Emerging Technologies & the Future of PLM Platforms

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Professional background

- Over 30 years of experience in the development of IT solutions for research, engineering, and manufacturing organizations worldwide; has run numerous projects in PLM analysis, selection, implementation & management, synchronous and lean manufacturing consulting & software engineering
  - B.S. in Computer Science (minor in Physics) & M.S.E. in Manufacturing Systems Engineering

Key Takeaways

Emerging Technologies & the Future of PLM Platforms

- Digitalization, IoT/IIoT, systems complexity, and the application of a host of new technologies are profoundly affecting the way organizations do product design, development & sustainment
- How we manage the lifecycle today will not cut it tomorrow; we must continually rethink the product lifecycle and how we enable it
- Today's complexities demand open and modular digital business platforms that define and manage an organization's various model-based constructs
- Future digital platforms must be easily extended and scaled as business requirements evolve and new PLM-enabling technologies become available
- The enablement of Product Innovation Platforms in support of PLM is where today's leading solution providers are taking the market

#1—PLM: Well Beyond PDM

Product data touches all phases of a product's life—the end-to-end connectivity required demands it

Portfolio Management

Planning

Conceptual Design

Product Engineering

Manufacturing Engineering

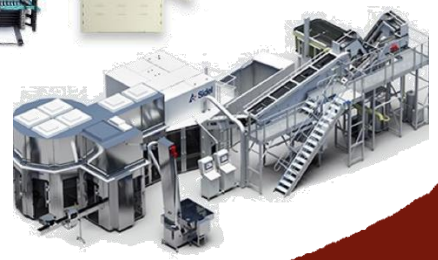
Simulation & Validation

Requirements

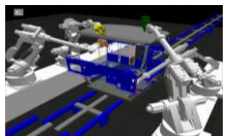
Info

Re-use
Re-purpose
Re-mfg.
Re-cover
Re-cycle
Re-tire

Disposal & Recycling



Build & Produce



Test & Quality

Sales & Distribution

Commissioning & In-service Operation

Maintenance & Repair

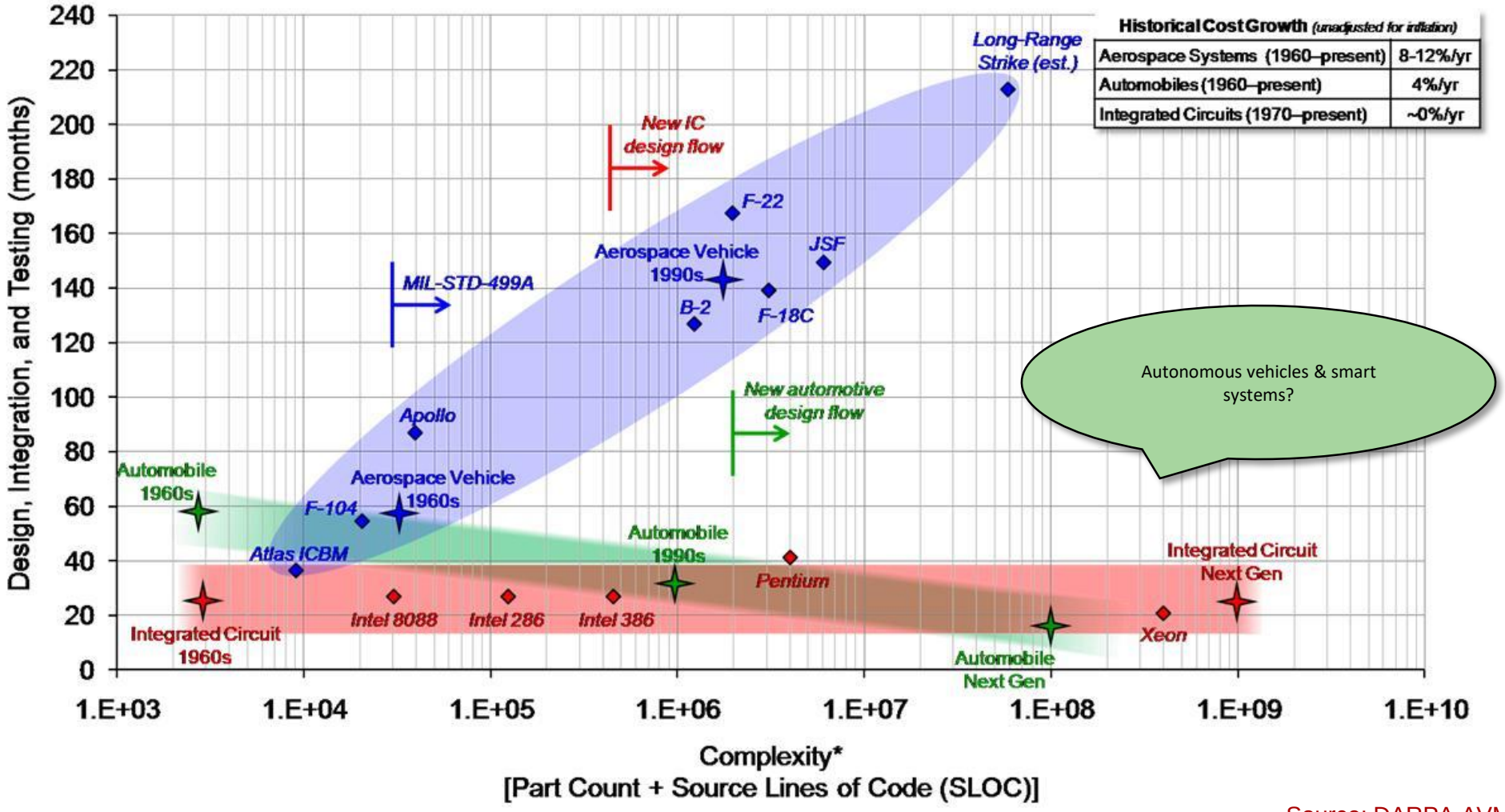
PLM Solutions—Information Management across Media, Process, Time, Geography & Enterprise

