GenAI-Powered PLM: Navigating Complexity and Driving Agility

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Abstract- The accelerating pace of innovation is fundamentally reshaping product development, creating a complex environment that demands rapid decision-making and efficient information management. To remain competitive, organizations must integrate Generative AI (GenAI) tools into their Product Lifecycle Management (PLM) processes. This integration is crucial because traditional PLM systems, often built on decades-old architectures, struggle to manage modern product complexity, vast data volumes, and interconnected supply chains.1 Limitations such as data silos, inflexible change management, and inadequate collaboration capabilities hinder the agility required today.3 GenAI offers transformative potential by automating complex tasks, enhancing data analysis, and facilitating more dynamic design and collaboration within the PLM ecosystem.5 This integration is not merely an upgrade but an essential evolution to overcome the inherent architectural and process constraints of legacy systems, which impede the speed and data fluidity necessary in the current market.

I. INTRODUCTION

In today's rapidly evolving market, characterized by intricate supply chains, heightened sustainability concerns, dynamic customer expectations, and the need to leverage real-time operational data, the central question for manufacturers is how to accelerate innovation while effectively navigating complexity to deliver exceptional products.2 The answer increasingly points towards harnessing the transformative power of Generative AI (GenAI) within the domain of Product Lifecycle Management (PLM).

Creating successful products necessitates synthesizing vast amounts of information from disparate sources, fostering seamless collaboration across functional departments, and making swift, well-informed decisions.[8] Traditional PLM systems, however, often fall short in facilitating these modern requirements, frequently operating as isolated repositories rather than integrated hubs for enterprise-wide product intelligence.[3]

GenAI presents an opportunity to supercharge PLM capabilities in several key areas. It can assist engineering teams by generating multiple design alternatives, evaluating their feasibility and performance against diverse criteria, and incorporating real-time supply chain data into the design process.[13] Furthermore, GenAI can streamline collaboration by facilitating more effective communication and knowledge sharing between teams, helping to break down the informational silos that often plague conventional development processes.[3] Its capacity for automating the analysis of vast datasets across the entire product lifecycle enables the identification of inventory levels, potential constraints, and emerging risks, suggesting alternative sourcing strategies before they disrupt production.[5]

Integrating PLM with GenAI empowers engineering and product teams to transition from reactive problem-solving to proactive product development.17 This shift accelerates innovation and enables organizations to effectively address supply chain complexities in an ever-changing global landscape. The value proposition extends beyond automating existing PLM tasks; it lies in enabling fundamentally new capabilities, such as rapid exploration of the design space or proactive risk simulation, which were previously impractical due to traditional systems' data processing limitations.13 Critically, successful GenAI deployment within PLM is intrinsically linked to overcoming the data fragmentation challenges inherent in many legacy environments.1 GenAI's effectiveness is contingent upon accessing and analyzing integrated data across the product lifecycle, underscoring the need for a concurrent focus on data strategy and potentially modernizing data infrastructure or implementing sophisticated integration layers.20

Table 1: Traditional PLM Limitations vs. GenAI Capabilities

Challenge	Description of Limitation	Relevant GenAI Capability	Description of GenAI Solution	Potential Benefit
Data Silos & Fragmentation	Information scattered across departments; lack of single source of truth; poor cross-functional collaboration; inconsistent data impacting decisions.[3]	Unified Data Analysis & Knowledge Management	GenAI (esp. via RAG) can access and analyze data from integrated sources or a unified knowledge layer, providing consistent insights.[5]	Improved decision accuracy, reduced errors, enhanced collaboration.
Inflexible Change Management	Rigid architectures; costly customizations needed for process changes; slow change cycles; increased compliance risks.[3]	Automated Impact Analysis & Workflow Automation	GenAI can analyze change impacts across systems, identify risks, and automate approval workflows based on business logic.[7]	Faster change cycles, reduced compliance risk, minimized disruptions.
Ineffective Collaboration	Poor support for connecting external stakeholders (suppliers, partners); fragmented communication; lack of supply chain visibility.[3]	Enhanced Collaboration Tools & Knowledge Sharing	GenAI can facilitate communication, summarize information, provide contextual insights, and act as a knowledge hub for dispersed teams.[5]	Improved alignment, faster decision-making, better supply chain visibility.
Design & Development Bottlenecks (Silos)	Knowledge gaps; parallel development; part duplication; inefficient sourcing due to isolated teams working on similar problems.[3]	Generative Design & Intelligent Part Reuse	GenAI can generate design options, identify existing reusable parts based on criteria, and surface relevant knowledge across projects.[7]	Reduced redundancy, lower inventory costs, faster design cycles, increased standardization.
Scalability & Extensibility Issues	Legacy architectures struggle to adapt to business growth, new product lines, or global expansion; difficult to integrate with modern tools.[1]	Scalable Cloud Architecture & Integration Capabilities	Modern AI/GenAI solutions often leverage cloud-native architectures; RAG/layered approaches facilitate integration with existing systems.[17]	Ability to adapt to growth, support digital transformation, integrate new technologies.

