“S1000D: Realizing the Benefits of Integrated Logistics Support”

October 12- October 15, 2009
Crown Plaza Hilton Head Resort, Hilton Head, SC, USA

Beyond Tech Pubs:
Automated Maintenance and the expectation of intelligent and interactive content

Panel Discussion
Logistics Management through an S1000D enabled Automated Logistics Environment

Vince Galluzzo
Lockheed Martin Systems Integration-Owego
LOGISTICS DATA ENVIRONMENT PARADIGM CHANGE

Transition

Pre-Automation
- Primarily Paper Based
- Pockets of Limited Automation

Automated Maintenance Environment (AME)
- Platform Specific
- Inconsistent scope
- Stove-piped capabilities
- Limited cross-applicability

Automated Logistics Environment (ALE)
- Cross Model/ Platform
- Entire Logistics Breadth
- Integrated Capability
- Closed Loop Feedback/Improvement

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ALE Definition / Characteristics

• Integrated information and maintenance management system (with all it’s associated procedures, processes and techniques).

• Not a “system” per se; it is the aggregation of various capabilities throughout the operational environment

• Holistic environment that includes all facets of maintenance and logistics support, from the platform to the Original Equipment Manufacturer (OEM)

• Includes related functions and processes (e.g., supply, transportation, training, technical data)

- Paraphrased from AIT paper produced by Logistics Management Institute
Key ALE Operational Domains
S1000D’s Enabling Role

• Provides a standard reference scheme for all disciplines associated with the platform.

• Provides flexible and scalable technical data structure enabling for more efficient and reusable integration methods between:
  – Engineering disciplines and
  – Logistics IT system components
S1000D and Beyond...

Transition To

- Portable Electronic Maintenance Aid

- Maintenance
- Supply
- Training
- Engineering

Platform Information
Discrepancy & Usage Information

Work Order Status, New Work Orders
Execute
Interrogative Diagnostics

Health & Usage Monitoring
HUMS Data

PEMA Baselines, Work Order State
Maintenance Data Repository

Part Request
Part Status, Issued Parts

Maintenance Control
Maintenance Status

IETM

Engineering

Product Data Management
Change Requests
Logistics Management
Technical Publishing

Platform Component Identification Framework

Operational Technical Data Baseline Management

Course Material Identification Framework

Course Material
Instructor-Based
Computer Based

Learning Content

Learning / Training Management
Training Curriculum
Training Schedules
Training Distribution
Student Records

Qualifications & Certifications

Order Status

Transportation Status

Transportation

Inventory & Warehouse Management

Supply
Supply Planning & Execution
Part
S 1000D M

S 4000 M

S 5000 F

OJT Records

Platform
As-Maintained Structure

Digital Technical Publications

Product Data Management Integration & Analysis

Fault to Technical Publication Mapping

Platform
Component Identification Framework

Course Material Identification Framework

- Maintenance
- Supply
- Training
- Engineering

Portable Electronic Maintenance Aid
Facilitating Challenges

• Consistent definition and assessment of an ALE

• Acceptance and use of S1000D outside technical authoring community
   Training
   Engineering (eg. Drawings)

• Cross-platform IT: Common S1000D interpretation / authoring guidelines

• Integration with…then transition from non-S1000D legacy technical data identification / formatting schemes

• Integration of S1000D with other Standards
“S1000D: Realizing the Benefits of Integrated Logistics Support”

Beyond Tech Pubs: Realizing the Goals of an Automated Maintenance Environment (AME)

Todd C. Hampson
The Boeing Company
Presentation Outline

- Boeing’s history with AME/ALE Systems
- AME/ALE System Overview
  - USN
  - USAF
- Return on Investment
  - Studies comparing Before and After impact of AME
- Use of Data Analysis with AME/ALE Systems
- Lessons Learned
- Need for Diagnostic Data Recording Standards
Boeing’s History with AME/ALE Systems
Boeing - Integrated Technical Information Timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>F/A-18 IMIS</td>
</tr>
<tr>
<td></td>
<td>Integrated Diagnostics Demonstration (IDD)</td>
</tr>
<tr>
<td></td>
<td>F-15 Computerized Fault Reporting System (CFRS)</td>
</tr>
<tr>
<td></td>
<td>Aviation Maintenance Integrated Diagnostics Demonstration (AMIDD)</td>
</tr>
<tr>
<td></td>
<td>AH-64D IETM</td>
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<tr>
<td>1990</td>
<td>F/A-18E/F Automated Maintenance Environment (AME) Deployment</td>
</tr>
<tr>
<td></td>
<td>Data Renaissance Suite (COTS)</td>
</tr>
<tr>
<td></td>
<td>F/A-18C/D IETM Conversion Complete</td>
</tr>
<tr>
<td></td>
<td>AME System Data Warehousing and Analysis</td>
</tr>
<tr>
<td>1995</td>
<td>C-130 IETM Conversion On Contract</td>
</tr>
<tr>
<td></td>
<td>F/A-18 Automated Maintenance Environment Integrator</td>
</tr>
<tr>
<td></td>
<td>F15K and F15E IETMs On Contract / Fielded</td>
</tr>
<tr>
<td></td>
<td>F/A-18 MADD Demonstration</td>
</tr>
<tr>
<td></td>
<td>Additional FMS F-15 and F/A-18 IETMs On Contract / Fielded</td>
</tr>
<tr>
<td></td>
<td>F15 Singapore IETMs On Contract / Fielded</td>
</tr>
<tr>
<td>2000</td>
<td>Kuwait and RAAF F/A-18 IETM On Contract / Fielded</td>
</tr>
<tr>
<td>2006</td>
<td>V-22 CAMEO On Contract / Fielded</td>
</tr>
<tr>
<td>2009</td>
<td>F15 Singapore IETMs On Contract / Fielded</td>
</tr>
</tbody>
</table>

