Use of Sensors and Scanning Technology for Asset Inventory, Condition and Service Reliability

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Core Elements of the Program

Continuous Improvement

Asset Management

Knowledge Management

Y=f(X)
Scanners

Thermal Imaging

- Partnered with **JACOBS**
- Mounted Thermal Imaging Camera to the front of a revenue service train
- Water detection (Leaks!)
- Hot Spots
- Heat from poorly bonded C-Bonds!
- 3rd Rail heat during non-summer months
- Proactive detection of potential cable fires due to degraded splicing
- Overheating joints
- Lights!
Scanners

Thermal Imaging
Scanners

Thermal Imaging

Leaks!

Lights

Asset Management

Knowledge Management

Y=f(X)
Asset Management

Knowledge Management

Y=f(X)

Scanner

Thermal Imaging
Scanners

Other usage

- Overheating equipment
- PM activity e.g. overloaded electrical panel
- Proving the 3rd rail heaters work from a safe distance and not disrupting service!
- Incorrect calibration
- Friction in machining
- Trespassing
- Combining with track geometry to predict premature rail aging
- The list goes on!.....
Cleaning Monitoring System

Requirements

- MBTA has a penalty based cleaning contract
- Onus on the MBTA to prove a defect has occurred
- Paperwork leads to under utilization of personnel
- We are paying our personnel to do paperwork and not effectively manage the contract
Cleaning Monitoring System

Worlds first cleaning app for transit

- Developed by the MBTA and DBE
- For the frontline personnel
- 100% Elimination of paper
- Personnel approved and process "owned"
- Easy to use, simple, and effective
- Cycle time savings on the entire inspection process
- Supervisor portal
- Statistical analysis
- Effective management

App Demo
Cleaning Monitoring System – App
Cleaning Monitoring System – App

Inspection Location

Work Area 1 - STATION
Charles MGH
Red

Inspection at Charles MGH

Defect: Inspection Items

- Busway: Furniture / Shelter / Vertical Surfaces
- Busway: Sidewalks / Pavers
- Entrance: Door
- Escalator & Elevator: Landing Plate / Floor
- Escalator & Elevator: Stainless / Vertical Surfaces
- Iron Maidens: Gates / Rails
- Lightning: Lighting
- Lobby: AFC Equipment
- Lobby: Floor / Furniture

Defect: Inspection Items

- Busway: Furniture / Shelter / Vertical Surfaces
  - Excellent
  - Meets Expectations
  - Meets Expectations, but with Concerns
  - Failing
  - Not Applicable

Done
Cleaning Monitoring System – App
Cleaning Monitoring System - Portal

Click to access
Cleaning Monitoring System - Portal
Cleaning Monitoring System - Portal
Cleaning Monitoring System
Cost Savings - minimum

<table>
<thead>
<tr>
<th>Average Hours Saved (monthly)</th>
<th>Paper</th>
<th>Tablet</th>
<th>App</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stations</td>
<td>26.56</td>
<td>25.21</td>
<td>16.45</td>
</tr>
<tr>
<td>Facilities</td>
<td>15.73</td>
<td>23.42</td>
<td>9.85</td>
</tr>
<tr>
<td>Surface Line</td>
<td>4.84</td>
<td>7.41</td>
<td>2.50</td>
</tr>
<tr>
<td>Total</td>
<td>15.71</td>
<td>18.68</td>
<td>9.60</td>
</tr>
<tr>
<td>Cost Savings</td>
<td>$511.40</td>
<td>$608.05</td>
<td>$312.48</td>
</tr>
</tbody>
</table>

| Annual Cost Per inspector              | $6136.80 | $7296.60 | $3749.76 |

39% annual labor cost savings per person

Does not include savings experienced by supervisors minimum of 4 days saved on data entry and paperwork
Bus Wash - Water Consumption Reduction Pilot

Problem Statement: - find ways of reducing the MBTA operating budget without effecting service delivery and be sustainable

Example:

- Water consumption of washing the 40ft bus fleet at Lynn Garage (pilot site) =

  42.45 Gallons (avg per wash) x $0.0188 x 75 (40ft busses) x 365
  = $21,845 for the fleet annually, or 1,162,069 Gallons

- Physical limitations –
Bus Wash - Water Consumption Reduction Pilot

Problem Statement: find ways of reducing the MBTA operating budget without effecting service delivery

