BIM Adoption
by
Public Construction Clients

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Thanks to...

• Ury Gurevich,
  • PhD student who performed the action research

• SBTIC 2019, UNICAMPI
  • Departamento de Arquitetura e Construção,
    Faculdade de Engenharia Civil, Arquitetura e Urbanismo
    Universidade Estadual de Campinas

• Sinaenko
To study, model, experiment with and understand the flow of work and teams in complex construction projects: **Lean Construction.**

**Observations, action research, process mapping and modeling, management games (LEAPCON), discrete event simulation, agent-based simulation (EPIC)**
To study and develop **Building Information Modeling (BIM)**

*IFC and BIM interoperability, BIM tools, virtual reality, BIM education*

*BIM & AI*

https://youtu.be/KJPnYKghqlw
To propose, define, develop and test BIM-enabled systems to support production planning and day to day production control on construction sites: **Lean and BIM synergies.**

**Prototyping (KanBIM, iKAN), field experiments, ‘Virtual Construction Site’ experiment.**
BIM Handbook author team
Building Lean, Building BIM

Improving Construction the Tidhar Way

Rafael Sacks, Samuel Korb and Ronen Barak
Outline

• Public Clients
• What should we do?
• Research Method
• Review of BIM Documents
• Case studies
• Results
• Conclusions
Public construction clients

- **Government Construction Departments**
  Defence, Education, Housing, Justice, Transport, Environment, Health.....

- **Government Agencies**
  US Army COE, Veteran’s Administration, GSA, TfL, CrossRail, Highways England

- **Universities**

- **Utilities**

- **Medical/health organizations**
Public construction clients

- Wide range of project types, scopes and sizes, (including very large projects with very big budgets)
- Subject to public review
- Strong influence on the construction sector
- Ability to demand and drive change in their supply chains
- Institutional Inertia
  - Complex hierarchies and power structures
New Children’s Hospital
BIM for Design with end user engagement
# BIM Uses

<table>
<thead>
<tr>
<th>Phase</th>
<th>BIM Uses</th>
<th>Software</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feasibility</strong></td>
<td>Site Analysis</td>
<td>Revit, AutoCAD</td>
<td>Laser Scanning</td>
</tr>
<tr>
<td></td>
<td>Phase Planning</td>
<td>Revit, AutoCAD</td>
<td>CAD</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>Existing Conditions</td>
<td>Revit</td>
<td>Modeling</td>
</tr>
<tr>
<td></td>
<td>Design Development, document authoring</td>
<td>Revit, Dynamo, NBS Create</td>
<td>Virtual Reality (VR), Augmented Reality (AR)</td>
</tr>
<tr>
<td></td>
<td>3D Coordination</td>
<td>Navisworks</td>
<td>Clash detection</td>
</tr>
<tr>
<td></td>
<td>Cost Estimation</td>
<td>CostX</td>
<td>Analysis</td>
</tr>
<tr>
<td></td>
<td>Structural Analysis</td>
<td>Dynamo, Tekla Structural Designer 2015, SCIA Engineer 16</td>
<td>Structural modeling and analysis</td>
</tr>
<tr>
<td><strong>Pre-construction</strong></td>
<td>3D Coordination</td>
<td>Navisworks</td>
<td>Virtual Reality (VR), Augmented Reality (AR), Laser Scanning</td>
</tr>
<tr>
<td></td>
<td>Cost Estimation</td>
<td>CostX</td>
<td>Relational database</td>
</tr>
<tr>
<td></td>
<td>Other Engineering Analysis</td>
<td>Dynamo, Tekla Structure, Designer 2015, SCIAEngineer16</td>
<td>Virtual Reality (VR), Augmented Reality (AR), Laser Scanning</td>
</tr>
</tbody>
</table>
Design Development

Google Cardboard, a visualisation tool where project stakeholders are placed ‘inside’ a virtual representation of their building.
Parametric Modeling
Detailing and Schedules
The question....

- What steps should public construction agencies take to promote adoption of BIM?
- What steps should they take to optimize the value from their adoption of BIM to improve:
  - business processes, and
  - buildings and other assets?
- Which activities:
  - are most effective?
  - generate value for the public client?
  - improve information flows?
Research Method

• Document review
  • Analysis of 15 BIM documents

• Case studies
  • Action research
  • Longitudinal study – follow organizations for three years
  • Measure organizations and projects

• Process Mapping
  • Compile a BIM Adoption Impact Map - BIM AIM
Document Review