II. CHALLENGES

Despite the promise of modern PLM strategies, significant challenges persist, often rooted in the limitations of underlying systems and processes.

These challenges create bottlenecks and introduce risks throughout the product lifecycle.

A. Design and Development Bottlenecks

A primary impediment in modern product development stems from knowledge gaps created by siloed development processes.3 When engineering teams operate in isolation, fragmented across different programs or disciplines, crucial opportunities for information sharing and effective collaboration are missed.3 This operational model frequently leads to several detrimental consequences:

- Parallel Development and Missed Standardization: Teams may unknowingly invest time and resources developing similar designs or components for different projects, leading to redundant effort and missed opportunities for standardizing parts across the product portfolio.27
- Duplicate Parts: The lack of visibility into existing designs results in the creation of multiple versions of functionally equivalent components. This part proliferation unnecessarily inflates inventory costs and complicates logistics.27
- Inefficient Sourcing: Siloed teams often negotiate separate contracts for similar parts, failing to leverage collective bargaining power and missing potential volume discounts.3
- Supply Chain Complexities: An increased number of unique part variations, coupled with decentralized sourcing activities, introduces significant logistical challenges, heightens the risk of disruptions, and can lead to potential production delays.1

Addressing these issues requires breaking down organizational and system silos to foster open communication and data sharing. Such integration is essential for streamlining product development, reducing operational costs, and improving overall supply chain efficiency.3

B. Change Management Blindspots

Another critical challenge lies in the management of changes. Frequently, modifications proposed for operational, design, or supply chain reasons are approved and implemented without a comprehensive, cross-functional understanding of their full impact.3 This lack of foresight, often exacerbated by the data fragmentation discussed previously, can have severe repercussions 30:

- Unforeseen Consequences: Teams involved in approving a change may not fully grasp the potential ripple effects on downstream factors such as material availability, production schedules, tooling requirements, or overall product costs.3 Many existing PLM systems struggle with robust change management capabilities.24
- Inventory Waste: Without clear plans for the disposition of materials rendered obsolete by a change, unusable inventory can accumulate, leading to significant waste.
- Delayed Problem Discovery: The true cost and consequences of poorly managed changes—such as increased warranty claims or manufacturing difficulties—may only become apparent much later in the product lifecycle, often resulting in unwelcome surprises for leadership.3

The inherent interconnectedness of design bottlenecks and change management blind spots becomes clear: siloed processes directly impede the visibility required for effective change impact assessment.3 Furthermore, the sheer complexity of modern products and supply chains presents a significant cognitive challenge.1 Even with accessible data, accurately predicting the cascading effects of a change across multiple domains is difficult for human teams.30 This limitation underscores the potential value of GenAI, which can analyze complex, interconnected datasets to provide end-to-end visibility and comprehensive impact analysis.7 By facilitating such analysis across systems, GenAI enables more informed decision-making, minimizes waste, and helps prevent costly, unforeseen consequences.18

WayForward: A GenAI-Powered Solution for Enhanced PLM

To effectively overcome the challenges inherent in modern product development, a strategic approach involves integrating GenAI capabilities with existing PLM processes and systems, rather than attempting immediate, large-scale replacements. This methodology offers several compelling advantages for enterprises:

