

# Complex Product Development Demands Data Governance

## Aug 10 2023



**PLM Road Map™ & PDT North America 2024**  
*Value Drivers for Digitalization of the Product Lifecycle*  
*Insights for the PLM Professional—Why the investment, what are the returns,*  
*and how are they achieved?*  
May 8 & 9 **europstep**

**Safest Products Evolve as  
New Data is Discovered**

**8 May 2024**

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The slide features a dark teal background with a faint world map and binary code. On the right side, there is a grid of hexagonal icons representing various industries and processes, including a factory, a storefront, a gear, a medical symbol, and a laptop.



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### Key Takeaways

 *Inexpensive electronics expands sensing which leads to new customer features*

- IoT has begun to foster end-to-end lifecycle connectivity, resulting in unprecedented growth of structured & unstructured data
- Empirical data is readily available across a product's life
- System of systems can be more difficult to manage than individual products, but when mastered provides a competitive advantage
- More and more product upgrades are happening over the air
- Multidiscipline collaboration, using customer data all the time, creates new revenue opportunities

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### Presenter's Bio



Craig Brown  
Executive Consultant

- Over 45 years of experience in systems engineering, both in the automotive and aerospace industries, especially the computer-based tools for virtual engineering
- Appointed PLM Leader at General Motors in 2012 governing planning and execution of key PLM initiatives
- Lead Simulation Methods Team developing techniques for virtual engineering of controls & calibration, tribology modeling predictions, balancing laboratory/field/simulation practices
- Lead ALM initiatives for GM and defense applications, including the development of EDA solutions, during 1980's and 1990's
  - Earned Boss Kettering Award for Remote Diagnostics Patents
- Joined the CIMdata team in 2019, with a focus on systems engineering, PLM governance, Digital Transformation consulting, and authoring commentaries/eBooks about mobility
- Mobility & Critical Systems Strategic Advisor to UL Solutions

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### Agenda

- Complex Products – What’s Happening?
- Electronics/Sensing/Data Opportunities
- Complex Products Need Measurement Data Management
- Managing Product Evolves from PDM & ALM -> Continuous PLM
- Safest Products Within Systems Adapt

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### Complex Products – More Electronics

Product Complexity Increasing thanks to Moore's Law miniaturizing electronics and sensors

Most electronics has S/W  
S/W can be installed often  
Features drive revenue  
Keeps customers satisfied  
Mass production with factories is managed in PLM/ERP

*What are S/W releases and where should they be managed?*

IDTechEx Research

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## Measurement Data Drives Product Engineering


 *Now coming from actual customer usage driven by decreasing sensing and storage costs*

- Near real-time insights are becoming affordable
- Insights on actual product applications based on environment and operators
- Development after mass production
- Feature cycles become months, maybe weeks, instead of years
- Validation of upgrades required
- Real machine learning enables adjusting to customer

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## Complex Systems – What’s Happening?

 *Systems are broader than individual products, MBSE is mandatory for Complex Systems*

- Multi-discipline, multi-domain requires simultaneous collaboration
- Effective collaboration needs a single, clear language

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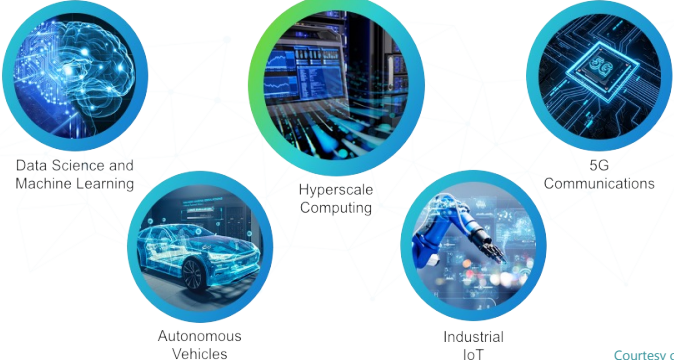
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### Technology Allows Greater Creativity—At a Cost

 *Managing product information & processes becomes more critical*

#### Disruptive Technology Drivers




- Data Science and Machine Learning
- Autonomous Vehicles
- Hyperscale Computing
- Industrial IoT
- 5G Communications