Observations:

- Busses must be fueled!
- Busses seem to be washed a minimum of twice a day
- Triggers the bus wash – when the bus does not need washing = waste of $$
- Bus wash does not turn off or have the ability to turn off when a bus approaches that has been washed
- MBTA Policy to wash buses only once a day or unless needed.
- MBTA has no active water reclamation system installed
Bus Wash - Water Consumption Reduction Pilot

1 year pilot – Building local innovation with the MBTA

- Enlisted Wentworth Institute of Technology students
  - Now created a company as a result – Intellah-Wash
  - Wentworth – Accelerate Program – sponsor
  - 4 students – now 3, small business owners

Intellah-Wash developed

Online Cloud data (click for link)
Bus Wash - Water Consumption Reduction Pilot

A bus is, on average, washed twice a day at this location.

Results From Initial Pilot Test

Costing the MBTA a minimum of twice as much or $43,690 and 2,324,138 Gallons.
### Expected Savings
(based on assumptions and validated data thus far):

<table>
<thead>
<tr>
<th>Lynn Bus Garage</th>
<th>All Authority Bus Garages (theoretical minimum, for 40ft busses annually)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fleet: 75 Buses</td>
<td>• 11 Bus Garages</td>
</tr>
<tr>
<td>• Annual consumption: 2,324,138 gallons</td>
<td>• Fleet: 915 Buses</td>
</tr>
<tr>
<td>• Annual Cost: $43,694</td>
<td>• Annual consumption: 30.3M gallons</td>
</tr>
<tr>
<td></td>
<td>• Annual Cost: $570,359</td>
</tr>
</tbody>
</table>

**Minimum Annual Savings:**
$21,874 or 1,162,069 Gallons

**Minimum Savings:**
$285,179 or 15.2M Gallons

*Numbers are based on estimates provided by MBTA Environmental Department

**What do you do with the cost savings?** — Invest in your system and find more ways to innovate!
Bus Wash - Water Consumption Reduction Pilot

- **Data – Validate, Validate, Validate!!**
- **Assumptions for pilot**
  - We are washing busses more than once
  - We are using 42.45 of gallons per bus to wash
  - Our bus wash instantly turns on and off with no redundancy
  - Potential of 50% savings in water consumption
  - Lynn Chosen as one of the smallest to trail the technology
  - Buses traveling through the bus was system per procedure
- **How are we validating??**
  - Intellah-Wash counts the busses going through the wash and the number of visits each bus makes
  - Flow meter to measure actual water flow and gallons used
  - Infield observations of the wash system
  - Verifying the cost data of the asset as a utility
  - Intellah-Wash system turns off bus wash automatically when bus has already been washed in 24 hours
  - Frequency and speed of travel of bus in the system
LiDAR – multiple usage of data

- Data Collected on all 4 lines
- Yard to terminus
- Above and below ground
- Partnered with HNTB & SSI
LiDAR

Colorized LiDAR data acquired at night utilizing artificial light
LiDAR

3D extruded linework with point cloud overlay
LiDAR – Example Usages

- Track Charts
- Point Cloud
- Inventory
- GIS
- BIM
LiDAR – Other Example Uses

- Design out Engineering Problems
- Survey Cost Savings (present and future)
- GIS / Point Cloud mapping of assets
- Climate Resiliency
- Design Cost Savings
Note, data is not the MBTA and was provided by Bentley for demonstration purposes
Research currently Underway

- Uptime Elements!
- Acoustic Emissions
- Vibration
- Wireless sensors
- Non contact
- Non destructive
- Defect code
- Energy consumption
- Innovation projects with local education establishments
- Data mining existing systems
- Switch throws before failure
- Environmental risk analysis
- Systems IPO

Remember
Collect once use many times!
Think about your business and how it could be used by others
MBTA – A System of Systems

All of this work would not have been possible without the cooperation of departments, stakeholders and teams across and outside the MBTA

Thank you to our partners inside and outside of our business…

We still have allot to do and more partners to work with!
Thank you
Any Questions?
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