SANDFORD FLEMING FORUM

Minimising Loss, Accelerating Recovery in Commercial Real Estate
Problem

- Concentration of value and operational intensity
- Increasing dependency of operations on information systems and ICS
- Increasing cost sensitivity to business interruption
- Changing/increasing hazards and risks to operations
- Legacy systems and structures.

Solution

- Integrated operational resilience:
  - Quantitative systems level risk awareness
  - Resilient operational practices
  - Resilient operational program within the structure
  - Cyclical ongoing operational risk assessment and posture adjustment
  - Integrated systems dependency model
Operational Control Framework

- Understand the System of Systems
- Understand Inherent Risk

Building systems inter-dependency BIM

Context:
- Power
- Emg Svc
- Transit
- Supply Chain
- Food Svc

Content:
- Telecom
- Water
- Waste Water
- Networks
- Distribution

Operations to building systems inter-dependency graph model

Extract

- Understand the System of Systems
- Understand Inherent Risk
Constructing the Control Framework

1. Scanning
2. Design
3. As Built
4. Revit Model
5. Interdependency Extraction
6. Inherent Risk Model
7. Visualization/Simulation
Apply Hazard

Downscaled Climate Models

Digital Watershed Model

Hydrological Model

Infrastructure inter-dependency model

Integrated Hazard (Flood) Modelling

Hazard Risk Profile

Inherent Risk Profile

Cumulative Impact versus Cumulative Failure
Visualization and Simulation

BIM Model

Normal Operation

Flood Hazard

https://www.youtube.com/watch?v=acsIDaGhXos&feature=youtu.be
Inherent vs Hazard Risk Profiles

**Inherent Risk**
- Exterior Structural Elements
- Generators, control units

**Hazard Risk**
- Exterior Structural Elements
- Turbine Room Elements
- Generators, control units

**Hazard Risk Scenario Cost Profile**

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Fixed</th>
<th>Day 1 Variable</th>
<th>Day 2 Variable</th>
<th>Day 3 Variable</th>
<th>Scenario Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Elements</td>
<td>$62,184,450.00</td>
<td>$2,552,337.00</td>
<td>$5,104,674.00</td>
<td>$7,657,011.00</td>
<td>$77,498,472</td>
</tr>
<tr>
<td>Turbines</td>
<td>$81,082,091.00</td>
<td>$1,194,221.00</td>
<td>$2,388,442.00</td>
<td>$3,582,663.00</td>
<td>$88,247,417</td>
</tr>
<tr>
<td>Generators and Control</td>
<td>$9,982,000.00</td>
<td>$9,250.00</td>
<td>$18,500.00</td>
<td>$27,750.00</td>
<td>$9,637,500</td>
</tr>
<tr>
<td>Totals</td>
<td>$152,848,541.00</td>
<td>$3,755,608.00</td>
<td>$7,511,616.00</td>
<td>$11,267,424.00</td>
<td>$175,383,389</td>
</tr>
</tbody>
</table>
Maintenance Activities That Informs Operational Resiliency & Enablement
Forward

Prior to reviewing this presentation, it is recommended that you read the one page briefing document that provides the necessary context.
Maintenance Pyramid

Self Evaluation – Where does your operation fit?
## Typical Maintenance Activities

### Outcome & Information

<table>
<thead>
<tr>
<th>Facility Assets</th>
<th>Outcome &amp; Information</th>
</tr>
</thead>
</table>
| Central Plant (Chiller/Boilers/Pumps)                | • Confirmation of operational status  
• Completed tasking checklist  
• Inspection/Service Records  
• Maintenance Reports  
• Repair Recommendation  
• Incident Reports  
• Up-to-date BAS Software and Firmware  
• Janitorial schedule and scope compliance  
• Periodic cleaning compliance  
• Services are based on number of labour hours and the frequency of visits with an expectation of certain outcome  
• Information capture today represents a “snapshot” at time of activity |
| Ventilation System (AHUs/RTUs/FCs)                   |                                                                                                                                                                         |
| Motors                                               |                                                                                                                                                                         |
| Backflow Preventor                                   |                                                                                                                                                                         |
| Sanitary System                                      |                                                                                                                                                                         |
| Building Automation System                           |                                                                                                                                                                         |
| Electrical Assets                                    |                                                                                                                                                                         |
| High Voltage Assets                                  |                                                                                                                                                                         |
| Exterior Shell                                       |                                                                                                                                                                         |
| Interior Furniture, Fixture & Equipment (FFE)         |                                                                                                                                                                         |
| Contact Surfaces Hygiene                             |                                                                                                                                                                         |
What’s the Business Outcome?
Does it inform you about resiliency, performance & operational risk?

