

State of PLM: Today's Market & Leading Trends

CIMdata PLM Market & Industry Forum

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PLM Market & Industry Forum

A CIMdata PLM Leadership Event

2 April 2020

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Global Leaders in PLM Consulting
www.CIMdata.com

#plm4um

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Our Mission...

Strategic management consulting for competitive advantage in global markets

CIMdata is the leading independent global strategic management consulting and research authority focused exclusively on PLM and the digital transformation it enables.

We are dedicated to maximizing our clients' ability to design, deliver, and support innovative products and services through the application of PLM.

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Products, Smartly Connected

2020 PLM Market & Industry Forum Theme

- In this forum, CIMdata will explore best practices and identify gaps in the processes and tools for developing smart connected products
- CIMdata believes that the work to date barely scratches the surface of what is possible
 - Many of the enabling technologies, like the IoT and AI/ML, are early in their adoption lifecycle so there is still a lot of experimentation driving learning
- Ultimately, CIMdata hopes that this discussion will kickstart the conversation on engineering smart connected products that meet and exceed customer and market requirements



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Key Takeaways

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- There should be no doubt that the development & management of smart connected products is changing what PLM is and how it is enabled
- Unfortunately, most are still spending on traditional areas of PDM
- The market had a good 2019, but today's events will have an impact
- There are several emerging trends & challenges that are impacting PLM today and will in the coming months and years
- PLM will continue to evolve, and we will need to be ready for it to do so
- The Product Innovation Platform isn't the end, there is much more to come
- To be successful in today's competitive and very challenging environment, solution providers must stay focused...it's time to carefully invest

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Agenda

- What's New from CIMdata
- 2019: The Year in Review
- 2020: Today's Trends & Challenges
- Looking Towards the Future
- Concluding Remarks

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CIMdata Services...

Creating, disseminating, and applying our intellectual capital in support of your digital transformation



**PLM
Foresight**

**PLM
Leadership**

**PLM
Transformation
PLM Invest
PLM
Success**

Delivering strategic advice and counsel through a comprehensive, integrated set of research, education, and consulting services

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PLM Success

Services for PLM Solution Providers—supporting the drive towards market success in the evolving digital economy



CIMdata's PLM consulting methodology for PLM solution providers

A comprehensive set of services tailored to fit your specific needs...

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CIMdata Membership Services & Research Topics

A rich set of community services and research areas continue to evolve to meet the community's changing needs



CIMdata Community

Solution Providers Industry Action Groups

Innovation Engagement & Governance

Design Creation & Collaboration

Simulation-Driven Systems Development

Manufacturing Systems Engineering

Enterprise Value & Integration

Quality & Reliability Engineering

Future Research Topics...

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Jim Roche, CIMdata
A&D Practice Director

AEROSPACE & DEFENSE PLM ACTION GROUP



Aerospace & Defense PLM Action Group

Founded in February 2014



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2016-19 Projects

Descriptions and project leaders

Global Collaboration – Cyd Watts, Boeing & Ken Versprille, CIMdata

- Define A&D collaboration patterns between airframe and engine OEMs, determine best practices for sharing electronic data throughout the lifecycle, and create a template to facilitate data standard formats and exchange practices for setup and connection of OEMs and their suppliers.

Model-Based Definition (MBD) and Bill of Material Definition – Brandon Sapp, Boeing & Ken Versprille, CIMdata

- Define the minimum data content in Model Based Definition type design required to meet manufacture, inspect, and regulatory certification requirements. Evaluate existing standards and tools to provide an industry standard data delivery process to regulatory agencies.

Multiple View Bill of Material (Multi-BoM) – Javier Reines, Airbus & Chris Gregory, CIMdata

- Define scope (e.g. eBoM, mBoM, sBoM) and use cases (e.g. reconciliation, consistency-traceability, add-replace-suppress part); and agree on high level objectives and requirements.

Model-based Systems Engineering (MBSE) – Jennifer Bacon, Boeing & Don Tolle, CIMdata

- Evaluate current capabilities of a typical aerospace supplier and an aerospace OEM to produce, exchange, and consume digital information via a collaborative shared data site using commercial MBSE software tools (i.e., SysML) and related data exchange standards.

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CIMdata PLM Leadership

PLM Industry's most comprehensive non-biased education & training offering

This CIMdata offering is comprised of a set of well-defined events & assessment-based PLM education and training certificate programs.

The certificate programs are available to industrial companies who are considering and/or implementing PLM, and to PLM software and service providers.

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CIMdata's PLM Road Map™

Right-sized, regional, industry-focused collaborative events

- PLM Road Map™ NA 2020 & PDT NA 2020
 - Stay tuned
- PLM Road Map™ EMEA 2020 & PDT Europe 2020
 - 17-18 November 2020, Stockholm, SWEDEN
 - Theme: "Digital Thread—the PLM Professionals' Path to Delivering Innovation, Efficiency, and Quality"



PLM Road Map, in its 27th year, continues to be a premier international PLM industry event in the rapidly transforming digital world.

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PLM Leadership

Conferences, seminars, and educational programs



- Self-paced E-Learning courses available and being expanded
- Complimentary Educational Webinars
 - Monthly one-hour educational webinars: <http://www.cimdata.com/en/education/educational-webinars> for details
 - Monthly complimentary educational webinars
 - Scheduled for the second Thursday of every month at 11am US Eastern
 - Solution providers are encouraged to attend & invite their clients & prospects
 - A sampling of past complimentary webinars
 - April 9, 2020: Extended Product Data – Making a Product Salable
 - March 12, 2020: Making Multiple-View Bill of Materials Management a Reality
 - February 13, 2020: PLM in Medical Devices
 - January 9, 2020: PLM and ERP Drive Digitalization

Currently planning on two per month starting in April.

