Technical Order Conversion to S1000D – Management Lessons Learned from the C-17

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Introduction

• Pre-conversion environment

• What’s in the contract

• Lessons learned we incorporated into the program thinking

• Where we are today

• Things we learned along the way
C-17 paper ecosystem

- 1980s air vehicle engineering design with DOD-STD-863B refdes breakdown
- LSA initially developed but no longer deliverable
- C-17 SNS based on DOD-STD-863B / MIL-M-83495
- 1970s/80s TO Military Standards extensively tailored
- TOs sustained by Boeing since first delivery
- Tables presentation of Fault Isolation data
- Aircraft identity within TOs defined by two character code vice tail number
- Early prototype Mil-Std SGML -> OmniMark -> XPP -> Tagged PDF and Paper
- Single source CSDB for USAF and FMS unique content
- Under PBL sustainment contract Boeing is the Technical Content Manager
C-17 S1000D timeline - we had a dream

- 2001 – Air Mobility Command (AMC) requests a Mil-Std IETM estimate
  - AMC eTools and distribution infrastructure plan placed into motion
  - Unfunded Priority for conversion deferred to future years
- 2004 – Boeing begins investments for C-17 S1000D conversion:
  - Air Force policy encouragement
  - Performance Based Logistics (PBL) enabler
- Feb 2008 – AMC requests an IETM Industry Day to understand:
  - US and International Commercial/Military commitments to S1000D
  - Boeing and C-17 Program commitments to S1000D
- Jul 2008 – USAF S1000D Working Group Kick-Off meeting
- May 2009 – FedBizOps released a C-17 S1000D conversion market survey request
- Dec 2010 – Contract awarded for C-17 S1000D conversion
- Apr 2011 – Issue 3.0 data set delivered for paper to digital verification
- Apr 2012 – Issue 4.0.1 data set delivery begins
Why S1000D?

Mil-Spec Paper Tech Publs
- Familiar
- Paid off

Full-Up Mil-Spec IETM
- All the bells and whistles
- Budget buster

S1000D
- More robust than paper
- Less expensive with trade-in

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C-17 Technical Order Conversion to S1000D
What we offered

- Use of the existing paper delivery SGML database of verified technical data and illustrations as transformed by Boeing’s existing transformation tools
- S1000D output synchronized to paper output based on single source CSDB
- Use of a step/milestone approach to conversion and verification:
  - Open conversion source code to USAF inspection to build confidence
  - Boeing Business Rules Issue 3.0 XML delivery to “mirror” paper PDF (paper -> digital)
    - No illustration creation or illustration hot-spotting
    - USAF verification of no paper to digital loss of data [frozen data snapshot]
    - Conversion related issue resolution responsibility of Boeing
  - USAF Business Rules Issue 4.0.1 XML (digital -> digital)
    - New schema naming applied along with improved 4.0.1 functionality
    - TO Number referencing links updated to DMC numbering display
    - IPD hot-spotting
    - Tail number filtering using USAF Maintenance System configuration data
    - USAF verification of Issue 4.0.1 functionality
- Risk contained at each level of milestone delivery without compromising the final deliverable or day-to-day sustainment of paper
1st Step: Paper data to digital data conversion

No loss of verified content
Contracting framework

- Pilot program for USAF
  - Draft USAF Business Rules applied
- Boeing S1000D datamodules licensed
- Incorporates IETM lessons learned
- Utilize SGML CSDB for live source
- Step approach to verification
- Use USAF designated viewer
- Includes Boeing wiring tools
- Current Status:
  - Issue 3.0 data verification – 100% complete
  - Deliver Issue 4.0 data functionality – Apr - Jun 2012
  - Scheduled USAF field user evaluation – late 2012
What’s in and out for the conversion

• Books included in S1000D conversion:
  – Job Guides
  – Fault Isolation
  – General Systems
  – Illustrated Parts Breakdown
  – Inspection Workcards
  – Structures, NDI, Corrosion, Miscellaneous

• Books not included in the conversion:
  – Flight and Loading manuals
  – Wiring diagrams [optioned licensing of existing Boeing wiring tool]
  – Schematics
  – Support Equipment
  – Intermediate Level
  – Aircraft Battle Damage Repair
Ground Rules and Assumptions

- No changes to aircraft required (no AME/ALE)
- USAF certifies software for use on their systems
- Contractor provides licenses for the specified IETM viewer
- Contractor provides proprietary wiring tool
- G081 is primary source of current aircraft configuration data
- AMC provides the finalized Air Force level IETM Business Rules to be enforced in the transformed data
- USAF infrastructure and eTools in-place to handle S1000D at time of delivery
- USAF provides a capability to verify that the transformation of data does not change tasks or data as currently described with the existing TOs
- Contractor provides initial familiarization training on the S1000D specification and the browser to Air Force users.
Previous Customer(s) views – Lessons Utilized

- Need full-time military and contractor Program Managers
- Early on effort to approve tools for IT infrastructure
- Sustaining two CSDBs is costly
- Cleaning data in the transform CSDB is costly, fix in the paper CSDB
- Define what is going to remain in paper [2-1, Wiring Diagrams, Schematics, inspection cards, engine run checklists, etc.]
- Validate eTool viability for engine runs [need solid state HDD?]
- Plan adequate reserves on customer side for scope growth [policy and functionality changes]
- Lock down the elements being transformed and new required elements in a specification interpretation document (SID) or the Business Rules
- Business Rules must be developed at multiple levels down to the specific aircraft and potentially the aircraft operator
Previous Customer(s) views—Lessons Utilized (cont’d)

