PU BIM Conference

Building Smart & Sustainable Cities with BIM - Sustainability and Asian Games 2018

Lyn Chua
Technical Account Manager, ASEAN Public Sector
*No buildings and bridges were harmed in the making of this presentation*
What is a Smart City?
Responsibilities set out in “Smart Cities Readiness Guide”
Smart Cities Framework

- Environment
- Economy
- People
- Living
- Mobility

- Smart Buildings
- Resource Management
- Sustainable Urban Planning
- Efficient Transport
- Multi-modal Access
- Technology Infrastructure
- Online Services
- Infrastructure
- Open Government

- Entrepreneurship & Innovation
- Productivity
- Local & Global Connections
- Inclusion
- Education
- Creativity
- Culture & Well Being
- Safety
- Health

© 2015 Autodesk
### What does a Smart City need? Majority of Livable Cities adopt BIM

**Mercer 2015 Quality of Living**[1] vs **BIM Adoption**[2]

<table>
<thead>
<tr>
<th>Rank / BIM?</th>
<th>City</th>
<th>Rank</th>
<th>City</th>
<th>Rank</th>
<th>City</th>
<th>Rank</th>
<th>City</th>
<th>Rank</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vienna, Austria</td>
<td>13</td>
<td>Bern, Switzerland</td>
<td>25</td>
<td>Nurnberg, Germany</td>
<td>37</td>
<td>Brisbane, Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Zurich, Switzerland</td>
<td>14 (Guidelines)</td>
<td>Berlin, Germany</td>
<td>26</td>
<td>Singapore, Singapore</td>
<td>38</td>
<td>Barcelona, Spain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 (Guidelines)</td>
<td>Auckland, New Zealand</td>
<td>15</td>
<td>Toronto, Canada</td>
<td>27</td>
<td>Adelaide, Australia</td>
<td>39</td>
<td>Lyon, France</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 (Guidelines)</td>
<td>Munich, Germany</td>
<td>16 (Guidelines)</td>
<td>Hamburg, Germany</td>
<td>27</td>
<td>Paris, France</td>
<td>40</td>
<td>London, United Kingdom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Vancouver, Canada</td>
<td>16 (Guidelines)</td>
<td>Melbourne, Australia</td>
<td>27</td>
<td>San Francisco, United States</td>
<td>41</td>
<td>Lisbon, Portugal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 (Guidelines)</td>
<td>Dusseldorf, Germany</td>
<td>16</td>
<td>Ottawa, Canada</td>
<td>30</td>
<td>Canberra, Australia</td>
<td>41</td>
<td>Milan, Italy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 (Guidelines)</td>
<td>Frankfurt, Germany</td>
<td>19</td>
<td>Luxembourg, Luxembourg</td>
<td>31</td>
<td>Helsinki, Finland</td>
<td>43</td>
<td>Chicago, United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Geneva, Switzerland</td>
<td>19</td>
<td>Stockholm, Sweden</td>
<td>31</td>
<td>Oslo, Norway</td>
<td>44</td>
<td>New York City, United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 (Mandate)</td>
<td>Copenhagen, Denmark</td>
<td>21 (Guidelines)</td>
<td>Stuttgart, Germany</td>
<td>33</td>
<td>Calgary, Canada</td>
<td>44</td>
<td>Seattle, United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 (Guidelines)</td>
<td>Sydney, Australia</td>
<td>22</td>
<td>Brussels, Belgium</td>
<td>34</td>
<td>Boston, United States</td>
<td>44 (Guidelines)</td>
<td>Tokyo, Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Amsterdam, Netherlands</td>
<td>22 (Guidelines)</td>
<td>Perth, Australia</td>
<td>34</td>
<td>Dublin, Ireland</td>
<td>47</td>
<td>Kobe, Japan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 (Guidelines)</td>
<td>Wellington, New Zealand</td>
<td>24</td>
<td>Montreal, Canada</td>
<td>36</td>
<td>Honolulu, United States</td>
<td>48 (Policy)</td>
<td>Los Angeles, United States</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Autodesk InfraWorks 360 2016

Singapore Model

Featuring the Singapore BCA Academy's BIM Model
by the Autodesk ASEAN TS & Smart Cities Teams – BuildTech Asia, Oct 2015
Sustainability
Urban Planning: Rapid Energy Modeling
REM provides useful results using building data to quickly identify high-potential retrofit strategies prior to costly site visits.
District Energy Modeling

Washington DC

Autodesk integrated two software programs to allow district-scale Rapid Energy Modeling.
Performing Rapid Energy Modeling of the Buildings in the Downtown Ecodistrict

- Ran 48 buildings, each in ~5-8 minutes, though can be run in parallel
- Where available, compared to 2013 Benchmarking Data (32 buildings in purple)
Filtering buildings by sensitivity allows us to know which buildings to target and which incentive to provide.
Savings can be found by evaluating the range, benchmarked, and ideal values of consumption.
Energy Cost Factor charts show which building system to target for greatest energy savings.
University of Carleton: Site & BIM

- **Digital Campus Innovation** is an interdisciplinary effort to define, develop and evaluate new processes, methods and technologies towards a systemic, integrative and collaborative approach to decision-making in planning, designing, construction and operation of sustainable communities.

