Value Drivers for Digitalization of the Product Lifecycle
PLM Road Map™ & PDT North America 2024—8 May 2023

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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?
CIMdata   May 8 & 9   eurostep

Value Drivers for Digitalization of the Product Lifecycle
PLM Road Map™ & PDT North America 2024

8 May 2024—Washington, D.C., USA

Peter Bilello, President & CEO, p.bilello@CIMdata.com
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Strategic management consulting for competitive advantage in global markets

The leading independent authority on PLM and its digital transformation. We provide research, education, and strategic consulting to clients around the world.

OUR MISSION:
Maximizing clients' ability to design, acquire, deliver, and support innovative products and services.

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CIMdata's Services

Strategic advice & counsel through a comprehensive & integrated set of services

RESEARCH — *Foresight*

EDUCATION — *Leadership*

CONSULTING — *Success • Invest • Transformation*

• Research & analysis	• Industry conferences	• Strategic guidance
• Technology evaluations	• Seminars & webinars	• Aligning solutions with needs
• Market-specific insights	• Certificate programs	• Program management advisement
• Industry news & trends	• Best practices	• Market positioning

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Peter A. Bilello, President & CEO

Professional background

- More than 36 years of experience in the development of IT solutions for research, engineering, and manufacturing organizations worldwide

- Led numerous projects in PLM analysis, selection, implementation & management, synchronous and lean manufacturing consulting & software engineering, as well as general data management & governance strategy development and support

- Authored many papers & research reports on PLM and related topics, as well as numerous articles, commentaries, and perspectives that have appeared in publications throughout the NA, EMEA & Asia

- Holds a B.S. in Computer Science (minor in Physics) & M.S.E. in Manufacturing Systems Engineering

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Key Takeaways

Value Drivers for Digitalization of the Product Lifecycle

- As PLM professionals, we must continually look to enhance the value resulting from the digitalization of the product lifecycle
  - This requires keeping an eye on the evolving trends & enablers of successful digital transformation
  - CIMdata's Critical Dozen represents a comprehensive set of trends & enablers
- Maximum value will only result from a holistic, end-to-end approach
- Don't forget, organizational change management plays a critical role in maximizing adoption and value delivery
- Evolving customer demands & market opportunities are motivating investment in digitalization of the product lifecycle
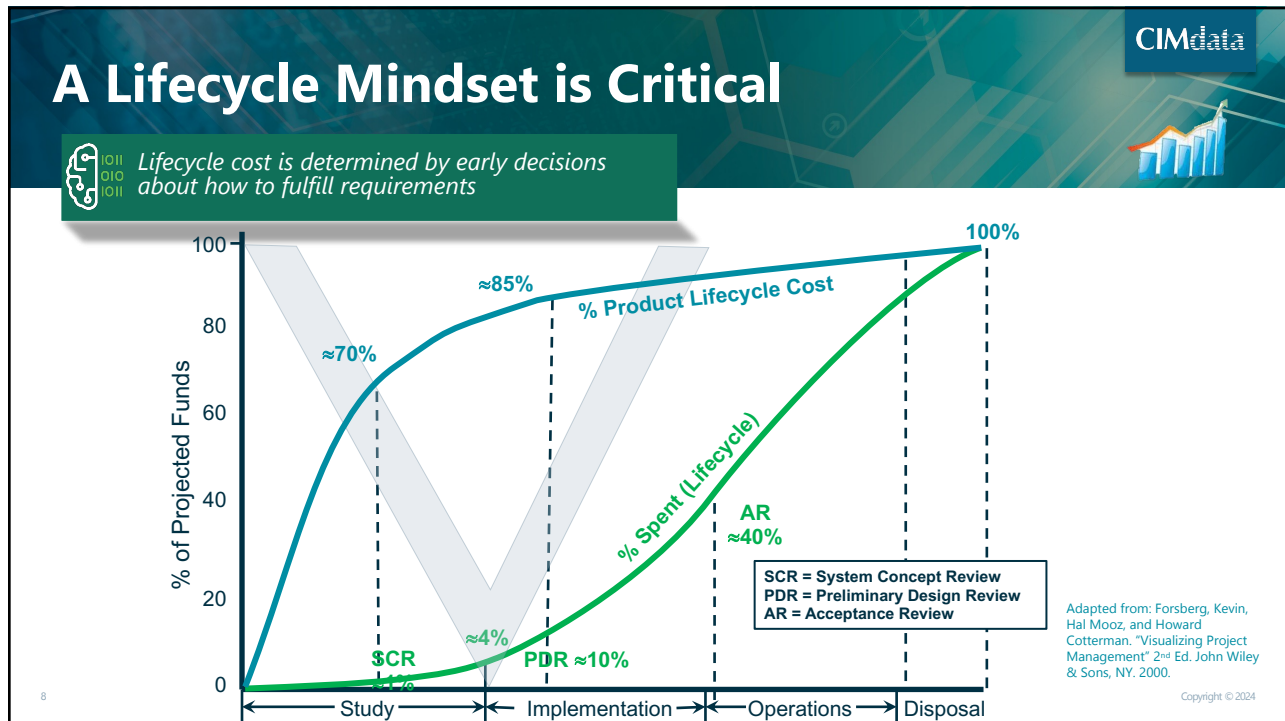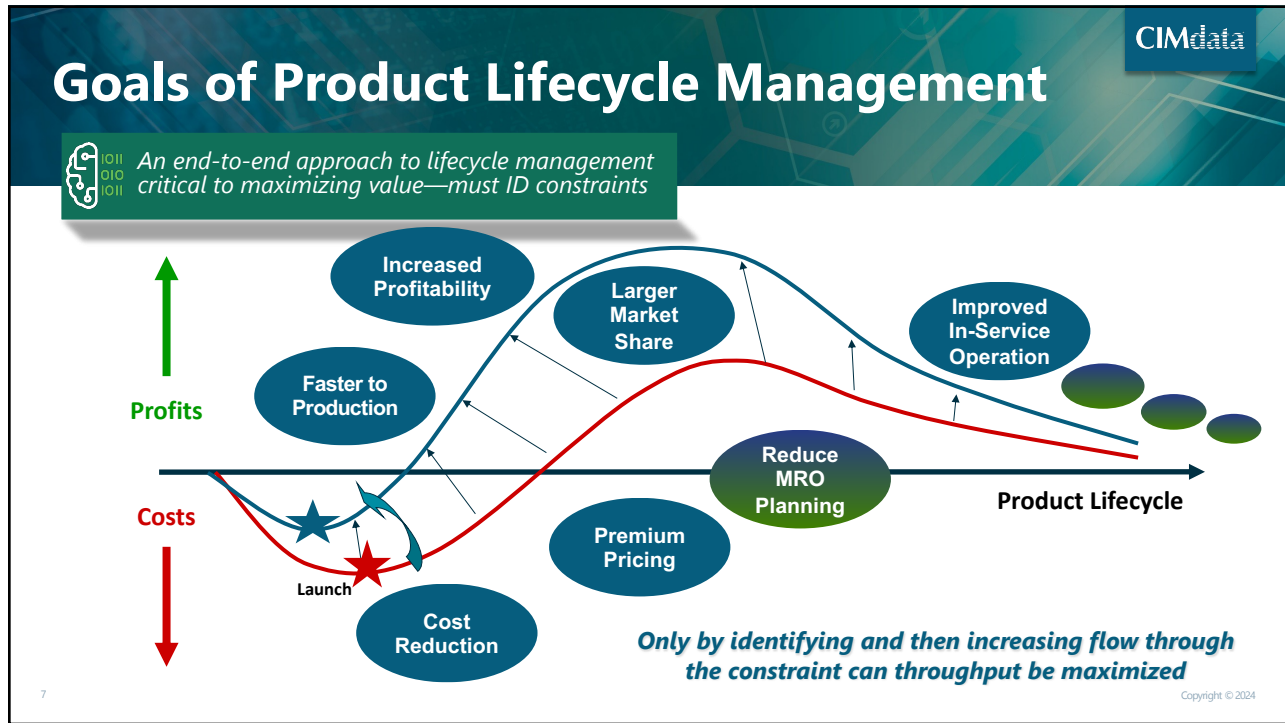
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Agenda

