Tan Swan Beng (TSB) Public Lecture Series on Sustainable Urban Living
3 October 2014

Presentation on:
Improving Productivity through enhanced process of preparing precast shop drawings using BIM

by

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AGENDA

Part 1 - BIM Centre of Excellence
- Mission
- Education
- Main Focus
- Industrial Collaboration

Part 2 - NTU HDB Precast Project
- Parametric BIM Components
- Data Exchange
- Present Workflow Vs. Proposed Future Workflow
- Productivity Evaluation
LABOUR-INTENSIVE sectors which have not raised their game are a big reason the productivity drive has struggled to gain momentum in the past two years, said labour chief Lim Swee Say (Straits Times, August 29th, 2014.

Sectors such as ... ?? are not only lagging behind in productivity levels but are also increasing their share of the total workforce.

These two factors have combined to pull down overall productivity growth, which has been weak over the past few years, said Mr Lim, who is secretary-general of the National Trades Union Congress (NTUC).

Q: What are these two Sectors?

A: Construction and Food Services
BIM - Centre of Excellence (COE) at NANYANG TECHNOLOGICAL UNIVERSITY
Mission

• To provide an excellent academic research environment for Building Information Modeling (BIM) to support engineering practices to improve construction processes,
  • facilitate collaboration between stakeholders,
  • reduce on site reworks,
  • to ensure highly productive construction management practices,
  • development of sustainable building projects.
Education

- NTU has proposed to introduce BIM Specialization courses at the Graduate Level.
- The aim is to develop an understanding of the broad theoretical and practical perspectives of BIM, and offer an innovative inter-disciplinary approach to the study of modern construction processes.
- The new courses are:
  - Information Technology in Construction (already started)
  - Virtual Design and Construction (proposed course)
  - Integrated Facilities Management with Advanced CAD (Building Information Modelling (BIM) Case studies) (proposed course)
Main Focus

• In order to support the engineering practices to improve construction processes
  • Bring together faculty members, researchers, students, and industry participants from diverse domains, such as, civil engineering, architecture, facility management, computer science, business to focus on BIM research and practices.
  • Introducing advanced BIM trainings, seminars, and workshops
  • BIM R&D projects
Industrial Collaboration

• To pursue & promote joint research & collaboration in various aspects of Building Information Modeling Solutions.

• Collaboration objectives:
  • To support the training of industry professionals towards their capability development in the field of Building Information Modelling (BIM) solutions for building and construction designs;
  • To provide a platform for mutual sharing of best practices in the application of BIM solutions.
  • To proliferate the adoption of BIM technology in the construction industry.

• Some Industrial Collaborators:
  • HDB
  • BCA
  • Precast Firms
  • BIM Vendors (Tekla, Allplan)
Capability Development

BIM for Precast

BIM for Construction

BIM for Design

BIM for Modeling
## NTU - HDB Precast Project

### “Enhancing the Process of Preparing Precast Shop Drawings Through BIM”

<table>
<thead>
<tr>
<th>Phase</th>
<th>Project Development Period November 2013 - November 2014</th>
<th>Activities</th>
</tr>
</thead>
</table>
| I     | 6 months                                                | - Study of HDB drawings and Precast processes  
          |                                                        | - Interviews & Surveys  |
| II    | 9 months [3 months overlap]                             | - Development of Parametric BIM Components  
          |                                                        | - Process Mapping  
          |                                                        | - Data Exchange  
          |                                                        | - Development of BIM Guideline |
## Project Partners

<table>
<thead>
<tr>
<th>Firm/Organization</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTU</td>
<td>Key Researchers</td>
</tr>
<tr>
<td>HDB</td>
<td>Project Leader</td>
</tr>
<tr>
<td>BCA</td>
<td>Funding Agency – (PIP Scheme)</td>
</tr>
<tr>
<td></td>
<td>Project Facilitator</td>
</tr>
<tr>
<td>Pre-casters</td>
<td>Domain Experts</td>
</tr>
<tr>
<td></td>
<td>HDB pre-casters</td>
</tr>
<tr>
<td></td>
<td>• Sunway Concrete Product Pte. Ltd.</td>
</tr>
<tr>
<td></td>
<td>• Excel Precast Pte. Ltd.</td>
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<td></td>
<td>• HL Building Materials Pte. Ltd.</td>
</tr>
<tr>
<td>BIM Vendors (Tekla, Allplan)</td>
<td>Technology Providers</td>
</tr>
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<td></td>
<td>Software Trainers</td>
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</tbody>
</table>
Objectives & Deliverables