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PLM Certificate Program Participants

A sampling of CIMdata PLM Leaders—approximately 1,000 PLM Professionals certified worldwide



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2019 PLM Market – Overall State

PLM market—overall growth of 7.6%



- The global PLM market fell short of CIMdata's forecast
 - Overall PLM market was up 7.6% to US\$51.4 billion (vs. forecast of 8.6%)
 - cPDM sector @ US\$17.4B (7.2%); software grew a bit faster than services
 - Tools sector @ US\$33.1B (7.7%); led by AEC, Other Tools & Simulation growth
 - Digital Manufacturing sector @ US\$886.5M (8.6%); strong link to Industry 4.0
- Global PLM market continues to be very strong
 - Autodesk has clearly come out of their subscription transition
 - Their 2019 growth was about 27.4% year-on-year, and plan ~21% in FY2020
 - Large growth in EDA and software development tools likely result of smart, connected movement
- Growth pace of M&A continue to build out depth & breadth
- Services continue to be critical for implementation success



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2020 CIMdata PLM Status & Trends Survey

Some key conclusions

- CIMdata once again executed its comprehensive PLM Status & Trends survey
- Most respondents have more than one PLM solution and have been working on PLM for more than 10 years
- Most implementations still focus on “traditional” PDM aspects of PLM
- For the most part, companies find PLM worth investing in
- There's an emphasis on getting faster, better, cheaper
- Enterprise systems confusion still exists, as well as lack of ROI clarity and potential conflicts with other priorities (e.g., digital initiatives)
- Management disconnect is believed to be widespread
- PLM may have worn out its welcome?

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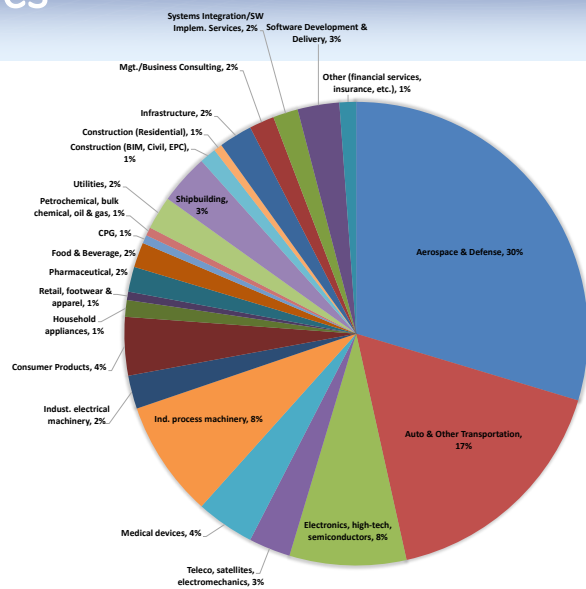
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Response Demographics

(1 of 4)

What industry does your company operate within?

CIMdata comment: This industry spread approximately matches the overall spend on cPDM offerings, traditionally led by automotive, then aerospace and defense, high-tech, and industrial machinery.



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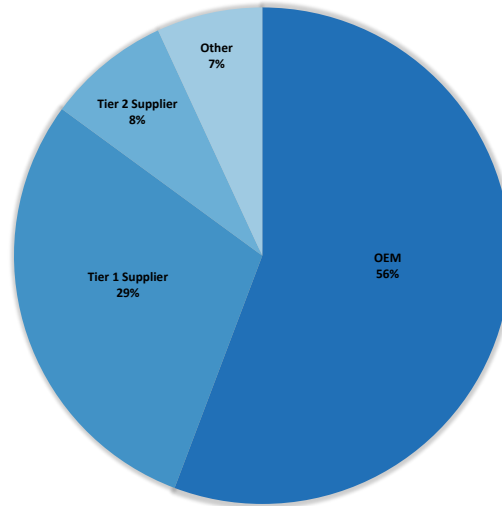
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Response Demographics

(2 of 4)

What is the primary position of your company in the ecosystem?

CIMdata comment: The survey respondents were weighed towards OEMs. Not surprising since historically they represent a large portion of the PLM spend.



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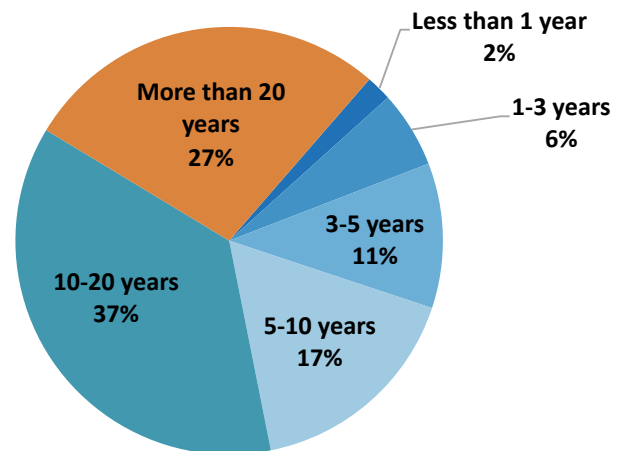
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Response Demographics

(3 of 4)

How long have you been working in PLM?

CIMdata comment: A rather mature set of respondents. About 2/3 have been at this for more than 10 years. This is consistent with other CIMdata research that many cPDM implementations are long-standing.



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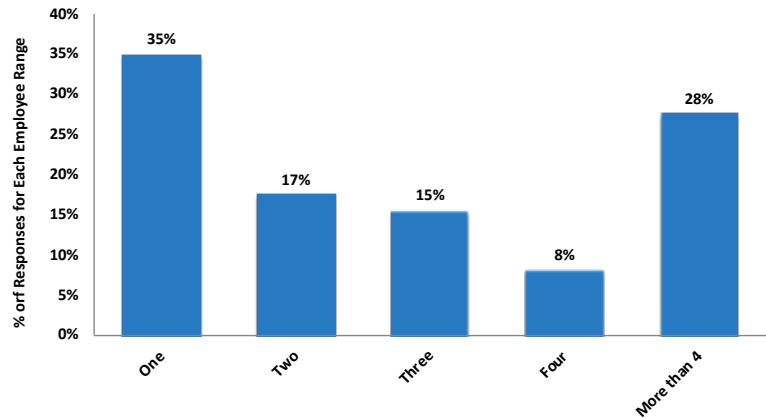
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Response Demographics

(4 of 4)

How many commercially available PLM solutions are currently in operation within your company?

CIMdata comment: 65% of the respondents have more than one PLM solution. This is consistent with CIMdata's industrial consulting work, where many large companies built through mergers and acquisitions have many solutions in place.