<table>
<thead>
<tr>
<th>Outcome &amp; Information</th>
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<tr>
<td>• These assets may be <em>working</em>, but to what extent do you know how they are <em>performing</em> (efficiency, reliability, etc.)</td>
</tr>
<tr>
<td>• Are the maintenance &amp; cleaning activities providing ongoing relevant data that informs decision making and reduces risks?</td>
</tr>
<tr>
<td>• This informed decision making contributes to your overall operational resiliency and building performance.</td>
</tr>
<tr>
<td>• Resiliency and operational matrices that are Specific, Measurable, Attainable, Relevant, Time-based (S.M.A.R.T.)</td>
</tr>
</tbody>
</table>
## What We Measure ≠ What We Want

<table>
<thead>
<tr>
<th>What We Measure Today</th>
<th>What We Really Want – Are You Receiving It?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of service on ventilation system</td>
<td>IAQ that contributes to the health &amp; well-being of the occupants</td>
</tr>
<tr>
<td>Frequency of interior surface cleaning (High Touch vs. Low Touch)</td>
<td>Low count of pathogen on surface that contributes to the health of the occupants</td>
</tr>
<tr>
<td>Confirmation of HVAC seasonal service is complete</td>
<td>Energy efficient operation, minimal risk of failure and optimal longevity of the equipment</td>
</tr>
<tr>
<td>Frequency of emergency power generator testing</td>
<td>A reliable emergency power source and a well-function life safety system</td>
</tr>
</tbody>
</table>

*And the list goes on…*

*Although there is merit to measuring leading indicator, we shall not forget about the lagging indicator which is essentially our end goal. This discrepancy creates a blind spot in our operational resilience planning and results in common challenges that we have all experienced.*
## Typical Challenges & Solutions

<table>
<thead>
<tr>
<th>Common Challenges</th>
<th>Solution to mitigate risk and improve resiliency</th>
</tr>
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<tbody>
<tr>
<td>We constantly worry about unexpected failure of key components in building system impacting our resiliency and occupant satisfaction</td>
<td>Continuously measure and monitor the performance of critical mechanical and electrical components in real time. Observe performance deviation and implement informed maintenance practice. (Reliability Centre Maintenance)</td>
</tr>
<tr>
<td>We collect tons of data from various building systems but how is it helping us achieve a higher level of resiliency and performance?</td>
<td>Maintenance program that can combine raw data with trade specific knowledge to convert useful information into optimal decision making. Please see Appendix A&amp;B to further evaluate where your operation is at.</td>
</tr>
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## Typical Challenges & Solutions

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<td>Our occupants complains about poor indoor air quality (Comfort &amp; Health) due to</td>
<td>Use virtual model that simulate the air movement to visualize and understand how the air distribution impact occupant comfort and potential contribution to health concerns</td>
</tr>
<tr>
<td>imbalance air distribution or presence of odors &amp; pathogens</td>
<td></td>
</tr>
<tr>
<td>High risk Issues that impact operations are not addressed with appropriate</td>
<td>Real time service video call between technicians and customers to outline the problems and recommendations. Service report contains image and video to provide visual records.</td>
</tr>
<tr>
<td>sense of urgency and clarity. (i.e. Recommendations identified on service reports</td>
<td></td>
</tr>
<tr>
<td>may not rise to the level of priority required)</td>
<td></td>
</tr>
<tr>
<td>It is a challenge to stay on top of every square foot of my building everyday.</td>
<td>Extend the value of contracted cleaning personnel who already are in the building everyday. Equip them with simple video/photo technology that capture identified area during their activities</td>
</tr>
</tbody>
</table>
Appendix A – Knowledge Hierarchy

- **Wisdom**
  - Understanding, integration, applied, reflected upon, actionable, accumulated, principles, patterns, decision-making process

- **Knowledge**
  - Idea, learning, notion, concept, synthesized, compared, thought-out, discussed

- **Information**
  - Organized, structured, categorized, useful, condensed, calculated

- **Data**
  - Individual facts, figures, signals, measurements
Appendix B – Using Data the Right Way

Where does your operation fall on the curve?
Appendix C – Leveraging Data into Actions

Generating Insights and Resolving Issues using Building Data

MANUAL CORRECTIVE ACTIONS
Appendix D – An example of Computational Fluid Dynamics Simulation

- Air above pool has high trichloramine (NCL3) concentration
- Swimmer complains with headache, nausea, burning eyes, itchy skin
- Can be applied to all ventilation applications
Appendix E – Leverage Technology for Communication

- See what field personnel see via their phones or tablets
- Hands Free – Remote control during live call (zoom/flash/draw)
- Field to Field or Office to Field
- Multi-platform from desktop to mobile