#2— Digitalization: Transforming Enterprises

Digitalization requires rethinking the business, products/services, organizations, solutions, and data

#3—Complexity Issue Cuts Across Industries

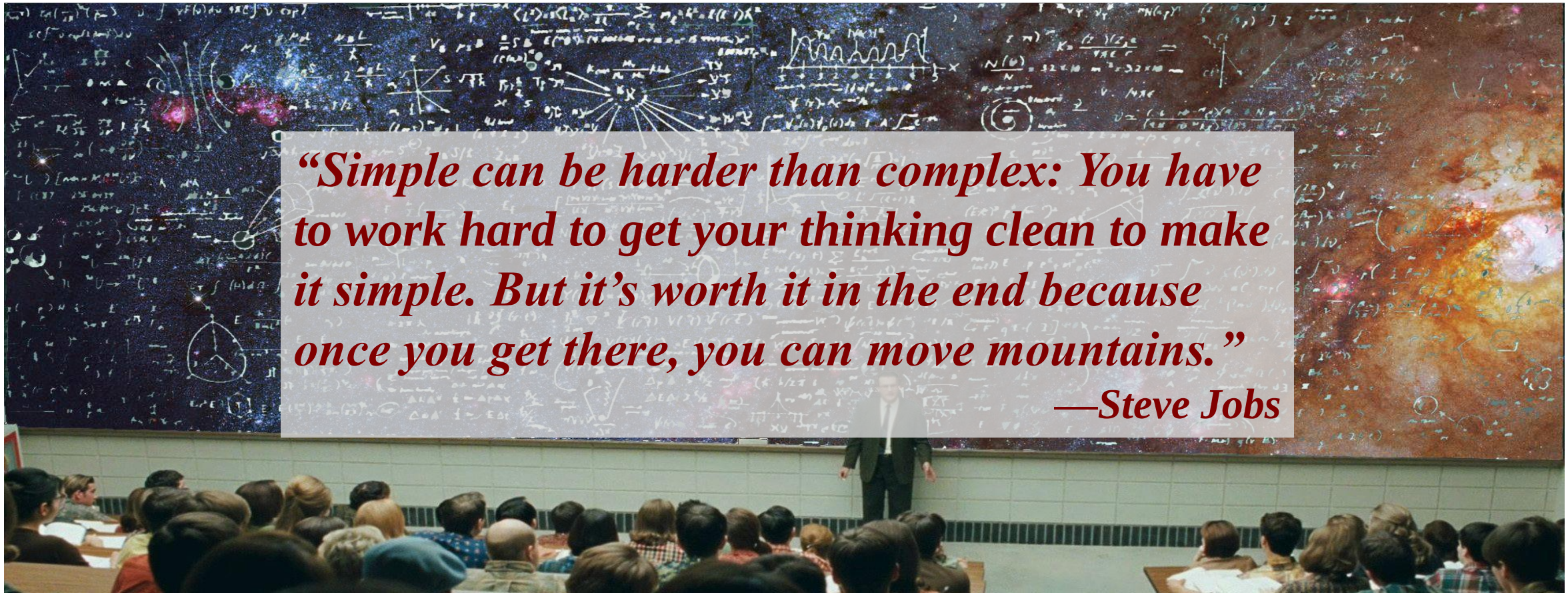
Smart connected products and autonomous vehicles pushing the industry state of the art and best practices



Source: DARPA AVM presentation, 2014.

Today's Reality: Perhaps A Simplification?

Yesterday's solutions aren't workable—a new sustainable & modular approach is necessary



Is this going to get any better tomorrow?

Today's Major Trends & Potential Disruptors

Compounding the problem: the convergence of ideas, technologies, strategies, and associated complexities

Death of Product Development As We Know It

Product development as we have known it is dead and there are many factors as to why

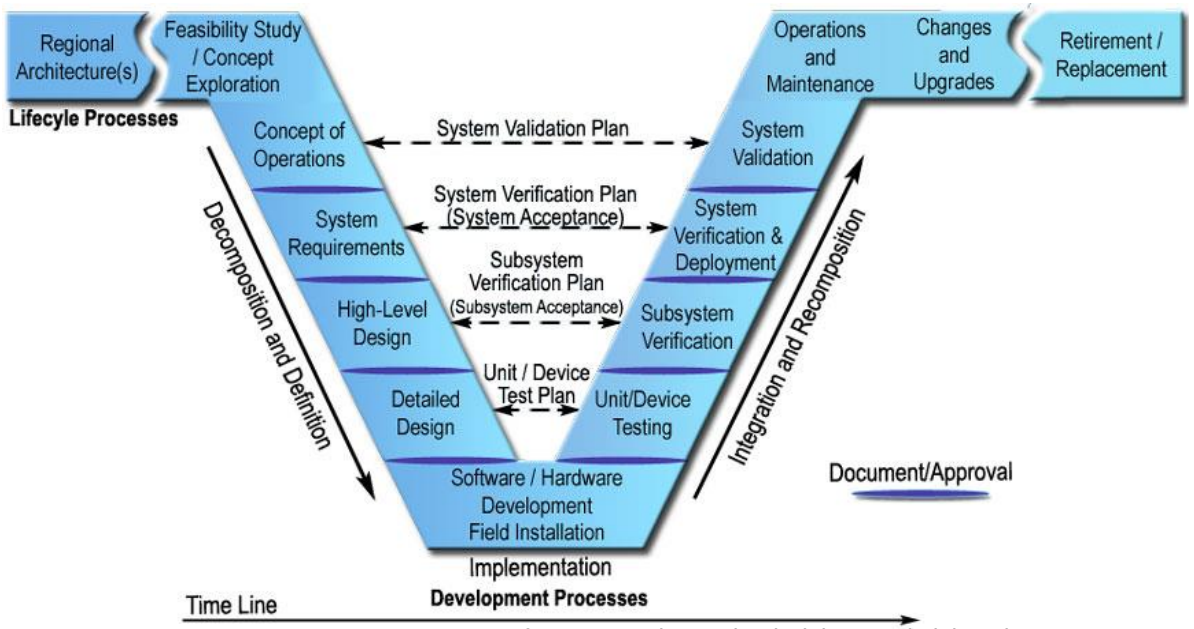
- Closed-door, experts-only approach to defining & engineering products is no longer good enough
- The old ways of working are being flattened by…
  - Unlocking files ▶ moving to data—the document paradigm must die
  - The new social-savvy workforce—expectations are changing
  - Internet-enabled, always-on mobile connectivity—constant collaboration
  - The consumerization of IT (bring your own device, work on cloud, etc.)
  - The "maker" movement, 3D printing, and design-centric thinking
  - Ever-increasing product & process complexity, and relentless global competition