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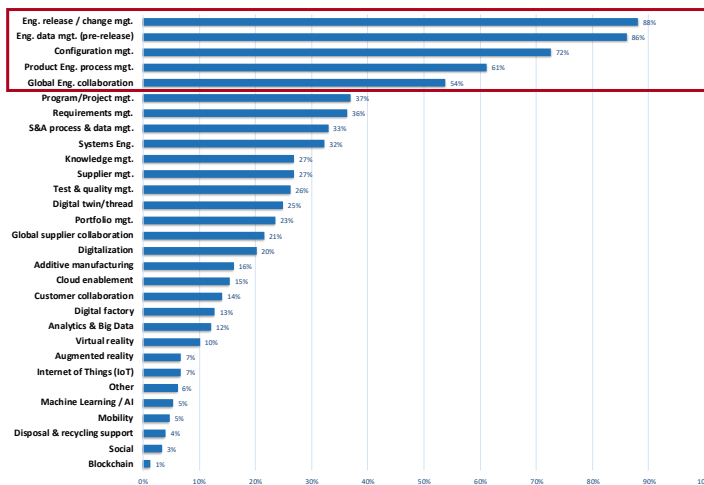
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Implementation Status

(1 of 2)

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: include Document Mgt., Lifecycle Management, Enhanced CAD Mgt., DMU & Compliance.



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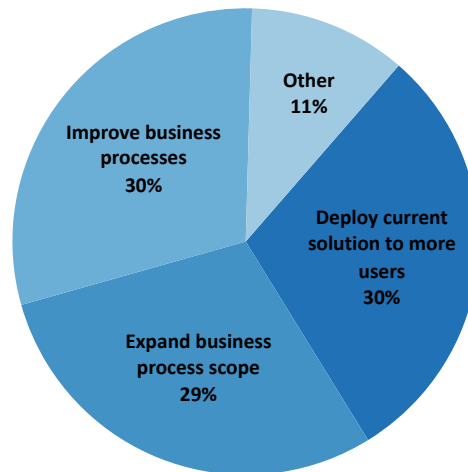
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Implementation Status

(2 of 2)

Please estimate the size, as a percent, of your total investment for each of the categories listed.

CIMdata comment: Investment evenly split among the three main investment areas.



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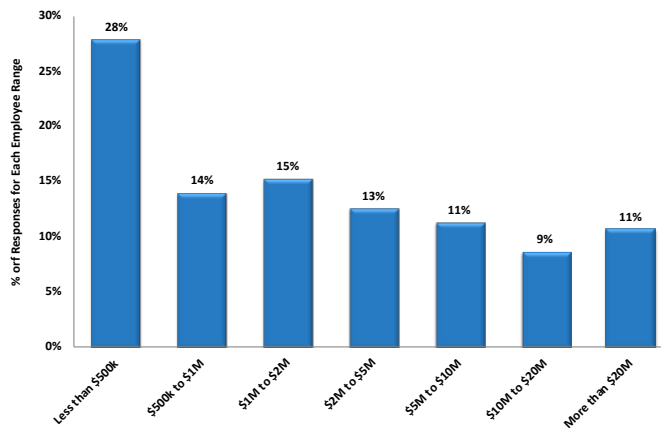
PLM Financials

(1 of 3)

What is your current annual PLM budget?

CIMdata comment: A good cross section of implementation sizes, with nearly 58% spending more than US\$1 million each year.

