Reducing EWIS Manufacturing Cost and Risk via the Digital Thread

Anthony Nicoli, John Judkins & Tera Schroeder
Mentor, A Siemens Business
Agenda

• EWIS Manufacturing is Challenging
• The Digital Thread Can Help
• Specific EWIS Manufacturing Examples
Integrates vehicle functions:

The Electrical Wiring Interconnect System

breathes life into an otherwise inanimate object

By its nature EWIS design demands intimacy with:

- 3D model
- Zone Environments
- Performance Constraints
Aerospace & Defense Platforms are Going ‘More Electrical’
Electrical complexity & implementation challenges exploding

Global Product Data Interoperability Summit | 2018

"We have amazing innovations in technology now, that allow us to use synthetic vision, rather than a big heavy mechanical system…,"
Boom Supersonc Engineer

Magnitude of Impact:
25% EE Content Growth Every 5 Years
10x Power Demand Over 50 years
EWIS now 3% of Aircraft Weight
EWIS Cost Grows Faster than Content
Aero EWIS: Miles of Wire & Hundreds of Harnesses

- **Military Cargo Aircraft:**
  - 40 miles of wire
  - 160 harnesses

- **Modern Business Aircraft:**
  - 50 miles of wire
  - 345 harnesses

- **Modern Commercial Aircraft:**
  - 70 – 100 miles of wire
  - 500 – 1400 harnesses
EWIS Manufacturing Must Satisfy Key Business Drivers

- Profitability – Margin Pressure
- Revenue Ramp
- Production Ramp
- Cost Control
- Just-in-Time, Quality Deliveries
- Supply Chain Collaboration
Profitably Manufacturing an EWIS Is Challenging

• Assembly is largely a manual process
• Requires skilled assemblers
• Design data often re-entered manually
• Large component variation, increasing carried inventory
• Incomplete MBOMs drive excess inventory
• Varied assembly specifics, forcing process research
• Difficult to create complete work instructions
• Building work instructions on-the-fly
• Assembly errors found in test, driving scrap & rework
• Tooling often incorrect
• Manufacturability changes not synced to design docs
• Delays can result in $M of unexpected freight costs
• Tribal knowledge, expertise, leaving the company
Digitalization changes everything

Digitalization: The use of digital technologies to change a business model

Bold reaction to digital

2.5x

Medium reaction

2.2x

1.9x

Telecom

Manufacturing

Retail and media

McKinsey Quarterly FIVE FIFTY on Digitalization, 5/22/18
<table>
<thead>
<tr>
<th>Ideation</th>
<th>Realization</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systems Driven Product</strong></td>
<td>Manages increased product complexity by providing accelerated product development via linked, shared, traced, and managed digital definitions achieving optimized designs with model-based systems engineering</td>
<td></td>
</tr>
<tr>
<td><strong>Development</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Integrated Program</strong></td>
<td>Provides a systems approach to project planning that integrates cost, schedule, risk and technical requirements in a fully planned, resourced and budgeted program management solution</td>
<td></td>
</tr>
<tr>
<td><strong>Planning and Execution</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Engineering and Design</strong></td>
<td>A best in class interdisciplinary development platform enabling design to evaluate mechanical and electrical component designs jointly prior to prototype and physical test</td>
<td></td>
</tr>
<tr>
<td><strong>Supplier Source Selection</strong></td>
<td>A digital thread approach to managing interactions with suppliers which coordinates processes and manages information, both internal and external, across all stages of the product lifecycle.</td>
<td></td>
</tr>
<tr>
<td><strong>and Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Verification Management</strong></td>
<td>Provides the ability to achieve certification faster through synchronizing requirements from design, analysis and test to ensure that analysis and simulation models are synchronized across all lifecycle information achieving conformance.</td>
<td></td>
</tr>
<tr>
<td><strong>Product Realization</strong></td>
<td>Leverage a comprehensive digital thread and digital twin by deploying a common system to orchestrate production processes and bring relevant production data to every aspect of program development</td>
<td></td>
</tr>
<tr>
<td><strong>Product Support Planning</strong></td>
<td>Enables manufacturers, owners and service organizations to support complex products with a configuration driven service management environment.</td>
<td></td>
</tr>
<tr>
<td><strong>&amp; Management</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Creating a Holistic Digital Twin (a.k.a. The Model!)

- Digital Twin of the product
- Digital Twin of the production
- Digital Twin of the performance

Cloud

feed back insights to continuously optimize product and production
Three Key Tenets of a Model Based Enterprise

DIGITALIZATION

Digital models become the authoritative information source driving all downstream implementation steps.