- Minimized Disruption: Layering GenAI capabilities on top of established PLM systems allows organizations to leverage advanced AI functionalities without the significant cost, time, and risk associated with complete system overhauls.29 This is particularly pertinent given the documented difficulties and high failure rates often associated with large-scale enterprise IT projects, including PLM implementations.10 This "AI overlay" approach provides a pragmatic path to modernization.19
- Vendor Independence: This strategy can reduce over-reliance on the development roadmaps and proprietary data structures of incumbent PLM vendors.1 By building an intelligent layer that interacts with the PLM system(s), businesses gain greater control and flexibility over their data and processes, mitigating risks associated with vendor lock-in.22
- Enhanced User Experience: GenAI can power more intuitive, conversational, or role-based interfaces, simplifying user interactions with complex PLM data and processes.5 This can improve user adoption and productivity, making PLM capabilities accessible to a broader range of stakeholders.5

This vision entails deploying a GenAI layer that functions as an intelligent intermediary between users and their underlying PLM infrastructure. This layer would be designed to:

- Translate User Needs: Convert user requirements, often expressed in natural language, into the structured data formats required by PLM systems, ensuring accuracy and consistency.13
- Personalize Data Analysis: Tailor the analysis and presentation of PLM data to the specific roles, responsibilities, and information needs of different user personas, delivering relevant insights in an easily digestible format.5
- Streamline Decision-Making: Facilitate more informed and rapid decision-making by providing clear, concise, and actionable information derived from underlying PLM and related enterprise data.5

The ultimate goal of this approach is to unlock the latent potential within existing PLM investments and empower engineers and product teams to drive innovation more effectively.11 This layered integration strategy represents a practical choice to harness AI benefits rapidly while managing the risks and inertia associated with legacy systems.10 However, it's important to recognize that this approach introduces its own architectural considerations. Effectively managing the interface between the AI layer and the PLM system(s), ensuring data synchronization, maintaining security across layers, and optimizing performance requires careful design and robust governance.20 Furthermore, while vendor independence is enhanced, some dependency may remain, as the AI layer often needs to access PLM data via vendor-controlled APIs.1 Achieving complete independence might necessitate more advanced data abstraction techniques, such as enterprise knowledge graphs.22

Solution Approach: Leveraging RAG

To implement the vision of a GenAI-powered enhancement layer for PLM, the proposed solution leverages the power of Retrieval-Augmented Generation (RAG) models.23 RAG is particularly well-suited for enterprise applications as it combines the generative capabilities of Large Language Models (LLMs) with the ability to retrieve and ground responses in specific, external knowledge sources. This directly addresses key LLM limitations like potential inaccuracies ("hallucinations") and reliance on potentially outdated training data, making it ideal for contexts requiring high factual accuracy based on current, proprietary information.46

The RAG-based solution architecture comprises several key components:

- Unified Data Layer / Knowledge Base: This involves consolidating diverse product-related data—including design files (CAD models, drawings), product information (specifications, BOMs, requirements), and relevant supply chain data (supplier information, inventory levels, lead times)—into a centralized, accessible knowledge base.3 This knowledge base, potentially structured using techniques like vector databases or knowledge graphs, serves as the foundation for the RAG model, ensuring all relevant information is readily available for retrieval, analysis, and decision-making.46 This component is crucial for overcoming the data silo problem prevalent in traditional PLM environments.3
- Intuitive User Interface: A user-friendly interface is developed, featuring modules tailored to specific teams and user personas (e.g., design engineers, sourcing specialists, change managers).5 This interface simplifies interaction, allowing users to query the system and access needed information using natural language or persona-specific dashboards, without needing to navigate the complexities of underlying PLM systems directly.5
- Targeted Prompt Training and Retrieval Optimization: The RAG model is trained and optimized using prompts relevant to specific user roles and tasks.13 Effective prompt engineering, combined with optimized retrieval strategies (e.g., sophisticated chunking, fine-tuned embedding models), ensures that the system accurately understands user intent and retrieves the most relevant information from the knowledge base to generate precise and contextually appropriate responses.13

This RAG-based architecture enables several powerful use cases, particularly for engineering design teams:

