A framework for implementing a BIM business transformation

There are few experiences that test the mettle of corporate leadership like implementing radical change within a large organisation. Whilst business transformations are nothing new to industry, the kind of transformation we are seeing from Building Information Modelling (BIM) today presents a new and unique set of challenges for the infrastructure industry, owing in large part to the technical complexity, scheduling, and financing of today's projects. For the complex and highly diverse companies that carry out these projects, the successful implementation of BIM poses distinct challenges at every level, and requires a careful and structured approach that takes into consideration the many integrated components of an organisation's business. With these challenges in mind, organisations are deciding to implement BIM due to the clear benefits at any levels offered by this innovative yet common sense approach. We know that implementing BIM starts with vision and leadership, but it is ultimately driven and successfully carried out through effort on the "shop floor" by the individuals who will apply BIM in their day-to-day execution of projects. To assist organisations in making a BIM business transformation a reality, this white paper will outline a high-level framework for implementing BIM—the key elements we have found that every successful implementation must consider.

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Introduction

BIM as a concept has surpassed the original significance of its name. From its origins as a technology-focused improvement to building design, we now see BIM as an approach to radically transforming and improving the overall business performance of organisations working in all sectors of the built environment. To say this is not to detract from the importance of “building,” “information,” and “modelling,” but to apply the broader, far-reaching BIM concept across all relevant industries, which is an even more radical and significant improvement over traditional approaches than considered possible when BIM was originally conceived.

What is BIM? As a concept, BIM is still evolving and as such, the definitions resulting from a review of current published literature vary. In general, BIM can be defined in a very limited way, focusing exclusively on the technology aspect, to a very broad definition, encompassing other organisational and operational aspects such as governance, processes, standards, and people. What is common to all definitions is the model-centric aspect of BIM; just as the benefits of BIM are derived from this model-centric approach, the implementation of BIM must address it. Therefore, in this white paper we take a broad and holistic definition of BIM, one that defines BIM as a collaborative, interdisciplinary model-centric approach to improving an organisation’s operations. BIM is squarely focused on improving the design, construction, and lifecycle management of all assets for the built environment, and that is done by inter-leaving processes, standards, and integrated modelling technology throughout the asset life cycle, from project execution to the built asset’s operation and management.

In the case of the infrastructure sector, BIM can transform the way owners, contractors, designers, planners, and those in a myriad of other roles that carry out projects come together to perform their jobs. Of course, when this transformation occurs at a high level, such as when an asset owner organisation has the vision to not only transform itself but its entire supply chain, the impact on project execution and inter-project coordination can be even greater. That isn’t to say that architecture, engineering, and construction (AEC) companies don’t benefit (in fact, the operational benefits for these companies are large), but that the power of a BIM business transformation on a major capital programme is considerable.

Infrastructure projects

Projects in the following sectors are often classified as infrastructure projects:

- Roads & Highways
- Rail
- Bridges
- Airports
- Ports
- Water
- Gas
- Electricity
- Telecommunications
- Public Health & Safety
- Storm Water and Waste water
- Flood Mitigation & Defence
- Environmental Management