1. Los Angeles Community College District
2. Georgia Institute of Technology
3. University of Southern California
4. Indiana University
5. Senate Properties, Finland
6. Statsbygg, Norway
7. New York District, U.S. Army Corp of Engineers
8. General Services Administration
9. Department of Veterans Affairs
10. State of Ohio General Services Division
11. NATSPEC
12. National Institute of Building Sciences - Buildsmart alliance
13. Building and Construction Authority, Singapore
14. CanBIM, Canada
15. BSI Standards Limited, UK

BIM Document Topics

- BIM Execution Plan
- Integrated Project Delivery
- Interoperability
- LOD Specifications
- Modes of collaboration
- Operation and maintenance
- Pre-qualification
- Role of the BIM manager
- Schedule of design payments
- Simulation & analysis
- Specification of folder naming
- Style of presentation
- Use of BIM for renovation

0% 25% 50% 75% 100%

BIM Adoption by Public Construction Clients
Sinaenco – BIM Era Seminar 2019, Sao Paulo
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Case study organizations

Israel
• Israel Ministry of Defense

UK
• Highways England
• Environment Agency
• Transport for London/London Underground
• Defense Infrastructure Organization
• Ministry of Justice
Case study organizations

Israel
• Israel Ministry of Defence (IMOD)

UK
• Environment Agency (EA)
• Transport for London/London Underground (TfL)
### Main BIM Adoption Actions

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption funding – intra-organization</td>
<td>Funding for training, creating data resources, outsourcing etc.</td>
</tr>
<tr>
<td></td>
<td>Software and hardware purchase, training programs</td>
</tr>
<tr>
<td>Leadership</td>
<td>Senior managers directing themselves and their employees to invest time in training and developing BIM abilities</td>
</tr>
<tr>
<td>BIM object libraries</td>
<td>Creating organizational BIM object libraries to be used by others</td>
</tr>
<tr>
<td>Training</td>
<td>Train technicians and PMs for BIM understanding</td>
</tr>
<tr>
<td>Prepare BIM Guide</td>
<td>BIM Guides are the national, organizational or project level documents that establish common ways of working and the contents of BIM exchanges that are appropriate within the relevant contexts and along project timelines.</td>
</tr>
<tr>
<td>Motivate managers</td>
<td>Understanding potential benefits and the required actions needed to achieve the project goals, including preparation of contracts</td>
</tr>
<tr>
<td>BIM Execution Plan</td>
<td>Define desired modes of collaboration and information sharing, roles and responsibilities of partners, software and LOD of the different aspects of the model, model management, quality control procedures, object composition and naming conventions, etc.</td>
</tr>
<tr>
<td>Cash incentives</td>
<td>Align project design demands and payment</td>
</tr>
</tbody>
</table>
Case study orientation sessions
## Project BIM Maturity

### The Project Overview:
- Mission, Vision, Goals, and Objectives, along with management support, and BIM Champions.

<table>
<thead>
<tr>
<th></th>
<th>0 Non-Existent</th>
<th>1 Initial</th>
<th>2 Managed</th>
<th>3 Defined</th>
<th>4 Measured</th>
<th>5 Optimizing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open Standard deliverables</strong></td>
<td>Deliverables verified by open standard specifications, eg IFC, COBie</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BIM Contract</strong></td>
<td>All parties should sign up to a project BIM contract, that allows for the sharing of models in a collaborative way.</td>
<td>None, or poorly-defined BIM agreement in consultant appointment</td>
<td>Bespoke BIM contract signed by Company, other parties’ contracts unknown</td>
<td></td>
<td>All design parties signed up to an Industry-standard BIM contract</td>
<td>All parties, including Contractors, signed up to an Industry-standard BIM contract</td>
</tr>
</tbody>
</table>
Israel Ministry of Defense (IMOD)
IMOD – Typical Project
IMOD – Typical Project

3D Viewer
Transport for London (TfL)
Victoria Underground Station Upgrade
BIM for infrastructure construction
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<thead>
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<th>Phase</th>
<th>BIM Uses</th>
<th>Software</th>
<th>Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Schematic Design</strong></td>
<td>Feasibility</td>
<td>Bentley Triforma, Bentley AECOsim</td>
<td>Modeling</td>
</tr>
<tr>
<td></td>
<td>Layout</td>
<td>Legion modeling</td>
<td>Crowd simulation</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Archiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design Development</strong></td>
<td>Design Authoring</td>
<td>Triforma, AECOsim</td>
<td>Modeling</td>
</tr>
<tr>
<td></td>
<td>3D coordination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>ProjectWise</td>
<td>File sharing, cloud</td>
</tr>
<tr>
<td></td>
<td>Archiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Construction Documentation</strong></td>
<td>Structural Analysis</td>
<td>STAAD, Hevacomp</td>
<td>Finite Element Method</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Design Reviews</td>
<td>Triforma, AECOsim</td>
<td>Modeling</td>
</tr>
<tr>
<td></td>
<td>Drawing</td>
<td>Microstation</td>
<td>CAD</td>
</tr>
<tr>
<td></td>
<td>Existing Conditions</td>
<td>Triforma, AECOsim</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>ProjectWise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phase Planning</td>
<td>AECOsim</td>
<td>4D simulation</td>
</tr>
</tbody>
</table>
Victoria Station Upgrade
Victoria Station Upgrade
Victoria Station Upgrade
Victoria Station Upgrade

