Implementing the Model-based Enterprise for a Measurable Return on Investment

Presenter: Kenn Hartman
khartman@dsasite.com
(216) 533-6302
Biography

Kenn Hartman is the Managing Director of DSA, a PLM/MBE Consulting Practice.

Kenn possesses more than 35 years of Experience in Engineering Systems and Processes.

Overview of Experience:
1. Primary consultant to seven multi-national corporations to derive Global Engineering System Strategy
2. Primary consultant to two multi-national corporations to derive Global MBE Strategies
3. Lead Process Analyst on 11 Global PLM Implementations (Master Black Belt)
4. Global Design Lead on two Global PLM Implementations (PLM Solution Architect)
5. Program Management Lead on six Global PLM Implementations (PMP, SCRUM Master)
6. Expert in SDLC Methodology (Waterfall, Spiral, AGILE)
Establishing a Project with Real Legs

Executive Education

- Corporate Alignment
  - Long-term Strategic Goals
  - Critical KPI’s

- Value Assessment
  - Process & Application Assessment
  - New Targets for Design

- Enterprise Architecture
  - Architectural Assessment
  - Future State Physical Diagram

- Execution Planning
  - Segregation of Use Cases in to Phases
  - Detailed Plans by Phase

Roadmapping

- Process Execution Targets
- Financial Targets
- Detailed Use Case Listing (Scope)
- ROI Analysis
- Architecture & Application BoM
- Program Governance

Phased Execution

- Find a Partner who knows the Space!
- Create an Executive Level Deck
  - What are the Typical Phases
  - What is the Typical Scope/Phase
  - What might our ROI look like
  - What might the time and cost to value be
- Establish buy-in to write Strategic Plan

- Find a Partner who’s done it before!
- Assess Current Operations & Systems
- Assess Supplier Readiness
- Review Other Relative Roadmaps
- Establish Phases & Scope per Phase
- Establish Time & Cost to Value
- Establish ROI per Phase
- Build Capital & Expense Authorizations
Strategic Scope & Phases – Stage One, Preparing for MBD

The Y14.5 standard is considered the authoritative guideline for the design language of geometric dimensioning and tolerancing (GD&T). It establishes uniform practices for stating and interpreting GD&T and related requirements for use on engineering drawings and in related documents.

The Y14.41 standard establishes requirements and reference documents applicable to the preparation and revision of digital product definition data (also known as model-based definition), which pertains to CAD software and those who use CAD software to create the product definition within the 3D model.

Y14.46 is intended to support engineers engaged in Additive Manufacturing including mechanical design, drafting, and quality assurance & control personnel especially those involved in extended, global supply chains.

MIL-STD-31000A defines a TDP as: A technical description of an item adequate for supporting an acquisition, production, engineering, and logistics support (e.g. Engineering Data for Provisioning, Training, and Technical Manuals). The description defines the required design configuration or performance requirements, and procedures required to ensure adequacy of item performance. It consists of applicable technical data such as models, drawings, associated lists, specifications, standards, performance requirements, QAP, software documentation and packaging details.

MIL-STD-31000B 31 October 2018
SUPERSEDED MIL-STD-31000A 26 February 2013

The types of information included are geometric dimensioning and tolerancing, component level materials, assembly level bills of materials, engineering configurations, design intent, etc. By contrast, other methodologies have historically required accompanying use of 2D engineering drawings to provide such details.

1. You will require multiple Data Definitions across your Part Family Tree e.g., Complex Machined Parts like Bearings and Gears vs. Sheet Metal parts like Brackets
2. Each Data Definition will require a corresponding Recipe and Template to Produce a Technical Data Package (TDP)
**Strategic Scope & Phases – Stage Two, Publication and Validation**

**Technical Data Packaging**

**Options:**
1. COTS TDP Supplier
2. Configure in PLM

**Trade-offs:**
1. COTS – License Fees, Implementation Costs, Maintenance Fees
2. PLM – Implementation Costs

---

**Data Validation**

**Data Validations:**
1. Model Data Quality
2. PMI
3. Revision Data Quality
4. Derivative Data Quality
5. Producibility

---

**PLM**

1. Single Source of the Truth – Global Engineering Data Model
2. Primary Control Mechanism for all MBD Functionality
3. Controlled Dissemination & Synchronization of Technical Data to Supply Chain

