U.S. Department of Transportation

Federal Highway Administration

Building Information Modeling (BIM) for Infrastructure

How It Affects Your Workflow

Agenda

- Concept of BIM for Infrastructure
- Applying BIM for Infrastructure
- State DOT example projects to date
- Lessons learned

Concept of BIM for Infrastructure

- BIM means build it twice, once virtually
- Digital representation of the physical and functional characteristics of an infrastructure asset
- The process of developing a precise, data rich, virtual 3D representation of existing and proposed elements belonging to a programmed construction project
- Serves as a shared knowledge resource for information about an infrastructure asset
- Basic premise: Collaboration by different stakeholders at different phases of the life cycle of an infrastructure asset (insert, extract, update or modify information)

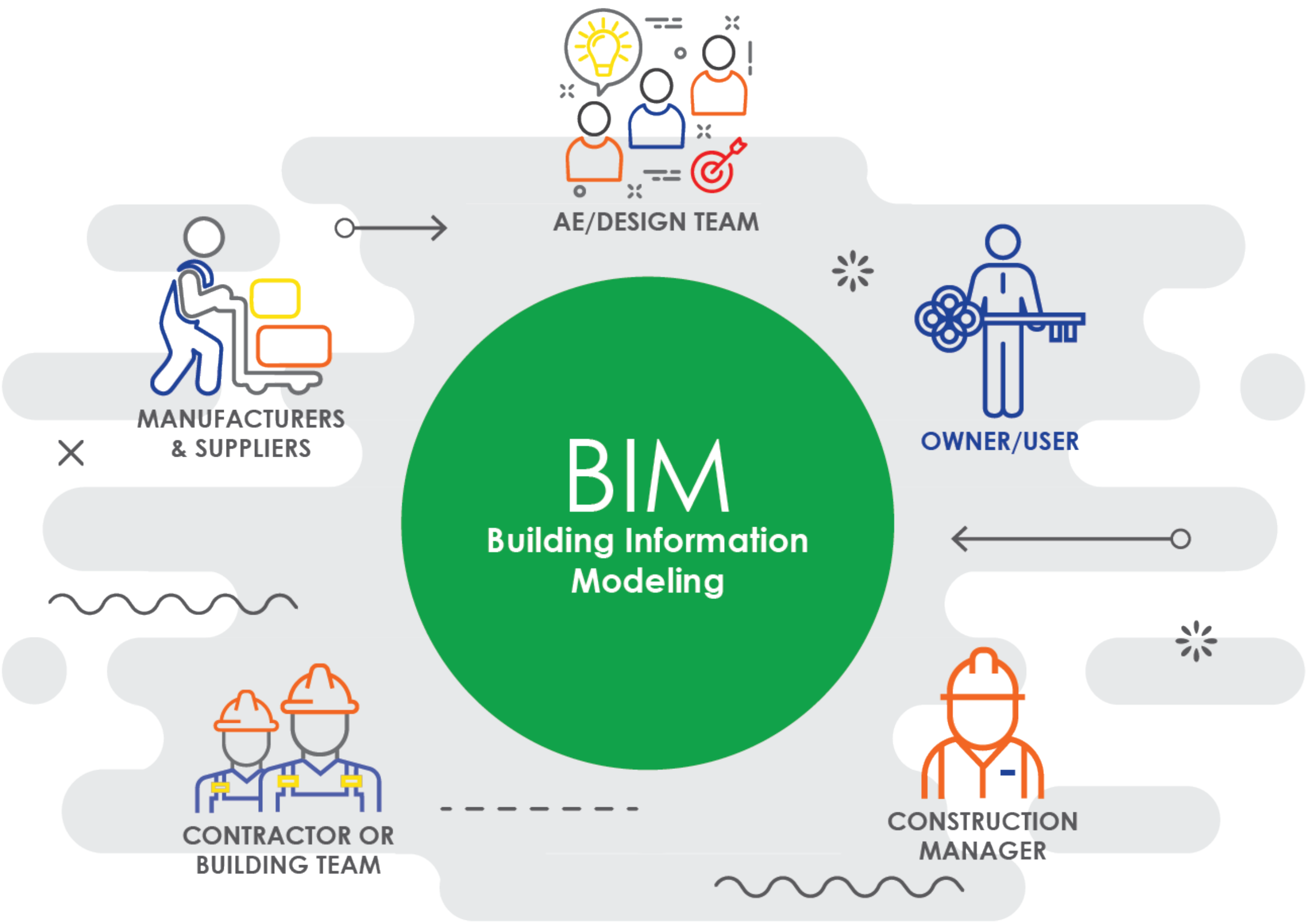
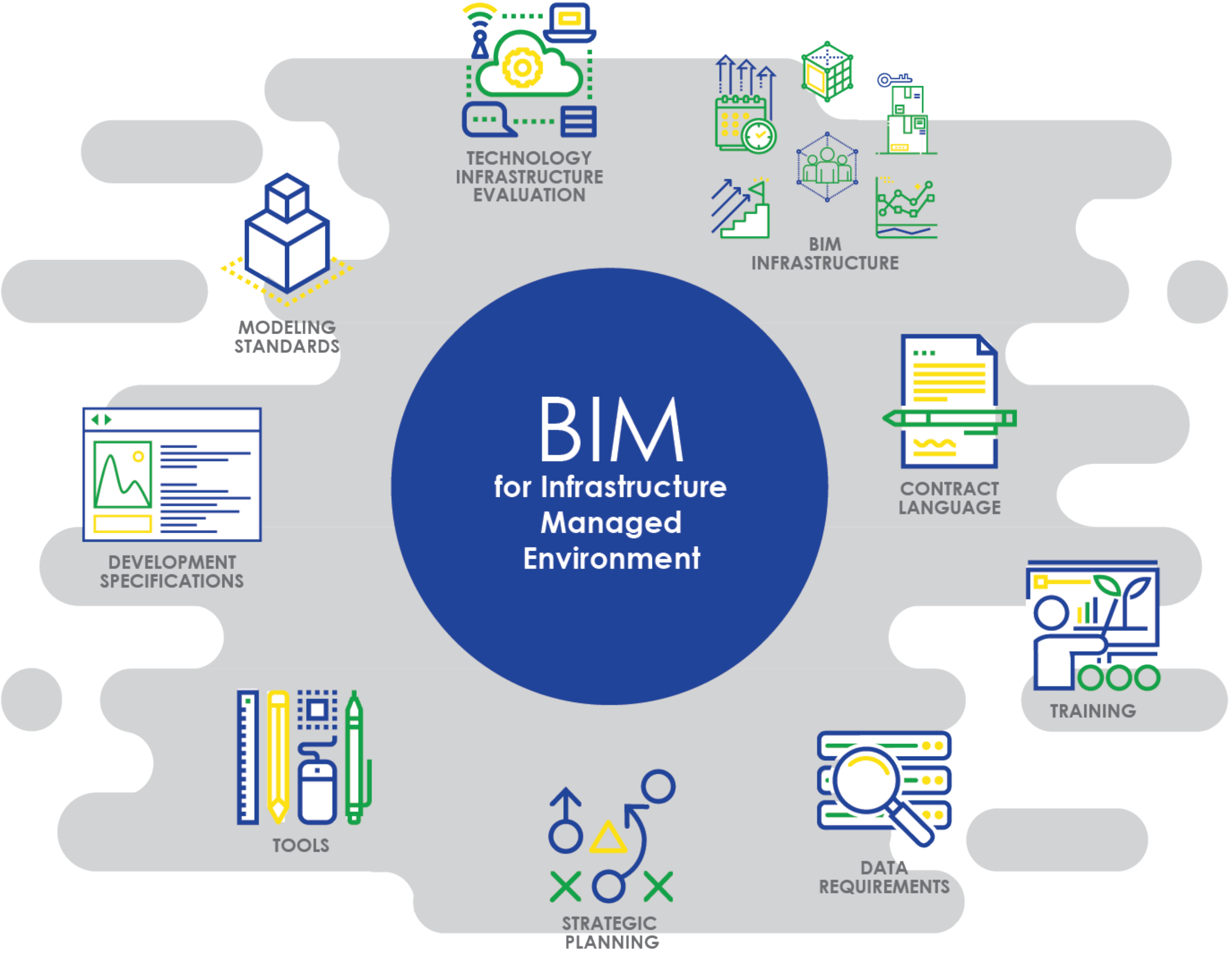