**Boeing - Integrated Technical Information Timeline**
AME/ALE System Overview

USN and USAF Implementations Shown
USN - F/A-18 AME Process Overview

- Data Stripping (DAS)
- Maintenance Debrief
- Engine LUI Processing
- Engine Trending

- Debrief Diagnostics
- IETM & MMS Interface
- Engine Diagnostics
- Record Code Report Tool

- Tracker
- NALCOMIS

- Server
  - IETM
  - Historical Data

- IETM
  - Diagnostics

- PEDD

- MU

- DEBRIEF

- Pilot

- Maintainer

- AIMD & Smart TPS

- Historical Data

- Work Center

- Maintenance Control

- Data Warehousing

- AEROSPACE SUPPORT
USAF – Integrated Maintenance Information System (IMIS)

Aircraft fault

Digital Wiring Data

IMIS “Positive Action”

“How to”

Corrective action captured

Fault isolation action required

Fault code (action required)

Automated forms

Portable Maintenance Aid

MMSI

IMIS database

MMS

IMIS

Pilot input

DTM

E-Tool

• Debrief Diagnostics
• IETM & MMS Interface

IETM

cc22590003.ppt
AME
Return On Investment
The following recent Government results (F/A-18 single squadron AME upgrade and T-38 IMIS effectiveness study) identify the benefits of ALE/AME technology use.

- All values assume AME or IMIS is installed and in-use for aircraft maintenance and policy exists and followed on the use.
- These values are for example only, and do not imply achievable levels within other infrastructures.

Existing documentation shows IMIS effect on maintenance costs in terms of reduced maintenance actions and man-hours.
# USN F/A-18 Single Squadron AME Results

<table>
<thead>
<tr>
<th></th>
<th>Avg/Mo May - Nov 05 (no AME)</th>
<th>Avg/Mo Dec 05 - Jul 06 (using AME)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight Hours</td>
<td>282</td>
<td>275</td>
<td>-3%</td>
</tr>
<tr>
<td>Maintenance Man-Hours</td>
<td>4137</td>
<td>3110</td>
<td>-25%</td>
</tr>
<tr>
<td>O-Level Maint Actions</td>
<td>826</td>
<td>580</td>
<td>-30%</td>
</tr>
<tr>
<td>O-Level R&amp;Rs</td>
<td>218</td>
<td>175</td>
<td>-20%</td>
</tr>
<tr>
<td>O-Level CND</td>
<td>33</td>
<td>17</td>
<td>-49%</td>
</tr>
<tr>
<td>I-Level CND</td>
<td>22</td>
<td>15</td>
<td>-29%</td>
</tr>
</tbody>
</table>