---

1. Define and configure the TDP Template for each Data Definition
2. Define and build the Scripts to extract the data – this will often require; rationalization of Non-PLM Data Sources into PLM or API’s into other systems
3. Classification schema to identify Part Family and enable automated selection of correct Publishing Template & Recipe

---

1. Define, Configure, and Tune Model Data Quality Checks
   a) An individual Data Quality Check used across multiple Part families could require unique configuration e.g., tolerance based upon the Part Family you will apply the check
   b) Criticality might also vary by Part Family
2. Classification schema to identify Part Family and enable automated selection of correct stack of Validations
3. PMI Checks are Syntactic and Semantic
4. Revision Data Quality produces a comparative view as well as executing the standard set of Model Data Quality and PMI Checks for a given Part Family
5. Producibility Checks are Part Family Specific e.g., complex machined part vs. sheet metal part
6. Plan for Tuning time!!!

---

1. Can require rationalization of Non-PLM Data Sources to create a Single Source of the Truth – eliminates requirements to design, build, maintain multiple API’s and reduces scripting costs
2. Reconfiguration of EC Workflow to trigger validation events
3. Reconfiguration of EC Workflow to trigger packaging events
4. Lifecycle Policy to enable specific Publishing and validation events by Lifecycle state
5. Configuration of Translators to Produce Neutral Formats of CAD
6. Configuration of Dispatchers to manage Publication Jobs
7. Middleware for Temp File Management
8. Configuration of CAD Cloning Tool to create a Clone against which Model Data Quality, PMI, and Producibility checks are executed
9. Configuration of Dispatchers to manage Validation Jobs on EC Approval
10. Modifications to Access Controls and Relationship Rules to enable attachment
11. May require a Bi-directional integration to ERP if ERP Data is required for any TDP
MBD Implementation Imperatives

Global Product Data Interoperability Summit | 2019

- Creation of an MBD Strategy is critical to enable:
  - Realistic calculations of Time & Cost to Value
  - Attainable ROI – real money in the Bank
- Like PDM is pre-requisite to PLM so is MBD to MBE
  - You must get MBD right!
- Great Standards are not enough
  - Institutionalization and real-time validation are critical
- Prepare your Executive Team for long Development & Tuning Cycles
  - Data Quality checks, Producibility checks
- Extend PLM as the Single Source of the Truth
  - You can’t get just the right data into a TDP if its Text-based
  - API’s to “Other Engineering Applications” are expensive
- You must exploit some form of a Lifecycle Policy and extend the Engineering Release process to enable effective application of Data Quality Checks, Publication, and Dissemination
- You will require Classification Schemas to enable selection of specific Data Quality Checks and Publication events by Part Family
- You will require integration of Temp a Dispatcher and Translator
- You may require a CAD Cloning Tool that produces a clone against which you execute Data Quality Checks to ensure Master Model integrity
- You will likely require Middleware to house Clones and manage transactions between Clone, Translator, Dispatcher, ECO, Part Item revision
**Core Tenant:** The Data Definitions derived by Part Family which specify the TDP Requirements must be derived from a regression analysis of each of the downstream Supply Chain processes which will exploit the Model-based Definition – **optimally annotated models by Part Family**

The Primary Objective is to enable a High First Pass Yield through the Downstream Supply Chain Processes.
MBE Implementation Imperatives

Global Product Data Interoperability Summit | 2019

- Creation of an MBE Strategy is critical to enable:
  - Realistic calculations of Time & Cost to Value and Cashflow requirements
  - Attainable ROI – real money in the Bank
  - Resource Loading & Balancing through the Program
  - Critical OCM Activities
- Supply Chain should take ownership of the Program at this Stage
  - Most of the work will be theirs
  - They will get the large & ROI post MBD – so, they should fund it and be accountable for its success
- Process Integration/Reengineering is critical to success
- Measure and report the real ROI along the way to maintain buy-in
- Don’t under-estimate the cost & time to retrain & institutionalize
- Must get Outsource Community On-board – increase Supplier Capability Maturity
  - Must be able to get your ROI from outsource Suppliers
MBD Exploitation – where’s the Money

Global Product Data Interoperability Summit | 2019

Image by ANARK

Technical Data Package
- Time/cost to Model Annotation
- Time/cost to Design Validation
- Time/cost to Productivity Validation
- Reduction in Producibility Escapes
- Increase in Design Reuse
- eQN Reductions
- Reduction in Time and Cost to Release

Manufacturing Data Package
- Time to assemble data
- Time to collaborate
- Time/cost to identify Problems
- Time/cost to specify Solutions
- Time/cost to FAI Plan
- Time/cost to FAI
- Time/cost to Mfg. Qual Plan
- Increase in Quality Metrics
- Quality process data directly Aligned to Production
- ..