Actual gaps in the tunnel face
Environment Agency (EA)

Asset Data Requirements including H&S

- Digitally align: Engineering standards
- Minimal technical requirements
- Validation

Define our Asset Data Requirements
The data & information we need
To support our project and whole life operational decisions
Environment Agency (EA)
Environment Agency (EA)

Network information – system of flood control projects
Environment Agency (EA)

Network information – system of flood control projects
Environment Agency (EA)

Network information – system of flood control projects
Process mapping method

• Prepare an initial process map
  • Actors: public clients, project managers, designers, contractors, permit agencies, end users, facility managers
  • Four aspects: Technology, Process, People, Information
  • Result – BIM AIM 1.0

• Review with case study participants to identify:
  • Missing activities
  • Activities that have not been done by any client
  • Activities that have amplified impact

• Revise and redraw
  • Result – BIM AIM 2.0
BIM AIM v1.0 – client actions

- **Adoption Funding**
  - Requires
  - Enables

- **Policy mandate**
  - Enables
  - Supports
  - Enables
  - Requires

- **Leadership**
  - Encourages
  - Supports

- **Prepare BIM guide**
  - Creates
  - Informs

- **Train PMs’ & others**
  - Enables
  - Requires

- **Train Technicians/ Eng**
  - Enables
  - Informs

- **Prepare BIM objects libraries**
  - Enables
  - Informs
  - Creates

- **Leadership**: Encourage/Inform
  - Enables
  - Informs

- **Implement BIM Guides**
  - Informs

- **Standardization**: Reduces
  - Enables

- **Value for organization**
  - Enables

- **Review & feedback**
  - Enables

- **Design cost & duration**
  - Enables

- **Facility maintenance**
  - Enables

- **IT System Operating Cost**
  - Enables

- **Improves Delivery on Budget & on Time**
  - Enables

- **Influences**: Improves
  - Enables

- **Organization’s BIM object library**
  - Enables

- **BIM object libraries**
  - Enables

- **PM training**
  - Enables

- **Practical training**
  - Enables

- **Leadership**
  - Enables

- **BIM Guide**
  - Enables

- **Organization**
  - Enables

- **BIM Era Seminar 2019, Sao Paulo**
  - Rafael Sacks © 2019
Results

• Measure over three years....
  • Organization BIM adoption actions
  • Organization BIM maturity
  • Projects BIM maturity

• Map organization BIM actions
IMOD – Project BIM level progression

Project BIM Adoption Level %

Organizational BIM actions

Project BIM Level

Big Room project

Time

dez/14 jul/15 jan/16 ago/16 mar/17 set/17 abr/18 out/18
IMOD – Analysis using BIM AIM
Observations

• The organization continued to actively pursue its adoption actions, but....

• Project managers were not sufficiently informed of the purpose and value of BIM use, because...

1. The organization failed to identify the value of information for:
   • Facility operation and maintenance
   • Future development of the system

2. The organization failed to monitor and support its own in-house project managers
Observations

What is the real value for public clients?

• Short term value
  • Reduce project construction costs
  • Reduce project durations
  • Improve project quality

• Long term value
  • Asset information
  • Visualization
  • Asset management
  • Maintenance
  • A basis for operational information
  • Managing staff

the *Digital Twin*
Conclusions

• The hypothesis:
  • “The more actions the organization implements to promote and support BIM adoption on its portfolio of projects, the better the BIM level of the organization will be”

  .... is wrong.

• There is a strong relationship between an organization’s actions and the BIM level achieved in projects

• Some actions have amplified effect while others have limited or no effect
Most valuable adoption actions

- **Leadership, guidance, and control** by senior management
- Involve and motivate suppliers (designers and contractors)
- Education and training
- Define **Asset Information Requirements** (AIR)
- Monitor and control in-house project managers
- Pay designers properly for BIM
- Manage expectations and collaboration – at both organizational and project levels
BIM AIM 2.0 (Adoption Impact Map)
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Value of BIM AIM 2.0

• Supports planning of adoption actions
• Identifies which actions amplify other actions
• Reflects extensive experience, grounded in case studies
• Identifies actions that have not been tried in practice
• Represents all aspects:
  • Technology
  • People
  • Process
  • Information
Thanks for listening!

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