Got Metrics? Evaluating BIM Performance and Tracking Your Return on Investment CR3331

Ken Stowe, Autodesk, Calvin Kam bimSCORE
Got Metrics? Evaluating BIM Performance and Tracking Your Return on Investment

- This class provides must-have knowledge for management-level facility owners, operators, contractors, architects, and consultants seeking objective methods to inform decisions as well as evaluate and optimize the success of Building Information Modeling (BIM) implementation for projects and enterprises. The class covers the bimSCORE evaluation framework developed at Stanford University Center for Integrated Facility Engineering (CIFE). We will discuss original methods developed to establish realistic goals, benchmark to global best practices, select scenarios for BIM investment, track progress, and calculate ROI. We will demonstrate scientific methods you can use to report on maturity of BIM implementations and compare results with other current projects around the world, using metrics to inform investment decisions and drive improvement. Special emphasis will be placed on the importance of ongoing evaluation and performance tracking to maximize BIM value throughout project lifecycles.

- Speakers Ken Stowe, Autodesk - Speaker
- Calvin Kam, BIMScore, Founder and CEO - Co-Speaker
- Audience Level of Expertise Advanced
- Primary Track Construction
- Secondary Track Business Ops
- Audience Type Owner/Principal
- Content Type Innovation
Speakers

Ken Stowe

Calvin Kam
Agenda

- The Benefits of BIM
- The Dominos of Failure
- BIM Return on Investment Workshop
- Strategic Response to BIM Opportunity
The Dominos of Failure
Project Waste -

- Inaccuracies in Existing in 2D
- Design in 2D Constrains Understanding
- Incomplete Coordination
- Review/Approval of Plans, Sections, Elevations
- Bids with Inadequate Information
- Trade Coordination findings
- Requests for Information
- Change Orders
- Rework
- Delays
- Low Confidence/Prefabrication
- Field Fit Problems/Rework
- Blaming Other Stakeholders
- Late Completion
- Litigation
- Pay Attorneys – Reduced Profits
Project Waste – the Dominos of Failure

…….when things go bad, they often go very bad.

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Project Waste – the Dominos of Failure

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| Design Productivity - Parametrically Coordinated Documents | Inaccuracies in Existing in 2D |
| Model Based Energy and Sustainability Analysis | Design in 2D Constrains Understanding |
| Fewer Owner Changes | Incomplete Coordination |
| Fewer and Leaner RFIs Addenda ASIs | Review/Approval of Plans, Sections, Elevations |
| More Universally understood Scope of Project Design | Bids with Inadequate Information |
| Fewer Design Change Orders | Trade Coordination findings |
| Easier Quicker Visualization for the GC’s, Subs, Inspectors | Requests for Information |
| Lower General Conditions for GC and Subcontractors - Shorter Project | Change Orders |
| Deliver Earlier C of O and Information-Rich As-Built Model | Rework |
| Lower Printing, Packing, Copying, Shipping, Receiving, Distributing | Delays |
| More Organized Efficient Document Management System | Low Confidence/Prefabrication |
| Lower Prices, Less Anticipated Risk by Subcontractors - Prefabrication and Just in Time Deliveries | Field Fit Problems/Rework |
| Overall Design Duration | Blaming Other Stakeholders |
| Faster More Accurate Prices | Late Completion |
| Smaller, more focused Team | Litigation |
| Higher Quality Facility, Fewer Warranty Problems | Pay Attorneys – Reduced Profits |
| 3D and 4D Visualization Logistics/Sequencing Studies - Efficiencies | |
| Field BIM - Safer Site, More Control, Digital Survey, Crew Tracking | |
1. Due to **better appreciation of design at an early stage**, and also due to the early functional evaluation of design against performance requirements (such as energy, acoustics, wind, thermal, etc) the quality of the end product is higher and more consistent with design intent. This reduces variability commonly introduced by late client-initiated changes during the construction stage. (Eastman et al. 2008 p.390; Manning and Messner 2008)

