Framing Construction Uses of Virtual Information Models

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Charles and Elinor Matts Professor of Architectural Engineering
Research Objective

To capture the state-of-the-art model use and identify future construction needs

This work focuses beyond the implementation of models for commercial building projects, and aims to identify the breadth of construction needs for using information models.

A Model Use is defined as:

“a method or strategy of applying digital modeling during a project lifecycle to achieve one or more specific objectives.”
Challenges remain in better leveraging models within facility construction processes.

This presents an opportunity to create coordinated industry guidelines and a process for leveraging model content through the construction phase.
Research Motivation

To better capture current model uses and also allow expansion for future needs
Research Methodology

An ontology to categorize current model uses and expand model uses for future needs

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<table>
<thead>
<tr>
<th>BIM Use</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gather</td>
<td>Facility Element</td>
</tr>
<tr>
<td>Generate</td>
<td>Facility Phase</td>
</tr>
<tr>
<td>Analyze</td>
<td>Discipline</td>
</tr>
<tr>
<td>Communicate</td>
<td>Level of Development</td>
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</tbody>
</table>

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**The Uses of BIM**
Classifying and Selecting BIM Uses
Version 0.9
September 2013

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(Kreider, 2013)
Research Methodology

Process of collecting and interpreting data

1. Literature Review
   Reviewed recent academic research and industry practices on construction model uses

2. Framing Construction Uses of Modeling
   Established an approach to capture the current leading model uses and identify future opportunities

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Framing Construction Uses of Modeling

Established an approach to capture the current leading model uses and identify future opportunities.

**Steps:***

1. Literature Review
   - Reviewed recent academic research and industry practices on construction model uses

2. Framing Construction Uses of Modeling
   - Established an approach to capture the current leading model uses and identify future opportunities

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**Graphs:**

- Model use technology
- Construction task
- Model use purpose
- Model use purpose

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**Institution:**

Penn State

**Program:**

Lean and Green Research Initiative
Research Methodology

A literature review of the development and implementation of construction modeling

“virtual model” & “construction”

<table>
<thead>
<tr>
<th>Source</th>
<th>Name</th>
</tr>
</thead>
</table>
| Journal | ASCE Journal of Computing in Civil Engineering  
ASCE Journal of Construction Engineering and Management  
Elsevier Journal of Automation in Construction  
Journal of Information Technology in Construction  
ASCE Journal of Architectural Engineering  
Canadian Journal of Civil Engineering  
Elsevier Journal of Advanced Engineering Informatics |
| Conference | International Society for Computing in Civil and Building Engineering (ISCCBE) Conference  
International Symposium on Automation and Robotics in Construction (ISARC)  
International Council for Research and Innovation in Building and Construction (CIB) W78 Conference  
eWork and eBusiness in Architecture, Engineering and Construction: ECPPM  
Annual Conference of the International Group for Lean Construction (IGLC) |

No. of Publications

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<td>2006 - 2010</td>
<td>18</td>
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<tr>
<td>2011 - 2014</td>
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Results – Dimensions of Model Use Matrix

To capture the current model uses and identify future construction needs

**Dimension 01: Model Use Technology**

- Simulation technology
- Positioning systems (or tracking systems)
- Imaging technology
- Geographic information system (GIS)
- Business management tools
- Mobile technology
- Robotics
Results – Dimensions of Model Use Matrix

To capture the current model uses and identify future construction needs

**Dimension 02: Construction Task**

- Construction planning & management
- Procurement
- Civil engineering activities
- Excavation and foundation
- Frame erection
- Assembly and installation
- Engineering systems
- Enclosure and finishes
- Quality Assurance/Quality Control (QA/QC)

Figure 7. Example Project Work Breakdown Structure

(CII, 1987)
Results – Dimensions of Model Use Matrix

To capture the current model uses and identify future construction needs

Dimension 03: Model Use Purpose

- **Gather:**
  
  “to collect or organize facility information;”

- **Generate:**
  
  “to create or author information about the facility;”

- **Analyze:**
  
  “to examine elements of the facility to gain a better understanding of the elements;”

- **Communicate:**
  
  “to present information about a facility in a method in which it can be shared or exchanged;”

- **Realize:**
  
  “to make or control a physical element using facility information.”

(Kreider, 2013)
Results – Model Use Matrices

Model use technologies supporting different construction tasks

<table>
<thead>
<tr>
<th>Construction task</th>
<th>No. of Publications</th>
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</thead>
<tbody>
<tr>
<td>Constr. Planning &amp; Mgmt.</td>
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<td>Procurement</td>
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<tr>
<td>Change Mgmt.</td>
<td>2</td>
</tr>
<tr>
<td>Simulation Technology</td>
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<tr>
<td>Business Mgmt Tool</td>
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<td>Positioning Systems</td>
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</tr>
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<td>Imaging Technology</td>
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<tr>
<td>Mobile Devices</td>
<td>1</td>
</tr>
<tr>
<td>GIS</td>
<td>0</td>
</tr>
<tr>
<td>Robotics</td>
<td>0</td>
</tr>
</tbody>
</table>

- Simulation Technology: 29%
- Imaging Technology: 26%
- Positioning Systems: 24%
- GIS: 8%
- Mobile Devices: 8%
- Business Mgmt Tool: 5%
- NA: 0%
Results – Model Use Matrices

Model uses with different purposes and technologies

<table>
<thead>
<tr>
<th>Model use purpose</th>
<th>Gather</th>
<th>Generate</th>
<th>Communicate</th>
<th>Analyze</th>
<th>Realize</th>
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<tr>
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<tr>
<td>Mobile Devices</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Robotics</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<td>15</td>
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</tbody>
</table>
### Results – Model Use Matrices

Construction tasks supported by different model use purposes

<table>
<thead>
<tr>
<th>Construction task</th>
<th>Model use purpose</th>
<th>No. of Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gather</td>
<td>Generate</td>
</tr>
<tr>
<td>Constr. Planning &amp; Mgmt.</td>
<td>18</td>
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</tr>
<tr>
<td>Procurement</td>
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<tr>
<td>Civil</td>
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<tr>
<td>Excavation &amp; Foundation</td>
<td>1</td>
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<td>Frame Erection</td>
<td>8</td>
<td>1</td>
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<tr>
<td>Engineering Systems</td>
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<tr>
<td>Envelope &amp; Finishes</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>QA/QC</td>
<td>3</td>
<td>0</td>
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</tbody>
</table>
Conclusions & Next Steps...

Need of implementation guidelines for progressive model use adoption

Model Uses Identified

Future Uses Defined

Guidelines Developed

Initial Publication Submission

2014
2015
2016

Nov
Aug
Oct
Feb

Identify Case Studies
Case Studies Complete
Validation of Guidelines
Annual Conference Report Out

http://www.3dcadservicesindia.com
http://www.autodesk.com/
http://www.neoformix.com/blog.html
http://nrccps.org/information-dissemination/publications/
http://cpvtconf.com/en/