PLM practitioners must expand their scope, rethink strategies & capabilities, and embrace the fundamental shifts in PLM requirements & their implementations!

Moving Toward a Model-Based Future

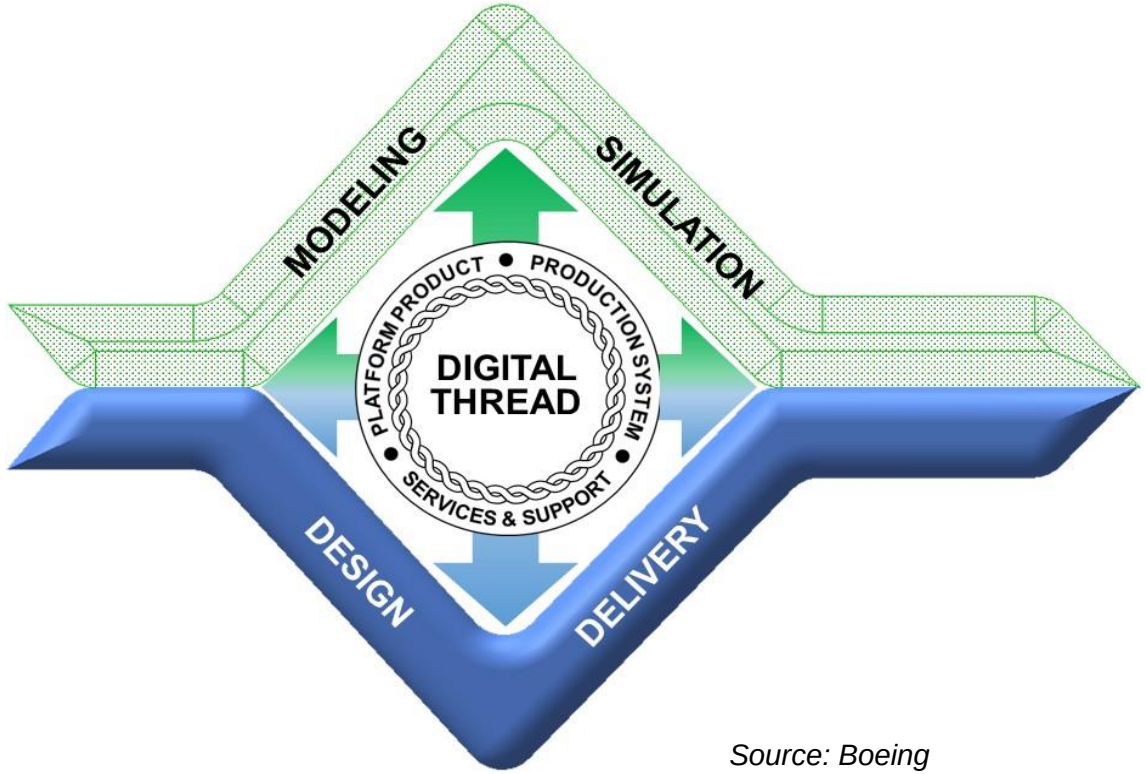
Transitioning to a digital thread of systems of systems

SE Vee



SOURCE: US Department of Transportation Federal Highway Administration
https://ops.fhwa.dot.gov/publications/seitsguide/section3.htm

MBE Diamond



Source: Boeing

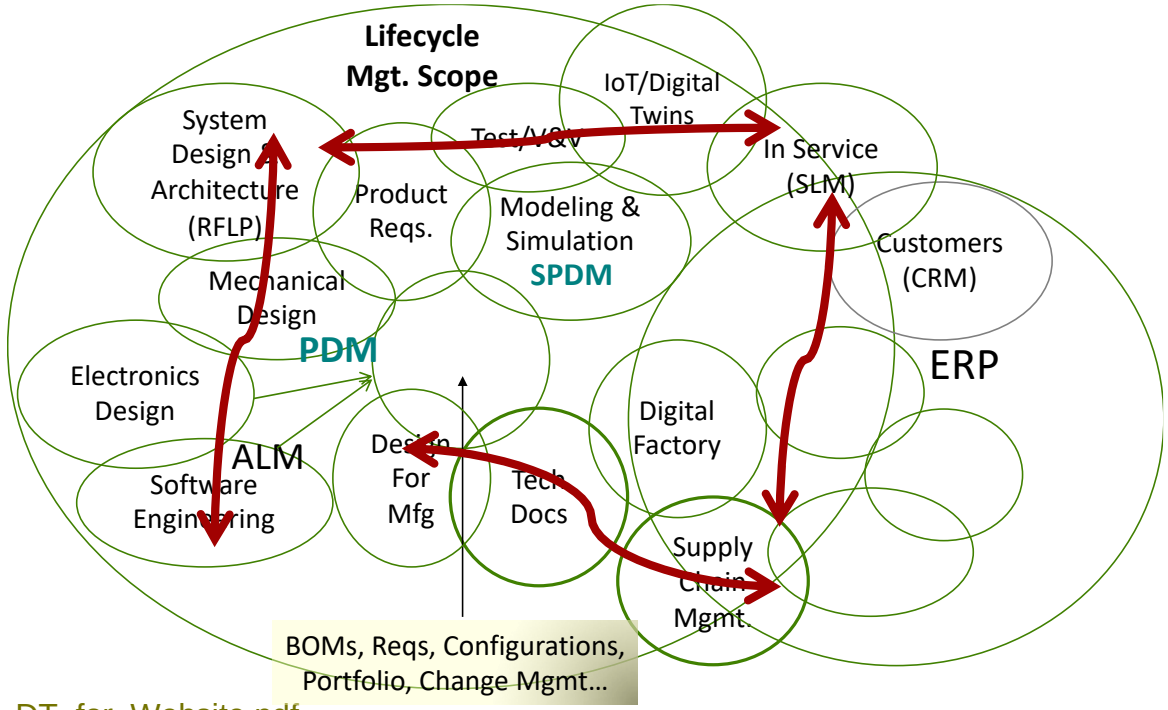
Transitioning from a document-focused mindset to a data-based model mindset that leverages information flow across the lifecycle