- A Lifecycle Mindset is Critical to Maximize Value
- CIMdata's Critical Dozen: An Update
- Organizational Change Management's Role
- Today's Main Motivating Factors
- Concluding Remarks

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Goals of Product Lifecycle Management

An end-to-end approach to lifecycle management critical to maximizing value—must ID constraints

Increased Profitability

Larger Market Share

Improved In-Service Operation

Faster to Production

Profits

Costs

Launch

Reduce MRO Planning

Product Lifecycle

Premium Pricing

Cost Reduction

Only by identifying and then increasing flow through the constraint can throughput be maximized

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A Lifecycle Mindset is Critical

Lifecycle cost is determined by early decisions about how to fulfill requirements

≈85%   % Product Lifecycle Cost

≈70%

100%

% of Projected Funds

% Spent (Lifecycle)

AR ≈40%

SCR = System Concept Review
PDR = Preliminary Design Review
AR = Acceptance Review

SCR

≈4%

PDR ≈10%

Adapted from: Forsberg, Kevin, Hal Mooz, and Howard Cotterman. "Visualizing Project Management" 2nd Ed. John Wiley & Sons, NY. 2000.

Study | Implementation | Operations | Disposal

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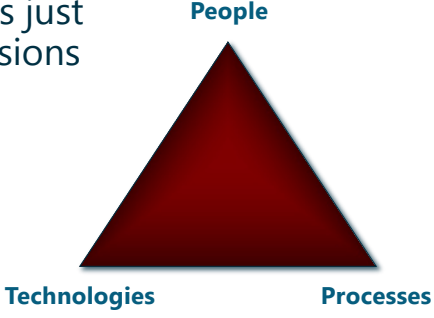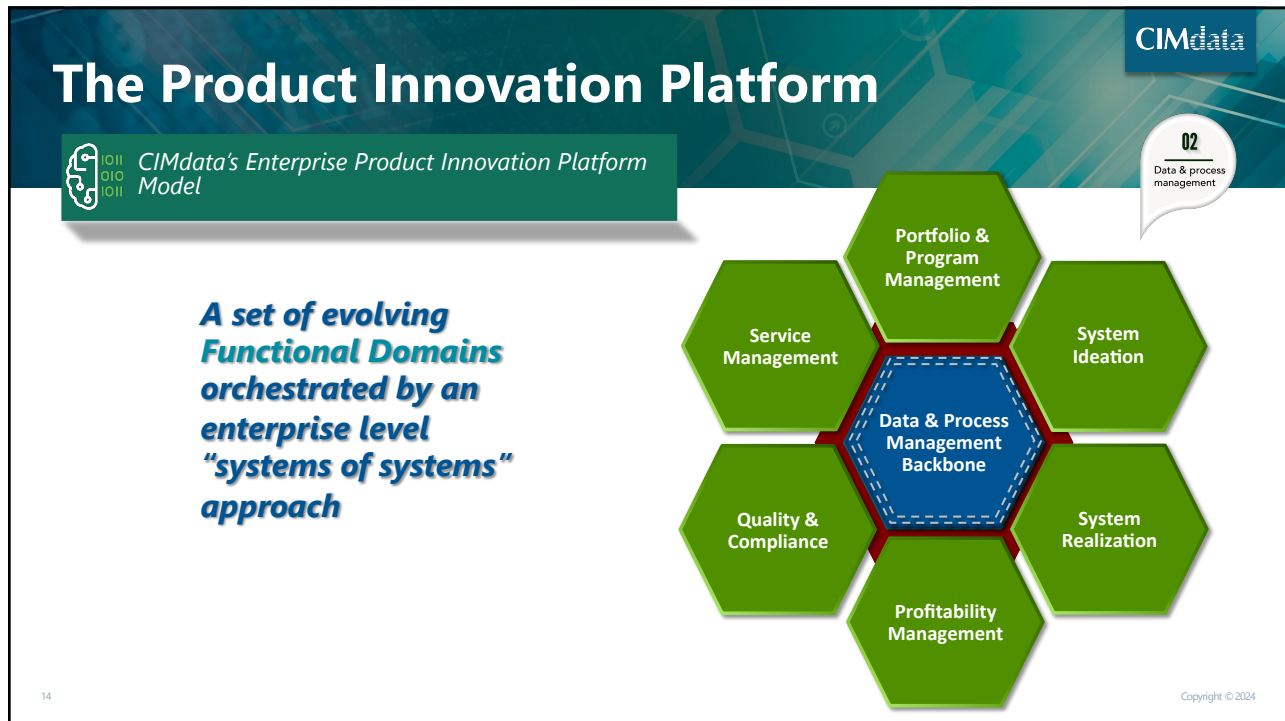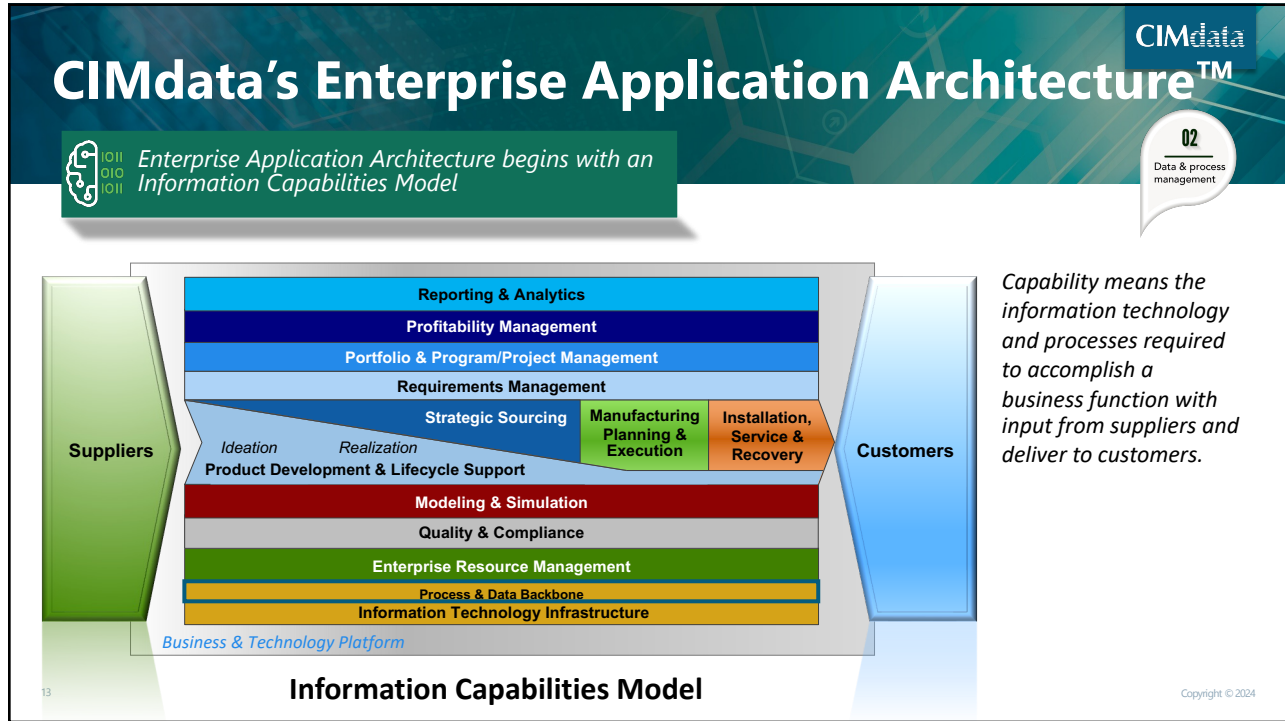# Value Drivers for Digitalization of the Product Lifecycle
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Ensure All Data is Under CM Control

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CMPIC definition of Configuration Management

03 Configuration management

The Configuration

Documents Data

Changes

Business Decisions

CMTools

Configuration Management is a set of inter-related processes, management techniques, and CM supporting tools that assures:

(1) Our products, facilities, IT Systems, services, processes, etc., are **what they are intended to be**

(2) That **changes** to our products, facilities, IT systems, services, processes, etc. are **properly evaluated, authorized and implemented**

(3) That **all information** necessary to define and manage our configurations and data is kept:
  (a) **current and accurate**
  (b) is **structured** for all users needs and
  (c) is readily **available** to all who need to know

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When Does CM Begin?