- Part Reuse: Engineers can query the system using specific engineering criteria (e.g., "find cooling modules with input/output capacity X made from material Y with tooling cost under Z") to quickly identify and reuse existing designs, reducing redundancy and development time.7 The RAG model retrieves potentially matching parts from the knowledge base for evaluation.23
- Digitized Product Catalog: The system provides access to a comprehensive and easily searchable catalog of product information, including 3D models, specifications, compliance data, and associated documentation.1 RAG allows engineers to ask natural language questions about products and components (e.g., "What is the fatigue life of part ABC?" or "Show me all components using supplier XYZ").23
- What-If Analysis: Teams can explore the potential impact of proposed design changes on various factors like cost, weight, performance, supplier capacity, or manufacturability.11 The RAG system retrieves the relevant data points (e.g., current material costs, supplier lead times, manufacturing process capabilities) needed to perform the analysis.23
- Designing for Supply Chain: The platform facilitates the optimization of designs for efficient sourcing, manufacturing, and logistics by providing access to real-time or near-real-time supply chain data (e.g., component availability, supplier risk scores, shipping costs) during the design phase.5 RAG retrieves this dynamic information from the knowledge base as needed.23

Table 2: RAG Application Examples in PLM

PLM Use Case	How RAG Enables It	Key RAG Components Utilized	Supporting Evidence

Part Reuse	Retrieves existing designs/parts matching specific engineering criteria from the knowledge base.	Knowledge Base Retrieval, Semantic Search, Prompt Engineering	7
Digitized Catalog Access	Enables natural language queries on product specifications, 3D models, documentation, compliance data.	Knowledge Base Retrieval, Natural Language Processing, Semantic Search	1
What-If Analysis Support	Retrieves relevant cost, performance, supplier capacity, manufacturability data to inform impact analysis of design changes.	Knowledge Base Retrieval, Data Integration, Context Augmentation	11
Design for Supply Chain	Accesses and incorporates real-time or near-real-time supply chain data (availability, risk, cost) into the design process.	Knowledge Base Retrieval (dynamic data), Data Integration, Context Augmentation	5

Change Impact Analysis	Retrieves data across the product lifecycle (design, manufacturing, sourcing, quality) to perform comprehensive impact assessments.	Knowledge Base Retrieval (cross-functional data), Data Integration, Generation (summarizing impact)	7
Risk Identification	Analyzes historical data (e.g., change requests, quality issues, supplier performance) stored in the knowledge base to identify potential risk patterns associated with proposed changes or designs.	Knowledge Base Retrieval, Pattern Recognition (via LLM analysis), Generation (risk summary)	15

By implementing this RAG-based solution approach, organizations can empower their engineers with faster access to more comprehensive and reliable information, enabling them to make better-informed decisions, ultimately accelerating innovation cycles and improving overall product development outcomes.6 However, the success of this approach hinges critically on the quality, completeness, and structure of the underlying "Unified Data Layer." Creating this foundation from potentially disparate and inconsistent legacy data sources represents a significant data engineering and governance challenge that must be addressed concurrently.22

Streamlining Change Management for Enhanced Efficiency

Beyond enhancing design and development, the proposed GenAI architecture, particularly leveraging a unified data layer accessible via RAG, offers substantial benefits for streamlining and improving the critical process of change management. This drives significant operational efficiency for product teams.

Key advantages for change management include:

- Comprehensive Impact Analysis: By accessing the unified data layer that integrates information across engineering, manufacturing, supply chain, and potentially quality domains, the GenAI model can perform far more thorough change impact analyses than typically possible with siloed systems.7 It can consider a wider range of relevant factors and potential downstream consequences, ensuring decisions are based on a holistic understanding and minimizing unforeseen disruptions.18

- Proactive Risk Mitigation: The system can be configured to automatically identify and escalate potential risks associated with proposed changes.18 This is particularly valuable for changes that might exceed predefined cost thresholds, impact critical compliance requirements, or affect high-risk suppliers. Early identification allows for timely intervention and prevents costly errors from propagating through the system.15
- Automated Approvals Workflow: By embedding business-specific logic and rules within the GenAI layer, the system can automatically identify the correct sequence of approvers required for each specific type of change request based on factors like product line, change complexity, or potential impact. It can then automatically notify these individuals, streamlining the approval process and significantly reducing administrative delays.18