2. Building modeling imposes a rigor on designers in that flaws or incompletely detailed parts are easily observed or caught in clash checking or other automated checking. This improves design quality, preventing designers from "making-do" (Koskela 2004a) and reducing rework in the field as a result of incomplete design. (Dehlin and Olofsson 2008; Eastman et al. 2008 p.422)

3. Building systems are becoming increasingly complex. **Even trained professionals have difficulty generating accurate mental models with drawings alone**. BIM simplifies the task of understanding designs, which helps construction planners deal with complex products. (Eastman et al. 2008 p.382)

4. As all aspects of design are captured in a 3D model the client can easily understand, the requirements can be captured and communicated in a thorough way already during the concept development stage. This can also empower more project stakeholders to participate in design decision making. (Eastman et al. 2008 p.378; Manning and Messner 2008)

5. Virtual prototyping and simulation due to the intelligence built in the model objects enables automated checking against design and building regulations, which in turn makes verification and validation of the design more efficient. (Eastman et al. 2008 p.390; Khanzode et al. 2008)

"...the sheer amount of the constructive interaction mechanisms identified strongly supports the argument of a significant synergy between BIM and lean."

"...any company or project on a lean journey should seriously consider using BIM for enhancing the lean outcomes..."
Measuring the Impact of Rework on Construction

- Using the data obtained from 359 construction projects in the Construction Industry Institute database...

- “Rework continues to affect both cost and schedule performance throughout the construction industry.

- The direct costs alone often tally to 5% of the total construction costs.
Agenda

- The Benefits of BIM
- The Dominos of Failure
- BIM Return on Investment Workshop
- Strategic Response to BIM Opportunity
The Benefits of All-in BIM

- 19 Benefits
Evolving, Structured Benefits Evaluation
19 Benefits – Focused on Value, not Technology
Better Understood Scope of Work

“Complete” buy-in and cooperation with all stakeholders
Higher Quality
“Better Final Product, Fewer Warranty Problems, Less Rework

Standing Seam Systems
Design Productivity and Better Documents
Coordinated Documents, More and Better Views, 3D Capabilities
Model Based Analysis

Energy savings, stress analysis, CFD, etc.
Overall Design Duration

Pace of change, better decision making, more/better views
Requests for Information

Fewer, Quickly Resolved, ASI’s Reduced, etc.
Fewer Design Change Orders
Coordination Errors, Inconsistencies, Omissions
Owner Satisfaction

Greater awareness, more confidence, etc.
Easier, Quicker Visualization for the GC, Subcontractors, Inspectors
3D and 4D Visualization, Logistics/Sequencing Studies – Field Efficiencies
Simple, Secure document, design, and data management tools
Smaller, Higher Performing Project Staff, more efficient, focusing on project excellence
PAPER: Lower Costs of Printing, Packing, Shipping, Receiving, Distributing, Copying, …
Subcontractors – Bids with Lower Risk, Less Built-in Contingency, Confidence in Prefab/Preassembly
Shorter Construction Phase: Lower General Conditions for GC, Subcontractors...
Field BIM – Equipment Tracking, Safer Site, Digital Survey, Machine Guidance
BIM for Safety Budget & Planning:

- Design a clip-in cable for fall protection
- Diagram a crane swing safety zone
- Diagram a construction safety net
Earlier Certificate of Occupancy…As-Built Model…
with Rich Information Useful for Operations & Maintenance
bimSCORE Framework and Scoring
bimSCORE Framework and Scoring
Four Primary Evaluation Areas

**Planning**
Establish objectives and protocols

**Performance**
Track impact, progress

**Adoption**
Find the right people & process

**Technology**
Provide the right tools

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[2] Source: www.us.spinnaker-nt.com; betterhiringtoday.com/5-signs-your-hiring-process-needs-help
[4] Source: Ipoint 3D
Confidence Level

- Reflects **completeness and diversity** of data used to derive the score
Establish Goals and Targets
Measure and Document Progress
Objective Dimension

- Objectives documented & shared with broader team
- Safety objectives for BIM/VDC are not in evidence
- Few quantitative objectives with benchmarks established
## Planning Results