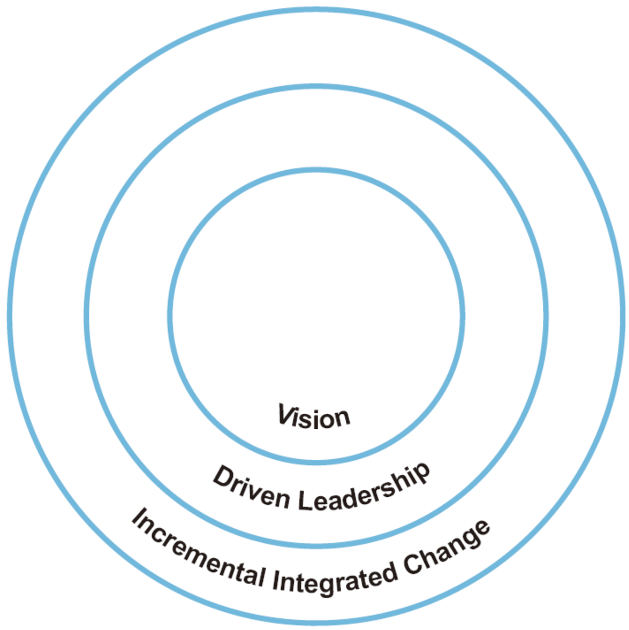
A framework for implementation

To be effective, a BIM implementation must reach across a business. It cannot be an IT initiative, or an R&D one, or done solely at a project or disciplinary level. These approaches (often called “lonely BIM”), whilst yielding some results, in the end do not transform a business, and deliver only a portion of the benefits promised by BIM. We have seen many BIM implementations that start on the shop floor or in the IT department deliver mediocre results, or even fail. These implementations were often opportunistic, taking advantage of project budgets and project stakeholders’ eagerness to “do BIM”; however, they missed out on the most valuable benefits BIM has to offer.

Conversely, the implementation framework presented in this white paper is based on an organisational transformation that starts with executive vision and sponsorship, but is carried out by an organisation's leaders and its project workforce. The framework is based on three essential strategies, each integral to the performance of the others. These three strategies are shown in the figure below.

Vision:

Essential to the success of implementing BIM is a succinct and well-articulated vision from executive leadership of what the BIM business transformation will achieve for the organisation, what the principle elements of the transformation are, and what this evolution will look like at various stages. This isn't just a vision statement; it is a narrative of where BIM will take the organisation.



Driven Leadership:

Leaders in an organisation undergoing a BIM business transformation are responsible for driving and motivating change throughout the organisation. There will be peaks and troughs of energy and inspiration, and these leaders must ensure that the transformation keeps moving forward. They must tangibly connect the vision to the integrated change that takes place on the shop floor.

Incremental Integrated Change:

The implementers of a BIM business transformation are the people working daily on the shop floor. In order to deliver on the BIM vision, changes must be integrated across business activities, with clear incremental improvements at each milestone. Change is realised through new policies and strategies, organisational change management, standards and processes, and integrated technology-enablers.

BIM vision

Essential to avoiding the pitfalls that organisations encounter when implementing large-scale, radical change is to ensure there is a solid vision of where the organisation is going. Without this vision of BIM and the executive leadership behind it, the effort to adopt new business practices will struggle and waste the dedicated resources. Using published references and guides for implementing BIM standards, and best practices—such as the U.S. National BIM Standard, the U.K. BSi Standard Framework and Guide to BS1192, or the Pennsylvania State University's BIM Project Execution Planning Guide and Templates—are a good starting point, but there is no established standard that will fit the situation of every organisation, with its wide variety of project types and strategic goals. To be successful at implementing BIM, organisations need a strategy that conforms to their specific needs and business values.

Therefore, successfully changing how an organisation performs starts with vision. This may seem like common sense, but as mentioned previously, it is surprising at times how many organisations see BIM as a technology or a technique to be applied only at the project level. To truly reap the advantages of BIM, executive leadership must learn to think, communicate, and manage expectations around BIM (in some cases requiring education for executives on these new processes). Executive leadership must be capable of positioning BIM within the overarching strategic objectives of the entire organisation. Remember, if BIM becomes a research and development initiative, or solely an IT roll-out, the performance promised from BIM will never be realised.

Key considerations for creating an effective BIM vision:

> **Inspirational and aspirational:** The vision must be far-reaching and sufficiently aspirational to unite the various elements of the organisation. A BIM implementation that is rolled out as a run-of-the-mill technology implementation exercise will not necessarily energise the organisation or provide the momentum needed to get through eventual lulls in motivation. The vision must break down into consumable steps (see “Milestone Accomplishments” below) whilst defining the big ideas. The steps must be prioritised and clearly indicate who they affect in the organisation. A common pitfall here is defining an inspired BIM outcome for an organisation with uninteresting intermediary steps of minimal value.

> **The five Ws:** Brevity and clarity are essential to communicate a BIM vision to the organisation. The Five Ws (Who, What, Where, When, and Why) will give each part of the organisation the factual details of the BIM vision it needs to execute its share of the work. Some of the questions will be challenging to answer and will require executive leadership to take risks.

> **Milestone accomplishments:** Staggering starts and creating milestones helps the organisation to overcome the initial paralysis of a monumental task. They also help to create short-term “wins” that can help generate energy and feed the momentum of the organisation toward the vision end-state. A methodical BIM implementation provides a logical set of milestones (in addition to specific ones specific to the organisation) based on a progression of BIM maturity. Adding staggered initiatives and pilot projects to the implementation plan also provides an opportunity for frequent recognition of achievements.