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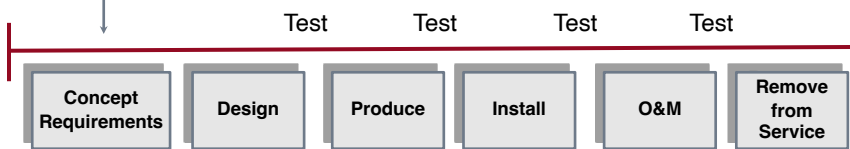
All parts required for CM activities

03 Configuration management

Configuration Management Begins Here...

…and continues throughout the product lifecycle.

Test   Test   Test   Test

| Concept Requirements | Design | Produce | Install | O&M | Remove from Service |

Various organizations may be responsible for change management as the product moves through its lifecycle.

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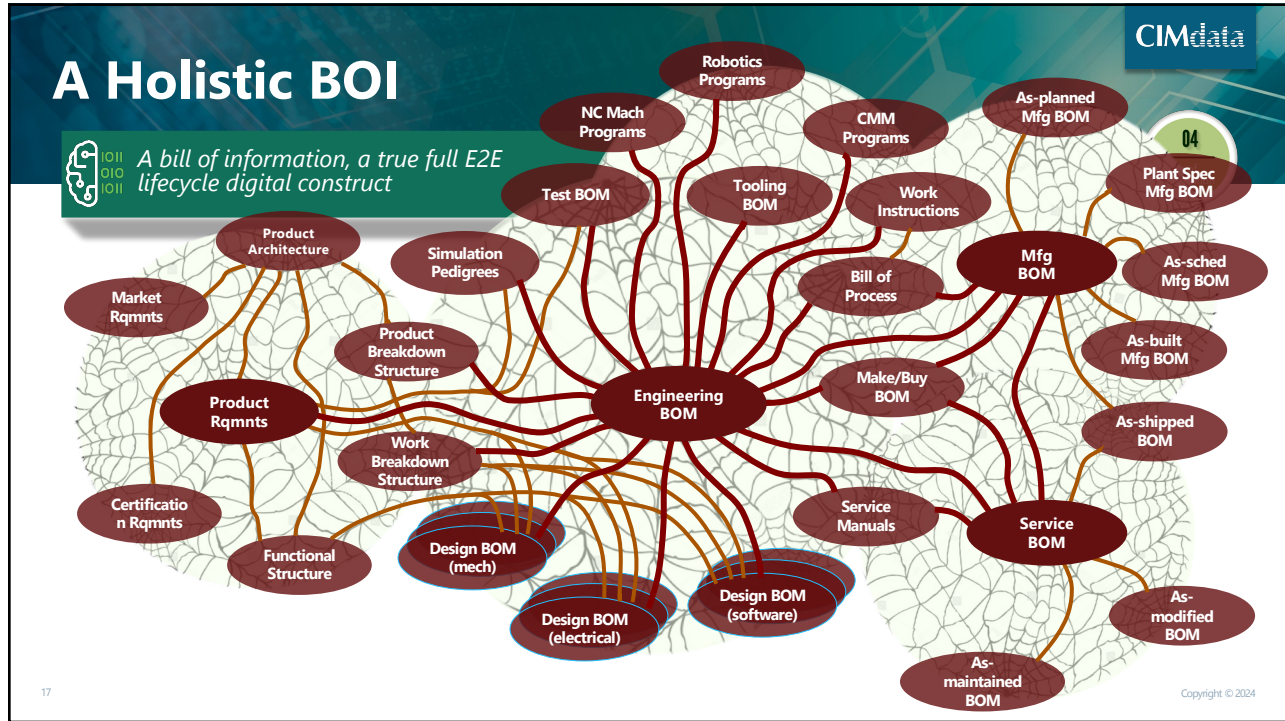## *PLM Road Map™ & PDT North America 2024—8 May 2023*

Model-Based Structures

Many types of model-based structures supporting disciplines throughout the product lifecycle

- **Model-Based Enterprise (MBE)** – "a vision to transform an enterprise's engineering, manufacturing, and aftermarket services through product data reuse and derived context, rather than interpreting inputs and recreating the models and drawings."

- **Model-Based Systems Engineering (MBSE)** – "the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

- **Model-Based Engineering (MBE)** – Integrated use of models to define the system technical baseline across the full life cycle, across all disciplines, across all program members

- **Model-Based Definition (MBD)** – The practice of using 3D models (i.e., solid models, 3D PMI and associated metadata) within 3D CAD software to define (provide specifications for) individual components and product assemblies.

- **Model-Based Design (MBD)** – "A mathematical and visual method of addressing problems associated with designing complex control, signal processing and communication systems as applied in the design of embedded software."

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CIMdata's Critical Dozen

01 End-to-end connectivity
02 Data & process management
03 Configuration management
04 Bills of information
05 Model-based structures
06 Digital thread/twin
07 IoT & PLM
08 Changing views of "product"
09 Big data & analytics

CIMdata's Critical Dozen
The Top 12 Trends and Enablers of Digital Transformation

12 familiar, evolving trends & key enablers of digital transformation that you cannot, or should not, live without.

