The True ROI of Information Modeling

Merging Geospatial Data, LiDAR, 3D Models and Business Data to Increase Project Efficiencies

Derricke Gray, Product Manager, Bentley Civil Americas
What is Information Modeling?
Interoperability

Engineering technology has advanced beyond what many of us ever thought possible. However, for the most part, deliverables have continued to target the same thing:

Plans Production
Interoperability

“Specialists in the various disciplines have been able to optimize their own in-house operations ... most failures are caused by poor handoffs between disciplines.”

Tommelein and Gil (1999)
Interoperability
Information Modeling utilizes technologies to create an information rich 3D model. This model can be used for a multitude of engineering requirements such as design decision making, planning, construction document production, performance evaluation and cost estimating, just to name a few.
Integrated Projects

*Information Modeling* is a process. Does it require technology and a 3D model? Of course.

But at its core it is a process, relying heavily on the use of *integrated projects* where a project team works in a collaborative environment, combining and sharing knowledge. This demands information management for scalable and controlled work sharing, versatile reuse of engineering content, and the gathering of dynamic feedback that is actionable.
Intelligent Infrastructure utilizes the resultant operational and digital information for ongoing maintenance, operations, and compliance activities.

- Disaster and incident response
- Operational changes such as remodeling, expansion or repurposing
- Drainage Pipe/Culvert Inventories
- Pavement Management Systems
- GIS Systems
- Traffic Signal Maintenance
- Vertical Clearances for Permitting
Information Mobility

*Information mobility* empowers project teams to share information within models across the infrastructure lifecycle and project disciplines, all in a controlled and secure fashion regardless of the file formats or devices used.

*Information mobility* is particularly crucial in integrated projects to facilitate not only the collaboration between disciplines but to facilitate the “hand-off” of information between them as well.
Asset Performance Management...

Information Mobility

- Fabrication
- Simulation
- Engineering
- Work Packaging
- Performance Management

“As-Maintained” 3D Imagery
Information Mobility

This is the long awaited payoff for interoperability: ensuring that the right information, in the appropriate format and level of precision, can be accessed by the right people at the right time.
Benefits

• Reduce errors and omissions by identifying conflicts
• Lower cost
• Improve project quality
• Lower project risk
• Enhanced coordination across disciplines
• Results in data re-use across the lifecycle
• Better performing assets
ROI – Information Modeling

- Better coordination and teamwork
- More and better feedback
- Broader understanding

Value

People

Design Team
Reviewers
Stakeholders
The Bentley Advantage

**Information Modeling**

through **Integrated Projects**

for **Intelligent Infrastructure**
ROI of Information Modeling
Business Drivers

Visualization

Machine Control

Map21 and Every Day Counts

Design Review

4D

LIDAR

Life Cycle Management
ROI / Benefits

Whether it’s a feasibility study, looking at design alternatives, analyzing traffic movements or obtaining stakeholder buy-in, visualization can be an invaluable tool on just about any project.

- Communicates a single, common vision
- Converts complex technical information into easily understood images or animations.
- Eliminates the need to interpret 2D drawings
- Provides a starting point for discussion
- Allows easy understanding of construction sequencing
Animations
Business Drivers

Visualization

Machine Control

Map21 and Every Day Counts

Design Review

4D

LIDAR

Life Cycle Management
The use of Automated Machine Guidance continues to grow.

http://www.siteprepmag.com/articles/84673-machine-control-report-results
ROI / Benefits

• Productivity gains (as high as 40%)
• Less repeat work (move dirt right the first time)
• Lower costs (e.g. reduce fuel consumption)
• Greater accuracy
• Less staking
• Safety
• Etc.
Business Drivers

Visualization

Machine Control

Map21 and Every Day Counts

Design Review

4D

LIDAR

Life Cycle Management
$105 billion program greatly increases federal share of funding for a project that...

“...introduces innovative construction equipment materials, or techniques, including the use of in-place recycling technology and digital 3-dimensional modeling technologies.”

Source: MAP 21 - Section 1304 - Innovative Project Delivery Methods
Every Day Counts

FHWA initiative encourages innovations that:

- Reduce delivery time
- Improve safety
- Reduce congestion

**U.S. Transportation Secretary LaHood Awards $16.3 Million to Support Innovative Highway Safety Projects**

*Grants for new technologies will help states improve safety and reduce congestion*

WASHINGTON – U.S. Transportation Secretary Ray LaHood today awarded more than $16 million to 14 innovative highway and bridge projects in 13 states and the District of Columbia that will improve safety, create jobs and enhance the quality of the nation’s transportation infrastructure.