This intelligent change management system empowers teams to assess the impact of changes with greater accuracy, mitigate associated risks proactively, accelerate the often-cumbersome approval process, and ultimately reduce operational costs associated with inefficient change cycles.18

Crucially, positioning this enhanced change management functionality within the GenAI layer, potentially outside the core PLM system, offers significant flexibility and control.22 This architectural choice directly counters the inflexibility often encountered in legacy PLM change workflows3 and reduces dependence on PLM vendor capabilities or roadmaps for process improvements.1 Organizations can more readily adapt and refine their change management processes, incorporating new AI-driven insights or automation capabilities without being constrained by their underlying PLM platform's limitations. This fosters greater agility and responsiveness, enabling businesses to navigate the constant flux of engineering and operational changes more effectively. However, implementing automated approvals and risk assessments necessitates careful governance. Establishing clear rules, validating the AI's analysis, ensuring transparency in decision logic, and maintaining appropriate human oversight are essential to mitigate risks associated with algorithmic errors or biases and ensure accountability.5

CONCLUSION

In today's dynamic business landscape, marked by relentless technological advancements and increasingly complex global supply chains, the integration of Generative AI with Product Lifecycle Management systems is transitioning from a competitive advantage to a strategic necessity.5 Traditional PLM approaches, often hampered by data silos, process rigidity, and limited analytical capabilities, are proving insufficient to meet the demands for speed, agility, and insight required for success.1

This strategic integration empowers organizations to realize substantial benefits across the product value chain:

- Enhance Agility: GenAI enables companies to navigate volatile market conditions and adapt more effectively to supply chain disruptions.6 For instance, AI-driven analysis can help predict potential supply chain bottlenecks based on diverse data inputs and proactively suggest alternative sourcing strategies or design modifications before production is impacted.5
- Accelerate Innovation: Product development cycles can be significantly shortened through increased speed and efficiency.6 By automating repetitive tasks like documentation generation or preliminary analysis, and by providing engineers with rapid, intuitive access to relevant information and design alternatives, GenAI frees up valuable human resources for higher-level creative problem-solving and design optimization.5
- Improve Decision-Making: Leveraging data-driven insights becomes more feasible across the

entire product lifecycle.5 GenAI can analyze vast and complex datasets—spanning design iterations, simulation results, manufacturing data, supplier performance, and customer feedback—to identify subtle trends, hidden risks, and new opportunities that might elude human analysis alone, leading to better-informed decisions regarding design choices, manufacturing processes, and supply chain management.5

- Optimize Operations: Processes can be streamlined, costs reduced, and cross-functional collaboration enhanced.5 GenAI can automate workflows, improve the flow and context of information between previously siloed teams, and reduce the likelihood of errors and delays often caused by manual data handoffs or miscommunication.3

The benefits derived from GenAI directly address the core weaknesses identified in traditional PLM systems, offering tangible solutions to inflexibility, slow cycle times, poor decision support due to fragmented data, and process inefficiencies.1 By embracing GenAI, organizations can unlock the full potential of their PLM systems and position themselves at the forefront of innovation. However, realizing these benefits requires a holistic approach that extends beyond mere technology deployment. It demands concurrent efforts in organizational change management, workforce upskilling in areas like AI literacy and data analysis, the establishment of robust data governance frameworks, and careful attention to ethical considerations and building trust in AI-driven processes.5

Call to Action

The future of product development is inextricably linked with artificial intelligence. Organizations should not wait for this future to fully materialize but rather embrace the transformative power of GenAI today.5 It is imperative to begin exploring how GenAI can be strategically integrated into existing PLM processes and data ecosystems. Acting decisively to adopt this technology allows organizations to reap its benefits early, driving new levels of efficiency, innovation, and competitive advantage, and positioning them for sustained success in an increasingly complex and fast-paced global market.6

REFRENCES

[1] The Multi-Level Complexity of Engineering Product Data and the Limitations of Existing PLM Technologies - Beyond PLM (Product Lifecycle Management) Blog, accessed April 16, 2025, https://beyondplm.com/2023/12/10/the-multi-level-complexity-of-engineering-product-data-and-the-limitations-of-existing-plm-technologies/

