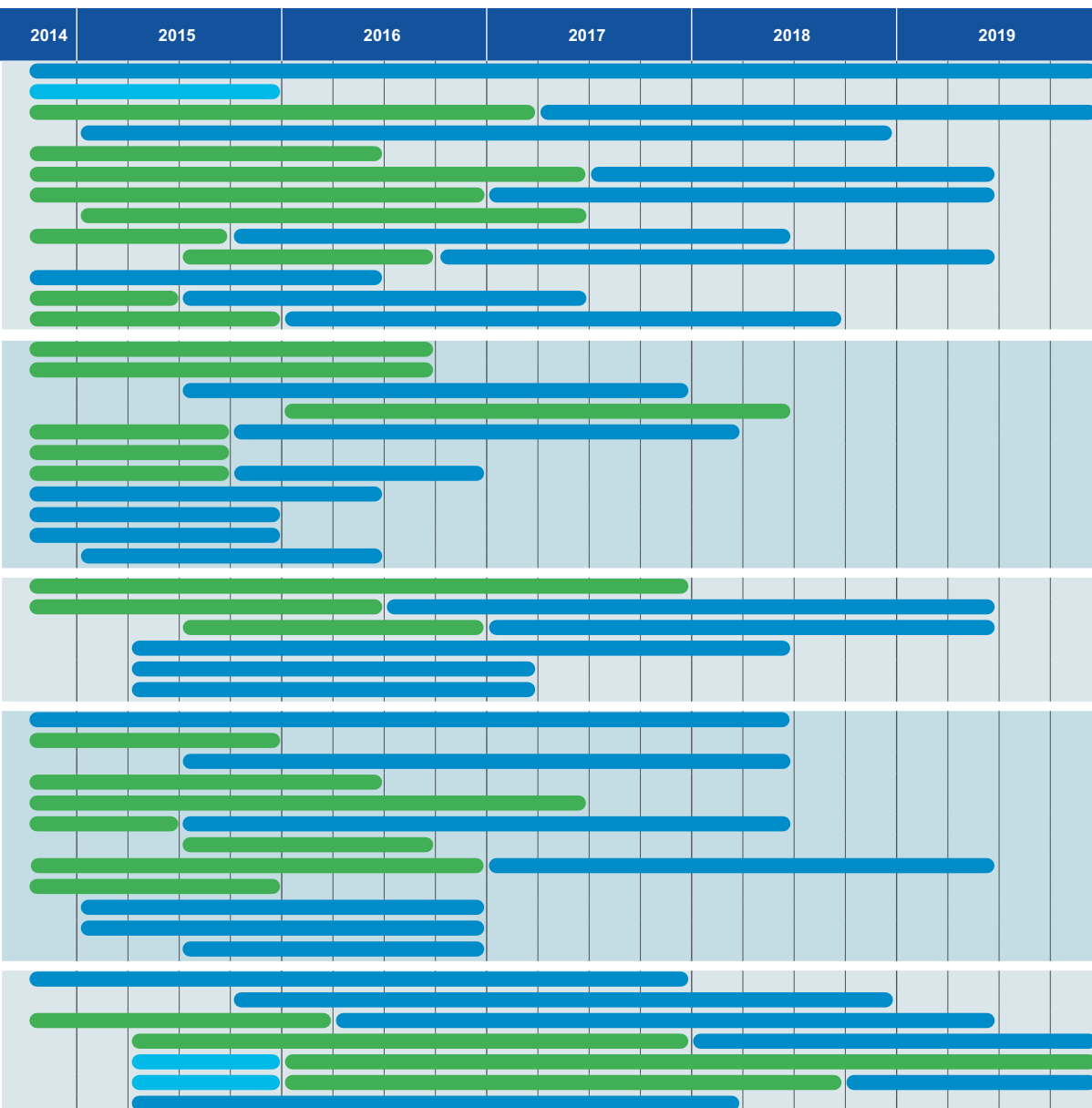## National Research Centre

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Project 2.33 New Project Management Structures

Briefing Paper

CONie: Lessons to be Learned from COBie Specifications and Standards

2014	2015	2016	2017	2018	2019

East, B, Kenley, R, & Harfield, T (2015) *CONie: Lessons to be Learned from COBie Specifications and Standards*. Project 2.33 New Project Management Structures Briefing Paper. Sustainable Built Environment National Research Centre (SBEnrc).