<table>
<thead>
<tr>
<th>Illinois</th>
<th>$880,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knox County Highway 4 alignments in west central Illinois near Galesburg. The project will use three-dimensional modeling technology to complete construction faster. The technology is also expected to provide significant cost savings, reduce lane closures, and increase safety for construction workers.</td>
<td></td>
</tr>
</tbody>
</table>
Business Drivers

Visualization

Machine Control

Map21 and Every Day Counts

Design Review

4D

LIDAR

Life Cycle Management
“There are significant benefits associated with 3D design methods beyond support for AMG. The highest ranked additional benefit is detection and elimination of design errors prior to construction ...”

Business Drivers

Visualization
Machine Control
Map21 and Every Day Counts
Design Review

4D
LIDAR
Life Cycle Management
The ability to sequentially visualize construction design plans through time. Facilitates identification of constructability issues that could not have been detected using 2D plans.

- Equipment placement
- Material fabrication
- Staging
- Site organization
- Etc.
Business Drivers

Visualization
Machine Control
Map21 and Every Day Counts
Design Review
4D
LIDAR
Life Cycle Management
ROI / Benefits

- Accuracy
- Higher data density
- Fast acquisition and processing
- Minimizes human dependence
  - Safety
- Weather/Light independence
- Canopy penetration
- Cost
- Etc.
Business Drivers

Visualization
Machine Control
Map21 and Every Day Counts
Design Review
4D
LIDAR
Life Cycle Management
ROI / Benefits

• Higher quality and better performing infrastructure assets
• Improved operational efficiency
• Safer infrastructure
• Reduced waste
• Greater return on infrastructure investments
• Etc.
Power of Information Modeling
Point Clouds

Point cloud data is becoming increasingly valuable for all projects regardless of the industry. Bentley is committed to supporting point clouds for all phases of an asset’s life cycle.

- Accuracy
- Higher data density
- Fast acquisition and processing
- Safety
- Weather/Light independence
- Canopy penetration
- Cost
- Etc.
Point Clouds in Descartes V8i

Point Cloud Processing
— Geometry Extraction
— Classification Editing
— Line Draping

— Classification Editing
— Fix classification errors
— Eliminate Point Cloud “noise”
— Enable hybrid and retrofit workflows

— Geometry Extraction
— Planes and Cylinders
Dynamic Views (Hypermodels)

Dynamic Views enables interrelated design information to be presented directly within spatial context of the 3D model.

- Decreases drawing production and design review cycle time by producing plan sets and construction annotation in context to the 3D model.
- Remove ambiguity between 3D models and 2D documentation
- Link directly to details, images, videos or other content from directly within the model.
Link to 2D Plan Sets
Link to Construction Documents
OpenRoads

Technology designed to remove any technical barriers to information modeling.

Building Better Models

- *Preserving Design Intent*
  - *Automated Intelligent Updates*
- *Design-Time Visualization*
- *Civil Cells*
What is OpenRoads?

OpenRoads is not a product, but a common **technology** for InRoads, GEOPAK, MXROAD, and PowerCivil for “Country”.

OpenRoads technology offers immersive interaction of

- Survey
- Geometry
- Terrain modeling
- Corridor modeling
- Site Modeling
- Dynamic cross sections
- Civil cells
- Design intent
- Design-time visualization
Parametric Modeling
Subsurface Modeling
Constructability

Clash Resolution

• Validate design at the time of creation
• Make changes in real-time during design and layout to avoid costly mistakes downstream
Information Mobility

The i-model is a container for open infrastructure information exchange. It allows a user to combine their design data into a single ‘model’ format and then publish that model so that it can be used by downstream consumers without the need for the original editing application.

In addition to our own design applications supporting this capability, we will provide plug-ins for other products which allow those solutions to produce and/or utilize i-models.

Autodesk Civil3D
Autodesk Revit
Microsoft Excel
Microsoft Access
Crystal Reports
Microsoft Visual Studio
Etc.
i-Model

The i-Model, at its most basic, is a container for open infrastructure information exchange. It allows a user to combine their design data into a single ‘model’ format and then publish that model so that it can be used by downstream consumers without the need for the original editing application.

In addition to our own design applications supporting this capability, we provide at no charge several application plug-ins for other products which allow those solutions to produce and/or utilize i-models.