2019: 43%



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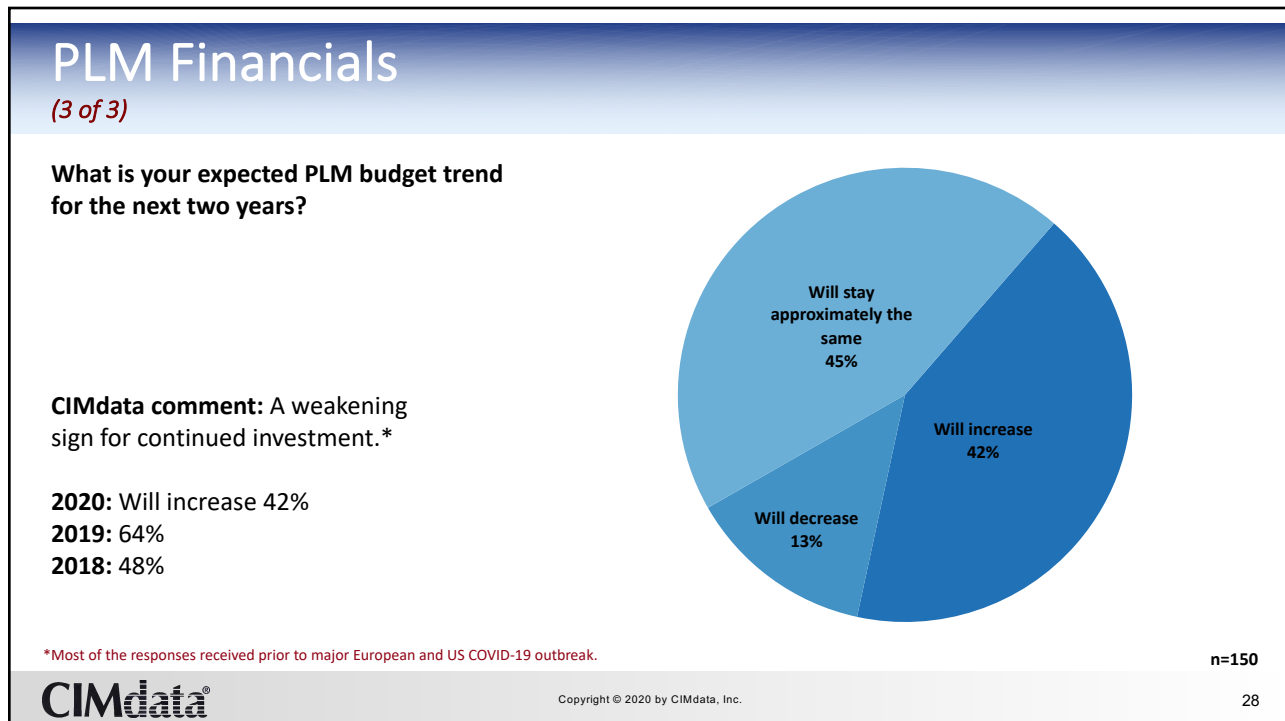
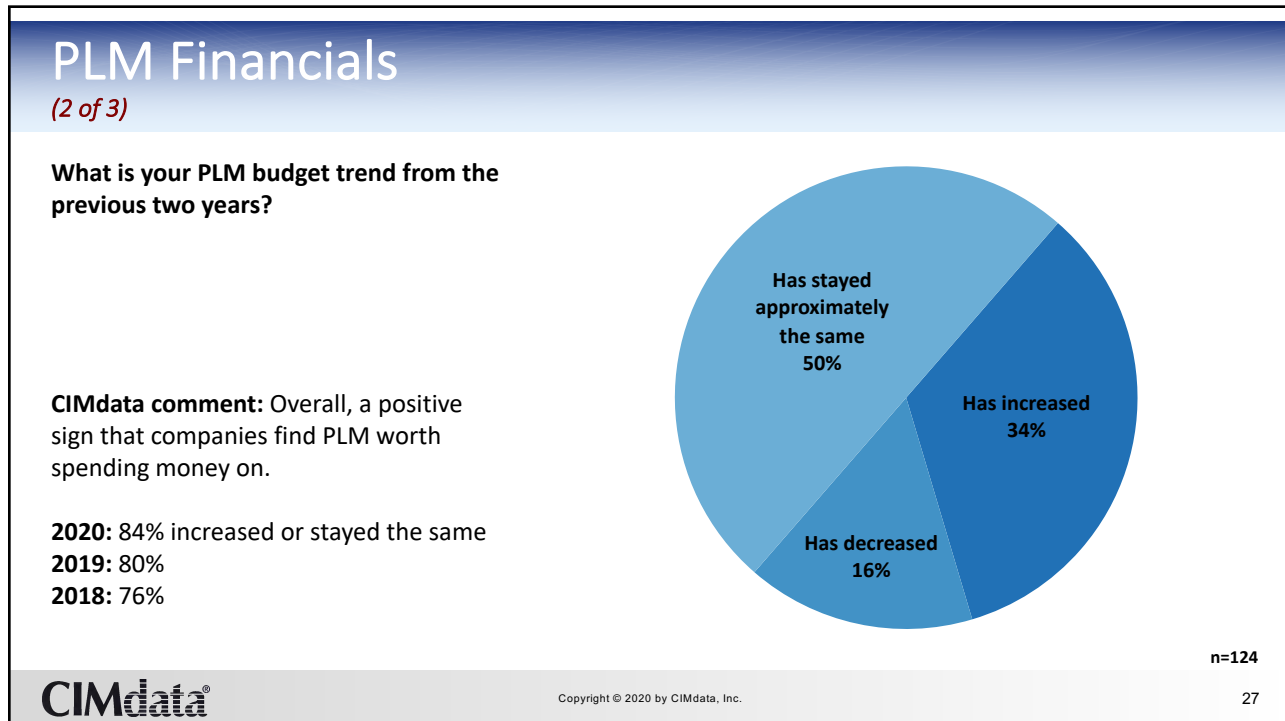
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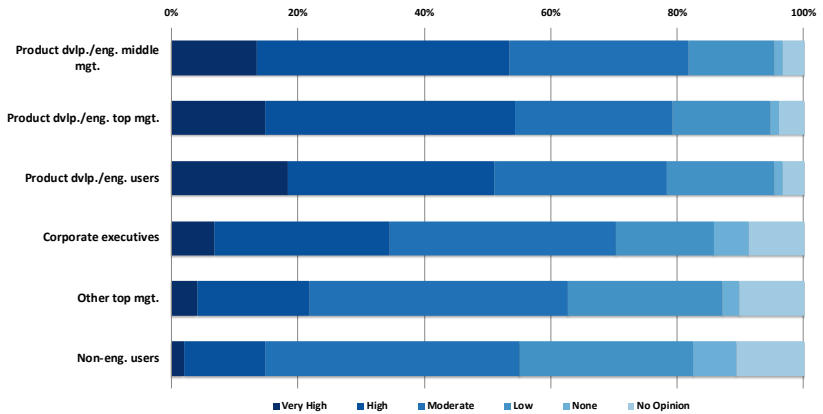
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Level of PLM Importance

What level of value do the following groups in your company believe your current generation PLM solution has delivered?

CIMdata comment: Heavily weighted towards the “traditional” areas supported by PLM. Not surprising given many of the respondents come from companies not spending money on non-traditional areas.



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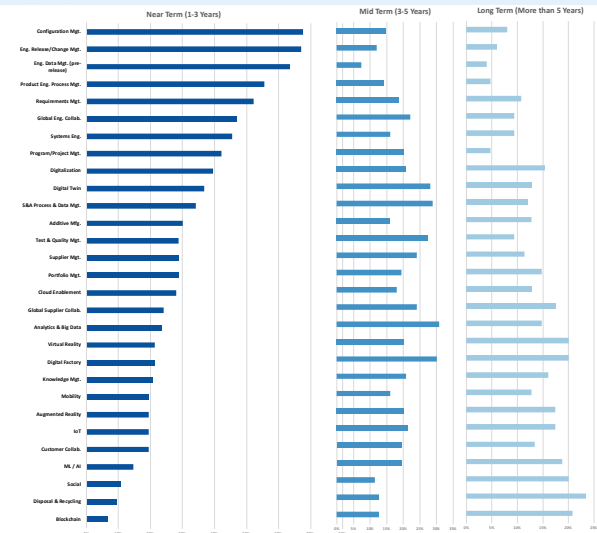
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PLM Investment

(1 of 2)

What business process areas will you invest in for your future PLM solution and what is the time frame for each investment area?

CIMdata comment: Short-term still focused on “traditional” areas supported by PLM. Mid-term more spread across traditional and non-traditional areas. Long-term focused moves towards non-traditional areas. Others: integration, feature mgt., persona-based UX, product line/variant mgt., and Mfg. PLM.



