MBSE Workshop
Model Management in PLM

Teamcenter Model Management

The Problem…
The Solution…
Where are we…
What’s missing…

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Apollo Guidance Computer (1966)
- 1st IC-based computer
- 2k core, 36k ‘rope’ memory
- 11.72 micro-second cycle
- 55 Watts
- 70 lbs
- 24” x 12.5” x 6.5”
- $$$$$$$$

Hallmark Card (today)
- 256mb+ memory
- ~2 ghz
- 1900 mAh (2 yrs)
- .085 oz
- 1” x 1” x .25”
- $. <$1
Deep Water Horizon

Increasing complexity everywhere...

~5000 sensors, ECU’s, etc. communicating over 9000 connections via 1,000,000+ types of messages, performing 2000+ functions—with each tail number different

An Oregon man discovered that his year-old Toshiba flat-screen TV was emitting an international distress signal (121.5 mhz) picked up by a satellite, leading a search and rescue operation to his apartment in Corvallis, Oregon, Oct. 18, 2004 CNN

Illustrative case example: Washers & Dryers

~10M LOC, 40-60 ECU’s, ~5000 parameters, ~30,000 functions (typical engine controller ~4000 functions)

Complexity everywhere... SE is a process for managing complexity
Unmanaged complexity produces problems...

Failing to manage cross-domain interactions/interfaces show up as problems later. Ignoring the risk is no longer affordable...

- 17.8 million vehicle recalls in the US in 2012 (more recalls than vehicles sold)
- Each recall costs $100/vehicle/recall ($1.8 billion/year) in direct costs

A sample list from the NHTSA recalls database...

- ...recalls 1.3 million vehicles where engine controller may develop solder joint cracks due to vibration
- ...recalls 1021 vehicles with automatic rear lid with leaking gas struts could cause injury...software update
- ...recalls 3.6 million vehicles...speed control switch leaks and overheats
- ...recalls 10,113 vans...brake lights don’t come on after first time; brake control software update.
- ...recalls 437 vehicles...seat sensor calibration error doesn’t turn on air bags

The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

Albert Einstein
Challenges in the “New Normal”
Success is getting harder

- **50%** product launches fail to live up to company expectations
- **33%** of new products fail to provide a satisfactory return
- **70%** of the resources spent on new launches are allocated to products that are not successful in the market
- **80%** of projects cost **20%** more person-hours to launch than initially forecast

Source: Booz & Co.
The systems engineering process to handle complexity
EIA-632, IEEE 1220, ISO 15288,...

EIA 632

Process Input:
- Customer Needs/Objectives/Requirements
  - Missions
  - Measures of Effectiveness
  - Environments
  - Constraints
- Technology Base
- Output Requirements from Prior Development Effort
- Program Decision Requirements
- Requirements Applied Through Specifications and Standards

Requirements Analysis
- Analyze Missions and Environments
- Identify Functional Requirements
- Define/Refine Performance and Design Constraints

System Analysis and Control (Balance)
- Trade-Off Studies
- Effectiveness Analyses
- Risk Management
- Configuration Management
- Interface Management
- Data Management
- Performance Measurement
  - SEMS
  - TPM
  - Technical Reviews

Requirements Loop
- Decompose to Lower-Level Functions
- Allocate Performance and Other Limiting Requirements to All Functional Levels
- Define/Refine Functional Interfaces (Internal/External)
- Define/Refine/Integrate Functional Architecture

Functional Analysis/Allocation
- Design Loop
- Synthesis
- Transform Architectures (Functional to Physical)
- Define Alternative System Concepts, Configuration Items and System Elements
- Select Preferred Product and Process Solutions
- Define/Refine Physical Interfaces (Internal/External)

Process Output
- Development Level Dependent
  - Decision Database
  - System/Configuration Item Architecture
  - Specifications and Baselines

Related Terms:
- Customer = Organizations responsible for Primary Functions
- Primary Functions = Development, Production/Construction, Verification, Deployment, Operations, Support, Training, Disposal
- Systems Elements = Hardware, Software, Personnel, Facilities, Data, Material, Services, Techniques
Requirements/Systems Engineering process...
The Systems Engineering Process...