These are just a few considerations when creating a BIM vision. Of course, there are many sources in business literature for vision planning techniques. They have the same validity and limitations in the context of BIM as they do in other industries. However, implementing a vision in the context of the infrastructure sector has its particularities (like any industry), such as at major capital project, major capital programme, and industry-wide levels. The specific context of the organisation and the market sectors it serves may require executive leadership to be educated on BIM, and to consider its impact in setting corporate strategies.

Ideally, the BIM vision would come from an executive level; however, today it is not uncommon for mid-tier BIM leadership to struggle to put BIM in the direct focus of an organisation's executives. In this case it may be necessary for BIM leaders to describe the vision themselves whilst seeking executive sponsorship. This step can serve as a transitional step (not an ongoing approach) toward an executive-driven business transformation. Whilst not ideal, Autodesk has seen some organisations succeed with this transitional approach, although it does limit some of the broader organisational BIM benefits, and increases the risk of a business transformation failure.

Lessons learned from the 2012 London Olympics

The importance of effective data provision and management processes was underlined by the experience of the £7.2 billion London 2012 Olympics programme. A common CAD collaboration platform was deployed to provide significant benefits in management and sharing of design and other project data, as well as reduce project coordination and information access issues. However, limited enforcement of standards and processes for data sharing and usability challenges, as well as dissatisfaction with the implemented solution, meant that in practice, first-tier suppliers and their supply chain each used their own systems within the Olympics projects. As a result, the client and programme management organisation needed to source data from multiple platforms.

Recommendations and lessons learned from the Olympics programme included:

- Establish a detailed plan of data requirements and standards at the outset
- Clear and simple guidance
- Progressive build-up of documentation
- User-friendly interfaces for data access and retrieval
- Continuous effort invested to update handover records to reflect overlay works, new scope, and so on
- Clear contractual obligations coupled with commercial incentives to provide information to required formats and standards

Further lessons include focusing on the value of fully coordinated 3D data that can be effectively provided from a BIM platform. Technology limitations on the deployed collaboration platform and delivery standards meant that the coordination model for the Olympics programme were in 2D only. It was proposed that integration of CAD and GIS data in a BIM environment would have helped designers to better achieve spatial coordination and eliminate time spent converting data between platforms.

Reference: Jennifer Whyte et al, Data handover from project delivery into operations, London 2012 Learning legacy, ODA, October 2011 (www.london2012.com/learninglegacy)

Driven BIM leadership

Innumerable surveys across any industry will attest to the difficulty in implement- ing change across large organisations and ecosystems. Any large-scale transformation, like implementing BIM, requires a BIM vision and integrated incremental change over a prolonged period of time. The challenge at the BIM leadership level of the organisation is ensuring that the BIM vision and the integrated incremental change are aligned. The BIM leadership team must ensure that the BIM vision is translated into actionable tactics and measures to produce the desired outcomes and performance in line with an organisation's strategic objectives.

Managing change—lasting, sustainable change—in any organisation is difficult and requires creative strategies tailored to the culture and particularities of the organisation at hand. That said, the organisational change management challenges Autodesk sees in many BIM leadership teams are common.

The following list highlights some common focus areas to assist in overcoming stagnant BIM implementation initiatives:

Bridging the gap: Whilst the BIM vision articulates an ultimate destination, it is also essential to carry out specific actionable steps to get there. As stated previously, the vision of a BIM-transformed organisation is realised on the shop floor. Therefore, if the architects, engineers, planners, fabricators, surveyors, and the many other related practitioners don't see the value in implementing their part of the BIM business transformation, the transformation will likely be stunted. Top-down approaches based on clear communication from executives and BIM leadership are important, but must be accompanied by bottom-up approaches, such as assessments, education, and change validation through piloting, to have a high likelihood of success.

High-profile communication: In line with raising awareness for top-to-bottom buy-in in an organisation, it is important that organisations communicate their ambitions and accomplishments related to BIM, not only internally but externally, too. A high-profile communication plan demonstrates to all stakeholders the organisation's commitment to BIM, helps to inject energy into the transformation, and bridges the gap from executive theorising to a daily reality.