Courtesy of Cadence


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# Autonomous Expectations vs. Realities


A product is a system within an ecosystem

### Autonomous Vehicles Are Driving Blind

Oct. 11, 2023



Harold Noggle  
<https://www.nytimes.com/2023/10/11/opinion/driverless-cars-san-francisco.html>

### Robotaxi breakdowns cause mayhem in San Francisco days after expansion vote

Public utilities commission had allowed Google's Waymo and

<https://www.theguardian.com/us-news/2023/aug/14/san-francisco-robotaxi-waymo-cruise-breakdown>

### How a robotaxi crash got Cruise's self-driving cars pulled from Californian roads

The whiplash from approval to ban in just two months highlights the fragmented oversight governing the fledgling industry

By Trisha Thadani  
October 28, 2023 at 7:06 a.m. EDT

<https://www.washingtonpost.com/technology/2023/10/28/robotaxi-cruise-crash-driverless-car-san-francisco/>

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# What if products shared insights?


A product is a system within an ecosystem

### The Problem Transcends the Product

Technology complexity is running head long into consumer expectations.

An additional challenge deals with new connected transportation systems. These systems go beyond the boundary of an individual vehicle. Complexity is caused from connecting vehicles to infrastructure—starting with service and moving quickly toward travel efficiency. A systems engineering view of the boundary diagram of these different systems shows that the vehicle is now a sub-system of a connected transportation service. And the services provided are changing as quickly as the pace of technology advances coming from Silicon Valley. In essence, technology complexity is running head long into consumer expectation complexity. Tackling this requires Systems Design Thinking, making sure your solution is robust enough in all its delivered capabilities. This includes those you may not be able to foresee, and an increased vigilance of the competition. Even forces outside the industry are changing customer expectations, for example: music playlists from your phone are available in your vehicle; and Alexa can pay at the gas station (via telematics in the car). Leading and managing this complexity requires MBSE processes and tools like those being brought to market by Siemens.



2005 - Diagnostics T...

Vehicles are I...



Courtesy of Siemens





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## Measurements make Products Safer


Data -> Information -> Knowledge -> Wisdom

- Safest products learn from experiences
- Comprehending usage data keeps subsystems safe
- Lacking data (really knowledge) leads to broader safety margins
- Data's role in innovation is expanding to include real-time measurements
- Dynamic context is important,
  - Leads to product improvements during use
- The pace of data acquisition is an emerging competitive advantage

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## Data Governance Helps Manage Complexity

Within systems engineering of complex product development

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- Precise, clear language
- A data dictionary that evolves
- Power of contextual search and discovery
- Policy and ownership
- Industry standards
- Life cycle of information – when to use and when to dispose
- Traceability, often driven by regulations
- Quality Management evolves, broadens

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# System of Systems Engineering

“Autonomous Vehicle Development Requires Closed Loop Solutions” – CIMdata eBook

### Engineering Beyond Individual Vehicles

**AV systems of systems development is broad**

There remains a gap in the journey from today’s Level 1, 2, and 3 ADAS capabilities to capabilities needed for a fully AV, see Figure 7. With AV development, integrating the sensing, communications network, and traffic management beyond the vehicle will be required to bridge this gap. Complexity grows as connecting vehicles to different infrastructures expands.



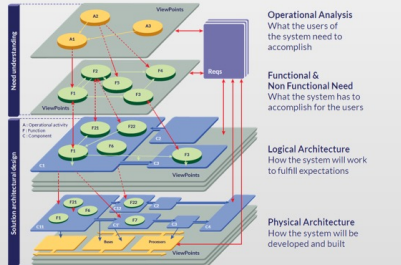
**Figure 7—ADAS to AV is Not an incremental Progression**  
*Courtesy of Siemens*

Connected transportation systems with AVs go beyond the boundary of an individual vehicle. Complexity is caused when connecting vehicles to different infrastructures—starting with service and moving quickly toward travel efficiency. A systems engineering view of these different systems’ boundary diagrams shows that the vehicle is now a sub-system of a connected transportation service.

The embedded computers are located onboard and in the cloud. Yes, IT departments managing cloud installations, both at OEMs and cities, will need to be part of the future transportation services leveraging integrated MBSE. They need a framework that allows dynamic configurations of services using proven and new components. The framework helps organize the development, testing, and packaging of future transportation services.