Service Data Package
- Time/cost to Mfg. Work Instr.
- Mfg. Troubleshooting
- Time/cost to Part & Assy Plan
- Time/cost to CMM release
- Time/cost of CMM correlation
- Time/cost to CNC release
- Time/cost to CNC correlation
- Time/cost to create RFQ
- Time/cost to FAI
- Time/cost to Tooling Release
- Reduction in Tool Changeovers
- Time/cost to Diagnose
- Time/cost to make reparation
- Better correlation of Service Data back to design and Mfg.
## MBE ROI Summary – Product Design

### Value Drivers

<table>
<thead>
<tr>
<th>Modeling &amp; Annotation Time</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data – Surveyed Respondents Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Modeling Standards (GD&amp;T, PMI)</td>
<td>• &gt;25% reduction in Model Preparation Time</td>
</tr>
<tr>
<td></td>
<td>• Single Source of the Truth</td>
<td></td>
</tr>
<tr>
<td>eQN's to make Drawing's match Model</td>
<td>• Modeling Standards (GD&amp;T, PMI)</td>
<td>• &gt;85% reduction in eQN's</td>
</tr>
<tr>
<td></td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conversion away from 2D Drawings</td>
<td></td>
</tr>
<tr>
<td>Model &amp; Derivative Validation</td>
<td>• Automated Model &amp; Drawing Validation</td>
<td>• 14% to 26% reduction in Model Validation Time</td>
</tr>
<tr>
<td></td>
<td>• Automated Producibility Validation Tools</td>
<td>• 100% reduction in Derivative Validation Time</td>
</tr>
<tr>
<td></td>
<td>• Classification Schemas to enable selection of a specific set of checks by Part Family</td>
<td>• &gt;80% reduction in Producibility Escapes originating in Product Design</td>
</tr>
<tr>
<td></td>
<td>• Reconfiguration of EC Release Processes to trigger specific validations by Lifecycle Release State</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Color-coded 3DPDF Zone Definition</td>
<td></td>
</tr>
<tr>
<td>Design Reuse</td>
<td>• Part &amp; Product Classification Schemas (Parametric Classification)</td>
<td>• &gt;11% increase in Design Reuse</td>
</tr>
<tr>
<td></td>
<td>• Single Source of the Truth – PLM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes</td>
<td></td>
</tr>
<tr>
<td>Big Data Analytics</td>
<td>• Technical Data Packaging Capability</td>
<td>No Evidentiary Data Available at this time</td>
</tr>
<tr>
<td></td>
<td>• Automated compilation and correlation of Supply Chain Feeds back on to Technical Data Package</td>
<td></td>
</tr>
<tr>
<td>Design/ME Design Reviews and Design Review Time</td>
<td>• Technical Data Packaging Capability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes</td>
<td></td>
</tr>
</tbody>
</table>

No Evidentiary Data Available at this time
### MBE ROI Summary – Mfg. Engineering

#### Value Drivers

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data – Surveyed Respondents Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producibility Analysis &amp; Release</td>
<td>• Automated Producibility Validation</td>
<td>Contact Kenn Hartman for ROI Data &amp; Calculation methods/formulas</td>
</tr>
<tr>
<td></td>
<td>• Extended EC Release process to trigger Producibility Analysis at specific Lifecycle States</td>
<td></td>
</tr>
<tr>
<td>Producibility Non-conformance Remediation</td>
<td>• Automated Producibility Validation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Extended EC Release process to trigger Producibility Analysis at specific Lifecycle States</td>
<td></td>
</tr>
<tr>
<td>Work Instruction Creation and Validation Time</td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Technical Data Packaging Capability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Single Source of the Truth - PLM</td>
<td></td>
</tr>
<tr>
<td>Work Instruction First Pass Yield</td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Technical Data Packaging Capability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Single Source of the Truth - PLM</td>
<td></td>
</tr>
<tr>
<td>Reduction in Lead time to initiate Tooling, CMM, CNC, Quality Planning</td>
<td>• Integrated Part &amp; Assembly Planning Process</td>
<td></td>
</tr>
</tbody>
</table>