Training & education: A BIM transformation requires new skill sets and new ways of working. It also requires an understanding of sometimes new and misunderstood BIM concepts. BIM practitioners will need the training and education to support their adoption of BIM into their daily work projects. BIM training and education programmes also drive and motivate practitioners, building up valuable intellectual capital in an organisation.

Contracts and legal considerations: BIM tools and their associated processes impact the contractual relationship between owners and their delivery partners. As a collaborative tool, BIM is a catalyst for changing the relationships and agreements between project stakeholders. BIM-enabled collaboration is a significant change to traditional processes (with great potential to improve the working relationship among the team), but it can also generate new challenges that need to be resolved.

Compliance, auditing, and quality control: Project reviews permit BIM leadership teams to evaluate lead measures and the effectiveness of BIM technology, standards, and processes on various project types. BIM leadership catch errors, improve standards and processes, and reproduce best practices on other project teams across the organisation. These reviews are also an excellent source for harvesting success stories that can infuse energy into the transformation process.

Major capital programme performance

Major capital programmes and the projects that make them up are characterised by cost and time overruns. Factors regularly cited include poor coordination across projects, poor collaboration within project teams, and confrontation between delivery partners and clients. In particular, capital project failure rates worldwide are found to be upward of 60-75 percent, with cost overruns of 30-50 percent and schedule overruns of up to 100 percent not uncommon. According to a recent study by the Independent Project Analysis Institute, major capital projects worldwide are found to have a 60 percent failure rate in terms of cost or schedule targets.

A brief analysis of historical industry data from around the world for major capital programmes reveals the performance indicator statistics shown in the table below.

Global major capital project failure rates

Infrastructure projects	Building projects
• Cost overrun by / variation: 10–50% • Schedule overrun by / variation: 30-120% • About 2/3 of the projects yield a budget and schedule overrun	• Cost overrun by / variation: average 15%, majority of projects with an overrun in the range of 5%–20% • Schedule overrun by / variation: average 50%, majority of projects with an overrun in the range of 30%–120% • About 2/3 of the projects yield a budget and schedule overrun

The cost of BIM

Autodesk has conducted BIM implementations on many projects of varying scales over recent years. Analysis of a subset of these projects' performance has revealed a number of trends:

- 80 percent of projects analysed needed to modify project setup substantially, costing approximately £11,000 per project
- 100 percent of projects that did not reconfigure poorly setup models bore approximately £14,000 of costs downstream (on an average five-person design team)
- Design iterations are to be expected; on a major civil infrastructure project, up to £52,000 of 'production' savings was achieved, and £17,000 was saved on a large healthcare scheme for undertaking ten design iterations. Such savings would be negated due to lost productivity executing iterations where modelling had not adopted BIM standards and best practices.

Measuring BIM maturity: BIM leadership will create many of the lead measures to predict the organisation's progress toward the goals and milestones laid out in the vision. A useful set of measures for BIM are related to BIM maturity. BIM maturity measures an organisation's capability to perform BIM within the organisation and on projects. There are a number of different types of maturity measurements, but at a high level they tend to focus on the technological and organisational transformation in an organisation, thereby providing a useful indication of an organisation's progress in implementing a BIM business transformation.

Incremental integrated change

As stated previously, a BIM business transformation can deliver real business benefits, but it requires companies to evolve their current beliefs, culture, technology, and standards. Changing the way infrastructure organisations work today is no small task. This transformation requires organisational and process improvement, technology adoption, and alignment with overarching strategies and goals to fully realise the organisation's BIM vision.

This change is where the implementation unfolds across an organisation. There are many new workflows and procedures that must be planned, tested, and deployed. With so much to address, Autodesk has grouped these changes into key BIM implementation areas for generating change in an organisation.

These high-level implementation areas are:

1. **Policies & strategies:** Approaches and benefits for adopting BIM that align with the overall goals and objectives of the organisation for competitive positioning, operational excellence, and effective delivery

2. **Change management:** The BIM change and adoption programme built to deliver the expected benefits in operational performance through programme coordination, knowledge transfer, performance management, and education and training

3. **Standards and processes:** Definitive standards and processes governing all projects and programmes that define BIM usage, support the application of those practices, and enable stakeholders to operate effectively whilst adhering to the established methods

4. **Integrated BIM technology:** BIM process and model management tools integrated with enterprise systems to deliver information in a collaborative environment across the organisation and project teams

Whilst the above implementation areas address the critical factors of integrated change in an organisation, there is also an underlying prioritisation that should be observed.

