

xClosing the Information Gaps in BIM

Critical for Industry Success

CIMdata Commentary

Key takeaways:

- *Buildings, infrastructure, and other similar physical assets are designed and constructed by AEC/EPC firms and typically owned and operated (O/O) by other organizations. This leads to a typical data dilemma: too much data that is often not the correct data nor semantically accurate to be usable. Data governance is badly needed, which itself requires data alignment.*
- *The AEC/EPC and O/O domains often struggle to deliver a complete and accurate information model to their O/Os, missing clear guidance from “data stewards.”*
- *Without an overarching data model and resulting digital twin of a physical asset, O/Os struggle to maintain their facilities making enhancing and modernizing difficult and more expensive.*
- *Holistic and standards-based solutions that integrate processes across the end-to-end asset value chain, as well as manage the resulting data are critical in solving the major lifecycle issues.*
- *Eurostep has leveraged its extensive experience solving similar long-asset-life collaboration and data management issues to create and deliver an integrated Asset Information Management (AIM) solution based on their ShareAspace PLM solution.*

Introduction

Asset intensive industries have long struggled with a complex value chain where no one organization has complete end-to-end control of any given physical asset. Architectural, engineering, and construction (AEC) firms, often referred to as engineering, procurement, and construction (EPC) firms in large scale capital projects, typically are only responsible for designing, building, and handing over a facility to an owner/operator. Things are often much more complex when one or more firms are responsible for architectural design, others are responsible for construction management, others for supporting fabrication and construction, and finally others are responsible for the handover to the O/O. It is these O/Os who are ultimately responsible for the rest of the lifecycle of the physical asset, which can span many decades. This handover isn't unique to the AEC/EPC industry, other industries (e.g., ship building) have similar lifecycle stages (see Figure 1).¹



Figure 1—Typical AEC/EPC-O/O Lifecycle Stages

Handover typically takes place during or upon the successful completion of the “Commissioning” stage. It is here where the AEC/EPC firm hands over the asset to the O/O. This should include all the digital assets (e.g., as-built structures, equipment descriptions, maintenance manuals, and operating manuals), as well as the physical asset itself.

¹ Research for this commentary was partially supported by Eurostep.

Unfortunately, the handover process is often limited and doesn't include all the necessary and usable data (i.e., data that is in a ready to use format) for the O/O.

Lifecycle Challenges

The AEC/EPC industry is riddled with poor handover examples, where the data is limited and often paper-based. The over-reliance on paper to manage processes and deliverables is widespread. Paper is frequently used for construction drawings, material procurement, equipment logs, daily progress reports, punch lists, and other project-related information (e.g., contracts). This has often resulted in poor asset development, utilization, and maintenance. Furthermore, ineffective information sharing is rampant. Architects, engineers, contractors, and owners often work from different versions of reality. This fact frequently triggers disagreements on change orders and claims management, as-built structures that don't match current as-designed structures, which can all lead to finger-pointing when cost overruns and project delays occur. Ineffective reuse and analysis of information is also widespread. Scattered and disconnected data and processes cause major problems analyzing data to identify opportunities for process improvement. This in turn seriously compromises jobsite efficiency, operations and maintenance, and overall project and risk management.

It is important to note that while this lifecycle is easy to understand, it is rather complicated to manage for a number of reasons. For one, the major stakeholders (i.e., AEC/EPCs, O/Os, and regulatory agencies) often have conflicting requirements (e.g., sub-contractors try to minimize the data overload, maintainers and operators lack contextualized data and traceability, and regulators try to ensure that the facility is meeting ever changing regulatory requirements). This makes managing the lifecycle of the physical asset (e.g., a plant) and all of its defining data rather difficult. Many view doing so to being like trying to hit a fast moving target with unpredictable speed and trajectory with a ball being thrown by a person in slow motion. The good news is that building information modeling (BIM) is a movement to try to gain control of this lifecycle data.

Building Information Modeling

As summarized on Wikipedia,² Autodesk's website,³ and by many others, BIM, sometimes also referred to as Building Information Management, is a process supported by various tools, technologies, and contracts involving the generation and management of digital representations of physical and functional characteristics of physical asset (e.g., buildings and infrastructure). According to Autodesk, a leading AEC software provider, BIM artefacts are based on an intelligent model and enabled by an information platform. Autodesk goes on to state that, "BIM integrates structured, multi-disciplinary data to produce a digital representation of an asset across its lifecycle, from planning and design to construction and operations." BIM are typically project-oriented data models that follow the lifecycle of the project responsible for the design, construction, and maintenance and upgrade of a facility.