Illustration: HDR, used with permission

BIM for Infrastructure: The Environment

Critical factors for success:

- Clear and precise contract language
- A strategically planned and well-managed common data environment
- Owner originated data requirements
- Modeling voluntary standards that are not regulatory in nature



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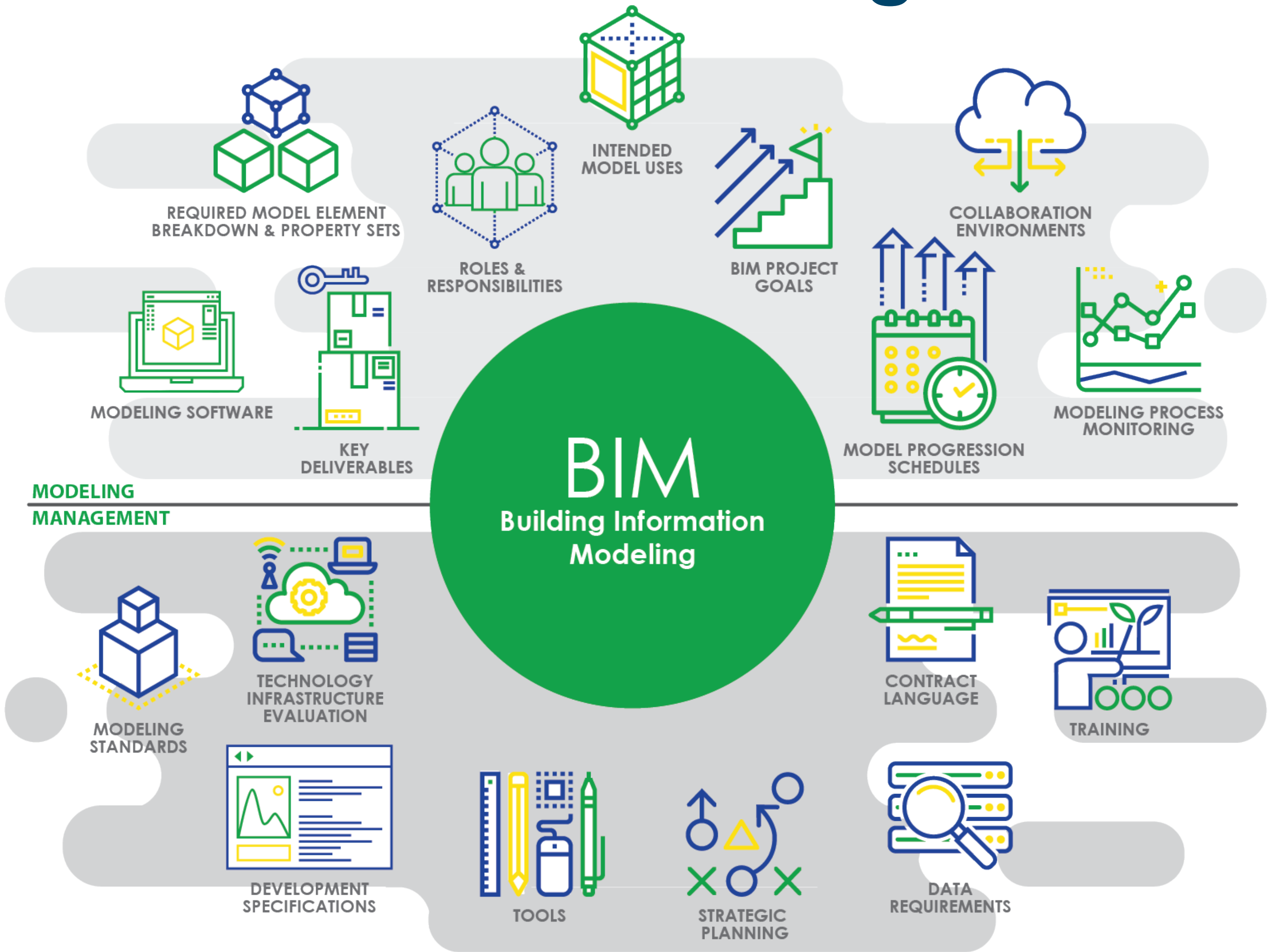
Note: The data requirements and modeling standards are voluntary and are not required or enforceable under Federal statute or FHWA regulations.