### Planning Objectives in Evidence

<table>
<thead>
<tr>
<th>Objective</th>
<th>Evidence</th>
<th>Qualitative?</th>
<th>Quantitative?</th>
<th>Metric?</th>
<th>Benchmark?</th>
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<tbody>
<tr>
<td>Use model for presentations to owner and other stakeholders</td>
<td>X</td>
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<tr>
<td>Use 4D for schedule visualization, construction phasing and sequencing</td>
<td>X</td>
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</table>
## bimSCORE Portfolio

### Planning Advice

<table>
<thead>
<tr>
<th>Confidence Level</th>
<th>Conventional Practice</th>
<th>Typical Practice</th>
<th>Advanced Practice</th>
<th>Best Practice</th>
<th>Innovative Practice</th>
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<tr>
<td>Objective</td>
<td>80%</td>
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<td>Standard</td>
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<td>Preparation</td>
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<td>Formalization</td>
<td>90%</td>
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<td>Source: Kent Bauer</td>
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#### Strategic Vision and Objectives

- **Vision**
  - What do we want to be in the future?

- **Strategy**
  - How do we intend to accomplish our vision?

- **Objectives**
  - What must we complete to move forward?
  - What areas must we focus on to achieve our vision?
  - What are our metric indicators of success?

- **Critical Success Factors**

- **Key Performance Indicators**

- **Key Action Initiatives**
  - What action programs will achieve our performance goals?
bimSCORE Portfolio

Planning Advice

Enterprise Mission and Vision
BIM-enabled IPD
20% Cost Savings, Commitment Reliability

Categories?
Measures?
Benchmarks?

Opportunities for Improvement

4D, “5D”, “6D” Initiatives

Source: Kent Bauer
Establish and track BIM-based objectives through the project lifecycle, and benchmark performance to fuel continuous improvements.
Expand Processes leveraging Virtual Design & Construction (VDC)

Involve Broader Team in BIM-enabled Decision-making Process
**bimSCORE Portfolio Adoption Results**

**Organization Dimension**

- Project teams have a general understanding of BIM/VDC terms & benefits
- **Most** team members are supportive of BIM
- BEP has established **explicit responsibilities** and roles for each stakeholder
- Some **variations in End User involvement** in VDC process

**Adoption Process**

- Incentives: 40%
- Responsibilities: 73%
- Decision Making: 80%
- Attitude: 80%
- Actions: 60%

**Planning**

- Conventional Practice
- Typical Practice
- Advanced Practice
- Best Practice
- Innovative Practice
**Forms of Project Delivery**

- **Integrated Enterprise**
  - Special Purpose Entity created specifically to deliver a project or portfolio of projects.

- **Integrated Form of Agreement (IFOA)**
  - Many Team Members (e.g. 13) bound in a single contract for Integrated Project Delivery

- **Integrated Project Delivery (IPD)**
  - Unifies team through strong organization / leadership supporting collaboration; includes shared goals and incentives

- **Design Assist**
  - Construction experts advise during design

- **Design-Build**
  - Single team develops design and construction concepts and documents

- **CM at Risk**
  - Separate organizations, separate contracts, construction management oversight
**bimSCORE Portfolio**

**Adoption Advice**

**Process Benefits From BIM/VDC**

- More Alternatives Evaluated
- Shorter Total Duration
- Minimal Waste
- Tight Synchronization Between Design and Fabrication
- Last Responsible Moment
Increase number of model uses
Model more building and site elements
Leverage design automation tools
bimSCORE Portfolio
Technology Results

Visualization
- 3D Rendering
- 4D Animation

Documentation
- Documents
- Laser Scanning
- Quantity Takeoff
- RFI's

Model-Based Analyses
- Spatial Validation
- Egress
- Energy Analysis
- Fire and Smoke
- Estimating
- Scheduling

Integrated Analyses
- Material Tracking
- Clash Detection
- Facility Management
- Off-Site Fabrication
- Integrated Cost and Schedule

Automation and Optimization
- Code/Model Checking
- Parametric Alternative Generation
### Technology Advice

#### Maturity Coverage Integration

<table>
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<tr>
<th>Confidence Level</th>
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#### bimSCORE Portfolio