AUTOMATION

Transformation into subsequent forms is significantly automated to create correct-by-construction outcomes.

DATA REUSE

Data created once is reused to the greatest extent possible by all downstream consumers.
Automation for Electrical Systems
Executable Transformations Between Abstractions
Global Product Data Interoperability Summit | 2018

Transformations

Digital Models

- Functional
- Signals
- Logical
- Designed
- Designed

Correct Outcomes

- IP
- IP
- IP
- IP
- IP

Functional → Logical
Signals → Networks
Logical → Physical
Designed → Produced
Designed → Maintained
Realizing the Electrical Model Based Enterprise

Product Life Cycle Management – Collaboration and Innovation
Current Engineering Practices: Manual Data Re-Entry

- Cycle times of months
- Manual mistakes cost money
- No time to optimize process

Methods are no longer adequate
But… the Entire Value Chain Can Use the Same Model!

### Digital Thread

**Assess** to cross-domain decisions
Faster **design cycles** – more iteration
“**Configuration aware**” design environment
**Address issues early** when costs are lower
**Reduce** rework, **minimize** NRE costs
Transformations via the Digital Thread

Model Transition & Transformation

Logical Design

Digital Thread

Buildable Design
Integrated process design, costing & documentation

Harness Model  →  Factory Model  →  Electronic Descriptions  →  Process & Cost Calculations, Documentation → Manufacturing
Tribal Knowledge Exiting Organizations

“A potential tidal wave of baby-boomer exits from the aerospace and defense sector is increasingly weighing on the minds of industry leaders.”

Aviation Week, 8/29/18
How to Capture & Reuse Expertise?

Capture Tribal Knowledge in Rules & Constraints

Example rules

1. Create modules for ‘networks’ of spliced connectivity
   - Single splice, spliced daisy chains and multi-crimped ring terminals
   - If the splices are attached to multicores via shield terminations then the multicores are included

2. Sort and creates single connector modules
   - Firstly looking at connector where all of the remaining wiring has no variance (e.g. same spec)
   - Work up from the smallest by remaining wire count

3. Creates single connector modules for remaining wires

4. If a module contains all of the wires in any bundle then it will include any insulations or fixings on those bundles
Formboard Fixtures

- Powerful automation
- Configurable fixture selection
- Rules-based fixture placement
- Exportable fixture BOM & drill coordinates
Problems Caused by Incomplete/Late Work Instructions

Causes
• Upstream schedule delays reduce time to manually generate work instructions
• Data is buried in process specifications

Ramifications
• Kits aren’t released until work instructions are complete
• Assembler spends time looking for data
• Key program delivery milestone aren’t met
Integrated process design, costing & documentation

Harness Model

Factory Model

Electronic Descriptions

Create Work Instructions from Design & Factory Data

Manufacturing
Automatically Create Work Instructions

Global Product Data Interoperability Summit | 2018

Design Data
- Digital Twin

Factory Data
- Digital Twin

Corporate Assets
- Fixture libraries
- Language dictionaries
- Process specification details
Quantitative Proof Point Examples
Significant Benefits Achieved Across Several Industries

90% manufacturing ECO reduction  Flight simulators
50% electrical design time reductionSatellites
30% electrical design time reductionMissile systems
85% formboard design time reductionBusiness jets

Weeks → hours test pattern generation time reduction Helicopters
Zero scrapped wire harnesses (first time ever) Helicopters
6.5kg per car weight reductionCars
Months → weeks EE architecture design time reductionCars
50% electrical design time reductionTrucks
30% quote-to-production cycle time reductionHarnesses
80% electrical documentation time reductionCars
40% electrical fault diagnosis time reductionCars
US integrated electrical solutions: Northrop Grumman

“We have consistently realized between 50-55% efficiency improvement over all previous methods.

Our workload has increased by 30% during the design process without additional man power.
Digital Thread Reduces EWIS Manufacturing Cost and Risk

Enabling the Model Based Enterprise

Functional Designs
Logical Designs
Physical Designs
Harness Designs
Formboard Designs
Work Instructions
Technical Publications

DEFINE  DESIGN  MANAGE  PRODUCE  MAINTAIN

Cloud
feedback insights to continuously optimize product and production

Digital Twin of the product
Digital Twin of the production
Digital Twin of the performance
Thank you

Feel free to contact us with questions:

anthony_nicoili@mentor.com
john_judkins@mentor.com
tera_schroeder@mentor.com