SBEnrc Project 2.33 Scope: 2015

The larger objective of the project is to improve productivity by reducing data-handling waste defined as 'adding cost without the addition of commensurate value' (Kenley, 2003). This objective is based on the view that the potential for productivity improvement in infrastructure construction is possible through the development of new project management structures (Kenley & Seppänen, 2010).

The road agencies and their providers narrowed the project scope to articulation of project specifications and standards to support the ongoing information transfer for Asset Management system harmonisation programs (Austroads, 2015; Kenley & Harfield, 2014).

The road network represents the single largest community asset in Australia; valued at more than $200 billion. All Australians use roads, and the maintenance of the road network is necessary for economic and social activities. Each year more than $21 billion is spent on the 900,000 kilometres of roads. An annual saving of between $65 and $130m could be taken from the cost of road data collection, storage, retrieval and utilisation, if all agencies 'harmonised their road asset data' (Austroads, 2015a, p11). Such a saving would have significant economic impact.

The economic benefit arises from more effective operations and resource allocation in the management of the national road network. More generally, this project also aims to align with the Federal Government's Digital Transformation Initiative. This policy will transform all government service provision through the use of digitally enabled technology, <https://www.dta.gov.au/standard/>. The current pressure to ensure value and service delivery through road Asset Management and maintenance suggests that development of methodologies to reduce waste will be a welcome contribution.

The mechanism that allows more effective operations and resource allocation is smarter use of data. In the specific case of roads, this aligns with Austroads' Asset Management up-grade priority. During discussions with project partners it has become clear that focusing narrowly on one phase of the construction project, hand-over, provides a significant opportunity.

This project tackles the problem of the bottleneck at the end of construction: an unstructured and unsearchable, discrete paper and file-based document hand-over practice. Currently, all road asset owners must allocate resources to find and convert the hand-over information for input into their existing asset management systems. This is an obvious example, of the possibility of removing data-handing project management process waste.

The recommendation of SBEnrc Project 2.21 *New Project Management Models for Productivity Improvement in Infrastructure* is to consider a new Asset Management tool that is focused on hand-over providing the ways and means for an information exchange: CONie (*Construction to Operations for Networks information exchange).* CONie is proposed as one methodology specific to road networks that will enable Asset Management systems to adapt more quickly within the emerging digital BIM/GIS environment.

Development of the CONie standard provides a vehicle for the exploration of the relationship between road infrastructure project models, project data and end-user asset management requirements. It also supports application of location-based thinking that can support service-oriented decision-making for both clients and their supply chain providers, in their operational allocations (Kenley & Seppänen, 2010).

What Is COBie and Why Is It Important?

One of the most significant sources of wasted effort in construction projects arises from the tedious task of producing documentation and product manuals. Because these types of information are critical to the ongoing operation of an asset; companies globally provide a significant amount of post construction resources to this task (East *et al*., 2013).

One of the priorities for BIM, more efficient life-cycle management, should be reducing the administrative workload. This reduction, in the area of transferring information to Facility Managers, is a major link with the increased use of BIM for whole-of-life functionality (Hampson*, et al*., 2014). However, it is not practical to require designers to embed all final product information within their design models. Experience shows that much of the required operational information only becomes known during construction when plant selections are made.

Capturing operations, maintenance, and asset management information from building projects is possible using COBie (*Construction to Operations for Building information exchange)*. COBie is part of the United States National Building Information Modeling Standard <http://www.nationalbimstandard.org/>.

Software is available to support COBie and Asset Management systems have already been adapted to receive and interpret COBie files for vertical infrastructure.