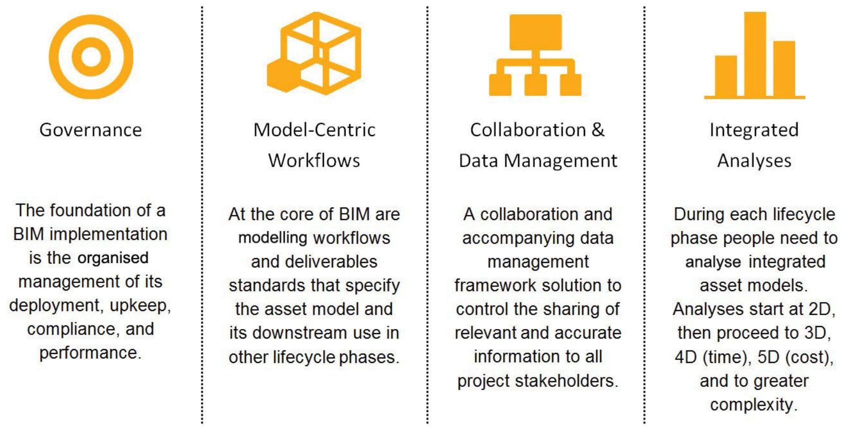


Figure 1: BIM implementation precedence

Autodesk has seen that organisations that stay focused on a logical order of change prioritisation are more successful in achieving the benefits targeted in implementation planning efforts. The order of priority when increasing the maturity of a BIM implementation is shown in figure 1—increasing BIM maturity starts on the left and continues to the right with collaborative and analytical capabilities built on the foundation of solid governance and modelling. Whilst this prioritisation is clear, that is not to say that these four categories are implemented sequentially; they are integrated areas of improvement, each area incrementally benefiting and alimenting the improvement of the other.

Bringing these two concepts together, Figure 2, below, shows each of the integrated BIM implementation areas listed above (e.g., BIM Policies and Strategies) and how it relates to the implementation priorities detailed in Figure 1 above (e.g., Collaboration and Data Management). Each implementation area is shown as a colour band demonstrating where it impacts the implementation and highlighting its key influences and outcomes.

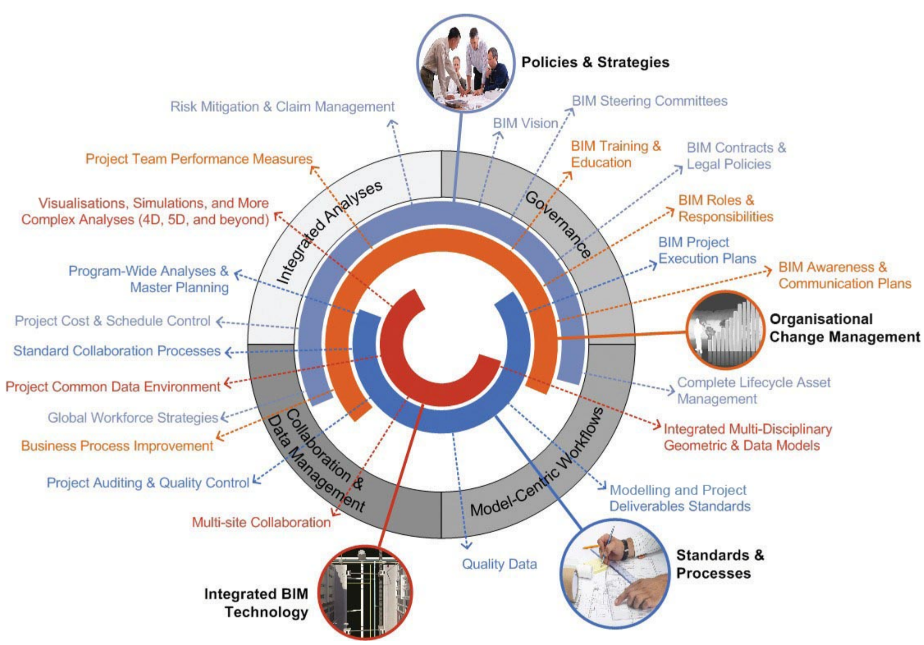


Figure 2: BIM implementation wheel

Glossary & Acronyms

2D – Two-dimensional: The use of design curves and figures in two-dimensional space for analysis; 2D exists and has a valid place in BIM.