[2] Process considerations for Product Lifecycle Management implementation for high-value Engineering-to-Order programmes | Design Science, accessed April 16, 2025, https://www.cambridge.org/core/journals/design-science/article/process-considerations-for-product-lifecycle-management-implementation-for-highvalue-engineeringtoorder-programmes/6D02C12CAE405DEC2A8F0736E91E3BEA

[3] 6 Critical Limitations of Legacy PLM - Converged by Propel, accessed April 16, 2025, https://converged.propelsoftware.com/blogs/plm-limitations

[4] The Fundamental Challenges of Traditional PLM Software ..., accessed April 16, 2025, https://www.openbom.com/blog/the-fundamental-challenges-of-traditional-plm-systems-a-critical-review

[5] Generative AI Trends For All Facets of Business - Forrester, accessed April 16, 2025, https://www.forrester.com/technology/generative-ai/

[6] Generative AI: What Is It, Tools, Models, Applications and Use Cases, accessed April 16, 2025, https://www.gartner.com/en/topics/generative-ai

[7] Can AI Boost Product Innovation? - Forrester, accessed April 16, 2025, https://www.forrester.com/blogs/can-ai-boost-product-innovation/

[8] Product lifecycle management - From its history to its new role, accessed April 16, 2025, https://www.researchgate.net/publication/26481

4281_Product_lifecycle_management_-_From_its_history_to_its_new_role

[9] Digitization and management of product data through the PRO.FILE PLM system - Webthesis, accessed April 16, 2025, https://webthesis.biblio.polito.it/26589/1/tesi.pdf

[10] The Impact of PLM Systems on the Digital Transformation of Manufacturing Companies, accessed April 16, 2025, https://www.researchgate.net/publication/379428525_The_Impact_of_PLM_Systems_on_the_Digital_Transformation_of_Manufacturing_Companies

[11] AI in PLM: Transforming Product Lifecycle Management - Rapid Innovation, accessed April 16, 2025, https://www.rapidinnovation.io/post/unleashing-the-power-of-ai-in-plm

[12] From Documents to Data: How Modern PLM Systems are Transforming Decision Effectiveness - OpenBOM, accessed April 16, 2025, https://www.openbom.com/blog/from-documents-to-data-how-modern-plm-systems-are-transforming-decision-effectiveness

[13] Prototyping with Prompts: Emerging Approaches and Challenges in Generative AI Design for Collaborative Software Teams - arXiv, accessed April 16, 2025, https://arxiv.org/html/2402.17721v2

[14] (PDF) Integrating ChatGPT, Bard, and leading-edge generative artificial intelligence in architectural design and engineering: applications, framework, and challenges - ResearchGate, accessed April 16, 2025, https://www.researchgate.net/publication/376224836_Integrating_ChatGPT_Bard_and_leading-edge_generative_artificial_intelligence_in_architectural_design_and_engineering_applications_framework_and_challenges

[15] How supply chains benefit from using generative AI | EY - Global, accessed April 16, 2025, https://www.ey.com/en_gl/insights/supply-chain/how-generative-ai-in-supply-chain-can-drive-value

[16] A Complete Guide to Product Lifecycle Management (PLM), accessed April 16, 2025, https://durolabs.co/blog/product-lifecycle-management/

[17] What Is the Future of PLM Tools in the Era of Industry 4.0? | Techreviewer Blog, accessed April 16, 2025, https://techreviewer.co/blog/what-is-the-future-of-plm-tools-in-the-era-of-industry-4-0

[18] Proactively Manage Risk Across the Product Lifecycle with AI and ..., accessed April 16, 2025, https://www.compliancequest.com/blog/risk-management-best-practices-ai-automation/

[19] Core transformation unlocked: digital opportunities for small and medium manufacturers, accessed April 16, 2025, https://www.engineering.com/core-transformation-unlocked-digital-opportunities-for-small-and-medium-manufacturers/

[20] Four data and model quality challenges tied to generative AI - Deloitte, accessed April 16, 2025, https://www2.deloitte.com/us/en/insights/topics/digital-transformation/data-integrity-in-ai-engineering.html

[21] New Accenture Research Finds that Companies with AI-Led Processes Outperform Peers, accessed April 16, 2025, https://newsroom.accenture.com/news/2024/new-accenture-research-finds-that-companies-with-ai-led-processes-outperform-peers