Digital Thread

CIMdata's preferred definition

- ***Digital Thread*** refers to the **communication framework** that allows a connected data flow and integrated view of an asset's data (i.e., its Digital Twin) throughout its lifecycle across traditionally siloed functional perspectives

Digital thread is enabled and supported by a robust end-to-end and connected systems model and MBSE processes



Extracted from: https://www.dodmantech.com/ManTechPrograms/Files/AirForce/Cleared_DT_for_Website.pdf
Also see: http://www.manufacturing-operations-management.com/manufacturing/2016/04/what-is-the-digital-thread-and-digital-twin-definition.html

Digital Twin

CIMdata's preferred definition

- ***Digital Twin*** (i.e., digital surrogate): a ***physics-based*** description of the system resulting from the generation, management, and application of data, models, and information from authoritative sources across the system's lifecycle

Digital twin is enabled and supported by a robust end-to-end and connected systems model and MBSE processes

Extracted from: https://www.dodmantech.com/ManTechPrograms/Files/AirForce/Cleared_DT_for_Website.pdf
Also see: http://www.manufacturing-operations-management.com/manufacturing/2016/04/what-is-the-digital-thread-and-digital-twin-definition.html

Augmented/Virtual Reality

VR is a subset of AR (data displayed without the real world context)—all driven by product data

- Virtual reality: artificial, computer-generated simulation or recreation of a real life environment or situation
- Augmented reality: technology that layers computer-generated enhancements atop an existing reality to make it more meaningful through the ability to interact with it
  - Superimpose digital info on the real world

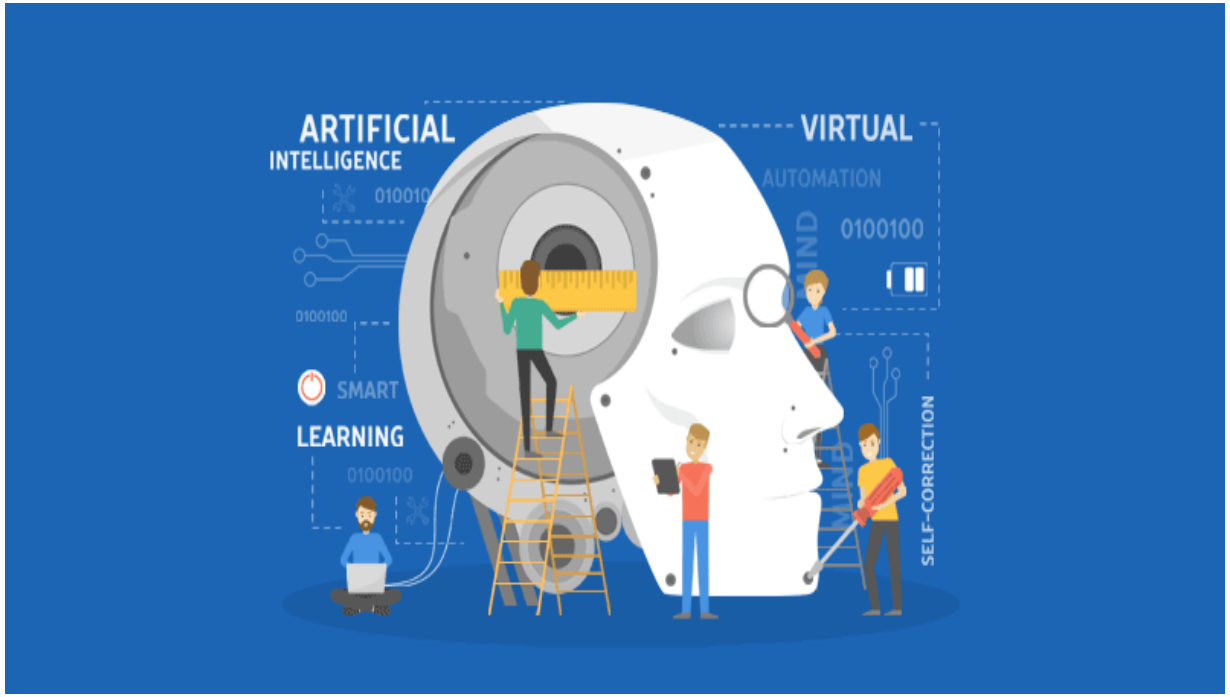
AR in Mercedes-Benz's Rescue Assist app gives first responders an inside look

techcrunch.com/2016/07/27/ar-in-mercedes-benzs-rescue-assist-app-gives-first-responders-an-inside-look/