Some attribute the concept of BIM back to Mr. Charles Eastman and his research report entitled *An Outline of the Building Description System*.⁴ But most agree that the term BIM came into the industry in the early 2000s. With the United Kingdom's push for BIM, which formed the basis of international standard ISO 19650, launched in January 2019, many other governments have followed. The UK's "...BIM program commenced in July 2011 and is focused on the

² https://en.wikipedia.org/wiki/Building_information_modeling

³ <https://www.autodesk.com/industry/aec/bim>

⁴ <https://eric.ed.gov/?id=ED113833>

adoption of BIM technology by both public and private sector organizations involved in the procurement and delivery of buildings and infrastructure.”⁵ Finally, according to Trimble, another industry leading provider of AEC software solutions, “Across the world, BIM is a crucial and even mandated process to ensure the planning, design, and construction of buildings is highly efficient and collaborative.”⁶

While the BIM movement is well developed and being promoted within many countries and companies, and supported by technologies from many solution providers, it is still being mainly leveraged by AEC/EPC firms and underused by O/Os. As a result, there is a clear need to increase BIM processes maturity and to communicate what value it can provide the AEC/EPC-O/O world.

Current Notable Trends

Like other major industries, the construction industry’s complexity and global reach are significant. Oxford Economics estimate the global construction market was valued at US\$10.7 trillion in 2020, and that the global construction market is expected to grow by US\$4.5 trillion between 2020 and 2030 to reach US\$15.2 trillion.⁷ The lifecycle complexities, as described above, aren’t new to the industry and as a result, much work has been done to address them. Today, there is a heightened awareness of, and increase in, deliverable expectations. A decade ago, it was often sufficient for architects and engineers to deliver 2D designs that were plotted or printed for use on the construction site. While that is still largely true in residential construction, in the world of commercial and industrial projects, BIM is now the standard. It should be noted that for process plants built by EPCs, the term “BIM” isn’t used—instead people talk about ISO 15926 (an ISO standard that defines the integration of lifecycle data for process plants)—but the idea is the same. It is becoming the standard to deliver a multi-disciplinary model that incorporates 3D geometry and relevant metadata.

Much of what passes for BIM today is little more than 3D geometry. However, this is changing. Just a few years ago, so-called Level 2 BIM (see Figure 2) became mandatory for public building projects in the UK, and the same is true in some other regions. While no one is executing to Level 3 BIM at any volume today, it is clearly coming. Note the phrase “Lifecycle Management” on this chart produced by the BIM Task Group in the UK back in 2010.

⁵ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/34710/12-1327-building-information-modelling.pdf

⁶ <https://constructible.trimble.com/construction-industry/what-is-bim-building-information-modeling>

⁷ <https://www.marsh.com/ng/industries/construction/insights/global-construction-outlook.html#:~:text=Oxford%20Economics%20estimate%20the%20global,in%20emerging%20markets%20in%202030.>

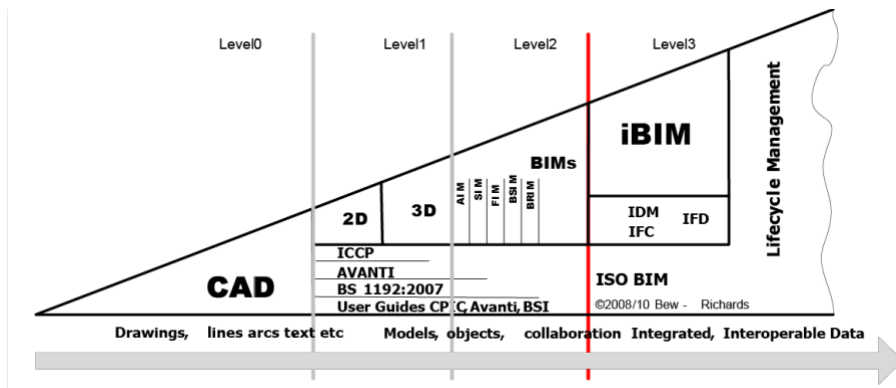


Figure 2—UK Government Three Milestone Levels as defined by the BIM Task Group
(BIM Task Group, 2010)

Besides various BIM initiatives, others focused on automated data handover are underway as well. For example, the Construction-Operations Building Information Exchange (COBie), an open standard leveraging the openBIM standard IFC (Industry Foundation Classes)/ISO 16739), exists for the UK and some U.S. states. But in general there is a lack of standardized handover information management. COBie is a performance-based specification for facility asset information delivery that addresses two types of assets: equipment and spaces.⁸ COBie is being designed to help project teams organize electronic submittals approved during design and construction and deliver a consolidated set of electronic documentation.