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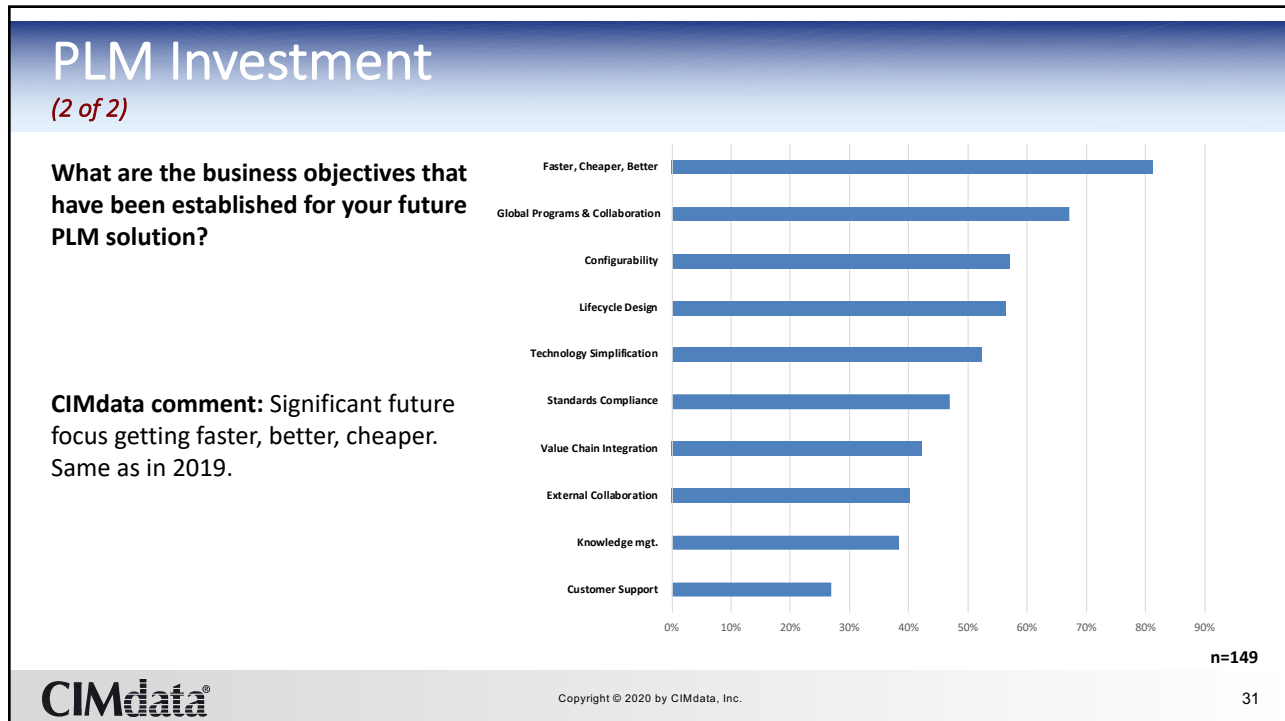
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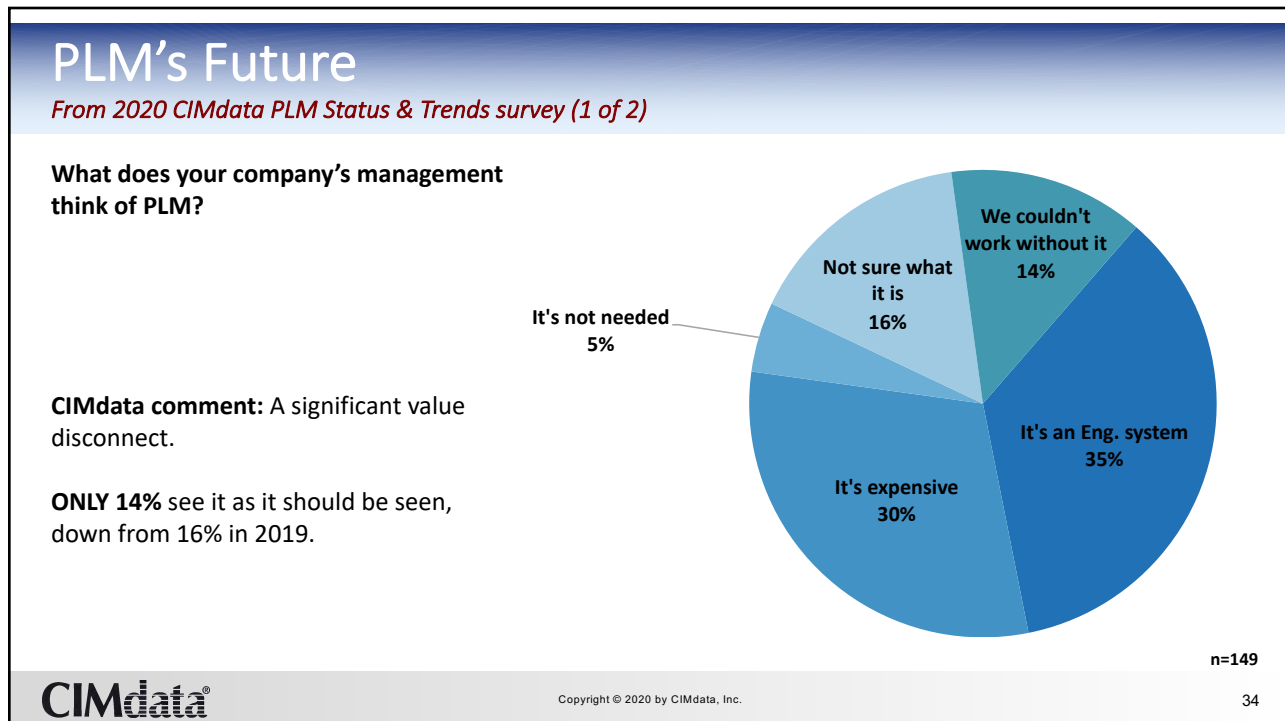
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PLM's Future

From 2020 CIMdata PLM Status & Trends survey (2 of 2)

Has the term PLM run its course?

Response	Percentage
Yes	44%
No	56%

CIMdata comment: PLM may have worn out its welcome.

2019: 52% said Yes

Please join our webinar on May 14, 2020 for a full review of our 2020 PLM Status & Trends survey.

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What CIMdata Has Been Saying

Some examples—have you seen what we have been publishing since the last Forum?

Tuesday, February 25, 2020

Why is PLM Often so Hard? (Simple Paper)

CIMdata and ANSYS

Design Trends: What's In, What's Over

Digital Threads, Twins Play Catch-Up in the Factory

By Peter A. Bilello, President & CEO, CIMdata

Industrie 4.0 and the dozens of Smart Factory initiatives worldwide seek to close the loop between product design and the product (software included) as produced in its final form. At their fundamental level, these initiatives are joining what design engineers set out to provide the customer and what the customer expected.