Siemens has capabilities that enable co-development using the Arcadia method, shown in Figure 8. An individual AV will be a subsystem at the physical layer with features enabled across all layers. The operational analysis will vary depending on the locale. Automakers will need these techniques that originated in defense industries. Siemens combines integrated MBSE and the Arcadia methods providing the framework for AV development and operations.

Tackling this requires Systems Design Thinking, making sure the AVs are robust in all their operational scenarios. This includes those not yet foreseen and requires increased vigilance of the competition. Leading and managing this complexity requires integrated MBSE processes and tools, combining product development, operations, learning, and adaptation into a continuous process. An architectural framework allows different disciplines to develop their systems in parallel, even asynchronously.



**Figure 8 — AVs Need Architectural Frameworks**  
*Courtesy of eclipse.org*


**ALM** manages all kinds of software and architectures, mostly in agile frameworks (e.g., SAFe) executing on digital computers, wherever the are.

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### PLM – CIMdata's Definition


 Digital transformation of the lifecycle—enabled by a product innovation platform

- An **end-to-end strategic business approach**
  - NOT just technologies
  - Consistent set of business solutions
- Collaborative creation, use, management & dissemination of product related **intellectual assets**
  - All product/plant definition information – the virtual product
    - AEC, MCAD, EDA, ALM, SE, requirements, simulations, analytics, portfolio, formulas...
  - All product/plant process definitions – the virtual processes
    - Processes that plan, design, produce, operate, support, decommission, recycle...
- **An innovation platform** that supports the extended enterprise



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### The Evolving ALM Connections

 Comprehensive, cross-domain connected data integrated into process management - ALM

- Supports MBSE enabling multi-domain simulation and analysis
- Provides links to all software – embedded and back office
- Supports integration of data sources (e.g., ERP, MES, CRM, ...) and customers usages
- Uses digital twins during software verification and validation
- Connects measurement data elements allowing traceability to regulations and requirements


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### Evolving to Continuous PLM

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 Comprehensive, cross-domain connected data integrated into process management - PLM

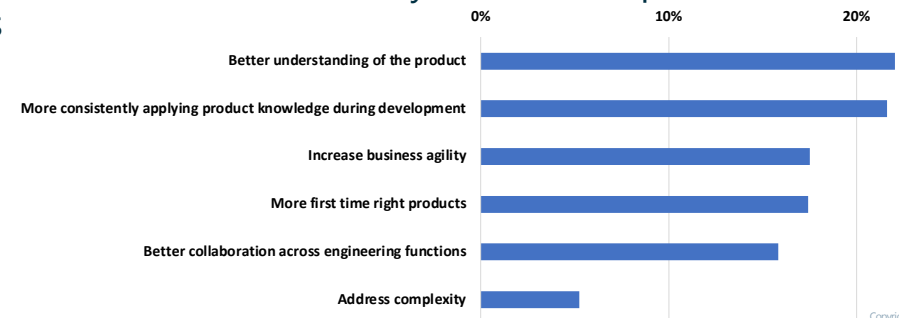
- Provides platform connectivity (PDM <-> ALM <-> Measurements)
  - Managing measurement data gathering & analyses
- Connects people—the more engineering disciplines use the same, accurate product data in the context of their customer usage, the more likely problems will be rapidly solved **once!**
  - Allows proposed systems design and performance behaviors to be quickly made available to all disciplines
  - Provides single **logical** source of systems truth when needed
- Consolidates and organizes data for safety investigations and convoluted regulatory reporting

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### Benefits of Continuous PLM

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- Integrated design tool suites can sustain complex products for tomorrow—enabling connections through a product’s lifecycle, across all aspects driving innovations, such as: propulsion, electrical, electronic, embedded software, and artificial intelligence
- 2021 Research on PLM use in industry identified expected benefits of digital twins



Benefit	Percentage
Better understanding of the product	~22%
More consistently applying product knowledge during development	~21%
Increase business agility	~18%
More first time right products	~17%
Better collaboration across engineering functions	~15%
Address complexity	~8%

