Digital Enterprise

Openness Standards and Best Practices

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**Global trends**

**Digital transformation**
Networked world of complex and heterogeneous systems

**Globalization**
Global competition driving productivity and localization

**Urbanization**
Infrastructure investment needs of urban agglomerations

**Demographic change**
Decentralized demand of a growing and aging population

**Climate change**
Higher resource efficiency in an all-electric world

**Market development** (illustrative)

- **Digitalization**
- **Automation**
- **Electrification**

**Innovating along the digital value chain**

- Digital model-based designs
- Simulation linking product and production
- Digital models of complete lifecycle
- Self-optimizing cyber-physical systems

1 Est. market growth (CAGR) over cycle
Siemens Digitalization

Leveraging digital technology trends for concrete customer benefits

Siemens Digitalization

Collaboration and mobile

Smart data and analytics

Cloud technologies

Connectivity and Web-of-systems

Cyber-Security

Improved productivity & time-to-market

Higher flexibility & resilience

Increased availability & efficiency

Design & engineering

Automation & operation

Maintenance & services

Combining the virtual & physical world …

… across entire customer value chains
Ever expanding scope for standards

Digital Twin

Manufacturing Planning

+ Manufacturing Engineering +

Physical production system

Manufacturing Execution
The reality of establishing a Digital Enterprise

- Many integration points to worry about across PLM, ERP, MES
- Many legacy systems and bespoke interfaces
- Many processes based on manual intervention
- People looking for ways to standardize the definition, execution, and exchange of the ‘Digital Twin’

Looks familiar? Complex enterprise IT is a major reason for OEMs to struggle and not being able to adopt the ‘Digital Enterprise’ to its full extent
The ‘big picture’ of Digital Enterprise Integration

- Foundation starts with PLM, MOM, and ERP
- Many loops!
- Don’t forget QMS, Factory Automation, and Field Operations
- Many BOMs!
- Include your supply chain
The ‘big picture’ of Digital Enterprise Integration

New variant for aircraft wingtip

1. Product design in CAD including PMI
2. eBOM → mBOM of winglet design – variant to wingtip
3. Author/Update ROP FP (unit-based effectively 0 to n)
4. Release unit-based execution plan to MES
5. Order information from ERP
6. XML and Services
7. Generate MES run-time job for operator execution
8. Generate as-built records – viewable from PLM
9. Create NC in MES – escalate to engineering with mark-up
10. ECO/ MCN Change
11. Release changes to existing execution plan

Escalate to engineering creates Shop Floor issue workflow in PLM

Issue workflow – analysis and resolution of NC
Standards Challenge

Growing interest in implementing processes based on standards supporting multiple disciplines and business needs

- IT / MIS / Operations
- Customer / Program
- Government / Regulation
- Supplier Management

Driving the identification, definition, evaluation of standards and processes across, and throughout, multiple tiers

- Industry
- Business
- Suppliers
- Customers

Standards for

- Interoperability
- Business processes and methods
- Models

https://www.zachman.com/about-the-zachman-framework
Advantages and Benefits Supporting Standards

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Realize a direct return on investment for the products you engineer and sell
  • Lowering installation and startup costs
  • Reducing need to maintain large inventories
  • Enabling interchangeability of components improving design with less "custom" effort
  • Increasing safety (e.g. ISO 26262)

Use of standards in industry
  • Improves communication
  • Provides practical application of expert knowledge
  • Represents years of experience and avoids necessity of starting each project from ground up
  • Support advancement of new technology / architectures while preserving existing SLAs

In general, standards help you achieve operational excellence by
  • Improving performance
  • Lowering maintenance costs
  • Reducing downtime and enhancing operability
**Example – PMI, GD&T ASME Y14.41 and ISO 16792**

**ASME Y14.41, ISO 16792**

- Conveys information such as geometric dimensioning and tolerancing (GD&T), 3D annotation, surface finish and material specifications
- Allows for the manufacture and inspection of the product without need for traditional 2D drawings
- Standards provide the underpinnings for Model Based Definition (MBD), i.e. a complete digital definition of the product within the 3D model.
- Good example of standards influencing commercial CAD software vendors