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Digital Thread

CIMdata's preferred definition

06 Digital thread/twin

- A ***communication framework*** that allows a connected data flow & 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

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Digital Thread & Lifecycle Integration

Integration across many applications, each often focused on a part of the lifecycle

06 Digital thread/twin

Portfolio Management
Planning
Conceptual Design
Product Engineering
Manufacturing Engineering
Requirements
Simulation & Validation

ALM MCAD EDA Digital Manufacturing

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

IoT / IIoT
Simulation & Analysis

ERP / MES / MOM

EAM / MRO / SLM

Disposal & Recycling

Build & Produce

Maintenance & Repair
In-service Operation
Sales & Distribution
Test & Quality

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Digital Twin

A digital representation of products and/or services at any point throughout the lifecycle

06 Digital thread/twin

- A ***virtual representation*** (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to/from the associated physical asset(s).

Digital Twin of the Product
Digital Twin of Production
Digital Twin of Service

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

22 *Adapted from input from ASSESS (see www.assessinitiative.com)

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The Ultimate Vision

Many credit Vickers as the first person to use the phrase—"digital twin"

06
Digital thread/twin

"The ultimate vision for the digital twin is to create, test and build our equipment in a virtual environment. Only when we get it to where it performs to our requirements do we physically manufacture it.

We then want that physical build to tie back to its digital twin through sensors so that the digital twin contains all the information that we could have by inspecting the physical build."

John Vickers, Manager, NASA's National Center for Advanced Manufacturing

23   https://www.forbes.com/sites/bernardmarr/2017/03/06/what-is-digital-twin-technology-and-why-is-it-so-important/?sh=783735a22e2a

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IoT & PLM

Successful IoT enabled strategies require a strong PLM foundation

07
IoT & PLM

- A truly successful IoT strategy requires far more than collecting and analyzing data, and taking an action on it
- Products can benefit from it all-through their lifecycle
  - The why of IoT seems clear and solid, but the what and how aren't…
  - Research shows that success typically requires the ability to work cross-functionally…to drive process transformation not just at the front end, such as in the field, but all the way across the back office that support the front in scalable ways (Genpact Research Institute, 2016)
- PLM acts as the cross-functional process and data backbone, a necessary requirement for success in IoT-enabled strategies

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IoT & Digital Twin: Enabling "PaaS"

KAESER KOMPRESSOREN "Smart Air Strategy" – Compressed Air 4.0

08 Changing views of "product"

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Big Data & Analytics

Another critical element—enterprises must be able to mine it to gain actionable insight

09 Big data & analytics

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- PLM essentially helps close the loop for Big Data from IoT, IIoT, and other sources, providing an essential link to digital twins
- Big Data is:
  - Growing at an unprecedented pace
  - Content management, data lakes, data marts, specialized file systems, data services and metadata will be the new "logical" data warehouse
- Most data collected is not used at all or poorly
- To create new value, organizations must treat data as an asset
- Data governance is critical—and you provide that

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10 Augmented intelligence

CIMdata's Critical Dozen
The Top 12 Trends and Enablers of Digital Transformation

12 familiar, evolving trends & key enablers of digital transformation that you cannot, or should not, live without.

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Augmented Intelligence

This is where we are at

10 Augmented intelligence

- *Augmented Intelligence* or intelligence augmentation (IA) is not about replacing human intelligence but rather about amplifying or augmenting it by enabling humans to make use of the large volume of data we're generating by combining human and machine intelligence

"Over the next decade, AI won't replace managers, but managers who use AI will replace those who don't."

Erik Brynjolfsson and Andrew McAfee, HBR (2017)

Artificial

Augmented

Human

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Some Definitions

What is artificial intelligence, machine learning, and deep learning?

AI | ML | DL

- **Artificial Intelligence** (AI) is the ability of a machine to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages

- **Machine Learning** (ML) is making predictions and recommendations by algorithmically detecting patterns in available data and information, and improving the algorithms over time with new data and information, without explicit programmed instructions

- **Deep Learning** (DL) is a type of machine learning in which a cascade of interconnected layers of processing units extract increasingly complex features from the output of previous layers, leading to a hierarchy of concepts that can help make determinations about new data

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Generative AI

The AI revolution is upon us

10
Augmented intelligence

- Deep-learning models that can generate high-quality text, images, and other content based on the data they were trained on

- AI has gone through many cycles of hype, but even to skeptics, the release of ChatGPT seems to mark a turning point

- OpenAI's chatbot, powered by its latest **large language model** (LLM), can write poems, tell jokes, and churn out essays that look like a human created them

- Prompt ChatGPT with a few words, and out comes love poems in the form of Yelp reviews, or song lyrics in the style of Nick Cave

30 Source: https://research.ibm.com/blog/what-is-generative-AI

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RAG's Importance

Setting the appropriate context using Retrieval-Augmented Generation (RAG)

10
Augmented intelligence

- When a LLM doesn't have enough information or has no contextual knowledge of a topic, it is more likely to hallucinate, and provide inaccurate or false responses
- AI researchers and developers have been exploring numerous RAG technologies, including:
  - Text chunking, query expansion, hybrid search, knowledge graph, reranking, and others
- An LLM needs the right data so that it doesn't have to make things up, and you need the best search technology to find the right data

31   Source: https://cloud.google.com/blog/products/ai-machine-learning/rags-powered-by-google-search-technology-part-1   Copyright © 2024