The developer of COBie, Bill East, has joined the research team. Project 2.33 has the benefit of a researcher with experience in developing an elegant solution for the problem of excessive administrative waste for building construction hand-over.

Hand-over: The Crucial Construction Phase

Traditional facility management information specified in building construction contracts was created at the end of the construction process. It was delivered to the facility operator prior to the fiscal completion of the project, as shown below.

Building Construction Hand-over Project Information

Evidence of the waste inherent in the hand-over process is that most building owners maintain one or more full-time data clerks. They retype (a small fraction of the) information from the paper documents into automated systems that support maintenance management. Retyping and transcribing are common activities during the capture and use of construction

information, despite the fact that virtually the entire set of information can be traced to an electronic source (East *et al.*, 2013).

The expense of transferring information remains embedded in virtually every construction contract in the industrialised world. This practice predominates even though the information contained in the paper documents is <u>almost useless</u> to those managing a facility (Eadie *et al.,* 2013).

At the same time, change is gradually taking place. Some Facility Managers are now specifying and receiving information rather than paper documents. More importantly, this transformation is taking place because Facility Owners are starting to specify a precise set of information, in an open-standard format, that can be objectively tested.

Today, in the building construction sector, the practice of facility operations and maintenance is in the first stages of transforming hand-over from a document-centric to an information-centric practice (Kenley & Harfield, 2014).

The standard that is gaining industry acceptance is COBie (*Construction to Operations for Building information exchange)*. It smoothly merges building asset information (East, 2014) by defining:

1. the specific set of managed assets
2. the location of an asset in a building
3. the asset information needed to insure proper maintenance
4. the common classification.

Essential to the COBie specification is the recognition that Facility Managers require a different level of information detail from the information level of detail needed by both designers and builders. Both designers and builders are concerned with the precise location of each piece of equipment. The designer has to properly size the equipment to provide the needed service. The builder has to place that equipment in the structure of the building to allow the equipment to perform it's function. Designers and builders need details that show information measured in millimetres. Exact measurements, made possible only by 3D object modelling and automated design-resolution software, allow the correct tolerances for engineered-to-order components (Utiome & Drogemuller, 2013).

However, once the building is built that level of information detail is typically not required. For the maintenance technician trying to check the operation of a piece of equipment, the only accuracy required is that of "spatial containment". This means knowing the room in which the equipment is located is more important to the Facility Manager than knowing the exact location of the equipment in 3-D space. In fact, the maintenance technician will be likely to ignore detailed 3D models unless equipment is being entirely replaced.

Designing Open Standards: Three Key Lessons

The US National Building Information Modeling Standards (NBIMS) are part of a global effort to design open standards that can be used for continued development of software to transform the construction industry.

Three standards developed for buildings could provide a roadmap for new specifications and standards for horizontal infrastructure. Applying lessons learned in one domain can guide the methodology in the design of a standard in a different domain (Carrillo *et al*., 2013; Boehm *et al.,* 2001).

Lesson 1. Be Specific, Not Abstract

A major issue for all research and development is how to narrow the scope of a project. The aim is to make an effective shift from a general problem to an implementable solution. For example, the ELie (*Equipment to Layout information exchange*) project was envisioned as a way to capture the information contained in schematic system drawings provided alongside traditional COBie-type information (East, 2009).

Given that equipment schematics all held similar graphic artefacts, it was assumed that a single standards design project could identify the information-based transformation of those drawings. However, the original conception of the ELie specification was too general.

A systematic review of the problem found that the underlying knowledge represented in the four major building service systems (temperature control, electrical power, water, and control systems) were very different. Thus, the single ELie development project, of necessity, became four discipline specific specifications.

Each specification is based on the information content that is developed and exchanged with the relevant geometric information. Three specifications are now part of the United States National BIM Standard version 3™ (NBIM 2015):

      1. HVAC system (HVACie) standard (Hitchcock, 2012)
      2. water system (WSie) standard (Chipman *et al.,* 2013b)
      3. electrical system (Sparkie) standard (Chipman *et al.,* 2013a).