Building Information Modeling



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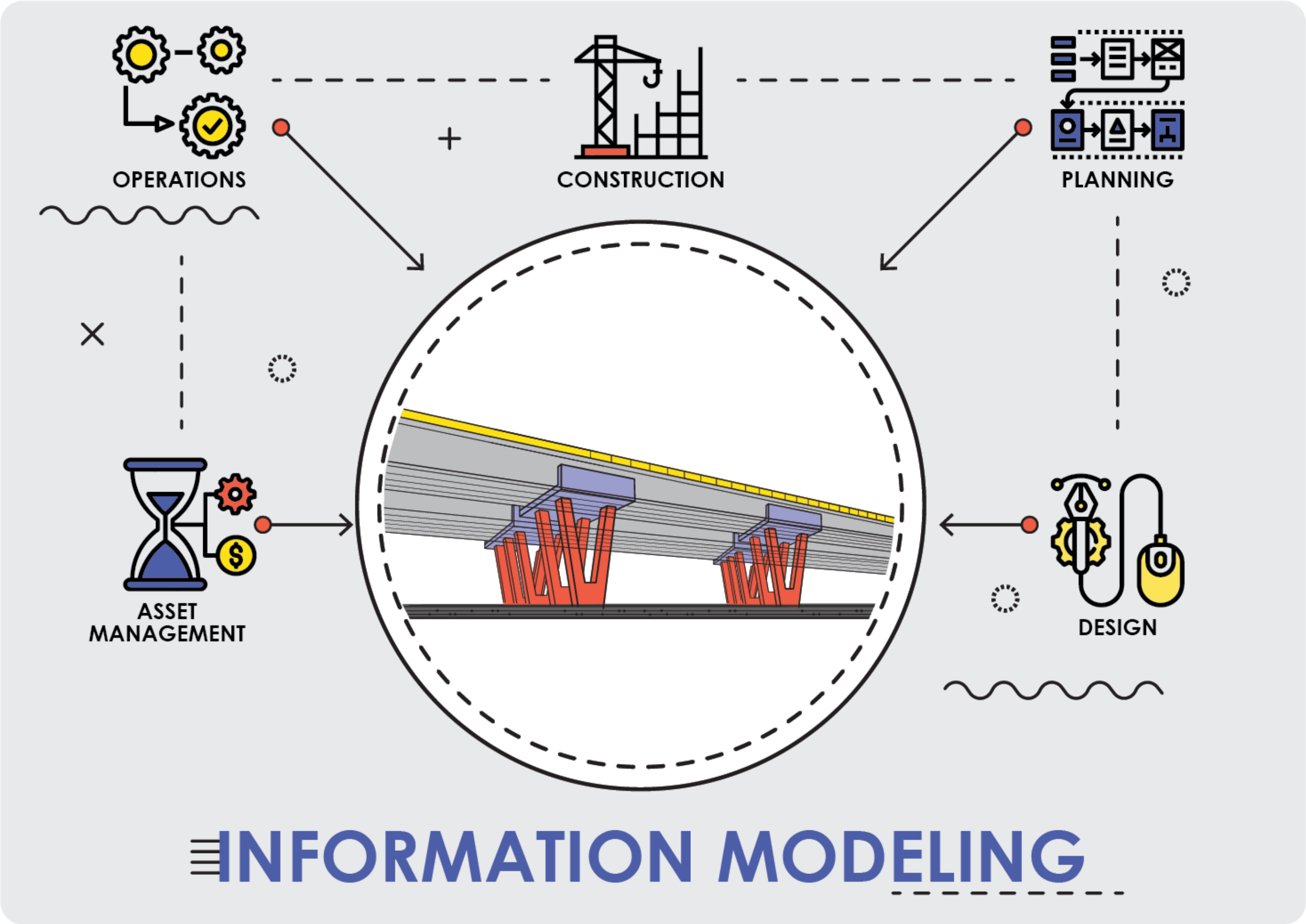
Note: The implementation of BIM is not required under Federal statute or FHWA regulations.

Information Modeling



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BIM Project Execution Planning Guide

- Overview of the project execution planning procedure for BIM
- Identifying BIM goals and uses for a project
- Designing the BIM project execution process
- Developing information exchanges
- Define supporting infrastructure for BIM implementation

These steps are not required under Federal statute or FHWA regulations.