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How RAG Impacts Enterprise Search

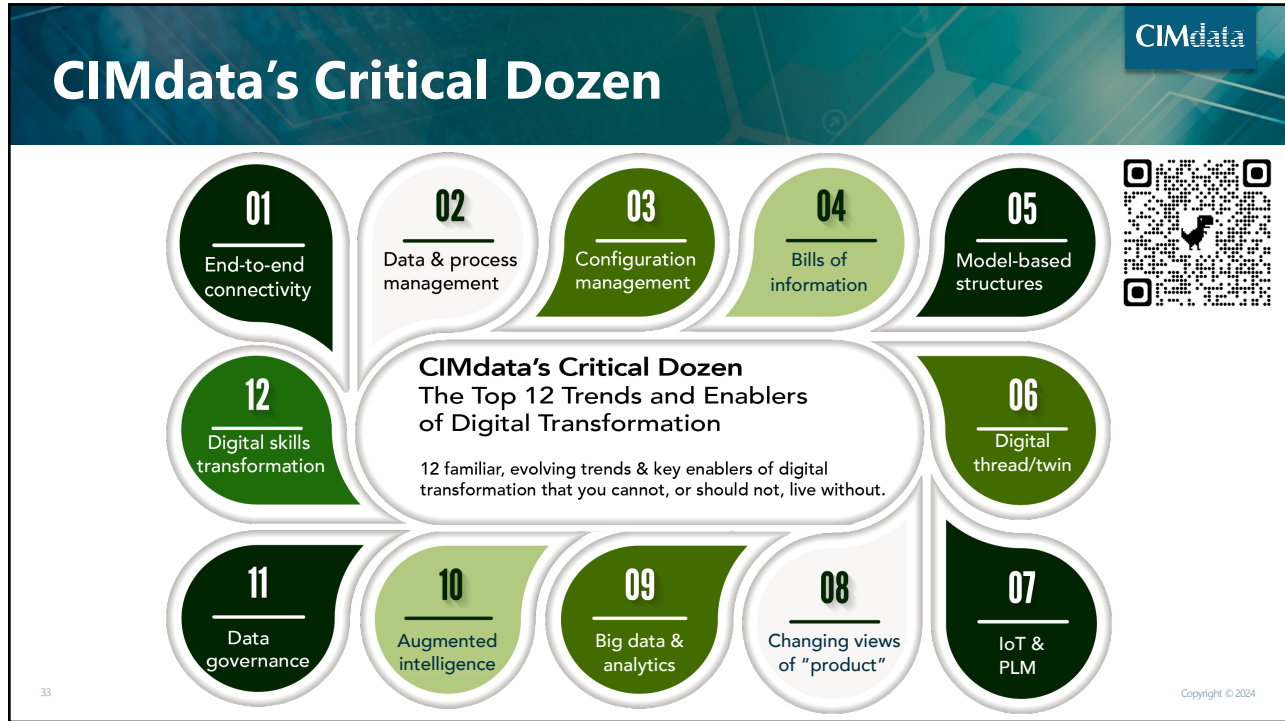*Maximizing ROI: How RAG Impacts Enterprise Search Strategies—from Sinequa*

10
Augmented intelligence

- RAG is leading the way in revolutionizing enterprise search
- RAG's combination of information retrieval & NL generation not only improves search relevance and precision but also...
  - It optimizes information resources, empowers decision-making, enhances business intelligence, and yields a significant ROI
- As organizations continue to use RAG, they will pave the way for a future where information retrieval goes beyond traditional boundaries, driving businesses towards greater efficiency & innovation

32   Source: https://www.sinequa.com/resources/blog/maximizing-roi-how-retrieval-augmented-generation-rag-impacts-enterprise-search-strategies/   Copyright © 2024

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Data Governance

CIMdata's definition

11 Data governance

The definition, implementation, and management of policies, procedures, structures, roles, and responsibilities that outline and enforce rules of engagement, decision rights & accountabilities for the effective management of information assets.

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Digital Skills Transformation

Assessing, defining & enabling the workforce of the future—you can't transform without it

12
Digital skills transformation

- A well-defined skills program is **multi-faceted**, and should include organizational, process, technology, content & delivery considerations
- An education & training framework, and related implementation & support structures **cover different organizational processes & supporting platforms**
- **Different experience and skill levels need to be incorporated** into one repeatable standard, applicable throughout an enterprise
- With the appropriate structure in place, an enterprise is in a better position to **proactively handle growth**, **reduce employee turnover**, and **successfully deal with** the **changes** encountered

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Agenda

- A Lifecycle Mindset is Critical to Maximize Value
- CIMdata's Critical Dozen: An Update
- Organizational Change Management's Role
- Today's Main Motivating Factors
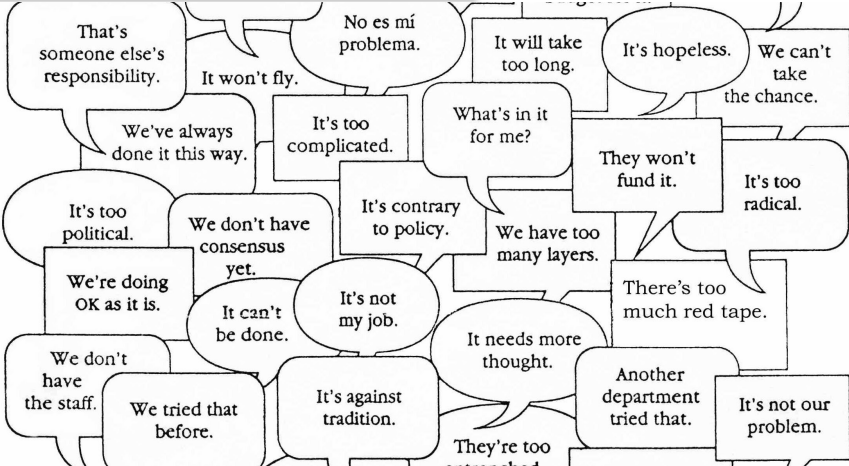- Concluding Remarks