Top of mind for many O/Os is long-term maintenance and modernization. Through the use of various scanning technologies (e.g., LiDAR), which are thought to be a cost-efficient way of capturing spatial decomposition in existing facilities, many are seeking to understand and replace current structures and equipment. Some are using this technology to produce models that can then be used as a basis for upgrading. Unfortunately, referencing these information models into a comprehensive asset information model (AIM) is rather costly due to their complexities and disconnection from the actual assets.

Leadership in Energy and Environmental Design (LEED) is another important construction initiative that impacts the complete lifecycle. According to U.S. Green Building Council, “LEED provides a framework for healthy, efficient, carbon and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement and leadership.”⁹ LEED and similar design and operational initiatives, as well as construction material upcycling, require often unavailable online property dictionaries to index digital twins’ elements to a shared definition. Fortunately, new ISO standards (i.e., ISO 23386 and 23387) have been published to ensure interoperability between these master data definitions, but now they need to be deployed.

Additionally, like many discrete industries, carbon benchmarking is trending for construction products (e.g., equipment) as well. Unfortunately, this benchmarking needs to be addressed from a systemic point of view (e.g., comparing HVAC and Solar energy functional systems rather than discussing a specific insulation type and thickness). This is an excellent example of where the construction industry can leverage significant learnings from the discrete manufacturing industry.

With the advent and significant and on-going expansion of smart, connected devices (e.g., HVAC systems, and water and waste systems/pumps), the use of Internet of Things (IoT)

⁸ <https://www.wbdg.org/bim/cobie>

⁹ <https://www.usgbc.org/leed>

sensors to monitor the configuration and behavior of physical assets within facilities is gaining momentum. It isn't good enough to know what was installed by the AEC/EPC firm, the O/O also needs to track and maintain the current as-operated, as-maintained view of their facility and all of its equipment. Again, the handover disconnect issue described above is problematic. This disconnect leads to data gaps in information models that prevent proper impact analysis during the subsequent O/O phases (e.g., on-going maintenance and upgrade).

Finally, a note on data governance. CIMdata defines data governance as “the organization and implementation of policies, procedures, structure, roles, and responsibilities that outline and enforce rules of engagement, decision rights, and accountabilities for the effective management of information assets.” The continued and apparent exponential growth of data means that data governance is no longer optional. Additionally, data governance—especially reversibility and sovereignty—is trending in Europe, with many companies pushing for more software interoperability.

Given this short summary of major construction industry trends, as well as the documented disconnects that exist in today's AEC/EPC-O/O lifecycle, the need for more holistic and end-to-end lifecycle enabling solutions supporting the construction industry should be clear. So, the only question should be...What are the main solution requirements that must be enabled to close the gap?

How to Close the Gap: Main Solution Requirements

The first, and perhaps the most critical, solution requirement is the ability to define and enable an accurate digital twin. CIMdata describes a digital twin to be “a virtual representation (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to/from the associated physical asset(s).” In general, BIM, as described above, provides the data and process management for the project-oriented information management in the context of a physical asset. Of course, a digital twin without the connection to a digital thread is an orphan, disconnected and with a high-likelihood of being out of date. Asset management and data governance provide and keep current the digital thread's functional requirements, from concept/project initiation to the O/O phases, across the end-to-end asset lifespan, focusing well beyond the construction deliverables. Finally, IoT sensors provide the dynamic view of the digital twin, updating the “as-operated/maintained” live data from hundreds, if not thousands, of geolocated sensors.