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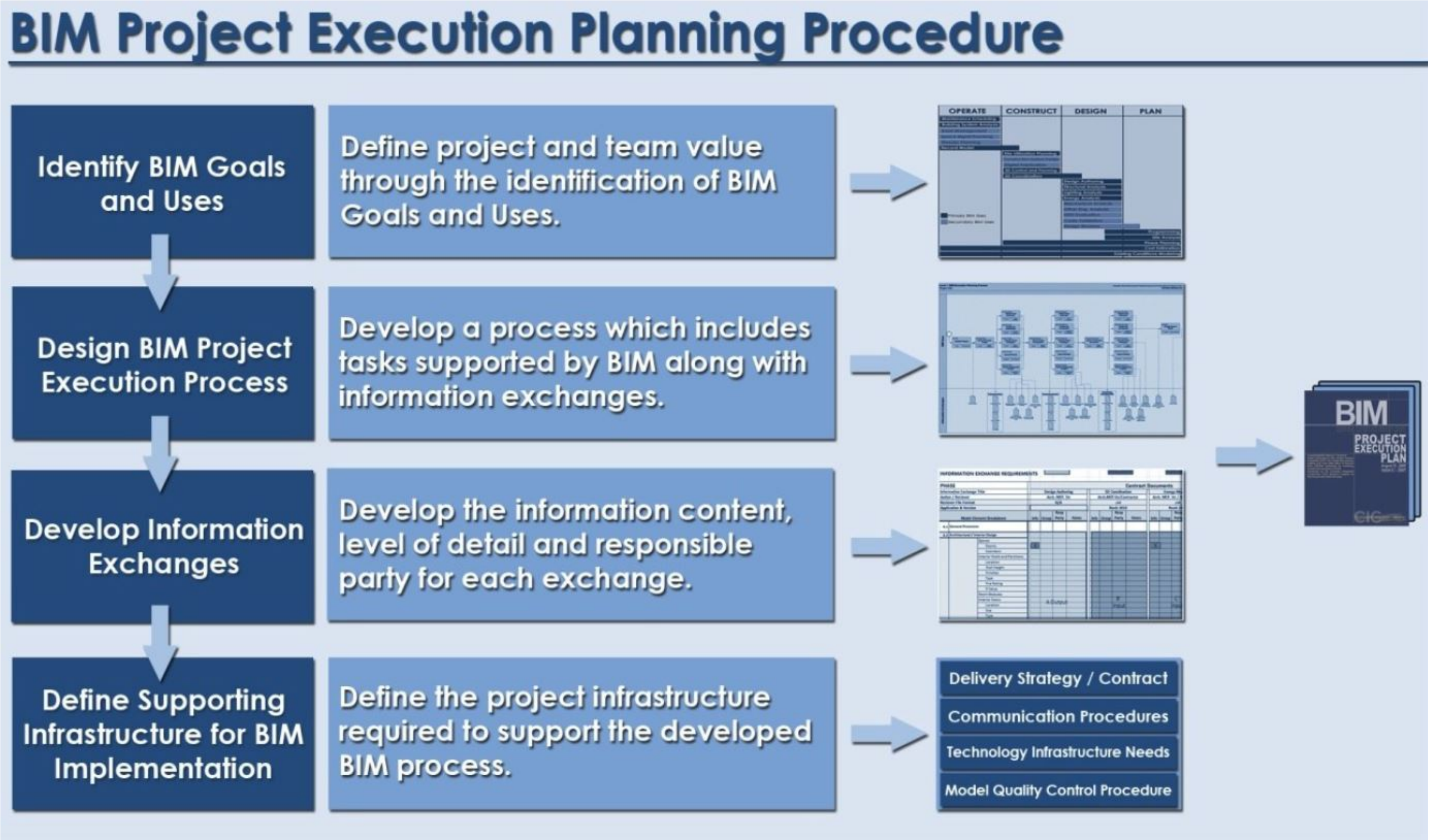
Image: Penn State University, used with permission
http://bim.psu.edu/bim_project_execution_planning_guide/bim-project-execution-planning-guide.html, *BIM Project Execution Planning Guide*, Version 2.1, CIC-Penn State University, 2011

Applying BIM for Infrastructure



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http://bim.psu.edu/bim_project_execution_planning_guide/bim-project-execution-planning-guide.html
BIM Project Execution Planning Guide, Version 2.1, CIC-Penn State University, 2011

The Uses of BIM

- Gather
  - Capture, Quantify, Monitor, Qualify
- Generate
  - Prescribe, Arrange, Size
- Analyze
  - Coordinate, Forecast, Validate
- Communicate
  - Visualize, Transform, Draw, Document
- Realize
  - Fabricate, Assemble, Control, Regulate

These steps are not required under Federal statute or FHWA regulations.

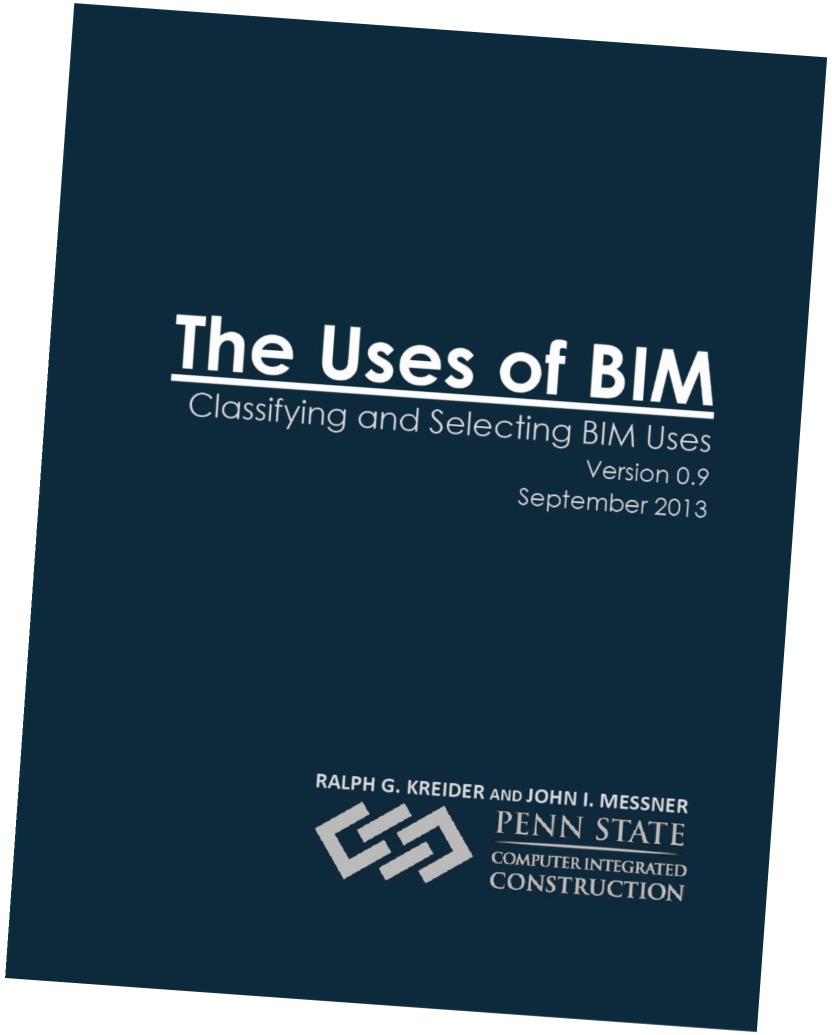


Image: Penn State University, used with permission
http://bim.psu.edu/uses-of-bim.html, *The Uses of BIM*, Penn State Computer Integrated Construction