Industrie 4.0 refers to the Fourth Industrial Revolution, i.e., the new pre-eminent role of data and information in manufacturing and, less obviously, eliminating anything still on paper ("analog") such as preprinted forms and setup sheets.

Periodically updated list of engineering, manufacturing, and technology shows cancelled or postponed due to Coronavirus...

ERIKS Collaborates with Ultimaker to Scale Up 3D Printing Capacity for...

Multi-product specialist supports customers through co-engineering and facilitates high industry standards to 3D print parts...

What were some trends you observed in the design and manufacturing in 2019?

Latest News

Digital Thread Latest Chapter in

Latest News

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Today's Major Trends & Potential Disruptors

A convergence of ideas, technologies, strategies, and associated complexities



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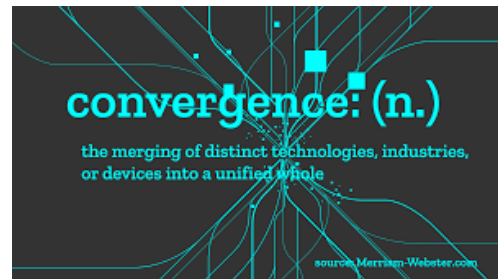
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Information & Operational Technology Convergence

Closing the multiple systems of systems loops that exist throughout an enterprise

- The integration of IT systems used for data-centric computing with OT systems used to monitor events, processes and devices, and adjust enterprise and industrial operations
 - IT includes any use of computers, storage, networking devices and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data
 - OT, traditionally associated with manufacturing and industrial environments, includes industrial control systems (ICS) such as supervisory control and data acquisition (SCADA)
- Convergence enables more direct control & more complete monitoring, with easier analysis of data from these complex systems



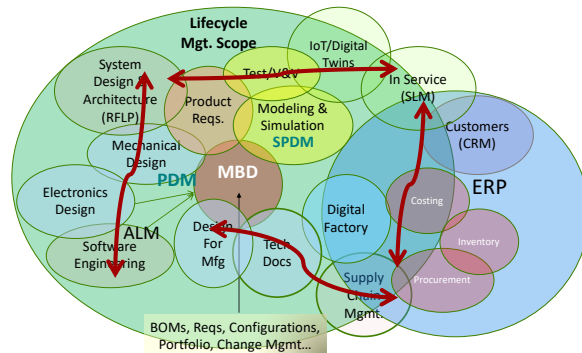
<https://searchitoperations.techtarget.com/definition/IT-OT-convergence>

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>

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Digital Twin

CIMdata's preferred definition

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

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

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Digital Twins

Key characteristics

- There is never a single Digital Twin
 - There are multiple Digital Twins for different purposes, each of which have specific characteristics
 - For example, Data Analytics Digital Twins, MRO Digital Twins, Financial Digital Twins, Engineering Digital Twins, and Engineering Simulation Digital Twins
- Each Digital Twin must have a physical twin (i.e., a physical asset)
 - A virtual representation can and should exist prior to the physical twin
 - The physical asset can be a plant, a ship, infrastructure, a car, any type of product
- Each Digital Twin must have some form of data communication with their Physical Twin
 - Does not have to be real time or electronic

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

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Engineering Simulation Digital Twin

CIMdata's preferred definition

- A **physics-based virtual representation** of a physical asset or collection of physical assets (physical twin) that exploits data flow to/from the associated physical asset(s)
 - Each physical twin may have multiple Engineering Simulation Digital Twins used for various purposes



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

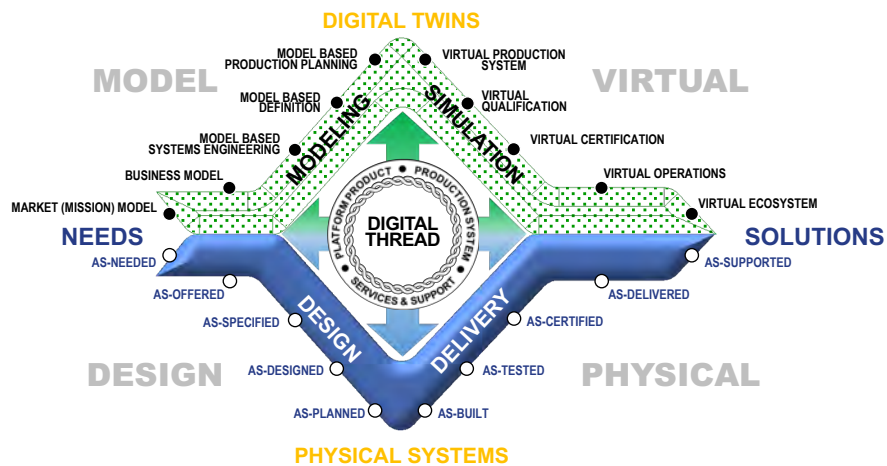
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MBE “Diamond” Symbol

As proposed by The Boeing Company



Courtesy of The Boeing Company

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The Emergence of the Graph Database

The what and the why...

- In a **graph database**, the relationships are stored at the individual record level, while in a **relational database**, the structure is defined by tables
 - If the *relationships between data*, not the data itself, are your main concern, then a graph database is in order
 - Graph databases are best suited for exploring highly connected data
- Graph databases are inherently more flexible than relational databases because it is possible to treat the metadata about the database as data itself
 - Until comparatively recently, this flexibility came at the expense of performance, but with the shift to GPUs, that performance disadvantage has largely disappeared
 - It turns out that a graph database is not that much different (in fact they are near identical) to the meshes used in graphics processing



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Building Out an Enterprise Platform

Span vision to operations, programs, and projects consuming organizational resources (e.g., people & money)



