Driving the Digital Enterprise

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Smart products are transforming every industry

Smart products
- Level 4 autonomous vehicles

Smart factories
- Autonomous machine behavior

Big data
- Gain Insight
“Digital is the main reason just over half of the companies on the Fortune 500 have disappeared since the year 2000.”

Pierre Nanterme
CEO Accenture
Technologies enabling the digital twins

Compresses the innovation lifecycle...

IDEATION

REALIZATION

UTILIZATION

Changing the way products are realized

Changing the way products evolve

Changing the way products come to life

GENERATIVE DESIGN

INTELLIGENT MODELS

SYSTEMS OF SYSTEMS

MACHINE LEARNING

ADDITIVE MANUFACTURING

ADVANCED ROBOTICS

CLOUD TECHNOLOGY

KNOWLEDGE AUTOMATION

BIG DATA ANALYTICS

IDEATION

REALIZATION

UTILIZATION

Compresses the innovation lifecycle...
Siemens Digital Enterprise Software Suite
Tools enabling the digital twins

MECHANICAL DESIGN
- NX
- Solid Edge
- Catchbook
- Fibersim
- Syncrofit
- Mastertrim

ELECTRONICS AND SOFTWARE DESIGN
- Mentor Graphics
- Polaris

PREDICTIVE ANALYTICS
- NX Nastran
- Imagine.Lab
- Virtual.Lab
- Test.Lab
- Simcenter
- Star-CCM+
- HEEDS

MANUFACTURING ENGINEERING
- Tecnomatix
- NX CAM
- Intosite
- Line Designer

PERFORMANCE ANALYTICS
- Omneo
- Mindapps

SERVICE LIFECYCLE MANAGEMENT
- Siemens Services

FACTORY AUTOMATION
- SIMATIC
- SINUMERIK
- SIMOTION

MFG EXECUTION
- SIMATIC IT
- IBS QMS
- WinCC
- Camstar
- Preactor
- Production Systems
- Engineering

COLLABORATION
- MindSphere
- Teamcenter
Digitalization ...

Digital Product

Holistic Digital Twin

Digital Performance
What problems do they solve?

**Product Twin – Predict**
- Physical appearance and attributes
- Performance characteristics
- Environmental Response
- Failure modes

**Production System Twin – Predict**
- Physical layout and attributes
- Production capacity and utilization
- Optimize throughput

**Performance Twins - Insight**
- Optimize in-service operation
- Predictive maintenance
- Validate “as designed”
Enable excellent performance on every program

Program Execution Excellence

Improve program cost, technical and schedule performance through a Model Based Enterprise, Digital Twin – Digital Thread

Gain competitive advantage by employing a pre-configured technology to focus on the automation of specific A&D value streams

Increase performance in production, support and future bids by sharing product knowledge & definition within a unified system
# Program Execution Excellence

Value Stream Solutions Generate Competitive Advantage

<table>
<thead>
<tr>
<th>Systems Driven Product Development</th>
<th>Integrated Prog. Planning and Execution</th>
<th>Product Engineering &amp; Design</th>
<th>Supplier Source Selection and Management</th>
<th>Verification Management</th>
<th>Product Realization</th>
<th>Product Support Planning and Management</th>
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<tr>
<td><strong>OPTIMIZATION &amp; INNOVATION</strong></td>
<td><strong>MEETING COST, SCHEDULE AND TECHNICAL REQUIREMENTS</strong></td>
<td><strong>EFFICIENT FIRST TIME RIGHT</strong></td>
<td><strong>EFFECTIVE SUPPLIER MANAGEMENT</strong></td>
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<td><strong>MEETING COST &amp; PRODUCTION GOALS</strong></td>
<td><strong>INTEGRATE SERVICE WITH THE FACTORY</strong></td>
</tr>
<tr>
<td>A systems driven product development approach leveraging systems engineering and 3D models from idea thru to support.</td>
<td>A systems approach to project planning a fully planned, resourced, budgeted and executed program management solution.</td>
<td>Design with advanced materials, integrated CAD/CAE, maximize reuse, advanced configuration management.</td>
<td>Enabling traceability from OEM requirements to suppliers. Proactive supplier management.</td>
<td>Enabling traceability from requirements thru virtual and physical test to ensure product verification.</td>
<td>“Shift left” manufacturing planning to ensure cost, schedule &amp; safety goals are achieved with fully integrated factory.</td>
<td>Design for support. Plan for support. Manage service planning. Closed loop support with manufacturing and design.</td>
</tr>
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Program Execution Excellence
Capabilities Matrix

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# Program Execution Excellence

## Capabilities Matrix

### Digital Enterprise

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## System Driven Product Development

- Integrated Program Planning & Execution
- Product Engineering & Design
- Supplier Source Selection and Management
- Verification Management
- Product Realization
- Product Support Planning and Management
Trends

Improve Operational Availability

Model Based Definition Requirement

Aftermarket Service Revenue
Product Support Planning and Management
‘Disconnected’ BOMs

Virtual
- As-Designed BOM
  - Engineering
- As-Planned BOM
  - Manufacturing
- Service BOM
  - Service Planning

Physical
- As-Built BOM
  - Manufacturing
- As-Maintained BOM
  - Sustainment
- Service Execution
Product Support Planning and Management

Digital-Thread for ‘Closed Loop’ Product Planning & Support

Virtual

As-Designed BOM
Engineering

As-Planned BOM
Manufacturing

As-Built BOM
Manufacturing

As-Maintained BOM
Sustainment

Physical

Service BOM

Service Planning

Service Scheduling

Service Execution

...changes...
Product Support Planning and Management

*Digital-Thread for ‘Closed-Loop’ Traceability*

As-Designed BOM ➔ As-Planned BOM ➔ As-Built BOM ➔ As-Maintained BOM

Virtual ➔ ...changes... ➔ Physical

- Engineering
- Manufacturing
- Fabricated
- Sustainment

- Work Instructions – EWP/CWP
- Service Manuals
- Training Manuals
- Work Order / EWI