Applying BIM for Infrastructure

BIM Uses

SNAPSHOT FROM THE *BIM PROJECT EXECUTION PLANNING GUIDE*

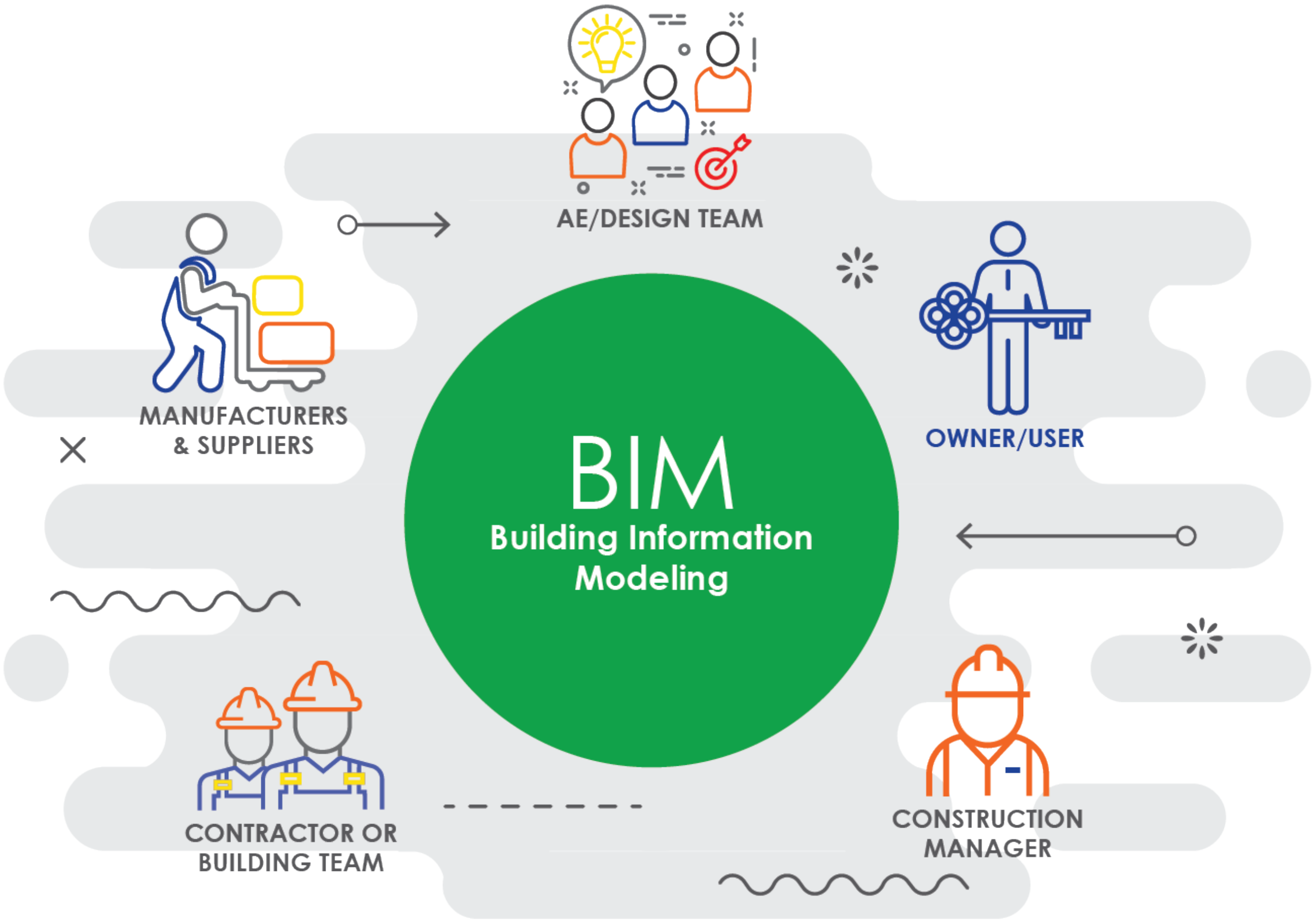
X	PLAN	X	DESIGN	X	CONSTRUCT	X	OPERATE
	PROGRAMMING		DESIGN AUTHORING		SITE UTILIZATION PLANNING		BUILDING MAINTENANCE SCHEDULING
	SITE ANALYSIS		DESIGN REVIEWS		CONSTRUCTION SYSTEM DESIGN		BUILDING SYSTEM ANALYSIS
			3D COORDINATION		3D COORDINATION		ASSET MANAGEMENT
			STRUCTURAL ANALYSIS		DIGITAL FABRICATION		SPACE MANAGEMENT / TRACKING
			LIGHTING ANALYSIS		3D CONTROL AND PLANNING		DISASTER PLANNING
			ENERGY ANALYSIS		RECORD MODELING		RECORD MODELING
			MECHANICAL ANALYSIS				
			OTHER ENG. ANALYSIS				
			SUSTAINABLITY (LEED) EVALUATION				
			CODE VALIDATION				
	PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)		PHASE PLANNING (4D MODELING)
	COST ESTIMATION		COST ESTIMATION		COST ESTIMATION		COST ESTIMATION
	EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING		EXISTING CONDITIONS MODELING

Note: These BIM uses are not required under Federal statute or FHWA regulations.

Image: Penn State University, used with permission
http://bim.psu.edu/bim_project_execution_planning_guide/bim-project-execution-planning-guide.html
BIM Project Execution Planning Guide, Version 2.1, CIC-Penn State University, 2011

Why Use BIM for Infrastructure?