3D – Three-dimensional: The surfaces and solids in three-dimensional space normally associated with geometric modelling and analysis in BIM. BIM requires 3D, but 3D can exist without BIM as simple objects without intelligence. Common types of 3D analysis include visualisations, clash detections, “fly-bys,” aesthetics, and sight lines, among others.

4D – Four-dimensional: The aspect of time built in to 3D analysis. This type of analysis is usually in the form of project phasing and construction sequencing. The addition of chronological data in 3D models permits project stakeholders to visualise a series of events in time and display them in 3D for analysis.

5D – Five-dimensional: The aspect of cost built into a 4D analysis. The construction of the 5D model enables project stakeholders to visualise the progression of construction activities and its related costs over time.

AEC – Architecture, engineering, and construction: Three built environment industries, often grouped together representing the project execution sector of the built environment.

Integrated analyses – During each lifecycle phase, people need to integrate various modeled asset elements for analysis. This implementation category focuses on implementing different types of analyses. The objective of the implementation is to make these analyses systematically available as a by-product of the model-centric workflows. For the most part, BIM analyses start at 2D, 3D (visualisations, clash detection, aesthetics, etc.), and then extend to 4D (3D plus time attributes), 5D (4D plus cost attributes), and then on to greater levels of complexity (some refer to ever-increasing levels of nD analysis, but for clarity, beyond 5D we will specify the type of analysis by name).

Building Information Modelling (BIM) – An integrated model-centric approach aimed at providing coordinated, reliable information about a building project throughout different project phases, from design through construction and into operations. BIM gives engineers, builders, owners, and others a clear overall vision of the project—helping them make better decisions faster, improve quality, and increase profitability.

BIM execution plan (BEP or BIM PxP) – A plan that is created to define roles and responsibilities within a project team. It is based on team, technology, and project requirements and allows the project team to determine the best path forward for BIM to achieve the project goals. Its purpose is to set clear goals and objectives across the team, increase accountability and productivity, standardise communication methods, define roles and responsibilities, and to control project cost, schedule, scope, and quality.

Business transformation – Fundamental change in the way a business operates, whether by moving into a new market or by changing its methods of operation. It requires alignment of an organisation's activities relating to people, process, and technology with its business strategy and vision. This fundamental change aims to meet long-term objectives.

Collaboration and data management – Throughout the asset lifecycle, data and information must be efficiently and effectively shared among all asset stakeholders. This implementation category focuses on collaborative processes and procedures and the accompanying data management framework. It can be broadly organised into the implementation areas of data sharing, information sharing (metadata), integration, and interoperability.

Infrastructure – The physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions such as roads, bridges, water supply, sewers, electrical grids, and telecommunications.

IT – Information technology: The study, design, development, application, implementation, support, or management of computer-based information systems and a branch of engineering dealing with the use of computers and telecommunications equipment to store, retrieve, transmit, and manipulate data.

GIS – Geographic information system is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data.

Governance – This implementation category focuses on the management, control, and direction of BIM use throughout an organisation's asset and project ecosystems. BIM governance can only be as effective as the level of authority and clarity of vision possessed by its governing body. Therefore, some key elements of effective governance include BIM vision, BIM steering committee (or equivalent governing structure), and BIM-related policies and strategies.

Lag measures – Metrics that indicate overall performance (for example, crop yield is a lag measure, whilst crops planted is a lead measure).

Lead measures – Metrics that predict overall performance (for example, crop yield is a lag measure, whilst crops planted is a lead measure).

Model-centric workflows – At the core of a BIM approach to project execution and asset lifecycle management are model-centric workflows (geometric and data models). These workflows determine the methods and techniques for creating asset models, asset modelling content, modelling deliverables (such as plans and other outputs for downstream use), and the model "critical path" to migrate from project planning all the way to the operation and management lifecycle phases.

NBIMS – National BIM Standard (U.S.)

R&D – Research and Development

RIBA – Royal Institute of British Architects (U.K.)

SME – Subject-Matter Expert

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