An additional specification, the exchange of building automation management systems (BAMie), has yet to reach the status of an accepted *open standard* (Byrum, 2015).

The importance of describing the 'failure' of the ELie project is to stress the inappropriateness of a **top-down solution**. The subsequent relative success of the discipline specific HVACie, Sparkie, and WSie projects is credited to **bottom-up solution** based on specific knowledge domains. The professions and trades involved with any construction project are many and varied with their own language and practices re-enforced by the educational system. More importantly, these specialist knowledge domains are re-enforced in law for to ensure the health and safety of the built environment users.

Attempting to identify a generic information exchange specification for an entire building, will probably never be successful. Projects developed from a top-down approach, without detailed domain and process-specific knowledge, will be considered too general or abstract

Standard definitions that are too general will be rejected by associated design disciplines, software developers, and ultimately owners who place required construction project management specifications in contracts (Manderson *et al.,* 2015; Larson & Golden, 2007).

The first lesson to be learned.

> *Care must be taken when presenting information exchange solutions to practitioners. Be specific, allowing each construction knowledge domain to be led by their own constituents. Generic solutions may be elegant from a data modelling perspective, but are likely not to support generalised implementation.*

Lesson 2. Be Complete, Support Implementation

Building information exchange standards development efforts began over 30 years ago with surprisingly little effect on the building industry as we know it today. When reviewing the COBie project, it is interesting to note that COBie went from initial discussions to an internationally recognised standard in under a decade.

Implementation of COBie as a global industry standard will take longer because owners and practitioners are limited by legal decisions in relation to construction contracts (Larson & Golden, 2007) as well as jurisdictional quality control/assurance regimes (van Nederveen & Bektas, 2013). However, the success of COBie is remarkable within these constraints.

Part of the success of COBie was to recognise which aspects of professional and management practices could be changed, and which practices could not be changed. The important decision for COBie not to utilise "new contractual paradigms of collaborative design" meant that COBie implementation depends on existing contracts and is managed through existing quality control and assurance procedures. Therefore, the developed COBie specification was not dependent on market timing for success.

The completeness with which COBie and other US NBIMS version 3^{TM} information exchange specifications were developed, demonstrates that the technical issues of a standard are a small part of the total effort. The major effort required for a new standard is to validate usability.

The second lesson to be learned.

The concerns and contracts of each party in an information exchange process, and the management of the standard itself, must be considered, documented, and tested before the specification for the standard is ready to be adopted.

Lesson 3. Be Incremental, Not Aspirational

Another type of information contained in construction hand-over data, not directly addressed by COBie was that of manufacturers' product data. SPie (*Specifiers' Properties for information exchange)* open standard was intended to deliver manufacturer product data to the facility operator by passing manufacturers' information through the construction contract (East *et al.,* 2011).

SPie development changed through a number of iterations. However, after six or seven different approaches were tried, no construction contract has used a SPie standard. Important processes are still not in place.

1. SPie failed to achieve United States national consensus about the properties required for manufactured or engineered equipment.
2. SPie failed to identify an agreed upon format for the exchange of such information.
3. SPie failed to create a critical mass of industry organisations that interface with manufacturers and/or suppliers to develop, update, and catalogue such information.

Obviously, the fundamental structure of an industry cannot be transformed rapidly. Radical (short-term and major) whole industry change has been advocated in a number of major government reviews as well as individual researcher studies. Change management models, tools and advice are aimed at this type of radical total-industry change.

The problems associated with the radical-whole industry approach are linked to the nature of the construction industry. The main production unit of the industry is a temporary organisation based on sub-contracting labour provision formed to construct a unique built environment structure. The lack of operational permanence is why radical whole-industry change is advocated, and also why implementation has been an ineffective method of increasing industry productivity (Henderson & Ruikar, 2010).