- Application of innovative technologies, practices, and solutions on the rise for highway project delivery
- A wide range of technologies to improve predictability, performance, transparency (Planning to Operations and Maintenance)
- It's time to analyze and understand the technology adoption at the agency-level, in its entirety!



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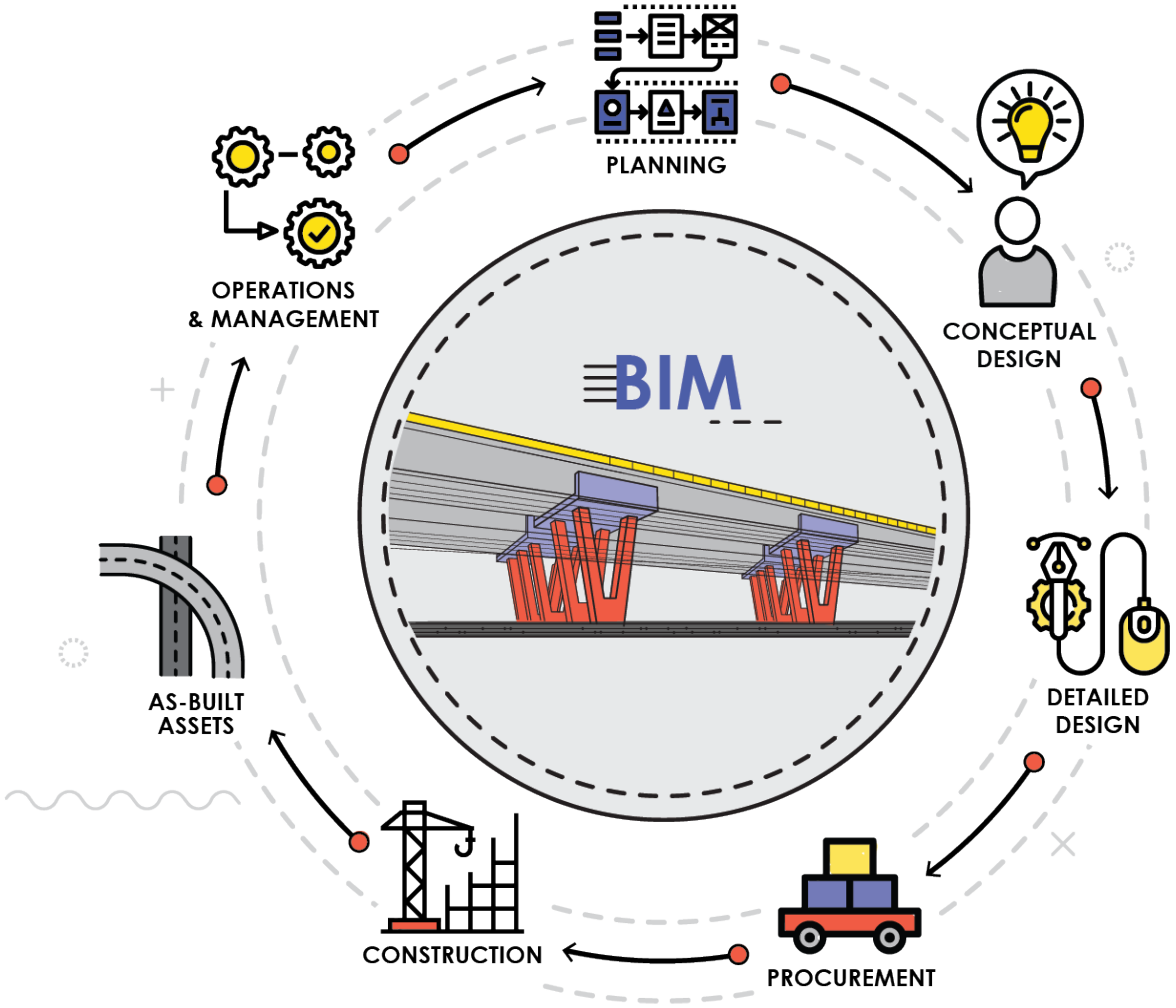
Challenges

- Initial acceptance
- Change management
- Training program development
- Technology investment

BIM for Infrastructure Life Cycle



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Example Projects

Iowa DOT

Michigan DOT

New York State DOT

Oregon DOT (Selwood Bridge)

Oregon DOT (Selwood Bridge Detour)

Texas DOT

Connecticut DOT

Wisconsin DOT

Iowa DOT

Location:

- Statewide 3D-engineered model development program

Primary Goal/Focus for Program:

- Use of 3D models for visualization and constructability reviews

Technology Used:

- Discipline-specific 3D models
- Digital delivery

BIM Uses Applied:

- 4D schedule integration
- Visualization
- 3D coordination (clash detection)

Lessons Learned:

- 3D visualizations provided by the contractor for constructability during this five-year project resulted in positive feedback from DOT staff