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Organizational Change Management

Responsible party: program manager & project managers—main elements

- **Plan development**—define and manage the overall organizational change management plan
- **Facilitation**—create the materials and execute the plan
- **Communication**—publish program related information to the general user/corporate community
- **Education**—define & deliver seminars/presentations that educate
- **Sales & Marketing**—work with users and corporate management to sell & market the program

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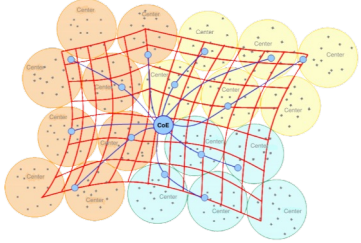
Organizational Change Management

Executing the organizational change management plan

- Maintain a detailed Organizational Change plan
  - You need to sell the solution & its value
- Communicate with end users early & often
  - Permanent agenda item on monthly presentations
  - Regular educational events
- Do road-shows in house to demonstrate functionality to all
- Obtain additional resources to help with organizational change efforts:
  - Communication Specialist

Acceptance by the organization is not possible without this communication & marketing effort!

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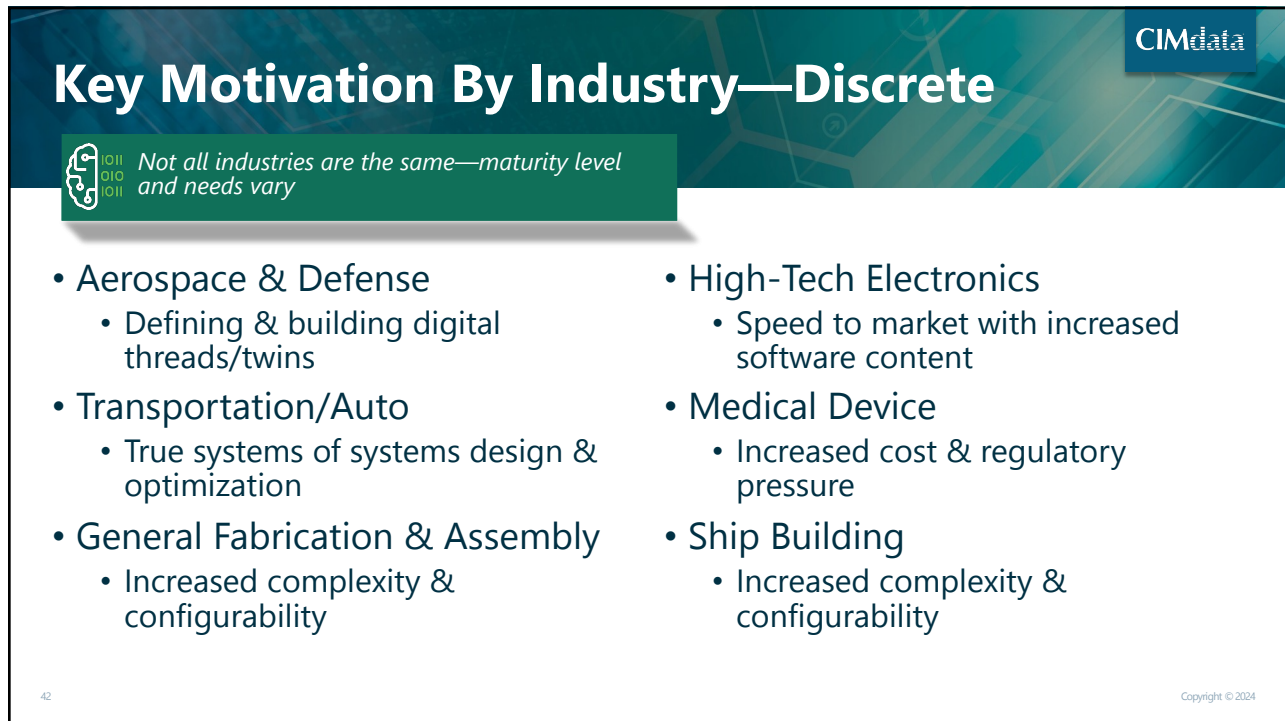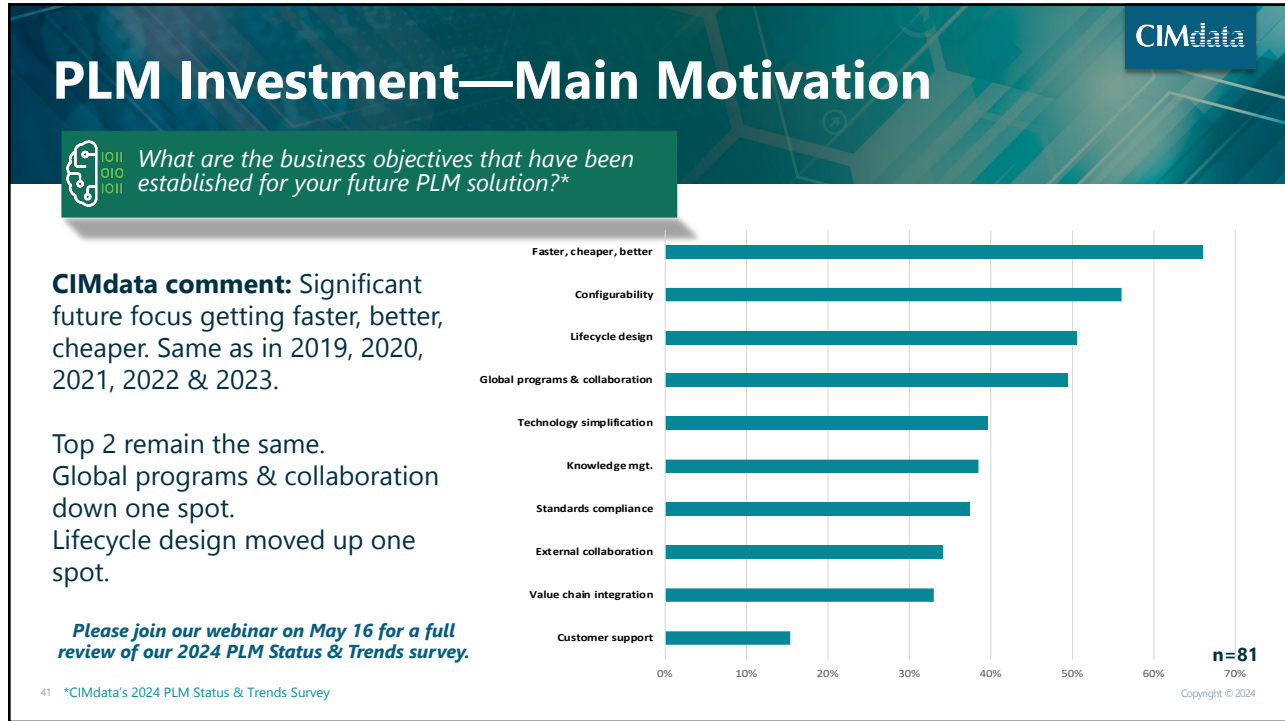

