Tech Brief

U.S. Department of Transportation
Federal Highway Administration

ADVANCING THE DEVELOPMENT AND DEPLOYMENT OF BIM FOR INFRASTRUCTURE

BACKGROUND

This Tech Brief highlights the origin of Building Information Modeling (BIM) from the National Institute of Building Sciences and its application across the life cycle of an infrastructure asset. Successful adoption of BIM for Infrastructure is a critical step towards a future of "smart" infrastructure that is data-driven from design concept to maintenance and operations. The FHWA is convening a task force to develop a national strategic roadmap to advance the development and deployment of BIM for Infrastructure.

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WHAT IS BIM FOR INFRASTRUCTURE?

The National BIM Standards (NBIMS) executive committee defined the term Building Information Modeling (BIM) to be "a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle" (Davis 2007). BIM is a digital conduit of information between the design, construction, and operations of an infrastructure asset.

Improvements in software and hardware have increased BIM's value potential. The ubiquity of cloud storage and mobile device usage has enabled BIM to expand from a single-use design tool to a multidimensional coordination, construction management, and operations platform.

BIM supports process optimization and data interoperability throughout the life cycle of an infrastructure asset. BIM provides the ability for design-build project teams to build the project "twice"—once virtually and again in real life. Building virtually first allows the traditional errors that plague construction productivity to be mitigated before a single dollar is spent in construction. The opportunity to integrate BIM data across the design, build, and operate (DBO) supply chain can benefit all infrastructure stakeholders, not just those in the construction phase. More importantly, BIM results in a digital record of what was built for use throughout the entire life of the asset.

Previously isolated to the vertical design and construction markets, BIM adoption on US transportation projects has been on the rise (Laquidara-Carr 2017). Building—the "B" in BIM—refers to the act of building, not the physical structure. Information—the "I" in BIM—is the key to success, but only when it is accurate and reliable. Model—the "M" in BIM—can represent a 3D geometric model or a mathematical or business model. Passing project information seamlessly across the DBO supply chain involves a significant shift in mindset, process, and policy.

The focus of BIM is to connect project and asset data, but it is not the only technology that leverages those data. The opportunity for return on investment comes from the integration of BIM data with other dimensions of project delivery, including schedule (4D), productivity (5D), sustainability (6D), and operations (7D). This digital information should also sync and exchange with geographic information system (GIS) and other infrastructure asset management databases. Aligning BIM for Infrastructure in the US with international standards may be useful.

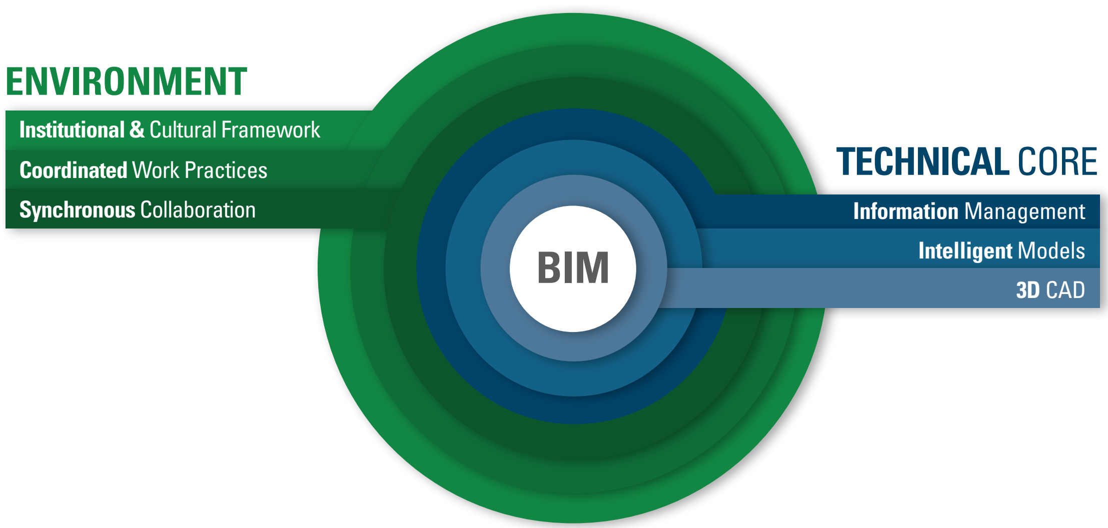
BIM BENEFITS AND IMPLEMENTATION

The intended benefits of BIM look to improve productivity and quality. However, the primary benefit of BIM begins with improved communication. According to "The Business Value of BIM for Infrastructure 2017," a report by Dodge Data & Analytics, the number one benefit of BIM is "improving [the] ability to show younger staff how projects go together." The top listed outcome from adopting a BIM process is "fewer errors" (Laquidara-Carr 2017).

Capturing the return on investment in BIM involves foundational changes to both technical and nontechnical aspects of project delivery, operations, and maintenance. Figure 1 shows the environmental and technical components.

The technical core of BIM is made up of three components: 3D computer-aided design (CAD), Intelligent Models, and Information Management. 3D CAD represents the spatial geometry and extent of a project and is produced to a specified level of development. The next layer, Intelligent Models, is the use of parametric rules to better automate the design production and asset delivery. The last layer of the technical core is Information Management, where the project team has access to an organized and searchable BIM with reliable data that are referenced to existing systems such as GIS.

The environmental conditions include Synchronous Collaboration, Coordinated Work Practices, and changes to the Institutional and Cultural Framework. BIM enables project teams to abandon linear workflows and adopt parallel processes through synchronous collaboration. This produces exponential time savings and productivity gains, but only when there are coordinated work practices. These new collaboration and data standards can only be adopted when there is an institutional and cultural framework that supports them.