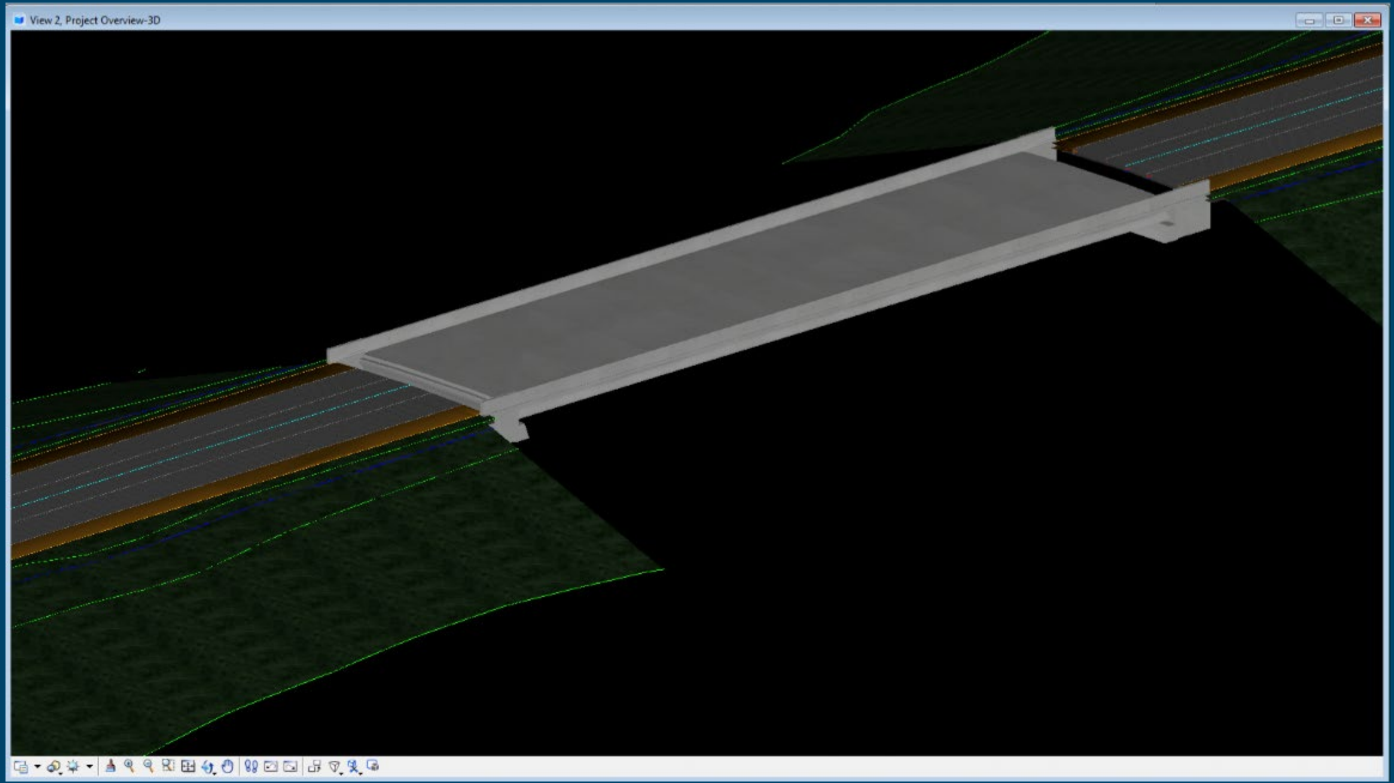

Image: Iowa DOT, used with permission

Michigan DOT

Location:
- Statewide 3D engineered model development program

Primary Goal/Focus for Program:
- Use of 3D models for visualization and constructability reviews
- Surface modeling for automated machine guidance

Technology Used:
- Discipline specific 3D models
- Existing conditions modeling

BIM Uses Applied:
- 4D schedule integration
- 3D coordination (clash detection)

Lessons Learned:
- Clash detection and 3D visualizations provided efficiencies in determining constructability of the project

New York State DOT

Location:
- NY17/I-81 Interchange and the Kosciuszko Bridge

Primary Goal/Focus for Program:
- Use of 3D models for visualization

Technology Used:
- Discipline-specific 3D models

BIM Uses Applied:
- 3D model authoring
- Visualization

Lessons Learned:
- Visualization and 3D coordination performed during design phase provided cost saving/avoidance during construction activities

Oregon DOT Selwood Bridge

Location:

- Statewide 3D engineered model development program

Primary Goal/Focus for Program:

- Use of 3D models for visualization and constructability reviews
- Surface modeling for automated machine guidance

Technology Used:

- Discipline specific 3D models
- Existing conditions modeling
- Digital delivery

BIM Uses Applied:

- 4D schedule integration
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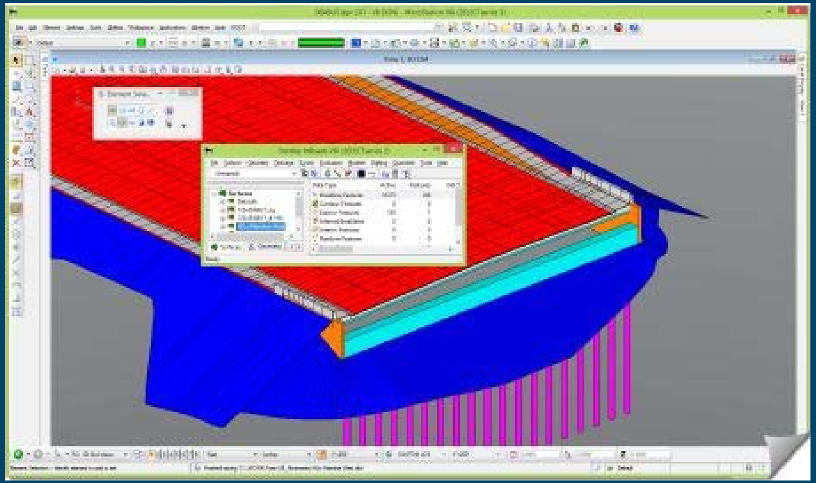
Lessons Learned:

- Clash detection and 3D visualizations provided efficiencies in determining constructability of the project



Images: Oregon DOT, used with permission
https://www.oregon.gov/ODOT/ETA/Pages/3D-Design.aspx

Oregon DOT (Selwood Bridge Detour)

Location:

- Sellwood Bridge, Portland, OR

Primary Goal/Focus for Program:

- Use of 3D models for visualization and constructability reviews

Technology Used:

- Discipline-specific 3D models
- Visualization, video

BIM Uses Applied:

- Visualization
- 3D coordination

Lessons Learned:

- 3D visualizations provided the platform to propose a less expensive, faster, more efficient and safer approach to construct the project.