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PLM Investment—Main Motivation

What are the business objectives that have been established for your future PLM solution?*

CIMdata comment: Significant future focus getting faster, better, cheaper. Same as in 2019, 2020, 2021, 2022 & 2023.

Top 2 remain the same.
Global programs & collaboration down one spot.
Lifecycle design moved up one spot.

Please join our webinar on May 16 for a full review of our 2024 PLM Status & Trends survey.

41   *CIMdata's 2024 PLM Status & Trends Survey

Chart (horizontal bar, n=81):
- Faster, cheaper, better — ~66%
- Configurability — ~56%
- Lifecycle design — ~50%
- Global programs & collaboration — ~49%
- Technology simplification — ~40%
- Knowledge mgt. — ~38%
- Standards compliance — ~37%
- External collaboration — ~34%
- Value chain integration — ~33%
- Customer support — ~15%

Axis: 0% 10% 20% 30% 40% 50% 60% 70%

n=81

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Key Motivation By Industry—Discrete

Not all industries are the same—maturity level and needs vary

- **Aerospace & Defense**
  - Defining & building digital threads/twins
- **Transportation/Auto**
  - True systems of systems design & optimization
- **General Fabrication & Assembly**
  - Increased complexity & configurability

- **High-Tech Electronics**
  - Speed to market with increased software content
- **Medical Device**
  - Increased cost & regulatory pressure
- **Ship Building**
  - Increased complexity & configurability

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Key Motivation By Industry—Process

Not all industries are the same—maturity level and needs vary

- Consumer Packaged Goods (including hybrid)
  - Speed to market with increase complexity & regulatory pressure
- Food & Beverage (including hybrid)
  - Increase complexity & regulatory pressure
- Pharmaceutical
  - Speed to market with increased regulatory & pricing pressure
- Oil & Gas
  - Need to be greener & diversify

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Key Motivation By Industry—Other

Not all industries are the same—maturity level and needs vary

- Retail
  - Own brand development & management
- Academia
  - Increased configurability & compliance
- Research Institutes
  - Increased complexity & data management needs
- Insurance
  - Increased product configurability & compliance
- Banking
  - Increased product configurability & compliance

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Slide: Key Motivating Factors — Almost all business sectors share these and other trends & challenges. Digital Transformation (Technology, Communication, Data, Internet of things, Automation, AI, Networking); Sustainability; Smart & Connected; Complexity / Elegant Simplicity. CIMdata. 45. Copyright © 2024

Slide: Agenda — CIMdata
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Concluding Remarks

Value Drivers for Digitalization of the Product Lifecycle

- As PLM professionals, we must continually look to enhance the value resulting from the digitalization of the product lifecycle
  - This requires keeping an eye on the evolving trends & enablers of successful digital transformation
  - CIMdata's Critical Dozen represents a comprehensive set of trends & enablers
- Maximum value will only result from a holistic, end-to-end approach
- Don't forget, organizational change management plays a critical role in maximizing adoption and value delivery
- Evolving customer demands & market opportunities are motivating investment in digitalization of the product lifecycle

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Questions & Answers

What's on your mind?

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