Artificial Intelligence/Machine Learning

Bringing data & advanced analytics making humans & the processes they deploy, more effective

- Deep learning is a subset of ML, and ML is a subset of AI, which is an umbrella term for any computer program that does something smart
- John McCarthy, AI "the science and engineering of making intelligent machines"
- Predictive and learning, data-driven algorithms for design, operations, and maintenance
- Applications already exist throughout much of the PLM ecosystem



https:// techcrunch.com/2016/07/27/ar-in-mercedes-benzs-rescue-assist-app-gives-first-responders-an-inside-look/

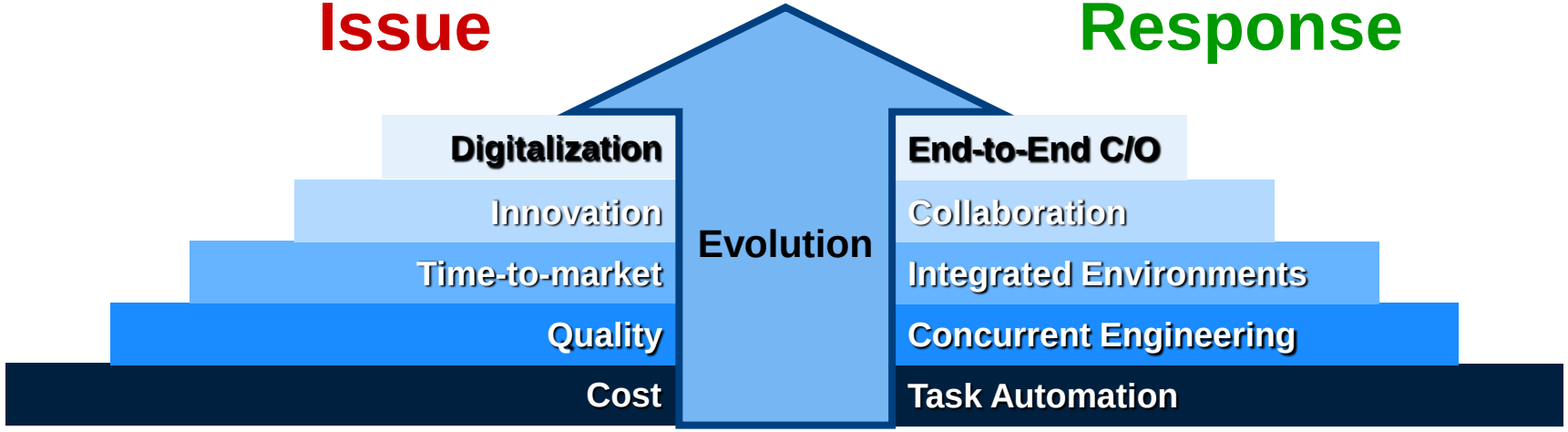
The PLM-Blockchain Connection

Potential PLM-blockchain use cases

- PLM Transactions take place continually
  - Order tracking, payments, account tracking
  - ECNs, Change Orders, and Design Reviews
  - Supplier management
  - Customer communications
  - Field service
- Every participant has their own version of the truth
  - Combined and validated they form a single version of the truth
- Blockchain is non-proprietary and transparent
- The goal is to see an engineering transaction end-to-end and reduce those vulnerabilities