"The Standard for Portfolio Management", PMI

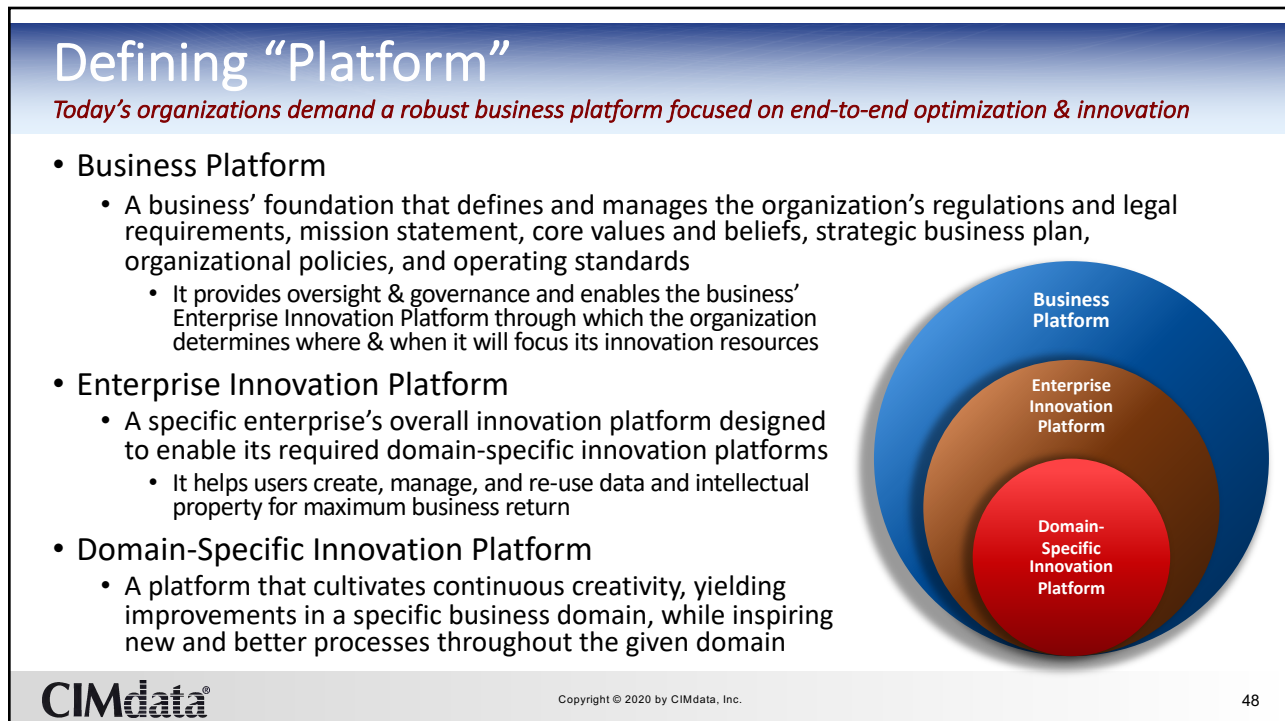
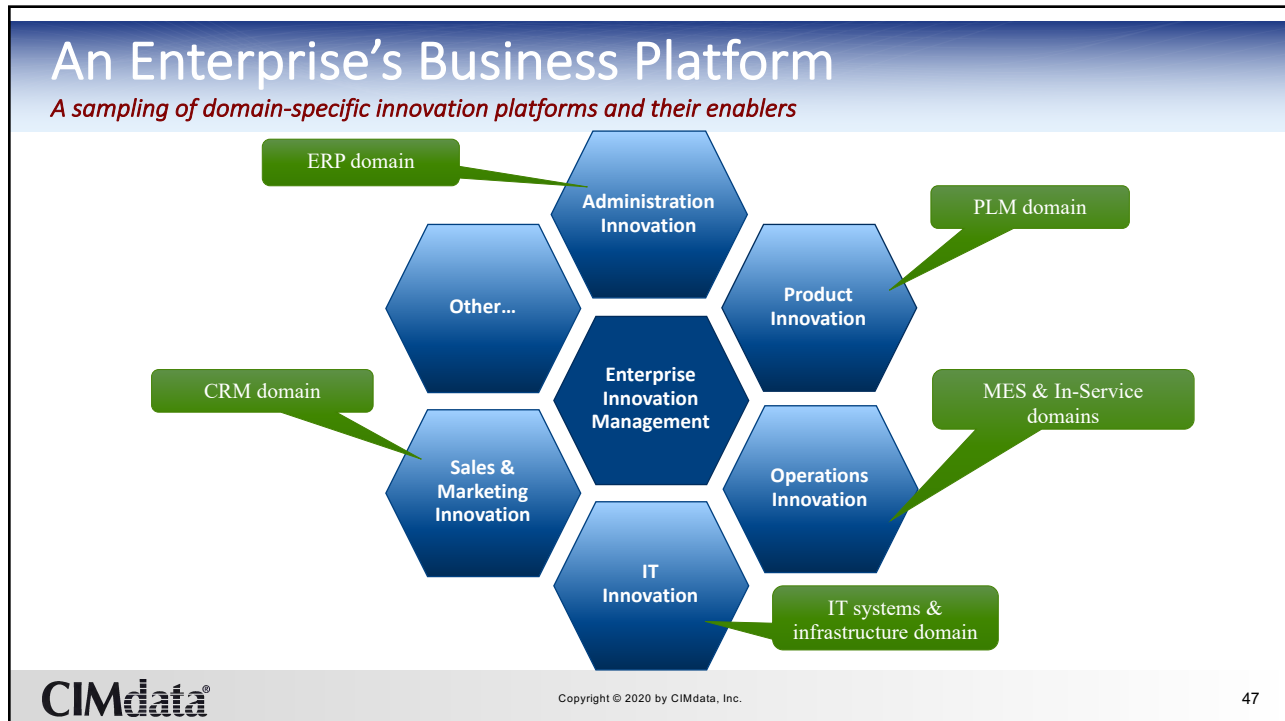
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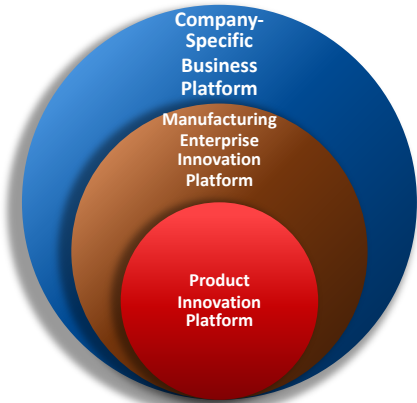
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Some Specific Platform Examples

From the business platform down to the product innovation platform for a manufacturing enterprise

- **Company-Specific Business Platform**
 - A business' foundation that defines and manages the organization's regulations and legal requirements, mission statement, core values and beliefs, strategic business plan, organizational policies, and operating standards
- **Manufacturing Enterprise Innovation Platform**
 - A specific configuration of Domain-Specific Innovation Platforms that enable and optimize an enterprise's end-to-end lifecycle activities
- **Product Innovation Platform**
 - A domain-specific innovation platform that cultivates continuous creativity, yielding improvements in products and processes plus inspiring new and better ones throughout full lifecycles and across generations of a products