• Develop a standard set of parametric BIM components for key precast elements commonly used for HDB projects in order to shorten the shop drawings production & approval process.
• Develop a robust data exchange technique to facilitate conversion of consultants design model to precast model.
• To streamline the workflow for shop drawing generation by proposing a new improved workflow in order to address the prevalent issues in the present scenario.
  — Key Performance Index – Measurement of expected Productivity Enhancement through comparison of the workflows.
Objectives & Deliverables

PARAMETRIC BIM COMPONENTS
# Parametric BIM Components

## Key HDB Precast Elements

<table>
<thead>
<tr>
<th>Easy Components</th>
<th>Moderate Components</th>
<th>Difficult Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duct</td>
<td>Gable End Wall</td>
<td>Household Shelter</td>
</tr>
<tr>
<td>Pre-Stressed Plank</td>
<td>Staircase</td>
<td>Façade – 1 Opening</td>
</tr>
<tr>
<td>Non Pre-Stressed Plank</td>
<td>Ferrocement Sunbreaker</td>
<td>Façade – 2 Opening</td>
</tr>
<tr>
<td>Infill Wall</td>
<td>Air-Con Ledge</td>
<td>Refuse Chute</td>
</tr>
<tr>
<td></td>
<td>Parapet Wall</td>
<td></td>
</tr>
</tbody>
</table>
Parametric BIM Components

Each component allows the generation of standard shop drawings from BIM model directly.

Parapet Wall

Facade Wall

CD Shelter
Parametric BIM Components
Objectives & Deliverables

DATA EXCHANGE
(Between Revit to Tekla)
DESIGN MODEL IN AUTODESK REVIT 2014
Data Exchange – Autodesk Revit 2014 Writer

- Development of Add-On in Autodesk Revit 2014 to export project data to Tekla Structures 20.0.
- The Files will be written as an XML schema. (Example)
Data Exchange — Tekla Structures 20.0 Reader

- Development of Add-On in Tekla Structures 20.0 to import project data from Autodesk Revit 2014.
- The Add-On reads the XML schema exported from Revit.
Data Exchange

PRECAST MODEL IN TEKLA STRUCTURES 20.0
Based on the precast model converted from Revit to Tekla, the precasters can easily select the components and generate Shop Drawings and Bar Bending Schedule.
# Generation of Shop Drawing

## BAR BENDING SCHEDULE

<table>
<thead>
<tr>
<th>Bar Mark</th>
<th>Type</th>
<th>Size</th>
<th>Nos</th>
<th>L</th>
<th>Shape Code</th>
<th>Dimensions</th>
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</thead>
<tbody>
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<td>T</td>
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<td>10</td>
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<td>620</td>
<td>33</td>
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<td>15</td>
<td>1570</td>
<td>Unk</td>
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<tr>
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<td>10</td>
<td>2</td>
<td>1790</td>
<td>Unk</td>
<td></td>
</tr>
</tbody>
</table>

### Element Quantity
- 6

### Element Weight (ton)
- 5.15

### Concrete Volume (m³)
- 2.11

### Concrete Grade
- C40

### Reinf. Bar 6-12 (kg)
- 0.0

### Reinf. Bar 16-40 (kg)
- 44.6

### Reinforcement (kg)
- 44.6

### Reinforcement (kg/m³)
- 21
Objectives & Deliverables

PRESENT WORKFLOW
Vs.
PROPOSED FUTURE WORKFLOW
Present Workflow

Productivity Improvement
Reduced time in Shop Drawing production due to automatic drawing production from the standardized parametric components
Proposed Future Workflow

**Consultant:**
BIM Model with Precast components

**Pre-caster:**
Shop drawings/Rebar Schedules from the Precast components
Map out the present workflow and identify areas of improvement.

Streamline and coordinated process
Productivity Evaluation
Based on precasters expectation*

“Estimated Values” for Present Workflow Vs “Expected Values” for Proposed Future Workflow

<table>
<thead>
<tr>
<th>Component</th>
<th>Present Workflow (in days)</th>
<th>Proposed Future Workflow (in days)</th>
<th>Expected Time Saved (ETS) (in days)</th>
<th>Productivity Improvement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy Components</td>
<td>36</td>
<td>21</td>
<td>15</td>
<td>41.66 %</td>
</tr>
<tr>
<td>Moderate Components</td>
<td>45</td>
<td>29</td>
<td>16</td>
<td>35.56 %</td>
</tr>
<tr>
<td>Difficult Components</td>
<td>61</td>
<td>42</td>
<td>19</td>
<td>31.15 %</td>
</tr>
<tr>
<td>Total</td>
<td>142</td>
<td>92</td>
<td>50</td>
<td>35.21 %</td>
</tr>
</tbody>
</table>