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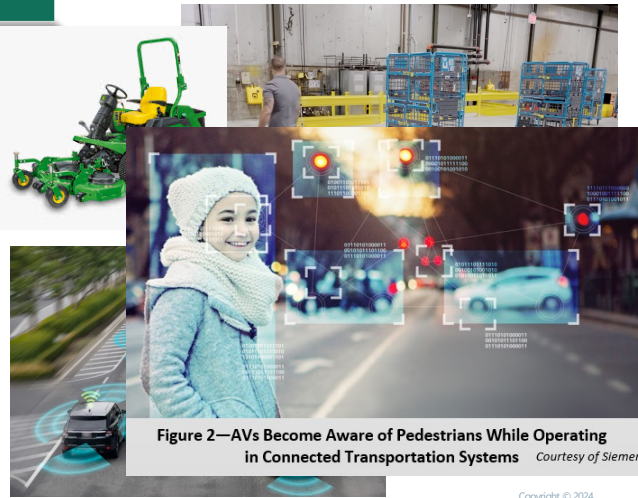
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### Some Adaptation Examples

 Proven levels of complexity, managed well

- John Deere Robot Lawn Mower—retrofitting a previous design
- Amazon warehouse robots working near humans
- Autonomous vehicles—a system of many communicating systems well coordinated