50% reduction in supplier response time  
50% reduction in prototypes  
Mistakes reduced by 40%
Example – Data exchange based on AP 242

AP 242

- Focused on all facets of a ‘digital Part’
- Siemens PLM Software closely followed the inception and development of AP242
- Currently extending the implementation of AP242 across our product portfolio
- For example, NX CAD extending the integration of AP242 in the following areas:
  - Semantic PMI
  - Tessellated Geometry
  - Import/Export of 242 Compressed Files
  - Import/Export of 242 XML Files
  - Import/Export of Compressed 242 XML Files
Example – JT (ISO 14306)

ISO JT

- The JT File Format unanimously passed a global ballot on December 11, 2012 and has been accepted by ISO as an International Standard
- JT V9.5 is now ISO/IS 14306:2012 - JT file format specification for 3D product data visualization
- The format specification was published to the ISO purchase/download site December 15, 2012
- JT Open membership going strong, JT International Conference 2016
Example – Co-simulation based on MODELISAR FMI

Functional Mock-up Interface

- Collaborative MBSE
  - Between OEMs and suppliers
  - Between departments
  - Involving different domains
- Tool neutral software interface for either model exchange, or co-simulation
- Open format, with publicly available specs

- Siemens is an active member of FMI Steering Committee and FMI Design group
- Siemens has highly contributed to the specification of FMI 1.0 and FMI 2.0
Example – Integrations based on OSLC

OSLC

- Focused on PLM and ALM integration
- Siemens has integrated OSLC principles with Teamcenter Linked Data Framework
- Reference remote resources based on persistent URIs
- Extend SOA to support HTTP REST services
- Delegate user interface where applicable

- Initially focused on CM and RM specifications as provided by OSLC
- OSLC support with service extensibility based on Teamcenter Business Modeler IDE
**Example – Electronic Disclosures based on JT + PDF**

**JT + PDF**

- Good example of combining industry-driven standards
- Addressing security and translation concerns from major customers
- Combining the strengths of JT with documents published as PDF
- Enabled by attaching JT to PDF for 3D and PMI interrogation and visualization
- Supporting ‘paperless’ collaboration

- No need for redundant for data translation to support 3D visualization
Example – MES integration based on ISA 95

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ISA 95

• The ISA 95 standard consists of the following parts:
  • Part 1: Models and Terminology
  • Part 2: Object Model Attributes
  • Part 3: Activity Models of Manufacturing Operations Management
  • Part 4: Object models and attributes for Manufacturing Operations Management
  • Part 5: Business to Manufacturing transactions
• Used as the foundational data model for MES and Enterprise Interoperability
• Foundation for Siemens SIMATIC IT Manufacturing Operations Management
Example – Programming standards, HTML 5

HTML 5

- HTML5 is the latest evolution of the standard that defines HTML
- Zero install content delivery
- Typically referenced along with other programming standards like CSS, JavaScript, and related technologies like WebGL
- For Siemens as technology provider key foundation for delivering product innovation, e.g. Active Workspace
- Allows for ease of configuration, extensibility and embedding as part of your extended enterprise
Example – Technology standards, Hadoop

Hadoop

- Open-source software framework for storing data and running applications on clusters of commodity hardware
- Good example of how open source can spark a new wave of innovation, i.e. Big Data
- Allows Siemens to close the loop between ‘virtual’ and ‘physical’ by correlating sensor and engineering data
- Hadoop and related technology set at the foundation of new Siemens products like OMNEO
Best Practices to Consider

- Establish a ‘Digital Enterprise’ office responsible for the governance of tool chain integration, semantics and best practices
- Focus on ‘digital threads’ with high ROI for your business, e.g. model based engineering, electronic work instructions, etc.
- Use industry ‘state of the art’ for critical and value-add business processes
- Leverage industry driven standards via consortiums
- Use open standards where semantics are comprehensive, mature and broadly supported and hence ‘least common denominator’ is not a problem, e.g.
  - PMI and GD&T
  - Model Based Engineering
- Make sure that you consider shared semantics between the virtual, and physical world to accelerate your IoT adoption
- Include your supply chain!
Thank you

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