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Images: Slayden Sundt, A Joint Venture, used with permission
https://www.autodesk.com/solutions/bim/hub/bim-reduces-cost-sellwood-bridge-project

Texas DOT

Location:
- Horseshoe Project I-35/I-30 Interchange, Dallas, TX

Primary Goal/Focus for Program:
- Use of 3D models for visualization

Technology Used:
- Discipline-specific 3D models

BIM Uses Applied:
- 3D model authoring
- Visualization

Lessons Learned:
- 3D visualizations provided by the contractor for constructability during this five-year project resulted in positive feedback from DOT staff

Connecticut DOT

Location:
- I-95 New Haven Harbor Crossing

Primary Goal/Focus for Program:
- Use of 3D models for visualization

Technology Used:
- Discipline-specific 3D models

BIM Uses Applied:
- 3D model authoring
- 4D schedule integration
- Visualization

Lessons Learned:
- 3D visualization and 4D schedule integration provided clarity to the owner and public

Wisconsin DOT

Location:
- Zoo interchange I-94 / I-41 / I-894 corridors

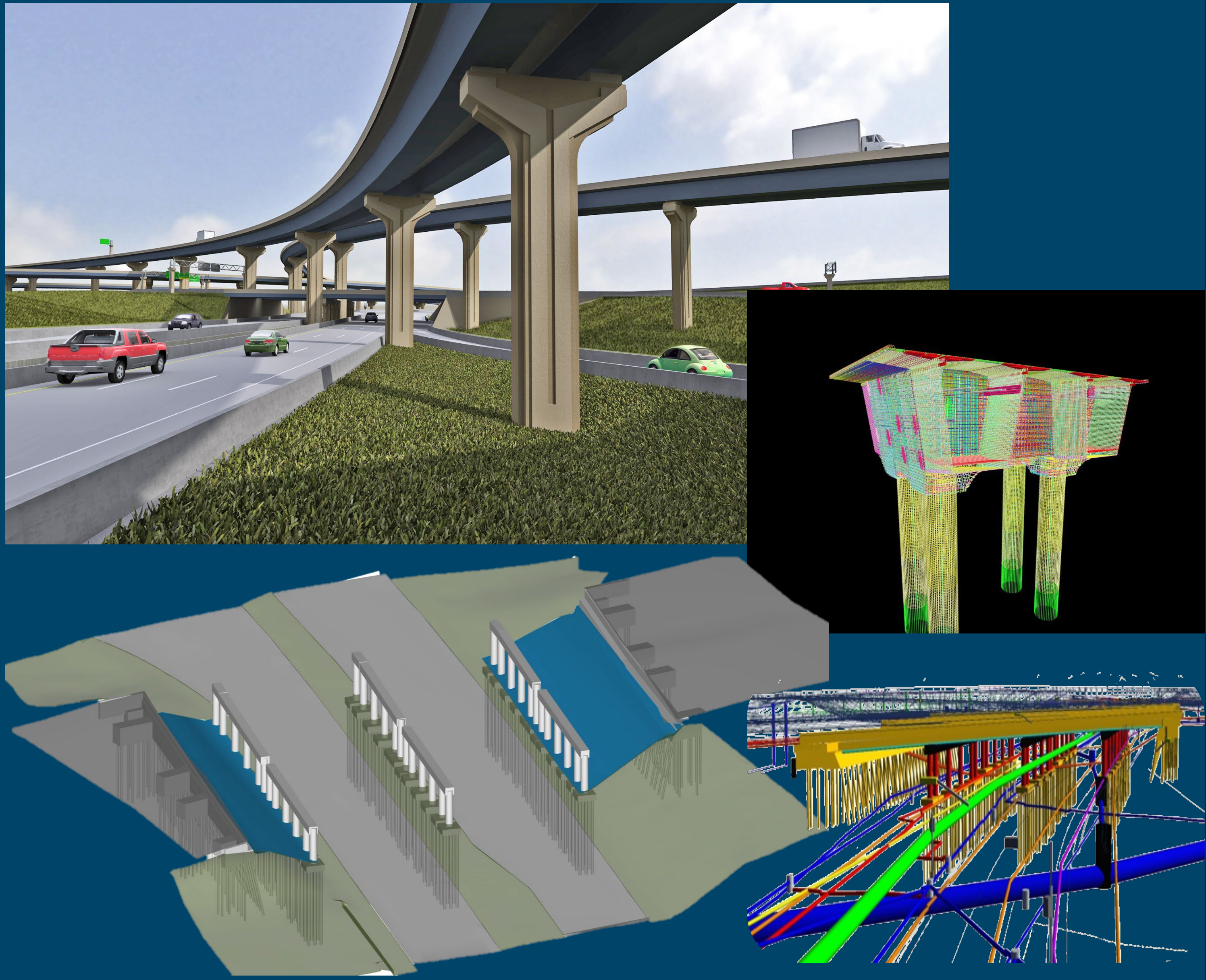
Construction Schedule/Project Cost:
- 2013-2018 (completed) / $1.7B

Primary Goals/Focus for Project/Program:
- Electronic project delivery
- 3D models used for AMG/grading/paving/structures/utilities
- Conflict/issue resolution in design to reduce costs in field

Technology Used:
- Full Discipline 3D Design Models
- Mobile-static LiDAR high-accuracy survey existing models
- Integrated CAD-BIM-GIS

BIM Uses Applied:
- 3D/4D design models including staged models
- 3D coordination for discipline clash detection/resolution
- Visualization and cloud-based design-construction reviews

Lessons Learned/ROI:
- 3D coordination and visualization reduced issues in field
- Cost savings/avoidance reduced change order/bid costs
- Plans quality improved and reduced schedule delays



Images: Wisconsin DOT, used with permission

Lessons Learned

- BIM for Visualization, 4D (scheduling), and design analysis have been deployed by several DOTs—and can be deployed more broadly now
- Some implementation of 5D (cost analysis), AMG, earthwork balancing, and 3D mapping of utilities
- Garbage-in garbage-out: Need for model validation to ensure model is correct and complete for its intended purpose

For more information visit:

- Penn State University: http://bim.psu.edu/
- Transportation Research Board (TRB), National Cooperative Highway Research Project (NCHRP) 10-96: http://www.trb.org/NCHRP/Blurbs/176610.aspx
- TRB NCHRP Report 831 Volume 2: http://www.trb.org/main/blurbs/174321.aspx
- TRB NCHRP Report 831 Volume 1 Guidebook: http://www.trb.org/main/blurbs/174318.aspx

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