- **DCI** involves a multi-phase project. In phase I, we will develop and utilize Building Information Modelling (BIM) to provide open access to building information and comprehensively evaluate the sustainability of a cluster of three diverse Carleton University buildings: Mackenzie, Canal, and Architecture.
University of Carleton: Site & BIM
University of Carleton: Site & BIM
University of Carleton: Site & BIM
Digital Campus Innovation: Energy

The team currently has access to monthly energy and water data for each building on campus and much higher spatial and temporal resolution for the Canal Building.

These are Sankey diagrams for energy consumption, mass flow, carbon emissions, and utility costs to facilitate the decision-making by the Facilities Management and Planning (FMP) and other stakeholders.
Simulation
Simulating the Future

- Accessibility
- Site Energy Management Analytics
- Energy Conservation Measures - Financial Analysis
- Virtual Reality
- Fire, Smoke & Heat Analysis
- Solar & Lighting Analysis
- Structural Analysis
- Wind Analysis
- Traffic Analysis
- Drainage Analysis
Site Energy Management

Analytics

### Building 1

#### Project 1

**Time zone:** America/Managua

1. Dashboard
2. 2D plan
3. 3D model
4. Device

#### These findings are from March 2015

**Load Type: COMPRESSOR**

<table>
<thead>
<tr>
<th>Device</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressor 1 R</td>
<td>Measurement under the lower outer fence threshold</td>
</tr>
<tr>
<td>Compressor 1 R</td>
<td>Measurement over the upper outer fence</td>
</tr>
<tr>
<td>Compressor 1 R</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
</tbody>
</table>

#### Load Type: MACHINERY

<table>
<thead>
<tr>
<th>Device</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 Welder</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
<tr>
<td>38 Band Saw R</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
<tr>
<td>G2 Table Saw R</td>
<td>Measurement over the upper inner fence threshold</td>
</tr>
<tr>
<td>G9 Table Saw R</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
</tbody>
</table>

#### Consumptions for Exhaust Fan Paint Boot R

- **Series 1:** Inner threshold up, Inner threshold down, Outer threshold up, Outer threshold down
- **Load Type:** HVAC systems with low consumption during on hours

#### Consumptions for Exhaust Fan D7 Laser R

- **Series 1:** Inner threshold up, Inner threshold down, Outer threshold up, Outer threshold down
- **Load Type:** HVAC systems with low consumption during on hours

<table>
<thead>
<tr>
<th>Device</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Unit CNC</td>
<td>Measurement under the lower outer fence threshold</td>
</tr>
<tr>
<td>Heating Unit CNC</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
<tr>
<td>Kitchen Hood Fan R</td>
<td>Measurement under the lower outer fence threshold</td>
</tr>
<tr>
<td>Kitchen Hood Fan R</td>
<td>HVAC systems with low consumption during on hours</td>
</tr>
</tbody>
</table>

**Consumption of all devices of fan load type**

- **Kitchens Hood Fan R:** 2.3 %
- **Exhaust Fan Paint Boot R:** 3.4 %
- **Exhaust Fan D7 Laser R:** 4.1 %

**Consumption of all devices of fan load type**

- **Series 1:** Inner threshold up, Inner threshold down, Outer threshold up, Outer threshold down
- **Load Type:** HVAC systems with low consumption during on hours
Site Energy Management

Financial Simulation & Costing

**Financial Information**
- ECM Investment ($): 0.00
- Incremental Investment ($): 0.00
- Baseline Investment ($): 0.00
- Discount rate (%): 10.00

**Energy Information**
- Baseline Energy Consumptions (Kwh): 0.00
- ECM Energy Consumptions (Kwh): 0.00
- Energy Savings (%): 10.00
- Baseline Energy Rate ($): 192,766.00
- ECM Energy Rate ($): 173,489.00

**Project Information**
- Project Title:
- Base Scenario:
- Alt. Scenario:
- Building Type:
- Floor Area (sq): 0.00

**Sensitivity**
- Upfront Costs
- Annual Energy Cost Saved
- Discounted Payback
- NPV
- IRR
- Benefits to Cost Ratio
- Effect on Asset value

Sensitivity Analysis is based on varying the following input values by +/- 20%: Discount Rate, Incremental Investment, Energy Savings, Electricity Rate, Fuel Rate.
Fire Simulation
Sprinklers
Smoke Visibility Legend:
1. **RED**: Low Visibility (High # of Smoke Particles)
2. **ORANGE**: Medium Visibility (Moderate # of Smoke Particles)
3. **YELLOW**: High Visibility (Low # of Smoke Particles)
Solar Analysis

For BIM Models
Simulating the Future

- Accessibility
- Site Energy Management Analytics
- Energy Conservation Measures - Financial Analysis
- Virtual Reality
- Fire, Smoke & Heat Analysis
- Solar & Lighting Analysis
- Structural Analysis
- Wind Analysis
- Traffic Analysis
- Drainage Analysis
Planning the Games