As with any digital transformation, data/information structures (or models) are required. The digital twin can be thought of as a data structure or model, but to manage physical assets for their lifecycle you also need to enable multiple geographic and functional information models. Geographic models help provide systemic impact analysis. For example, a failure in a water treatment pump, which is part of an industrial system model, can cause a local water treatment plant to shut down because redundancy was not prioritized at the facility level of the model. It can also trigger preventive maintenance some distance away in a similar plant because a pump from the same supplier is installed at that water treatment facility. Functional models also provide systemic impact analysis support. Using enterprise architecture methodologies, such as CIMdata's Enterprise Application Architecture™, to relate use stories to systems to parts to maintenance history can help detect potential built asset pitfalls or weaknesses. These models, if implemented correctly, can result in significant lifecycle cost savings for the AEC/EPC, as well as the O/O. The ISO 81346 standard is getting traction to deploy global referencing systems across functional/spatial/system data structures. Pulling these data modeling and management capabilities together provides a powerful and integrated asset management solution, well beyond your typical BIM solution. Such a solution will close the gaps (e.g., relating

input BIM models from construction, remodeling, and maintenance projects to the broader digital asset of the built and operating facility). This solution would also deliver significant value by reducing data re-entry and duplication, as well as providing more actionable insight and asset understanding due to aligned, powerful, and accurate conceptual models based on digital thread enabled digital twins. Eurostep, a software and service provider that is based in Sweden, provides one such solution.

Eurostep is well known in the PLM industry for providing software and consulting services on a global basis that focus on the application and leverage of various “STandard for the Exchange of Product model data (STEP)¹⁰ standards, such as ISO 10303-239 (AP 239—the standard that defines “Product Life Cycle Support”). Eurostep’s ShareAspace and its iAIM solutions leverage this industry neutral data representation.

iAIM: integrated Asset Information Management

Understanding the shortcomings of many of today’s construction industry solutions, which either focus on the construction or project phase, or those that provide asset management support, are generally described as Project Information Management (PIM) or Asset Information Management (AIM) solutions. Additionally, concepts like Common Data Environment (CDE) (see Figure 3) are used but they are typically limited to PIM. All of this pointed to the need for a more integrated asset information management solution. Eurostep’s ShareAspace integrated Asset Information Management (iAIM) solution has been designed to solve the problem of sharing asset data between disciplines across the entire AEC/EPC-O/O industry and lifecycle. Like other Eurostep solutions, ShareAspace iAIM is compliant with a number of important data and process standards. For example, it supports spatial and functional structures for both openBIM standards (i.e., IFC and BCF) and closedBIM popular formats from Autodesk and soon Bentley.

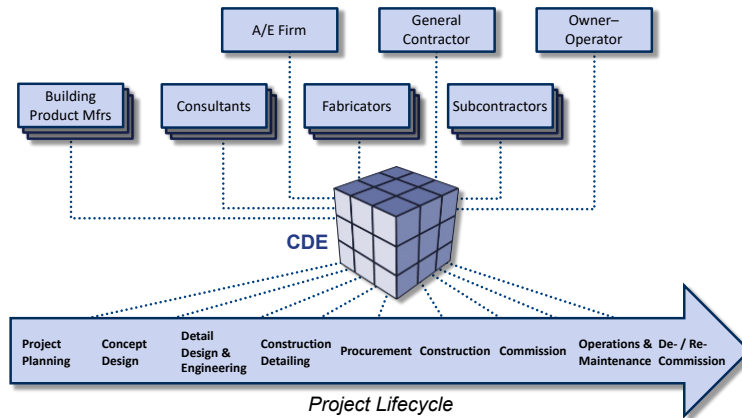


Figure 3—The Common Data Environment
(British Standards Institute PAS 1192-2:2013 and UK Construction Industry Council)

ShareAspace iAIM provides synchronized PIM and AIM, using open standards such as PLCS (AP 239) to handle the lifecycle management of configured data (see Figure 4).

¹⁰ An evolving international product data representation standard (ISO 10303).

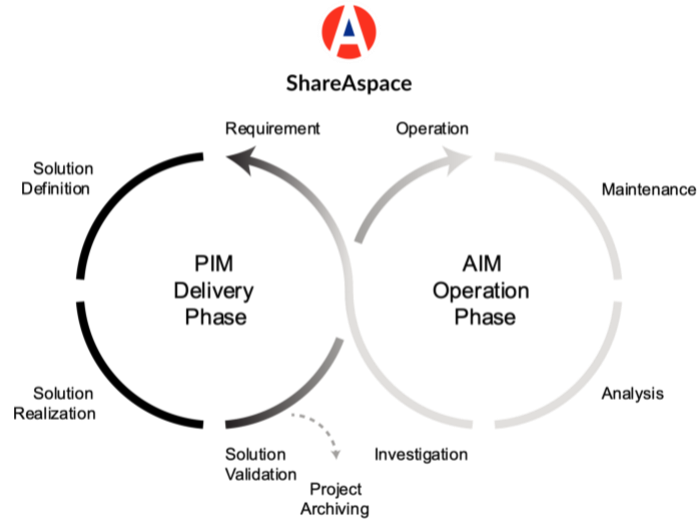


Figure 4—Lifecycle Management of Configured Data
(Courtesy of Eurostep)