**Visualization**
- 3D Rendering
- 4D Animation

**Documentation**
- Documents
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**Model-Based Analyses**
- Spatial Validation
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**Integrated Analyses**
- Material Tracking
- Facility Management
- Clash Detection
- Integrated Cost and Schedule

**Automation and Optimization**
- Code/Model Checking
- Off-Site Fabrication
- Parametric Alternative Generation
Frequent, accurate performance tracking
Confidence Level

Quantitative Dimension

- Few quantitative objectives established
- Lacking mature benchmarks and tracking mechanisms
- Lack of alignment between objectives and proposed model uses and/or BIM applications
- Lack of safety and facility performance oriented objectives
Quantitative Dimension

**Metrics Maturity:**
- Benchmark with *past projects* and *industry trends*
- Track and compare performance *within the project*
- Qualitative or Quantitative
- Leading or Lagging

**Frequency:**
- Weekly, monthly, at key milestones, at-need

**Mechanisms:**
- *In-house* or *3rd-Party* Professionals
- Surveys or interviews
bimSCORE Performance Indicators
Fischer reports on June 21 that "We are having a breakthrough CIFE summer program yesterday and today...every single presentation given by owner, design/engineering, construction, and technology companies from the U.S. and overseas about a wide range of project types, from small homes to large hospitals and science centers, has measured and reported dramatic improvements in project performance."

Fischer gives brief examples of metrics reported by industry partners and projects:

 Owners:
62% reduction in energy use for data centers (Autodesk)
73% reduction in space needed for data centers (Autodesk)
300% energy efficiency improvement on a fuel basis for district-scale power plants (Disney)

Designers/engineers:
30% reduction in project schedule from phase to phase, for a total of about 50% reduction from phase 1 to phase 3 (GPLA)
33% cost reduction (Sera)
60% reduction in design time (Sera)
67% reduction in construction time (Sera)
50% reduction in RFIs (Sera)
51% reduction in email (Sera)
62% reduction in change orders (Sera)
99.98% reduction in design cycle time for a structural (3 seconds vs. 4 hours) (Arup + CIFE)
328x increase in number of design versions considered for a structural design (Arup + CIFE)
Critical Success Factors | KPI | Metrics
--- | --- | ---
Communication | Prefabrication Index | % components prefab
Cost | | % labor savings
Schedule | | % reduction in rework
Project Delivery | | % reduction in field supervision
Safety | | 
Facility Performance | | 
Management | |
Diamond of User Emotion:
- Track, trend, and publish satisfaction with BIM/VDC processes and tools

source: BJ Fogg
Four Primary Evaluation Areas

**Planning**
Establish objectives and protocols

**Adoption**
Find the right people & process

**Performance**
Track impact, progress

**Technology**
Provide the right tools

[2] Source: www.us.spinnaker-nt.com; betterhiringtoday.com/5-signs-your-hiring-process-needs-help
[4] Source: Ipoint 3D
Objective Framework | Summary and Detailed Views

1 Score
4 Areas

Planning 20%
Adoption 20%
Technology 25%
Performance 35%

10 Divisions

Objective 40%
Standard 30%
Preparation 30%
Process 50%
Organization 50%
Maturity 40%
Coverage 20%
Integration 40%
Quantity 70%
Quality 30%

60+ Measures

Source: Stanford CIFE  vdcscorecard.stanford.edu
Confidence Level

- Reflects **completeness and diversity** of data used to derive the score
Global BIM Trend

PORTFOLIO

Planning

Adoption

Technology

Performance

Confidence Level

10%

Conventional Practice

Typical Practice

Advanced Practice

Best Practice

Innovative Practice

Flags from various countries representing the level of BIM adoption and practice globally.
## bimSCORE Portfolio

### Planning:
- Adoption:
- Technology:
- Performance:

### bimSCORE

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**TARGETING**

**EXPRESS**

**IN-DEPTH**

**PORTFOLIO**
Establish Goals and Targets
Measure and Document Progress
Objective Dimension

- Objectives documented & shared with broader team
- Safety objectives for BIM/VDC are not in evidence
- Few quantitative objectives with benchmarks established
## Objectives in Evidence

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### Confidence Level

- **Planning:** 80%
- **Formalization:** 90%
- **Management Objectives:** 70%
bimSCORE Portfolio
Planning Advice

Confidence Level

Planning
Objective
Standard
Preparation

Formalization

Source: Kent Bauer
bimSCORE Portfolio
Planning Advice

Enterprise Mission and Vision
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20% Cost Savings, Commitment Reliability

Categories?
Measures?
Benchmarks?