▼ Lower numbers are better
# USAF T-38 IMIS results

## T-38C MTBF by month for 2005

<table>
<thead>
<tr>
<th>Month 05</th>
<th>Squadron A (w/o IMIS)</th>
<th>Squadron B (w/IMIS)</th>
<th>Squadron C (w/IMIS)</th>
<th>Avg Vance &amp; Col</th>
<th>% Improvement w/IMIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>42.14</td>
<td>46.92</td>
<td>42.07</td>
<td>44.49</td>
<td>5.59</td>
</tr>
<tr>
<td>Feb</td>
<td>31.95</td>
<td>64.86</td>
<td>58.45</td>
<td>61.66</td>
<td>92.95</td>
</tr>
<tr>
<td>Mar</td>
<td>30.44</td>
<td>83.73</td>
<td>51.21</td>
<td>67.47</td>
<td>121.62</td>
</tr>
<tr>
<td>Apr</td>
<td>45.71</td>
<td>158.73</td>
<td>110.58</td>
<td>134.65</td>
<td>194.58</td>
</tr>
<tr>
<td>May</td>
<td>78.21</td>
<td>126.48</td>
<td>91.39</td>
<td>108.93</td>
<td>39.29</td>
</tr>
<tr>
<td>Jun</td>
<td>40.87</td>
<td>83.98</td>
<td>38.58</td>
<td>61.28</td>
<td>49.93</td>
</tr>
<tr>
<td>Jul</td>
<td>38.84</td>
<td>195.37</td>
<td>26.94</td>
<td>111.16</td>
<td>186.17</td>
</tr>
<tr>
<td>Aug</td>
<td>41.33</td>
<td>101.71</td>
<td>32.58</td>
<td>67.15</td>
<td>62.44</td>
</tr>
<tr>
<td>Sep</td>
<td>56.03</td>
<td>90.62</td>
<td>62.42</td>
<td>76.52</td>
<td>36.57</td>
</tr>
<tr>
<td>Oct</td>
<td>73.28</td>
<td>141.20</td>
<td>39.07</td>
<td>90.14</td>
<td>23.00</td>
</tr>
</tbody>
</table>

**Avg. Improvement w/IMIS%** 81.21
Previous DOD studies (identified on next Slide) found that an AME/ALE environment increases aircraft maintenance efficiencies by:

- Reducing “Cannot Duplicate Discrepancies” (CNDs or false removal of serviceable parts) anywhere between 25% and 50%
- Reducing time required to fault isolate failures by 17%
- Misdiagnosis in fault isolation tasks are reduced by 56%
- Data has relationships and is filtered for the aircraft configuration, resulting in a 50% reduction in Technical Order research time
- Unscheduled maintenance man-hours can be reduced over all by 5% and scheduled (inspection) task times reduced by 25%
Government Studies

- US Army IETM Study and CBA, July 1997
- Carderock Division, Naval Surface Warfare Division, "Results of a Joint Navy/Air Force Operational Test to Evaluate USAF IMIS and IETM Technology Applied to the F/A-18 Aircraft,” June 1993
Use of Data Analysis with AME/ALE Systems
Data Analysis Advantages to the User

• Using AME/ALE data can be very beneficial
  – Find common Maintenance Actions for a given problem
  – Track fault history for a given aircraft or compare squadrons

• How can this help the IETM?
  – Did the maintainer perform the recommended task?
    • If not, maybe there is a better fix than what the IETM identifies?
    • Or training is needed to show benefit of using recommended task?
  – Did the recommend maintenance fix the fault the first time?

• How can this help aircraft maintenance?
  – Identify disparities between squadrons
  – Improve fix effectiveness
  – Identify training needs
  – Reduction of CNDs (RTOKs)
  – Identification of Bad Actors
  – Identification of false alarms
  – Predict Causes of Failures
  – Identify product improvements (aircraft design, tech data, etc.)
Lessons Learned
Lessons Learned

- ALE/AME requires significant IT/infrastructure focus
  - Security accreditations (IATT, ATT, SSAA, IATO, ATO, …)
  - Security Policy (standardized vs. site/wing/command uniqueness)

- To be successful ALE/AME requires system integration
  - The system should be part of the customer’s “System of Record”
    - Integration Challenges (Policies, politics, dependency on customer organizations)
    - Scheduling & funding challenges (Keeping an implementation going with changing deployment schedules and variable funding)
    - Hardware (getting it in place and keeping it refreshed)

- The ALE/AME system must be supported
  - Fleet Support (Keeping squadrons self sufficient in spite of personnel turnover)

- Diagnostics data standards need to be created and used
  - Discussed on next slide…
Need for Diagnostic Data Recording Standards
Diagnostic Data Recording Standards

- Recorded data needs to be standardized
  - In the commercial aviation world standards exist, such as ARINC and FRED (Flight Recorder Electronic Documentation) specification for Digital Flight Data Acquisition Units
  - Even the automotive industry has a standard – OBD-II – since mid 1990s!
  - In the military world, no such standards exist making it difficult to decode recorded data between platforms
    - Even worse, some data is recorded in a vendor proprietary format
    - Some platforms record little or no data, or may not have an easy method to retrieve it

- Vehicle data must be readily retrievable
  - Should have a standard interface to the standard format!
  - This needs to be pushed for and contracted in the design of any new platform

- At a minimum, a standard format should be selected or created to convert and store the data in once downloaded
  - MIMOSA, IEEE, others?
  - Having such a standard format would enable common diagnostic tools
  - Could convert legacy data into standard format to enable common tools
  - It will take a long time to get there, but if we don’t start pushing for it then it will never happen…
Questions?
AIA /ATA/ ASD
S1000D Users Forum

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Standardized ALE Development
Dwayne Cole
E-2D ALE Lead
Common ALE Development Strategy