Digitalization: The Next Step in PLM's Evolution

Previous PLM-related initiatives provide the foundation

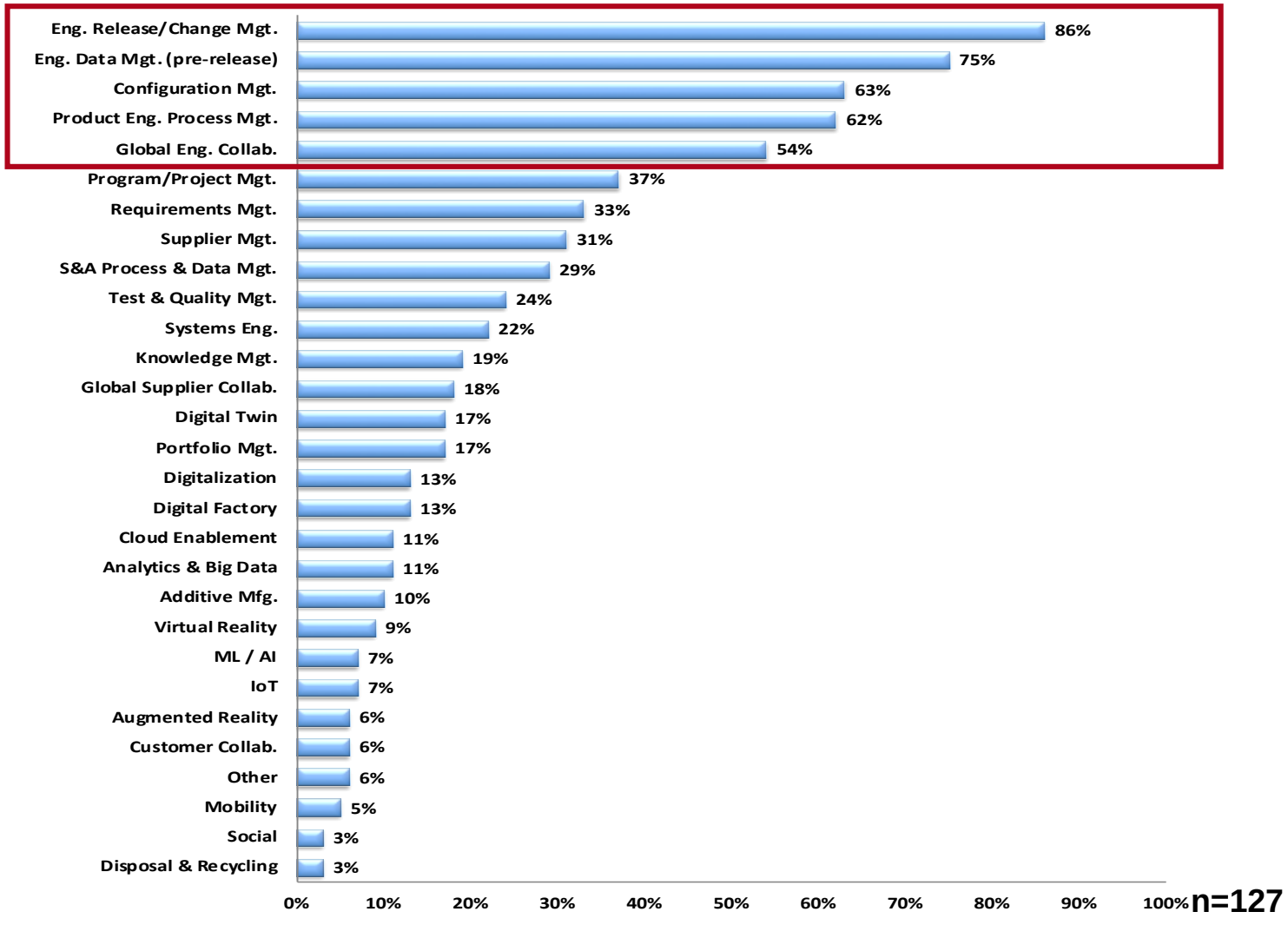


- Digital Transformation is not the starting point, but rather the next step
- Digital Transformation leverages existing and future technologies
- Enabling Digital Transformation requires end-to-end connectivity and lifecycle optimization (C/O); **it requires a robust digital platform**, as well as organizational, cultural, and technological changes

Today's Reality: PLM Implementation Status

From 2019 CIMdata PLM Status & Trends survey—organizations must push beyond the foundational elements

What is the business process scope of your current generation PLM solution?

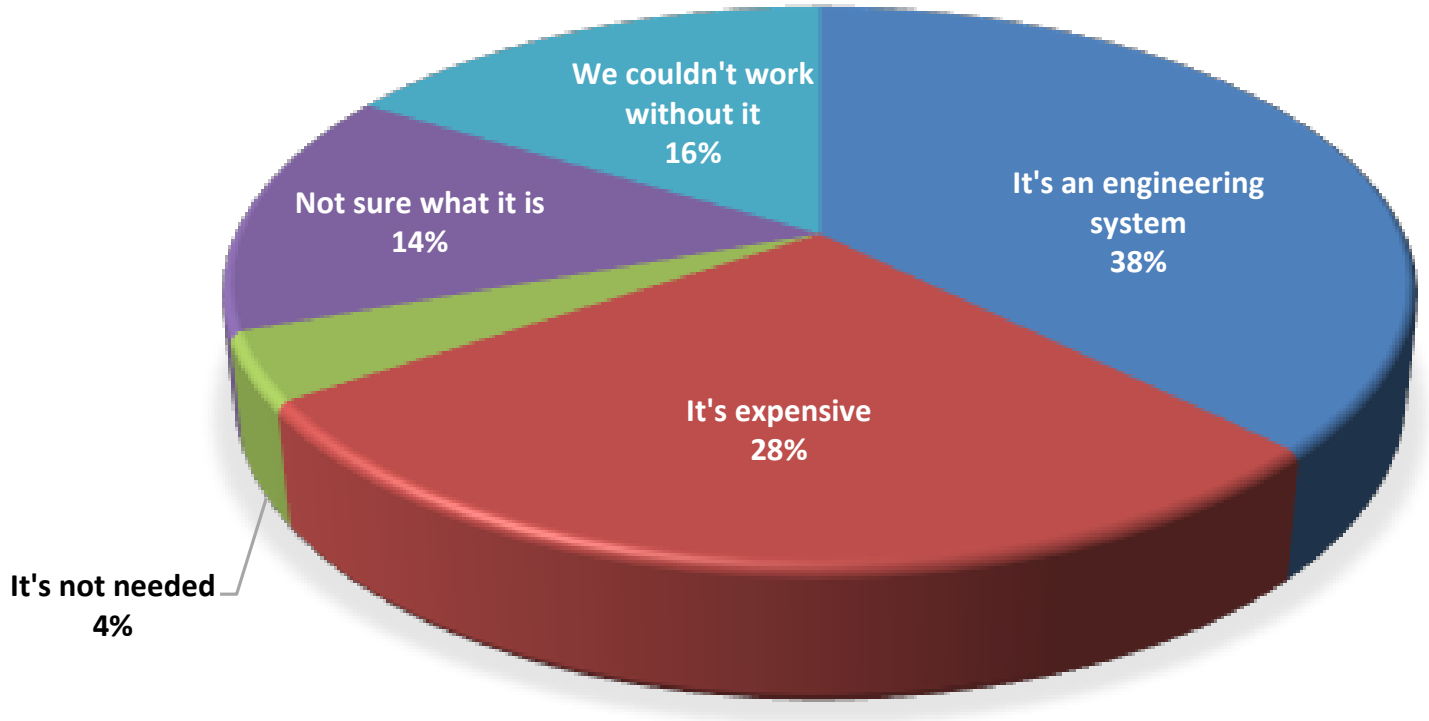


CIMdata comment: Heavily weighted towards the "traditional" PDM aspects of PLM. This is consistent with CIMdata's experience with industrial clients. Others: ERP integration, ALM, installed base management, and customer satisfaction.

PLM's Future

From 2019 CIMdata PLM Status & Trends survey—a significant disconnect exists

What does your company's management think of PLM?



CIMdata comment: A significant value disconnect.

ONLY 16% see it as it should be seen.

We must rethink and reposition PLM!