Contact Kenn Hartman for ROI Data & Calculation methods/formulas

khartman@dsasite.com

(216) 533-6302
## MBE ROI Summary – Manufacturing

### Global Product Data Interoperability Summit | 2019

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data – Surveyed Respondents Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrap &amp; Rework from Producibility Escapes</td>
<td>• Automated Producibility Validation Tools&lt;br&gt;• Classification Schemas to enable selection of a specific set of checks by Part Family&lt;br&gt;• Reconfiguration of EC Release Processes to trigger specific validations by Lifecycle Release State&lt;br&gt;• Color-coded 3DPDF Zone Definition</td>
<td>Contact Kenn Hartman for ROI Data &amp; Calculation methods/formulas&lt;br&gt;&lt;br&gt;<a href="mailto:khartman@dsalite.com">khartman@dsalite.com</a>&lt;br&gt;&lt;br&gt;(216) 533-6302</td>
</tr>
<tr>
<td>Scrap &amp; Rework from Drawing to Model Mismatches</td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes&lt;br&gt;• Conversion away from 2D Drawings&lt;br&gt;• Technical Data Packaging</td>
<td></td>
</tr>
<tr>
<td>Scrap &amp; Rework from Model Interpretation Errors</td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes&lt;br&gt;• Conversion away from 2D Drawings&lt;br&gt;• Technical Data Packaging</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Troubleshooting</td>
<td>• Data Definitions which prescribe Model Content to enable a High First Pass Yield of the Downstream Dependent Supply Chain Processes&lt;br&gt;• Conversion away from 2D Drawings&lt;br&gt;• Technical Data Packaging</td>
<td></td>
</tr>
<tr>
<td>Part Fabrication Time &amp; Cost</td>
<td>• All Above&lt;br&gt;• Advanced Tooling Lifecycle Management Process&lt;br&gt;• Automated compilation and correlation of Tooling Lifecycle Data to CMM and Inspection Data</td>
<td></td>
</tr>
</tbody>
</table>
## MBE ROI Summary – Tooling

Global Product Data Interoperability Summit | 2019

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data – Surveyed Respondents Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooling Design Time</td>
<td>• Increased Design Fidelity from Standards and Validation Technologies&lt;br&gt;• Optimally Annotated Models&lt;br&gt;• Increase in Mfg. Work Instruction First Pass Yield</td>
<td>Contact Kenn Hartman for ROI Data &amp; Calculation methods/formulas&lt;br&gt;<a href="mailto:khartman@dsasite.com">khartman@dsasite.com</a>&lt;br&gt;(216) 533-6302</td>
</tr>
<tr>
<td>Tooling Conditioning &amp; Validation Time</td>
<td>• Increased Design Fidelity from Standards and Validation Technologies&lt;br&gt;• Optimally Annotated Models&lt;br&gt;• Increase in Mfg. Work Instruction First Pass Yield&lt;br&gt;• High First Pass Yield/Automated Creation of CNC from Optimally Annotated Model&lt;br&gt;• High First Pass Yield/Automated Creation of CMM from Optimally Annotated Model</td>
<td></td>
</tr>
<tr>
<td>Tooling Reconditioning &amp; Changeover</td>
<td>• All Above&lt;br&gt;• Advanced Tooling Lifecycle Management Process&lt;br&gt;• Automated compilation and correlation of Tooling Lifecycle Data to CNC and Inspection Data&lt;br&gt;• Automated compilation and correlation of Tooling Lifecycle Data to CMM and Inspection Data</td>
<td></td>
</tr>
</tbody>
</table>
### MBE ROI Summary – Quality

