INTEGRATED VEHICLE HEALTH MANAGEMENT –
BENEFITS AND CHALLENGES

AMC Big Data Symposium
April 23, 2018
IVHM: Management vs. Monitoring

Monitoring: Data for data’s sake?

Management: Closed Loop Data → Decisions

– “Without the why, the how doesn’t matter”

Integrated Vehicle Health Management

“The unified capability of a system of systems to assess the current or future state of the member system health and integrate that picture of system health within a framework of available resources and demand.”
What Does IVHM Look Like? Sample Architecture

Source: SAE JA6268™
SAE Standards Efforts

- SAE HM-1 Committee created to develop standards to aid in IVHM adoption, development
- Multiple Documents released; many more in work
  - Overview
  - Work Flow (figure)
- Recent Effort – JA6268™ Health-Ready Components
  - Released April 2018
**SAE IVHM Capability Levels (JA6268™)**

- Sets interaction expectations between OEM and system suppliers

- Goal: moving from manual repair, diagnosis to analytics-based diagnosis, predictions

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### Manual Diagnosis & Repair Process performed by Technician

<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Vehicle Health Capability</th>
<th>Narrative Description</th>
<th>Participation in Repair Actions</th>
<th>Key Data Resources</th>
<th>Availability of Logged &amp; Real-Time Data</th>
<th>Use of Supporting Models</th>
<th>IVHM System Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>Limited On-Vehicle Warning Indicators</td>
<td>Service actions for scheduled maintenance or when Operator notices problems or is alerted by indicator lights or simple gauges.</td>
<td>Operator/Driver &amp; Service Tech</td>
<td>On-Vehicle Measurements &amp; Observation</td>
<td>N/A</td>
<td>Paper-based Manuals</td>
<td>Only Manual Diagnostic Tools &amp; No Condition-Based Services</td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>Enhanced Diagnostics Using Scan Tools</td>
<td>Service techs gain added diagnostic insight using automated scanners to extract vehicle operating parameters &amp; diagnostic codes.</td>
<td>Operator/Driver &amp; Service Tech</td>
<td>On-Vehicle &amp; Service Bay/Depot Tools</td>
<td>Logged Diagnostic Codes &amp; Parameters available to Service Tech</td>
<td>Paper-based Manuals</td>
<td>On-Board Diagnostics Available</td>
</tr>
</tbody>
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### Diagnosis & Repair Augmented by Prognosis & Predictive Analytics

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<tbody>
<tr>
<td><strong>3</strong></td>
<td>Component Level Proactive Alerts</td>
<td>Operator and service techs are provided with component health status (R/Y/G) before problem occurs. Limited condition-based maintenance.</td>
<td>Operator/Driver, Service Tech &amp; Cloud-based Services</td>
<td>On-Vehicle, Service Bay &amp; Cloud Data</td>
<td>Telematic Data Available to Service Tech with Diagnostics Info</td>
<td>Addition of Component-Level Health Models</td>
<td>Component-Level Health Predictions</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Integrated Vehicle Health Mgmt.</td>
<td>Operator and service techs are provided with system or vehicle level health indicators before problems occur with remaining useful life estimated. Condition-based maintenance.</td>
<td>Operator/Driver, Service Tech &amp; Cloud-based Services</td>
<td>On-Vehicle, Service Bay &amp; Cloud Data</td>
<td>Telematic Data Available to Service Tech with Diagnostics Info</td>
<td>Addition of Vehicle-Level Health Models</td>
<td>Vehicle-Level Health Management</td>
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Source: SAE JA6268™
BELL IVHM IMPLEMENTATION EXPERIENCE
What were the “why’s” that drove our approach?

- **Local Maintenance**
  - “Tell me what’s wrong, and tell me how to fix it”

- **OEM Support**
  - Support troubleshooting
Integration Points

- Enterprise Information Systems (CRM)
- Existing Customer Portal
- Electronic Tech Pubs
Finding Anomalies in Vibration Data

- **Thresholds**
  - based on fleet characterization

- **Automated trend detection**

Clear change in trend, scatter during fault progression

Consistent, low scatter once gearbox is replaced

Time period = 1 year
What did We Learn?

Benefits
• All data in one place
• Easy ad-hoc queries
• Customer responsiveness - able to update as needed

Challenges
• Cultural/Organizational
• Business case
• Data quality
• Data Transmission

Lessons
• “Implement early, implement often”
  • Can’t do everything at once; early value breeds continued investment
• The more people learn about your data, the more requests you will get