An incremental theory of change rather than a radical theory of change is one obvious option. The idea that 'small but significant' change will, in the long-term, be the most effective method of implementing change in the construction industry is intuitively correct. In addition, focusing on individual projects, the unit of industry production, is also an obvious fit-for-purpose in concentrating on changing practice (Dangerfield, *et al*., 2010). In this project, incremental change is proposed through extension of standardised project management systems.

The third lesson to be learned is that to be successful in industry transformation, research and development projects must have modest goals. The goal of industrial transformation is unlikely without a complete national mobilization backed by long-term political capital and resources, such as the Singapore adoption of BIM (Singapore, 2013).

The goal of replacing existing paper construction hand-over documents, with some portion of their related information in a standard format, could be accomplished with a much lower threshold of resources and effort. The lesson to be learned from the SPie project.

> *When scoping a project, focus on what can be reasonably accomplished within the context of existing practice. Simply stated - innovate for today, the future will take care of itself.*

Designing and *information exchange* standard

One example of an open standard is COBie. COBie defines a precise set of information needed to solve a specific problem at a specific point in the building life-cycle: hand-over. COBie is an information exchange tool designed to transform construction hand-over documents into a set of information that is useful to a Facility Manager (East *et al.,* 2013).

In one decade, COBie has gone from a small ITC research project to an internationally recognized, nationally mandated, performance-based contract deliverable (Manderson *et al.,* 2015; Larson & Golden, 2007).

COBie supports the transformation of document-centric to information-centric construction deliverables for the facilities management function. Automated COBie testing tools can only evaluate the format and referential integrity of data provided. To check the quality of the COBie data an objective criterion is necessary.

Criterion: the information currently presented on paper drawings must match the information found in the COBie presentation of that information.

Without an active acknowledgement of the fact that the work of designers and contractors is, today, inextricably bound to document-centric references there is no basis to allow these professionals to trust a move from document-based to data-based presentation of their work.

A significant feature of a successful standard is how it distinguishes between commonly used information and discipline or trade specific information.

Common information will typically relate to the overall physicality and gross measurements. Beyond that, little of the specific information that makes disciplines or trades unique will be of interest outside their designated spheres of endeavour (Kenley & Harfield, 2014). Therefore, until data and information that is required for all phases of construction are able to flow easily in digital systems and be stored in a two-way exchange system, the progress of total sector change will be slow.

However, the lessons learned during the development of the COBie standard provide a foundation for designing a construction hand-over solution for effective and efficient road network asset management operations in a BIM-enabled environment.

CONie: Information Exchange for Road Network Asset Management

In line with the small but significant change, is the proposed CONie (*Construction to Operations for Networks information exchange*). It will provide contractible methods, mandating the use of a connected digital repository (such as an SQL database) constructed to a standard specification, and suitable for automated input into redesigned compatible operations management systems.

Construction to Operations for Network information exchange

CONie: is perceived as a hand-over open standard to facilitate the transfer of information from one medium (paper documents) to another (digital information). The process does not change the information that is currently delivered about construction projects; instead it ensures long-term survival of road network construction information in an easy retrievable format.

CONie can transform the way that information is to be delivered.

CONie can support an information data format that can be widely used.

CONie can provide a performance-based specification for project information delivery.

Much of the data needed by specific domains (such as pavements, signage or geometrics) may be similar, but clearly all information should be modelled consistently across all domains.

For CONie to be successful, it must model the details of each part of the road infrastructure network in ways that professionals and practitioners clearly understand. Asset Managers, Operations Systems, Maintenance Work Orders, and New Capital Works will all depend on accurate and usable information to provide the best service for all road network stakeholders.

Focusing on the specific issue of effective hand-over information aims at a digital specification that can be achieved. Especially if the requirement for a working standard is that the information in the standard must be directly related to the experience of those using that information in daily practice.

If the COBie lessons learned are applied in the design of the CONie open standard for road networks, it will be possible to incrementally change to an information-centred approach for hand-over. Over time, verification that the digital hand-over information is correct, will support trust in a new way of managing road network works (Austroads, 2015b).

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Core Partners

Project Partners

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