#### Global Product Data Interoperability Summit | 2019

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data –Surveyed Respondents Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Article Inspection Defects</td>
<td>• High Fidelity Design Package – advanced ballooning for Feature and Characteristic Identification</td>
<td>Contact Kenn Hartman for ROI Data &amp; Calculation methods/formulas</td>
</tr>
<tr>
<td>First Article Inspection Time &amp; Cost</td>
<td></td>
<td><a href="mailto:khartman@dsasite.com">khartman@dsasite.com</a></td>
</tr>
<tr>
<td>CMM Lead Time and Validation</td>
<td>• Automated Derivation of CMM Code</td>
<td>(216) 533-6302</td>
</tr>
<tr>
<td>Equipment Calibration Issues</td>
<td>• Advanced Trend Analysis from CMM (Persistent Ballooning ID’s and Intelligent FAI Forms)</td>
<td></td>
</tr>
<tr>
<td>Reduce Correlation Time</td>
<td>• High Fidelity Design Package – advanced ballooning for Feature and Characteristic Identification • Advanced Trend Analysis from CMM (Persistent Ballooning ID’s and Intelligent FAI Forms)</td>
<td></td>
</tr>
</tbody>
</table>

Contact Kenn Hartman for ROI Data & Calculation methods/formulas
khartman@dsasite.com
(216) 533-6302
### MBE ROI Summary – Procurement

**Global Product Data Interoperability Summit | 2019**

<table>
<thead>
<tr>
<th>Value Drivers</th>
<th>Advanced Capabilities Required</th>
<th>Evidentiary Data – Surveyed Respondents Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead Time to Assemble RFQ</td>
<td>• Data Definitions which enable a High First Pass Yield of the Downstream Manufacturing, Quality, and Tooling Analysis, Planning &amp; Costing Processes</td>
<td>Contact Kenn Hartman for ROI Data &amp; Calculation methods/formulas</td>
</tr>
<tr>
<td></td>
<td>• Automated Model Validation</td>
<td><strong><a href="mailto:khartman@dsasite.com">khartman@dsasite.com</a></strong></td>
</tr>
<tr>
<td></td>
<td>• Single Technical Data Package to enable a High First Pass Yield</td>
<td><em>(216) 533-6302</em></td>
</tr>
<tr>
<td></td>
<td>• Automated Validation of Technical Data Package</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vendor Portal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Enhanced EC Process to enable release of New &amp; Revised TDP’s to Outsource Portal</td>
<td></td>
</tr>
<tr>
<td>Lead Time to Quote</td>
<td>• High Fidelity Technical Data Packages</td>
<td></td>
</tr>
<tr>
<td>Contingency Pricing</td>
<td>• All Above</td>
<td></td>
</tr>
</tbody>
</table>
## MBE ROI Summary – Outsource Suppliers

### Summary:

**Value Drivers**

- All Value Drivers from Mfg. Engineering, Quality, Tooling Slides Above

**Advanced Capabilities Required**

- All Advanced Capabilities from Mfg. Engineering, Quality, Tooling Slides Above

**Lead Time to Ship**

- All Advanced Capabilities from Mfg. Engineering, Quality, Tooling Slides Above

**Evidentiary Data – Surveyed Respondents Report:**

- Contact Kenn Hartman for ROI Data & Calculation methods/formulas
  - khartman@dsasite.com
  - (216) 533-6302

---

### Lead Time to Ship

- ARDEC/NIST Study Respondents with Advanced MBD/MBE Capability reduced Lead Time to Ship by more than 50%

### NOTE: Securing the ROI from your Outsource Community

- Understand through Survey and TDP Walkthroughs what the real MBE Capability Maturity is across your Critical outsource Suppliers
- Establish a Capability Maturity Process for your Critical outsource Suppliers
- Measure and Understand your Own Internal ROI to enable Comparative Analysis Time and Cost Data from your Critical outsource Suppliers
- Establish Vendor RFP Evaluation & Contract Process that Captures the ROI you enable from your MBD/MBE Investments

---

### Value Drivers

- All Value Drivers from Mfg. Engineering, Quality, Tooling Slides Above

### Advanced Capabilities Required

- All Advanced Capabilities from Mfg. Engineering, Quality, Tooling Slides Above

---

### Evidentiary Data – Surveyed Respondents Report:

- Contact Kenn Hartman for ROI Data & Calculation methods/formulas
  - khartman@dsasite.com
  - (216) 533-6302
Key Takeaways
Global Product Data Interoperability Summit | 2019

• Like PDM is pre-requisite to PLM so is MBD to MBE
  • You must get MBD right!
• You must have Executive Buy-in
• You must have a Strategic Execution Plan
• You must know what you’re in store for – it won’t be easy!
• You must plan effectively
• You must execute methodically
• You must measure success along the way