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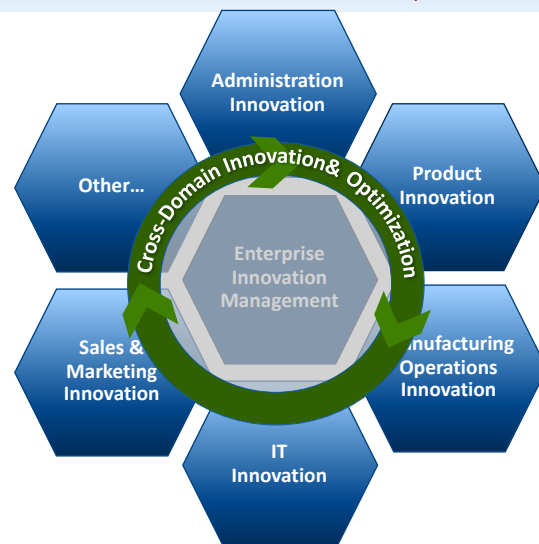
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Manufacturing Enterprise Innovation Platform

Defining this Enterprise Innovation Platform configuration that enabled cross-domain innovation & optimization

- A suite of integrated solutions that support product development, sales & marketing, manufacturing operations, and product support in close concert
 - With the Product Innovation Platform at its core
- Makes technical knowledge available to the business domains of the enterprise and creates an actionable environment based on clear, concise & valid data
- Requires deep integration & understanding of business and domain-specific processes, while eliminating the boundaries between technical and administrative functions
- Helps individuals, organizations, and enterprises harness and leverage the power of data across multiple innovation platforms



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The Product Innovation Platform

CIMdata's Enterprise Product Innovation Platform Model

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

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10 Strategic Tech Trends

Gartner's Top 10 Strategic Technology Trends

2018

1. **AI Foundation**
2. **Intelligent Apps & Analytics**
3. Intelligent Things
4. **Digital Twin**
5. **Cloud to the Edge**
6. Conversational Platforms
7. **Immersive Experience**
8. **Blockchain**
9. **Event Driven**
10. **Continuous Adaptive Risk & Trust**

<https://www.gartner.com/newsroom/id/3812063>

Direct connection
Indirect/secondary connection

2019

1. Autonomous Things
2. **Augmented Analytics**
3. **AI-Driven Development**
4. **Digital Twin**
5. Empowered Edge
6. Immersive Experience
7. **Blockchain**
8. **Smart Spaces**
9. **Digital Ethics & Privacy**
10. Quantum Computing

<https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2019/>

2020

1. **Hyperautomation**
2. **Multixperience**
3. **Democratization of Expertise**
4. Human Augmentation
5. Transparency & Traceability
6. The Empowered Edge
7. Distributed Cloud
8. Autonomous Things
9. Practical Blockchain
10. AI Security

<https://www.gartner.com/en/newsroom/press-releases/2019-10-21-gartner-identifies-the-top-10-strategic-technology-trends-for-2020/>

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A Digital Transformation Update

Digital transformation: Improving the odds of success (1 of 2)



Most digital transformations don't yield the benefits that leaders expect. New research shows that five practices maximize the chance of extraordinary outcomes.

Article - McKinsey Quarterly

Digital transformation: Improving the odds of success

October 2019 – Most digital transformations don't yield the benefits that leaders expect. New research shows that five practices maximize...

- Laying out clear priorities
- Investing in talent—especially at the top
- Committing time and money
- Embracing agility
- Empowering people

<https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-transformation-improving-the-odds-of-success>

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State of PLM: Today's Market & Leading Trends

CIMdata PLM Market & Industry Forum

A Digital Transformation Update

Digital transformation: Improving the odds of success (2 of 2)

- **Laying out clear priorities**...focus on a few clear themes that are tied directly to measurable business outcomes
- **Investing in talent**—especially at the top...put emphasis on attracting and developing highly talented people with strong digital & analytics skills
- **Committing time and money**...executives must sustain their focus on digital enablement
- **Embracing agility**...businesses must revisit & rearrange their priorities more often than ever
- **Empowering people**...must seek to enable performance gains that result from reinforcing digital enablement's importance for employees at all levels

<https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-transformation-improving-the-odds-of-success>

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COVID-19's Impact Will Potentially be Far Reaching

A March 16, 2020 McKinsey article—currently, two possible scenarios

Economic impact. Large-scale quarantines, travel restrictions, and social-distancing measures drive a sharp fall in consumer and business spending until the end of Q2, producing a recession. Although the outbreak ends in most parts of the world by late in Q2, the self-reinforcing demand shock kick in and prolong the slump until the end of Q3. Consumers lose revenue and lay off workers, and unemployment levels rise. Investment contracts, and corporate bankruptcies soar, putting pressure on the banking and financial system.

Economic impact. Demand suffers as consumers cut spending throughout the year. In the most affected sectors, the number of corporate layoffs and bankruptcies rises throughout 2020, feeding a self-reinforcing downward spiral.

The financial system suffers significant distress, but a full-scale banking crisis is averted because of banks' strong capitalization and the macroprudential supervision now in place. Fiscal and monetary-policy responses prove insufficient to break the downward spiral.

The global economic impact is severe, approaching the global financial crisis of 2008–09. GDP contracts significantly in most major economies in 2020, and recovery begins only in Q2 2021.

<https://www.mckinsey.com/business-functions/risk/our-insights/covid-19-implications-for-business>

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Agenda

- What's New from CIMdata
- 2019: The Year in Review
- 2020: Today's Trends & Challenges
- Looking Towards the Future
- Concluding Remarks

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Concluding Remarks

The market continues to expand and evolve—differentiation is key

- The development & management of smart, connected products is changing what PLM is and how it is enabled
- Most companies are still spending on traditional areas of PDM, how do we get them past the foundational elements
- The market had a good 2019, but COVID-19's impact could be long lasting
- The more specific application of AI, graph databases, and other emerging technologies appear to hold great promise
- PLM is evolving, and strategic investment will need to continue
- The Product Innovation Platform isn't the end, enterprises require enterprise level platforms to drive their transformations

“The only thing we have to fear is fear itself...”

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