• Autodesk Civil3D
• Autodesk Revit
• Microsoft Excel
• Microsoft Access
• Crystal Reports
• Microsoft Visual Studio
• Etc.
Benefits

• Portable

• Combines disparate data into a single model

• Contains intelligent engineering data

• Protects the sanctity of the model

• Time persistent

• Etc.
Query the Model
ProjectWise Explorer for the iPad

- For project managers and construction field workers
- Synchronizes with ProjectWise
- Meta-data and files
- Provenance
- Dis-connected/Connected modes
- Passport licensing
Bentley Navigator for the iPad
Creighton Manning Case Studies
Case Study

Slingerlands Bypass Extension
NYSDOT Route 85
Bethlehem, NY
NYSDOT Pilot Project

- Selected by DOT as a construction automation pilot project
- Required full 2D and 3D model
- Required contractor to use GPS & automated grading equipment
- Reduced construction plan set
- Provided 3D data and Geometry digitally instead of tables
- As-Built plans generated
NYSDOT Pilot Project
Grading Plan Provided via Digital Data

ALIGNMENT RA1_CVRT_DC
(SEE NOTE 4)
Horizontal Control Tables Not Required

<table>
<thead>
<tr>
<th>Survey No.</th>
<th>Point</th>
<th>RL Station</th>
<th>Coordinate</th>
<th>Easting</th>
<th>Northing</th>
<th>Length (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>50 300.000</td>
<td>200 000</td>
<td>100</td>
<td>50</td>
<td>10</td>
<td>Existing 1-47 Northbound</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>50 400.000</td>
<td>300 000</td>
<td>200</td>
<td>40</td>
<td>20</td>
<td>Existing 1-47 Northbound</td>
</tr>
</tbody>
</table>

**ABBREVIATIONS**
- P - Point of Intersection
- HC - Horizontal Control
- FL - Field Length
- CP - Control Point
- EP - End Point
- PCH - Post-Construction Hi
- PEH - Post-Construction Ext Ht

[Diagram of Horizontal Control Tables]
Detailed Layouts Not Required
Time Savings

• Construction delayed 7 months due to permit issues

• Contractor was still able to meet the original schedule by using the technology
Design Savings & Costs

- Detailed model added ~20% more time than the typical project (learning curve)
- Savings (~15%)
  - Reduction of tabular horizontal control info
  - Improved quantity takeoff
  - Increased drainage automation
  - Decrease in CADD production
  - Decrease in errors due to duplication of data and tables
- Overall, ~5% additional time was required for pilot project
3D Modeled and As Constructed
Completed Project
Case Study

Washington Avenue / Fuller Road Intersection
NYSDOT
Albany, New York
Project Goals

Take lessons learned from previous project.

Produce an accurate, constructible 3D model of interchange, including the bridge.

Design-time visualization.

Produce an excellent 3D visualization as a by-product.

Leverage the 3D Model to produce details for plans in MicroStation.

Model utilities in 3D for clash detection.

All 3D data out to contractor for automated grading and stake-less construction survey to reduce construction costs and improve quality.

Real time 3D as-builts and data to GIS
Alternative 3 - Roundabout with Bridge
Digital Data Used for Roundabouts

No DIMS

No DIMS
Digital Data Used for Striping

Dimensions not required
3D Visualization
3D Visualization Photo Match

- Land swap to create a contiguous campus.
- Fill type retaining wall to minimize footprint, reduced shoulder width to narrow roadway.
- New bus stops to facilitate transit usage.
- New 10’ path to connect Rensselaer Lake with UAlbany and CNSE.
- New 10’ path along Washington Avenue and UAlbany frontage.
- Excavated soil donated to an Albany Pine Bush habitat restoration project.
- Reuse of existing roadbed as parking for CNSE expansion.
- Removal of invasive and non-native plants.
- New landscaping plan developed in harmony with Albany Pine Bush.
Clash Detection

Modeled drainage in 3D and compared against 3D utility survey for any conflicts.
Machine Control

Stake-less grading

Expertise required to utilize equipment

GPS rover utilized to check elevation
Return on Investment

- Providing digital files reduced plan set drafting time by about 10 percent.
- Using associative dimensions ensured drawing dimensions were updated automatically when changes were made to the models, reducing drafting time by another 10 percent.
- Checking as-built data against the 3D model provided an accurate basis for determining earthwork quantities.
- Using 3D data in the field enabled more accurate stakeless grading and machine control grading, saving time and money.
Summary

- Information Modeling provides intelligent 3D models that can be used to accelerate project delivery.
- Information Mobility enables project teams to readily share information across regions, disciplines, and project lifecycle.
- Bentley Technology provides the tools to achieve both.