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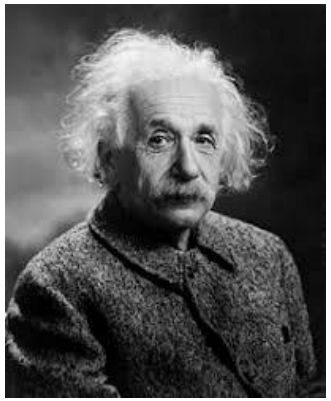
The Definition of INSANITY

So, if we aren't getting it done now…why do we think things will change?



"Doing the same thing over and over again and expecting different results."

—Albert Einstein

Call to Action: We have to think and operate differently!

We Must Build Out Innovation Platforms

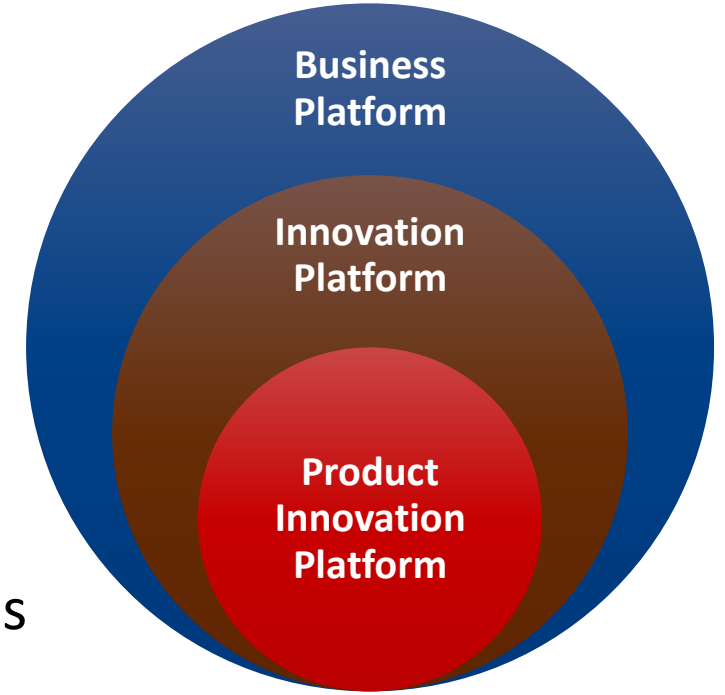
To be successful companies must change the way they enable their end-to-end product lifecycle!

- Innovate or Die
  - A Personal Perspective on the Art of Innovation
  - February 1, 1996, by Dr. Jack V. Matson
- To survive, new innovative processes throughout the lifecycle are required
  - Conceptualization, R&D, quality/compliance, production, and support
  - R&D: collaborative product development, systems engineering, end-to-end requirements management, and many others
  - Production: 3D printing, mass customization, and many others
- The “platformization” of PLM is required
  - Enabling lifecycle support of process & product innovation on an enterprise level

Defining "Platform"—So there is No Confusion

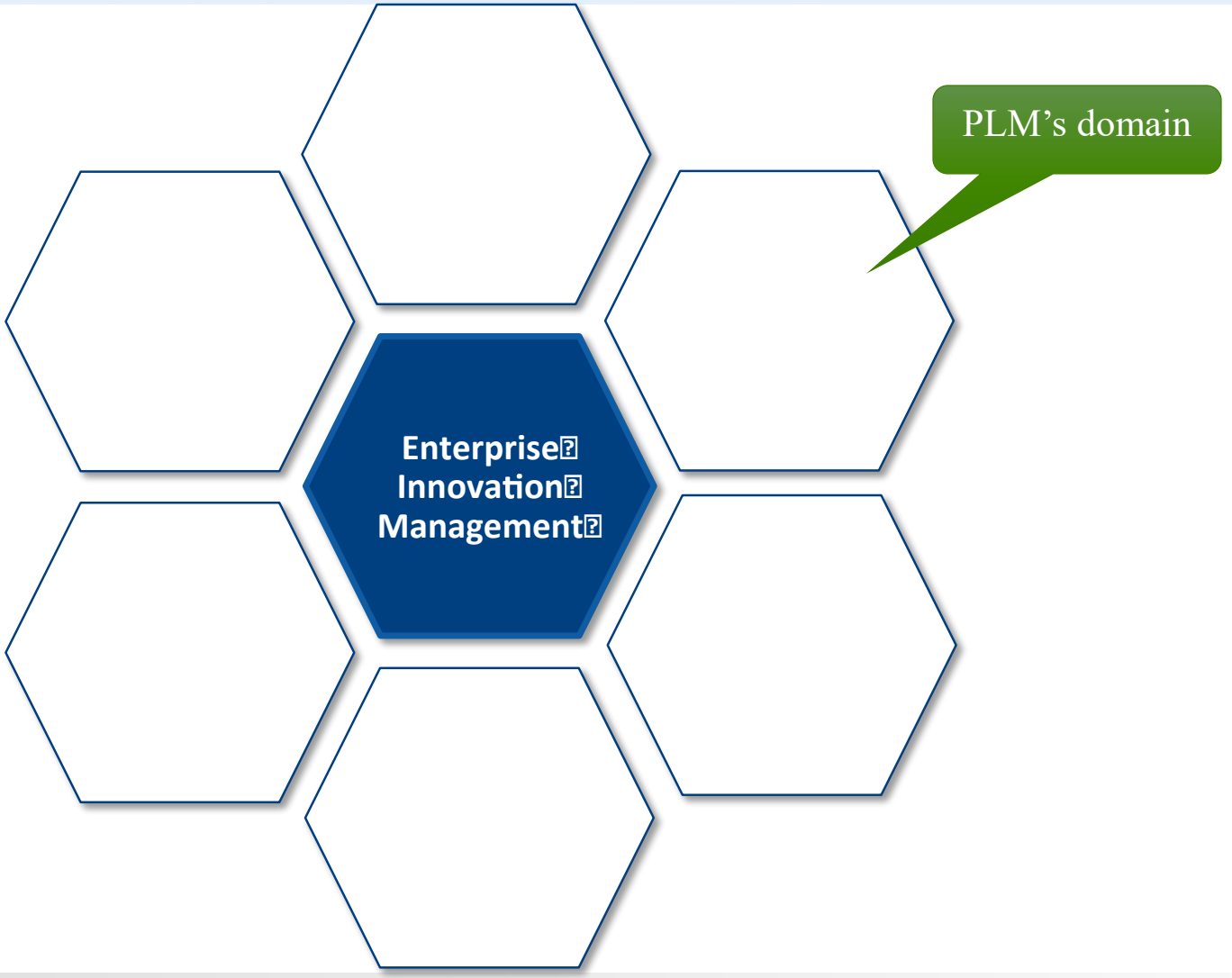
Today's organizations require, no demand, business platforms