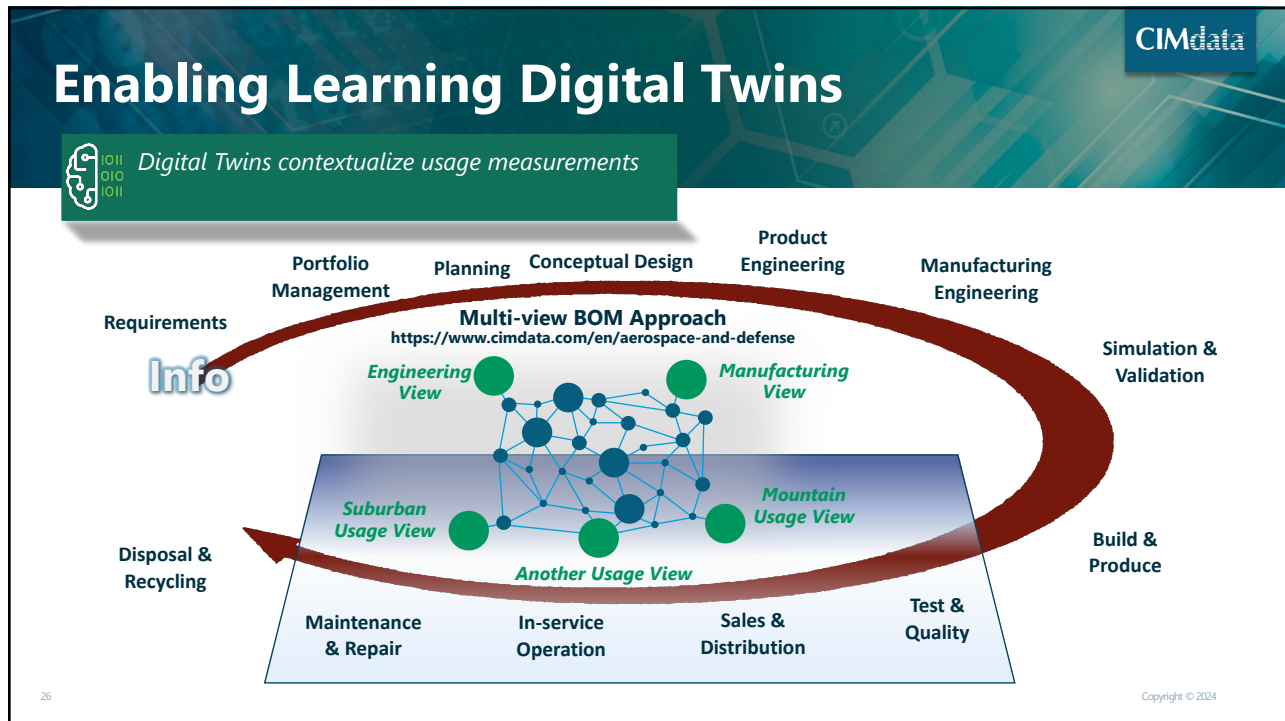
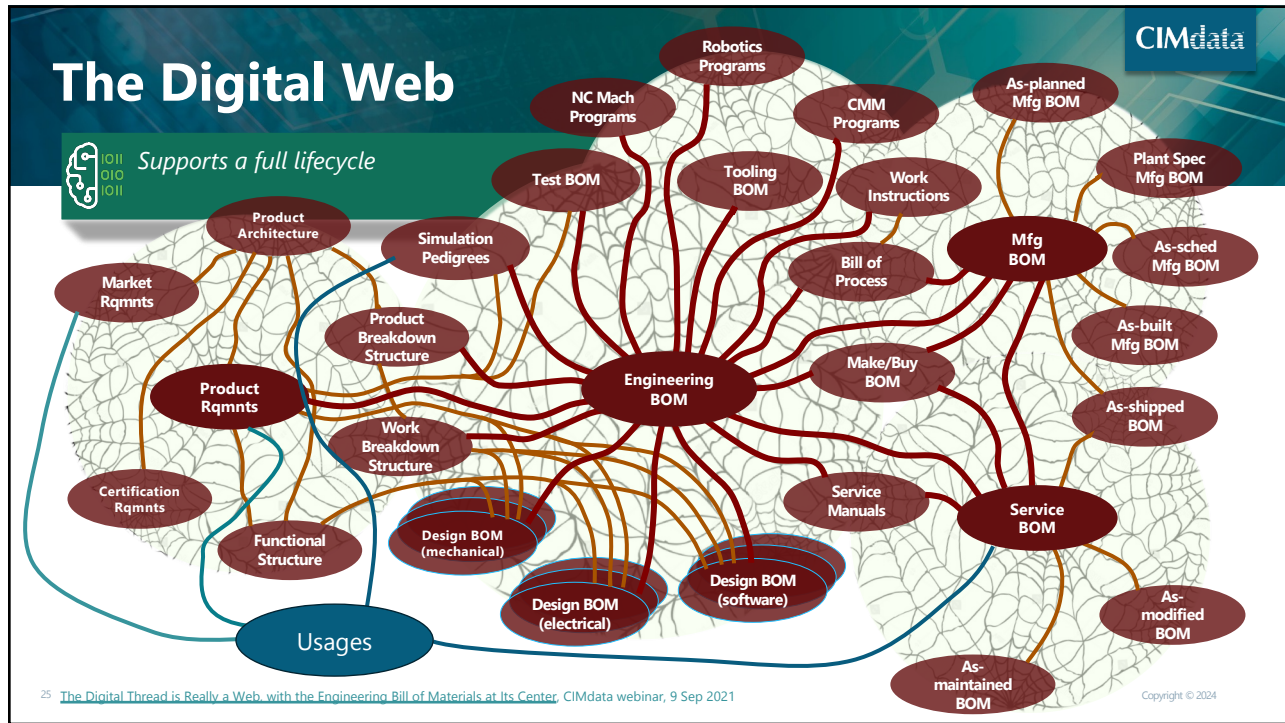
**Figure 2—AVs Become Aware of Pedestrians While Operating in Connected Transportation Systems** *Courtesy of Siemens*

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## Expanding Use of Digital Twins


 *Digital twins & IoT measurements make continuous validation practical*

- An operational digital twin (linked to IoT) can put experience data in context, which in turn makes operational improvement and validation manageable
- Learning Digital Twins improve understanding by:
  - Exploring innovative design options using expansive “destructive” simulations, i.e., exposing weaknesses impacting a product’s safety margins
  - Leading to upgrades with certainty
- You can explore the unknown unknowns lowering risks
- This is the scope of feature validation—now continuous

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## Model-Based Systems Engineering Always

 *New business paradigms require Continuous PLM with accurate, learned digital twins*

- Safest products evolve, leading to new businesses
- Models powered by accurate digital twins broaden understanding of system changes and realizing new revenue opportunities
- Design for Six Sigma is all about controls, signals, and noise
  - Data from IoT (measurements) improves understanding
  - Experience (aka wisdom) becomes pervasive instead of residing with experts
- Product engineering must be a continuous, operational role, enabled by **Continuous PLM**

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**Thank You**

From the whole CIMdata team



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