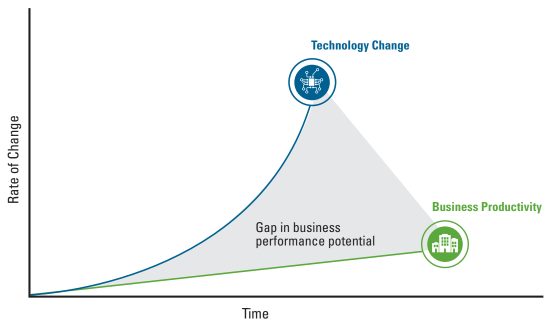
Adapted from WSP, 2013 (no longer available online). What is BIM? *News In the Media*.

Figure 1. Environmental and technical components of BIM

DEPLOYING BIM FOR INFRASTRUCTURE

The deployment of BIM is by definition a digital transformation that involves the integration of people, processes, and technology. As Deloitte University explains in their report "Rewriting the Rules for the Digital Age," these transformations do not happen all at once. Figure 2 presents a graphical representation of the pressure business faces when technology advances exponentially compared to historically linear expectations.

The success of digital transformation initiatives like BIM depends less on the maturity of the technology itself. Rather, it is the ability for digital tools to enable teams to solve traditional challenges in new and innovative ways. Figure 3 depicts the reality of digital transformation through four separate "tipping points"—Technology, Individuals, Businesses, and Public Policy. BIM is a mature technology, but it is only as effective as the individual using it. The success of BIM may be affected by that willing individual working within a business environment where there is an incentive to adopt and deploy BIM. The success of BIM also may be affected by whether Public Policy supports BIM adoption.



Bersin et al. 2017, adapted from © Deloitte Development LLC 2017, used with permission

Figure 2. What APPEARS to be happening

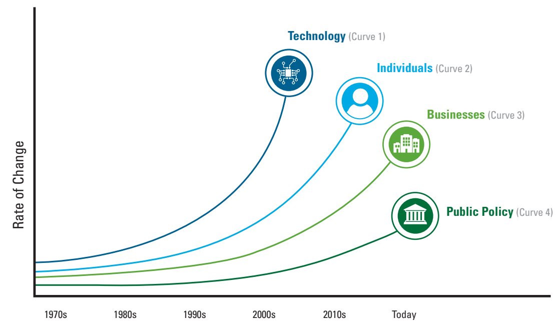


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Figure 3. What is ACTUALLY happening

To collaborate and share BIM data across the DBO life cycle, contract incentive and government policies should work together to support digital transformation. Changes at the government level can take time due to the number of variables that must be considered. The byproduct of BIM collaboration should be closer partnership and knowledge sharing between state agencies, local transportation officials, and third-party contractors. To produce exponential value from the use of BIM, it is critical to identify the impacted stakeholders and align their motivations to adopt the necessary changes.

BIM brings together enabling technology and process transformation to improve the quality and speed of infrastructure project delivery. BIM also provides a structured data handover to be utilized during the operations and maintenance phase. Underneath the photo-realistic 3D renderings and high-density laser scans lie a sea of data with the potential to significantly benefit all project stakeholders. The intersection of mobile devices, cloud computing, and business intelligence have solidified the potential for infrastructure projects to embrace BIM. Thus, the question for DOTs and external stakeholders may no longer be if BIM can be adopted, but when and how.

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DISTRIBUTION AND AVAILABILITY
This tech brief can be found at https://www.fhwa.dot.gov/construction/bim/.

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ADVANCING BIM DEPLOYMENT: WHAT IS NEXT?

For BIM to connect disparate sources of data across the infrastructure life cycle, project delivery and operations stakeholders should be equipped with the right tools, processes, and incentives to work more collaboratively and exchange reliable data from virtual reality to reality and back.

According to 2017 survey data from Dodge Data, the United States leads Germany, ties France, and trails the United Kingdom by only 2% in the utilization of BIM for Infrastructure. Of those not using BIM, the majority of respondents claimed that although they have not used it, they are open to exploring its potential value.

Successful BIM adoption involves reinspecting the everyday roles and responsibilities of each stakeholder along the infrastructure life cycle from a new perspective. BIM is a catalyst for improving the exchange of data between stakeholders across the project delivery process, consistent with legal requirements. If there is a current administrative workflow that is causing waste and frustration for multiple stakeholders, this may be a place to start implementing BIM.

In February 2019, the FHWA convened a BIM workshop with participants from the state DOTs and industry and BIM subject matter experts to discuss BIM for Infrastructure in the US.

REFERENCES

Bersin, J., B. Pelster, J. Schwartz, and B. van der Vyver. 2017. Introduction in *Rewriting the Rules for the Digital Age: 2017 Deloitte Global Human Capital Trends*. Deloitte University Press. https://www2.deloitte.com/content/dam/Deloitte/global/Documents/HumanCapital/hc-2017-global-human-capital-trends-gx.pdf.

Davis, D. 2007. *National Building Information Model Standard NBIMS*. National Institute of Building Sciences, Washington, DC, and AEC Infosystems, Inc. Baltimore, MD. p. 9. http://portal.opengeospatial.org/files/?artifact_id=20644.

Laquidara-Carr, D. (managing editor). 2017. Executive Summary in *SmartMarket Report: The Business Value of BIM for Infrastructure 2017*. Dodge Data & Analytics, Research & Analytics, Bedford, MA. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/finance/us-fas-bim-infrastructure.pdf.