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A **digital thread** approach to Product Support Planning and Management, enables manufacturers, owners and service organizations to support complex products with a service management environment. This configuration-driven environment provides service-oriented physical product definitions and maintenance information that facilitates the accurate and rapid performance of critical service functions.
Systems Driven Product Development

Conduct physics-based analyses for early behavior and performance insight

Key Tasks
- Execute behavioural performance simulation
- Pass results to Teamcenter to create derived measurements/requirements

Value
- Early validation of design approach via performance analysis
- Traceability between functions, models, simulations and derived requirements
- Clear change impact visibility
Systems Driven Product Development

Key Tasks
- Execute behavioural failure mode simulation
- Pass results to Teamcenter to create derived measurements/requirements

Value
- Early validation of design approach via failure analysis
- Traceability between functions, models, simulations and derived requirements
- Clear change impact visibility
What MADe does

**Define**
How and where system will be used

**Model**
Identify potential failures and when they will occur

**Validate**
Technical analyses

**Analyze / Mitigate**
Identify optimal failure mitigation approach

**Calculate**
Generate expected maintenance costs for the solution

- Mission Profile Definition
- Functional / Failure Analysis
- FMEA / FMECA
- Reliability Centered Maintenance
- Maintenance Cost Estimate
- Environment Loading
- Reliability Analysis
- Fault Tree Analysis
- CBM Design
- Maintenance Action Reports
Product Support Planning and Management

Design in safe, quick and easy replacement of components

Key Tasks
• Simulate human maintenance to optimize design
• Validate maintainability with virtual reality immersion

Value
• Elimination of physical prototype through earlier consideration of maintainability
• Maintenance costs and downtime reduced through better designs
Product Support Planning and Management

Create and Manage Service Plans tied to the Model Based Configuration

Key Tasks
• Develop service plans that support proactive service models such as preventative, condition and reliability-based maintenance as well as platform upgrades.

Value
• Enhance service quality by ensuring that approved service procedures are defined and followed.
Product Support Planning and Management

Build the foundation for all future maintenance activities being tied to the Engineering Configuration

**Key Tasks**
- Leverage engineering definition to define physical structure including serialized parts and operational characteristics

**Value**
- Improves asset tracking and life usage by leveraging fully defined lifecycle bill-of-materials (BOM)
- Service quality improvements
Key Tasks

- Define work scope and schedule within the limitations of resources and available qualified personnel.

- Deliver assignments with all the necessary information to execute work.

Value

- Increase service operations efficiency through visibility to schedules of current and future work.
Product Support Planning and Management

Key Tasks

- Service personnel receive order tasking at the appropriate time.
- View the schedule of current and upcoming tasks
- Capture service results and signoff on work.

Value

- Accelerate service execution.
- Ensure technician is using correct data.
Product Support Planning and Management

**Tie deficiencies directly to Engineering and Planning**

**Key Tasks**

- Technician captures failures and corrective actions directly in Service Work Instruction interface.
- Routed directly to responsible supervisor for action

**Value**

- Enables the non-stop execution of work at the point of service.
- Enhances service and asset performance by retaining and delivering service experience and knowledge at the point of task
What makes Product Support Planning and Management Unique?

- Single System Providing Product Support & Planning Digital Thread
- Configuration Driven Maintenance
- Real-time Visual Reporting and Digital Work Instructions
Summary - Product Support Planning and Management

- Manage the service lifecycle directly from the product definition
- Configuration-driven closed-loop maintenance
- Improve asset availability and reliability: avoid unplanned asset downtime (failures)
- Improved service quality: standardize service best practices in service processes for plans
- Real-time visual reports and Deficiency tracking
Summary
Digital Thread – Digital Twin

Compresses the product lifecycle...

IDEATION

REALIZATION

UTILIZATION

Program Execution Excellence
The Digital Twin – Digital Thread delivering real value
Achieving….. Program Execution Excellence

Continued investment in the Digital Enterprise

Digitally represent what is real
Simulate what is possible

Achieving customer success

Powering
Digital transformation

Integrating
Virtual development with real production

Driving
Successful business outcomes

>$6.5 Billion since 2013

Increased engineering and execution
Product development
Digitalization changes Everything...
Digital Thread for Additive Manufacturing (DTAM)

Siemens Innovation Leadership Summit
March, 2018
Digital Thread
Connecting the Entire Product Lifecycle

**Digital Thread** - “A single, seamless strand of data that stretches from the initial design concept to the part end-of-life”  
(From 3D Opportunity and the Digital Thread)

The digital thread enables organizations to design anywhere and build anywhere at scale while unlocking insights into rapid product and process optimization.
Deloitte and MIT: “Following the Digital Thread”

8 Part Documentary Series

Brings to life a real application of the digital thread, from product design to production.

All episodes fully available on MIT’s site March 12, 2018

Follows the journey of an Aerospace bell crank, with cross-industry applicability.

Developed by Deloitte Insights and MIT Sloan Management Review

In collaboration with Siemens PLM Software, ONE Aviation, America Makes, M7 Technologies, and Youngstown State University.

The Path Toward the Digital Enterprise

Watch this great series of videos to understand the impact of operationalizing the digital thread within your organization.

Episodes range 2–8 minutes in length – the total series can be viewed in under an hour.

https://sloanreview.mit.edu/tag/following-the-digital-thread/