Supporting PLCS has been a cornerstone for Eurostep for many years, as most other standards offer only limited views for built assets, and usually only for specific stages of an asset’s lifecycle. ShareAspace iAIM enables the online alignment between data models. For instance, an IoT sensor alert from a piece of equipment can trigger a BCF ticket update relating the alert to the related BIM object, including history for other surrounding BIM objects. Additionally, ShareAspace iAIM provides a strong library of organized data concepts, including the support of several out-of-the-box open standards like IFC or IEC/ISO 81346 (a standard that defines the rules for reference designation systems (RDS) focused on industrial systems, installations and equipment, and industrial products). Data stewardship is also addressed by the solution from a model-based point of view rather than “connecting pipes” like the current approach from Extract, Transform, and Load (ETL) software.

Eurostep reports that they have designed ShareAspace iAIM to enable the highest BIM level (i.e., Level 3, setting the information unit at the object level instead of the file level). It is a best-of-breed software solution designed specifically to manage common data for sharing and reuse across the construction lifecycle—from project concept to asset decommissioning. ShareAspace iAIM has been designed to connect different CDEs for a consolidated view of an asset’s digital twin, as well as to navigate an asset’s information and its models in many ways, supporting data-driven processes and delivering actionable insight. ShareAspace iAIM also provides timely access for all stakeholders of a project to accurate information for fast and precise incident response. Also, it should be noted that ShareAspace iAIM’s secure data access approach allows external organizations to access data based on data ownership and access rules. Critical for the construction industry where dozens of organizations need to collaborate to design, build, and maintain an asset for its entire lifecycle.

Finally, iAIM, being enabled on Eurostep’s ShareAspace platform, provides a proven and performance minded solution. Its graph database supports complex queries with no performance loss, and its development is based on automatic REST API publication of the data model and a versatile graphical user interface (GUI). Finally, Eurostep offers an Azure cloud hosted option or on-premises deployment.

Conclusion

Asset intensive industries have long struggled with a complex value chain where no one organization has complete end-to-end control of any given physical asset. AEC/EPC firms are typically only responsible for designing, building, and handing over a facility to an O/O. It is these O/Os who are ultimately responsible for the rest of the lifecycle of the physical asset, which can span many decades. Unfortunately, AEC/EPC firms often have difficulty delivering a complete and accurate information model to their O/Os, missing clear guidance from “data stewards.” Without an overarching data model and resulting digital twin of a physical asset, these O/Os, in turn, struggle to maintain their facilities making enhancing and modernizing difficult and more expensive. All of this points to the need for holistic and standards-based solutions that integrate processes across the end-to-end asset value chain, as well as manage the resulting data that are critical in solving major lifecycle issues.

Eurostep’s ShareAspace iAIM solution has been designed to solve the problem of sharing asset data between disciplines across the entire AEC/EPC-O/O industry and lifecycle. Like other Eurostep solutions, ShareAspace iAIM is compliant with a number of important data and process standards. Eurostep has leveraged its extensive experience solving similar long-asset-life collaboration and data management issues to create and deliver an integrated asset information management solution based on their ShareAspace solution offering. Being enabled on the ShareAspace platform, ShareAspace iAIM provides a proven and performance minded solution that seeks to overcome the lifecycle data challenges rampant across the AEC/EPC-O/O industry. This solution should be considered by those who want to overcome the issues commonly found in the AEC/EPC-O/O value chain.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise’s ability to design, deliver, and support innovative products and services by identifying and implementing appropriate digital initiatives. For nearly forty years, CIMdata has provided industrial organizations and providers of technologies and services with world-class knowledge, expertise, and best-practice methods on a broad set of product lifecycle management (PLM) solutions and the digital transformation they enable. CIMdata also offers research, subscription services, publications, and education through certificate programs and international conferences. To learn more, visit www.CIMdata.com or email info@CIMdata.com.