- FRAT (Commercial) vs RFAT (Mil/Aero, Energy, …)
- Captured requirements…
- Linking requirements to functions…
- Functions linked to physical alternatives/architectures

...keep going until realizable
More than RFLP to worry about…

- More to a product’s life than RFLP…
- No decision is an island
- Need to worry about other views (safety, mfg, cost, test, …)
- Balance product performance against other views to achieve “global optimization”
...managing variation over time

- Reliability
- Safety
- Materials
- Cost
- Mfg.
- Suppliers
- Disposal
- Maint.
- Test
- ...
...changing over time

...different versions of different requirements apply to different versions of the same product...

...cross linked...different versions of different views linked among each other—traceability thru variants; as designed, as built, as maintained,...

...different versions of interfaces, consisting of different versions of signals, with different messages, ...

Reliability

Safety

Materials

Cost

Mfg.

Suppliers

Disposal

Maint.

Test

Battery

ECU

Sensor

Drive
PLM understands versions/variants/change... RM & SE need to be integrated with PLM...
Up the ‘what if’ rate

What’s effected if this requirement changes?
Can we consolidate these functions?
What’s the impact if this test fails?
What happens if this part changes?
PLM is the place to bring these models together
...to enable visibility

...to manage something, you need to see it
Cross-Domain products require Cross-Domain Solutions
About Siemens AG...
Four Sectors Cover the Global Trends –

1) IPO planned
## Industry Automation Supporting Customers from Product Design to Production and Beyond

### Product Design and Engineering
- **PL**: Siemens PLM Software
  - Grindstaff (CEO)
  - Affuso (Chairman)

### Production Engineering and Automation
- **AS**: Industrial Automation Systems
  - Eberle (CEO)
- **CE**: Control Components and Systems Engineering
  - Kaul (CEO)
- **SC**: Sensors and Communication
  - Kumpfmüller (CEO)
- **WT**: Siemens Water Technologies
  - Dr. Löffler (CEO)

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Siemens PLM Software
Teamcenter: Delivering Value Across Industries
56,000 Customers, Operating 6.0M+ Seats Across the Globe

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Siemens PLM Software
Teamcenter Leadership!
PLM Platform of Choice for Industry

- All of the top aircraft engine manufacturers...
- All of the top 10 High Tech Electronics...
- All of the top 10 Semi-conductor manufacturers...
- Most of the Top Shipbuilding companies...
- 8 of the top 10 aircraft airframe manufacturers...
- 10 of the top 15 Automotive OEM’s...
- 13 of the top 15 Automotive Suppliers...
- 14 of the top 15 Machinery manufacturers...

Managing Product Development means... we have to manage product models
Where we are…
Model Configuration/Variant Management

• Models associated with product elements (BOM’s)
• Models configured with product structures
• Scalable to massive systems/systems of systems

Millions of parts
1000’s of versions
100’s of Workflows
100’s – 10,000’s of People
Where are we...
Requirements moving between physical, mfg, project, ... models

- Requirements driven digital validation
- Simulation Verification
- Visual Reports
- Embedded visualization and markup
Vision: Integrated systems-oriented decision support...

Minimum Turn Radius: 24 ft.
Dry Pavement Braking Distance at 60 MPH: 110 ft. 90 ft
...models communicating thru PLM backbone
What’s missing…

• Interface configuration (consistent levels, messages, etc.)
• Fine-grained Model configuration (not just models on parts, but mapping of interfaces on parts) input/output, ground paths, vibration, corrosion,… including multiple-function components (speaker wire)
• What does a change to an interface/message mean to product configuration
• Standard model exchange (which standard is going to catch on…ISO-AP-233, RIF, OSLC, SLIM,… plus existing XML/XMI, CSV,…)
• Pervasive exchange standard adoption
• Notation mapping/alignment (SysML, Block diagrams, OPM, DSM, FMEA,…)
• Granularity agreement (Cost vs Mfg vs …)
• System of system model exchange
• Model Fidelity/Confidence agreement (20x20 room)
In the meantime, this requires culture change...
Teamcenter

Thank You.