- Phase I Focus: Essential capabilities required for initial training at the Organizational Level of Maintenance
  - Ground Station
  - IETM Viewer and “ALE Extensions”
  - Data Repository (local and global)
  - Maintenance Information System (OOMA) already established

- Collaborate
- Position for Phase II and III
- Non-proprietary, common and Govt owned solutions (buy once use many)
- Mature or maximize reuse of existing solutions and get for free (if possible)
  - V-22 CAMEO Ground Station: Zero startup cost to begin development
  - IETM Viewer (NSIV): NAE Common solution (Minimal cost to mature)
  - Global Data Repository: An example of how the process should work
  - WC Maintenance (work order processing) Solution: A Hidden Capability Gap

- SOW Verbiage: Require OEM collaboration with other Government Programs and Industry Partners as required to develop Enterprise common and Government owned solutions (Require source code deliverables)
- Minimize or avoid one-off solutions that are not absolutely required
- Sustainment may be transitioned to Government
Smart Aircraft / S1000D
ALE Requirements

• **Automated Flight Debrief** *(Ground Station)*
  - Download, translate and parse aircraft data
  - BIT filtering / trending (ID False alarms)
  - Pre-fill / Increment Logs & Recs (no dup documentation)
  - Auto work order generation (auto populate / submit to OOMA-MIS)
  - Single sign-on user interface (Dashboard aircraft status)
  - Engine Management SW

• **Maintenance Work Center** *(IETM / ALE Extensions / OOMA-MIS)*
  - IETM point of entry from Aircraft BIT data
  - Suspend / Resume and IETM Audit Log Management
  - Auto-populate Work Order with IETM QA Steps (DM Title)
  - PN/SN/CAGE Tracking/Verification (via OOMA interface)
  - OOMA Configuration Data to filter IETM on applicability
  - Integrated Parts Ordering (IPD auto-populate in MIS)
  - Discrepancy reporting (IETM and other ALE components)

• **Data Storage / Media Management** *(Local / Global Repositories)*
  - Local Storage (Aircraft Data, ALE generated data, IETM, HW/SW CM data)
  - Removable Media file management / SW loading capability
  - Automated upline reporting / Global Repository
Challenges and Opportunities

• Undefined ALE Policy
• Undefined Enterprise Level Process Owner
• Risks associated with common solutions
  – Development / sustainment strategies and funding
  – Total Solution / Modular Solutions (ideal end state?)
  – Keeping pace with evolving information technologies
• Architecture dependent (not yet standardized)
• Information Assurance
• Bandwidth requirements and limitations (afloat)
Challenges and Opportunities

• Data Repository Capabilities
  – Common Metrics and methods for determining each
  – Efficient integration of disparate databases
  – Authoritative sources
  – Data Validation processes
  – Business Rules / Assumptions
  – Common Capabilities for Common Data
    • Dashboard
    • Automated Trending / Analysis and Data Visualization
    • Data tells the story in time to reverse trends before becoming degraders
    • Intuitive Drill Down to Root Cause Capability
    • Measure Material Availability, reliability, Maint and Cost
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Beyond Tech Pubs:
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Backup Slides
Beyond Tech Pubs Panel
Take-Aways

- We need to inform maintainers *why* they’re filling out forms so we get good data.
- If the [HUMS etc.] data were *trusted*, it would be used more, forcing policy & usage change.
- Is there an effort to standardize data types on the government side… is policy needed?
- **Standardization = answer**; there are pieces of standardized tools/processes, but how close are we? Collaboration...
Cheryl Combes has worked in the defense industry for the past 16 years, serving on a variety of logistics related programs with customers including the US Marines, US Army, & USAF, and collaboration partners including Boeing, SPAWAR, PBM & Assoc., and Synesis7.

Cheryl has served as Project Manager or Team Lead for conceptualization, recommendation, planning, risk management, implementation, and control of numerous publications, logistics, and process integration projects with technology solutions.

Cheryl earned an MBA from the University of Texas at Arlington, a BA in English/Technical Writing from the University of Florida, and is a certified Textron Six Sigma Green Belt.
Vince Galluzzo is a Lockheed Martin fellow from Systems Integration in Owego, NY. He has over 27 years of experience with total life-cycle development on enterprise-wide Information Systems in both commercial and DOD spaces. He has held a number of technical and management positions throughout his career and is currently a principle architect in logistics information technology in Owego. Through his teams efforts over the last five years, concepts and components developed under his leadership have defined the logistics application layer of the Lockheed Martin corporate Product Support Framework.

Vince has a Bachelor of Science degree in Computer Science from Syracuse University.
Todd Hampson

Todd has 14 years experience in Automated Maintenance Environment (AME) with the Super Hornet.
Dwayne Cole
Bob Sharrer