- "Business Platform"
  - An architecture that allows a comprehensive set of heterogeneous functional process-enabling capabilities to be packaged and configured to establish and support standardized end-to-end business processes, and related data access
- "Innovation Platform"
  - A business platform designed to enable an enterprise's innovation processes
    - Helping users to create, manage, and re-use data & intellectual property for maximum business impact and effectiveness
- "Product Innovation Platform"
  - An innovation platform that cultivates continuous creativity, yielding improvements in products & processes plus inspiring new and better ones throughout full lifecycles and across generations of products



The Enterprise Business Platform

It all starts with Enterprise Innovation Management, which is at the core



The Product Innovation Platform

CIMdata's Enterprise Product Innovation Platform Model (1 of 2)

A set of evolving Functional Domains orchestrated by an enterprise level "systems of systems" approach

The Product Innovation Platform

CIMdata's Enterprise Product Innovation Platform Model (2 of 2)

- For the domain of product innovation, this extended process enablement must meet the requirements of modern markets and operating models…
  - The innovation process ***must be fully aligned to customer requirements*** rather than simply be a product-centric process driven by R&D
  - The platform ***must integrate to a host of organizational disciplines*** outside of the traditional engineering and program management disciplines
    - These disciplines include compliance (e.g., sustainability and safety), manufacturing, service, marketing…
  - The platform ***should natively support***:
    - Systems modeling and simulation
    - Data analytics and visualization
    - Closed-loop decision making
    - Intellectual property management and protection
    - …

Characteristics of a Successful Platform

Before we move forward…the 5 imperatives for a successful platform

- Success of a platform strategy is determined by 5 strategic imperatives:
  - *Connection*—how easily others can plug into the platform to share & transact
  - *Gravity*—how well the platform attracts participants, both producers and consumers
  - *Flow*—how well the platform fosters the exchange and co-creation of value
  - *Openness*—how easily the platform can be extended and enhanced
  - *End-to-End Lifecycle Support*—its ability to support the complete product lifecycle
- A product innovation platform must…
  - Extend beyond solving enterprise and extended enterprise issues
  - Be adaptable, extensible, enable solutions to unforeseen problems, and scale to a global network of extended enterprises
  - Attract a deep and diverse set of participants and capabilities that can easily be configured to solve product definition lifecycle related problems
  - Provide value to all participants including the platform provider

Bonchek, Mark and Choudary, Sangeet Paul, "Three Elements of a Successful Platform Strategy," *Harvard Business Review*, Jan 31, 2013.

The Platform's Foundational Characteristics

Definition of the foundational characteristics that describe the underlying platform

- The 7 foundational imperatives of the product innovation platform are based on CIMdata's research into PLM solution sustainability
  - The foundational imperatives of the product innovation platform represent core technical capabilities required to manage the definition of a product through life
- A product innovation platform must support…
  - *Sustainability*
  - *Data management* & *find*
  - *Through-life configuration management* & *traceability*
  - *Process* & *knowledge management*
  - *Upgradeability*
  - *Enterprise infrastructure utilization*
  - *Availability* & *stability*

Beyond PLM: the Product Innovation Platform

Where the enablement of product lifecycle management is heading

- When evaluating PLM-enabling platform providers, users should prioritize:
  - Capabilities that enable them to connect to best in class functionality for diverse needs spanning research, design, engineering, sourcing, manufacturing, sales, marketing, and service
  - Platforms that can enable capabilities conducive to innovation, such as business intelligence and analysis functions, IoT enablement, as well as social collaboration

PLM is still what is being done, but now the emphasis is on how to truly enable end-to-end modular and open business platforms, not just a set of integrated tools.

Concluding Thoughts

Emerging Technologies & the Future of PLM Platforms (1 of 2)

- Digitalization, IoT/IIoT, systems complexity, and the application of a host of new technologies are profoundly affecting the way organizations operate
- The development & end-to-end lifecycle management of complex, smart-connected products demand open and modular digital platforms that can be extended and scaled as business requirements evolve
- The era of end-to-end digital business platform enablement is upon us
- Digital business platforms that define and manage an organization's various model-based constructs—end-to-end—are mandatory
- The shift towards enabling robust and resilient digital business platforms requires a fundamental change

Concluding Thoughts

Emerging Technologies & the Future of PLM Platforms (2 of 2)

- The identification & adherence to standards and the openness of interfaces that permit solutions to be adaptable, maintainable, extensible, scalable, compatible, stable, and reliable over multiple upgrade cycles is critical
- Industrial companies wishing to implement digital business platforms now or in the future must continually rethink their PLM solution strategy
- Vision & strategy will play a key role in an organization's ability to successful compete well into the future

What end-to-end business platforms will your company seek to enable & evolve? Are you ready?

*See www.cimdata.com/en/resources/about-plm/a-cimdata-dossier-plm-platformization

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