Building Information Modeling (BIM) for Infrastructure

An Administrative View
Agenda

• Concepts of BIM for Infrastructure
• State DOT example projects to date
• Business value of BIM for Infrastructure
• 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)
Information Modeling
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

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

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

• Initial acceptance
• Change management
• Training program development
• Technology investment
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!
BIM for Infrastructure Life Cycle

Illustration: HDR, used with permission
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
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
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BIM Uses Applied:
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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.

Images: Slayden Sundt, A Joint Venture, used with permission
**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
Business Value of BIM for Transportation Infrastructure

Business Value of BIM for Transportation Infrastructure

Nearly two thirds (65%) perceive that they get a positive ROI from their investment in BIM.

Includes all BIM users surveyed in the U.S., U.K., France, and Germany

U.S. Numbers:
- Positive, 56%
- Break-Even, 15%
- Negative, 5%
- Not Sure, 24%

Perceived ROI on BIM for Transportation Infrastructure
(According to All BIM Users)

- 37% Positive ROI under 25%
- 28% Positive ROI of 25% or more
- 11% Break-Even
- 4% Negative ROI
- 20% Not Sure

Business Value of BIM for Transportation Infrastructure

What is keeping companies away from BIM?

- Owners are not asking for it, 43%
- Cost required, 31%
- Less Efficient for small projects, 30%
- Training time required, 22%
- Lack of understanding, 21%
- Current software inadequate, 20%

“Overall, 74% report that they do formally measure BIM ROI, and measurement occurs on average on about one third (34%) of their projects”

(Dodge Data & Analytics)
Business Value of BIM for Transportation Infrastructure

Years Measuring BIM ROI
(According to Engineers and Contractors Using BIM by Country)

- More than 2 years: 33%, 30%, 35%, 40%
- 1 to 2 years: 34%, 55%, 52%, 52%
- Less than 1 year: 33%, 15%, 13%, 8%

U.S. | U.K. | France | Germany
---|---|---|---
33% | 30% | 35% | 40%
34% | 55% | 52% | 52%
33% | 15% | 13% | 8%

Lessons Learned

High Value BIM Activities

(Percentage of BIM Users Rating Each Activity as Having a High/Very High Value)

<table>
<thead>
<tr>
<th>Cost/Schedule/Labor/Materials Planning</th>
<th>Analysis &amp; Coordination</th>
<th>Approvals/Submittals/Other Tasks</th>
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<tbody>
<tr>
<td>30% U.S.</td>
<td>64% U.S.</td>
<td>50% U.S.</td>
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<tr>
<td>26% U.K.</td>
<td>48% U.K.</td>
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<td>60% FRANCE</td>
<td>47% FRANCE</td>
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<td>68% GERMANY</td>
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Spatial Coordination (aka Geometric Detection)
Structural Analysis
Environmental Impact & Feasibility Studies
Client Review & Approval
Submittals Process (Other than Shop Drawings)
Automated Machine Guidance

Lessons Learned

Most Common Use of BIM Models by Those Not Creating Them
(According to Engineers and Contractors Using BIM)

- 23% Interdisciplinary Project Collaboration
- 20% Deliver Design Intent to Construction
- 20% Aid Production of 3D Deliverables to Owner
- 15% Visualizations
- 12% Communication with Client & Stakeholders
- 10% Aid Production of 2D Deliverables

Lessons Learned

Industry Factors with the Greatest Positive Impact on Increasing the Ability to Experience BIM Benefits on Future Transportation Projects
(Differences by Country)

- More Internal Staff with BIM Skills
- More Owners Asking for BIM
- More Use of Contracts to Support Collaboration and Define BIM Deliverables
- Availability of National or International BIM Standards
- More Hard Data Demonstrating the Business Value of BIM
- Automated Machine Guidance

FHWA BIM for Infrastructure Point of Contact:

Task Manager
Connie Yew, Team Leader
Federal Highway Administration
1200 New Jersey Avenue, S.E.
Washington, DC 20590
(202) 366-1078, connie.yew@dot.gov