Opportunities for Improvement

4D, “5D”, “6D” Initiatives

Source: Kent Bauer
Enterprise Mission and Vision

BIM-enabled IPD

20% Cost Savings

Example:

Critical Success Factors

KPI’s

Source: Kent Bauer

What action programs will achieve our performance goals?
How Do The Stations Compare By Guiding Principle?

FUNCTION

PASSenger EXPERIENCE

CONNECTIVITY

SOCIETAL IMPACTS

CRITICAL SUCCESS FACTORS

KPI’s

METRICS

PROXIMITY

ACCESSIBILITY
Establish and track BIM-based objectives through the project lifecycle, and benchmark performance to fuel continuous improvements.
Expand Processes leveraging Virtual Design & Construction (VDC)

Involve Broader Team in BIM-enabled Decision-making Process
### Adoption Process

#### Incentives
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- Typical Practice: 73%
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Forms of Project Delivery

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- Tight Synchronization Between Design and Fabrication
- Last Responsible Moment
Increase number of model uses
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Source: Stanford CIFE
bimSCORE

Confidence Level

Maturity Coverage Integration

Model Uses

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Quantitative Division

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- Track and compare performance within the project
- Qualitative or Quantitative
- Leading or Lagging

**Frequency:**
- Weekly, monthly, at key milestones, at-need

**Mechanisms:**
- In-house or 3rd-Party Professionals
- Surveys or interviews
### Critical Success Factors

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<th>Metrics</th>
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<tbody>
<tr>
<td>Communication</td>
<td>Prefabrication</td>
<td>% components prefab</td>
</tr>
<tr>
<td></td>
<td>Index</td>
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</tr>
<tr>
<td>Cost</td>
<td></td>
<td>% labor savings</td>
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<tr>
<td>Schedule</td>
<td></td>
<td>% reduction in rework</td>
</tr>
<tr>
<td>Project Delivery</td>
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<td>% reduction in field supervision</td>
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<tr>
<td>Safety</td>
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### Critical Success Factor

<table>
<thead>
<tr>
<th>Factor</th>
<th>KPI</th>
<th>Metric</th>
<th>Tracking</th>
<th>VDC Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>Meeting Effectiveness</td>
<td>Meeting Participation (% attending, % participating)</td>
<td>Bi-weekly</td>
<td>Big Room, ICE, Visualization</td>
</tr>
<tr>
<td>Cost</td>
<td>Change Orders</td>
<td>CO rate due to mis-coordination</td>
<td>Monthly</td>
<td>Clash Detection</td>
</tr>
<tr>
<td>Project Delivery</td>
<td>Field Management</td>
<td>QA / QC reporting time reduction with field BIM</td>
<td>At-need</td>
<td>Field tables, field management software</td>
</tr>
<tr>
<td>Schedule</td>
<td>Just-in-time Delivery</td>
<td>% components delivered w/in 1 week of install</td>
<td>Bi-weekly</td>
<td>Material tracking</td>
</tr>
<tr>
<td>Facility</td>
<td>Energy</td>
<td>Energy Savings</td>
<td>Monthly</td>
<td>Energy Analysis</td>
</tr>
<tr>
<td>Safety</td>
<td>Site Safety</td>
<td>RIR Reduction</td>
<td>Monthly</td>
<td>Safety Modeling</td>
</tr>
<tr>
<td>Management</td>
<td>VDC Proficiency</td>
<td>% FTE's w/ IPD experience</td>
<td>Semi-Annually</td>
<td>Many</td>
</tr>
</tbody>
</table>
Diamond of User Emotion:
- Track, trend, and publish satisfaction with BIM/VDC processes and tools