- Continue to fund the paper deliveries until you have a final approved product for use by the field
- Involve the training community at the beginning of the process for continuing training
- Avoid separating the current content authors from the conversion team
- Identify, plan, and budget for the customer staff to support the program
- Identify the IETM verification plan prior to contracting for the IETM
- Provide a full-up disconnected mode capability
- Provide ability to filter technical data by tail number and completed TCTO
- Provide a capability to print out a procedure
Boeing View – Lessons Utilized

• Verification of paper to digital is difficult to do if content display is changed
• Proprietary AME/ALE bundling adds complexity – just the data
• Make sure the data is S1000D viewer agnostic - all data valid and well formed
• Have the Customer define the target viewer – keep contract focus on the data
• Keep all related technical data on one device (S1000D viewer, PDF, and Wiring)
• Link the S1000D data to referenced PDF books and external wiring tools
• Establish user focal groups early on to test the usability of the data and viewer
• Minimize user clicking to retrieve data by reducing data layers where feasible
• Ensure rapid partial data delivery (PDD) update data delivery for USAF distribution
• Provide a robust search capability
Boeing View – Lessons Utilized (cont’d 2 of 3)

- Display all steps with a legacy step number – facilitate verification, enable use of existing illustrations
- Allow display/printing of -6 Type Scheduled Inspection / Replacement criteria
- Retain an ability to go back to paper if required
- Use a common risk management system with the customer
- Utilize Decision Records signed by the USAF and Boeing program managers and military user focals when areas of contract/scope interpretation reach consensus between all technical parties
- Use a common formal action item tracking system
- Share data and conversion discrepancies using common tools like SharePoint
- Imbed information expeditors at the customer’s verification location
- Third party verification of conversion script quality reduces risk to both sides
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Boeing View – Lessons Utilized (cont’d 3 of 3)

• Utilize AFTO Forms 27 to document verification of each converted book
• Keep customer informed on the progress of source data corrections on the sustainment contract
• Save all the extra IETM improvement possibilities for post-conversion sustainment
## C-17 pages converted to data modules

<table>
<thead>
<tr>
<th>Technical Order Type</th>
<th># Pages</th>
<th># Data Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illustrated Parts Breakdown (IPB)</td>
<td>32,040</td>
<td>3,844</td>
</tr>
<tr>
<td>Job Guide (JG)</td>
<td>89,320</td>
<td>16,749</td>
</tr>
<tr>
<td>Fault Isolation (FI)</td>
<td>10,220</td>
<td>7,702</td>
</tr>
<tr>
<td>General Systems (GS)</td>
<td>7,726</td>
<td>1,519</td>
</tr>
<tr>
<td>Structure Repair (SR)</td>
<td>13,064</td>
<td>4,484</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>15,247</td>
<td>5,607</td>
</tr>
<tr>
<td>*<em>Total</em></td>
<td>167,617</td>
<td>39,905</td>
</tr>
</tbody>
</table>

*NOTE: Wiring Diagrams not converted to S1000D*
C-17 Illustrations converted to approved format

- 58,611 legacy graphics for the paper books being converted
- All graphics updated with ICN board numbers
- All graphics delivered as full vector WebCGM 2.0
- 12,493 IPD specific graphics hot-spotted for index callouts
- No new illustrations created
What we learned along the way

• Our SGML DTDs were too flexible, writers are creative
  – We needed to create new SGML checker tools to reduce variability
  – We needed to tweak our SGML DTDs for tighter rule enforcement
  – Reducing writer variables reduced rework for both paper and digital
• XML provides better cross checking of matching data (or lack of match)
  – We improved the quality of our paper and digital products
• How applicability was handled within the SGML could be improved
• In the paper world, we were driven to non-optimal SGML tagging methods to force paper output expectations that had to be undone (ex: placement of warnings, caution and notes within para tags)
• Switching to the ICN format for our paper based illustration board numbers reduced potential conversion work/issues
Summary

• Supported a long term commitment to a digital environment
• Made use of the customer’s verified data investment
• Incorporated lessons learned
• Leveraged programmer skills to reduce key punching
• Focused on making the verification as easy as possible
• Separated bells and whistles from content conversion
• Improved our core source data along the way
• Involved the end user maintainer early in the process to improve buy-in
• Measurement of our success to be verified in late 2012 during user testing
Questions?
Bob Behrens is currently Senior Manager of C-17 Technical Data and Training for the Boeing C-17 Program.

He has overall responsibility for the sustainment of technical publications used by the United States Air Force and several foreign air forces in the day-to-day maintenance of the C-17 airlifter. He has held a number of leadership positions within the C-17 product support environment including field service and supply chain management since joining the company in 1989.

Before joining Boeing, Behrens served over twenty-one years in the United States Air Force in a variety of aircraft maintenance and flight related positions and retired in the grade of Chief Master Sergeant.

Behrens holds a bachelor’s degree in business management from the University of New York and a master’s degree in from Argosy University in international trade.

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