[22] PLM: Vision vs. Reality – The Ongoing Disconnect and Current Momentum, accessed April 16, 2025, https://beyondplm.com/2025/02/01/plm-vision-vs-reality-the-ongoing-disconnect-and-current-momentum/

[23] A Survey on Knowledge-Oriented Retrieval-Augmented Generation - arXiv, accessed April 16, 2025, https://arxiv.org/html/2503.10677v2

[24] From Traditional Product Lifecycle Management Systems to Blockchain-Based Platforms, accessed April 16, 2025, https://www.mdpi.com/2305-6290/6/3/40

[25] AI in Change Management: Use Cases, Applications, Implementation and Benefits, accessed April 16, 2025, https://www.leewayhertz.com/ai-in-change-management/

[26] Traditional vs. Modern Approach to NPD - Arena Solutions, accessed April 16, 2025, https://www.arenasolutions.com/white-papers/new-era-of-product-development/traditional-vs-modern-approach-to-npd/

[27] Improve Product Development with Value Chain Collaboration - PTC, accessed April 16, 2025, https://www.ptc.com/en/case-studies/ls-industrial-systems

[28] A new era of generative AI for everyone | Accenture, accessed April 16, 2025, https://www.accenture.com/content/dam/accenture/final/accenture-com/document/Accenture-A-New-Era-of-Generative-AI-for-Everyone.pdf

[29] Introducing the Distributed Artificial Intelligence Management System (DAIMS): A Bottom-Up Approach to Industrial AI - Mode Technologies, accessed April 16, 2025, https://modetech.ca/introducing-the-distributed-artificial-intelligence-management-system-daims-a-bottom-up-approach-to-industrial-ai/

[30] Process considerations for Product Lifecycle Management implementation for high-value Engineering-to-Order programmes, accessed April 16, 2025, https://www.cambridge.org/core/services/aop-cambridge-core/content/view/6D02C12CAE405DEC2A8F0736E91E3BEA/S205347012200021Xa.pdf/div-class-title-process-considerations-for-product-lifecycle-management-implementation-for-high-value-engineering-to-order-programmes-div.pdf

[31] How AI is Revolutionizing Change Management in Projects - Dart AI, accessed April 16, 2025, https://www.itsdart.com/blog/how-ai-is-revolutionizing-change-management-in-projects

[32] AI-DRIVEN CYBER RISK MITIGATION IN COMMERCIAL PROPERTY INSURANCE - IRJMETS, accessed April 16, 2025, https://www.irjmets.com/uploadedfiles/paper//issue_3_march_2025/69641/final/fin_irjmets1742586612.pdf

[33] Uniphore Acquiring Actioniq And Infoworks To Deliver The Industrys First Zero Data AI Cloud - TechDogs, accessed April 16, 2025, https://www.techdogs.com/tech-news/business-wire/uniphore-acquiring-actioniq-and-infoworks-to-deliver-the-industrys-first-zero-data-ai-cloud

[34] Leveraging AI for Enhanced Product Life Cycle Management (PLM) Transformation, accessed April 16, 2025, https://www.researchgate.net/publication/389156537_Leveraging_AI_for_Enhanced_Product_Life_Cycle_Management_PLM_Transformation

[35] The Evolution of IS Projects in Manufacturing Industries: The Case of Product Lifecycle Management - ScholarSpace, accessed April 16, 2025, https://scholarspace.manoa.hawaii.edu/bitstreams/3b9fd4bf-155b-4046-85f5-7ce8530c3b71/download

[36] Managing Data and Mindsets in Manufacturing, accessed April 16, 2025, https://manufacturingleadershipcouncil.com/managing-data-and-mindsets-in-manufacturing-11691/

[37] (PDF) RAGVA: Engineering Retrieval Augmented Generation-based Virtual Assistants in Practice - ResearchGate, accessed April 16, 2025, https://www.researchgate.net/publication/389274041_RAGVA_Engineering_Retrieval_Augmented_Generation-based_Virtual_Assistants_in_Practice

[38] Polimex - Venture Capital, accessed April 16, 2025, https://polimex.org/

[39] GenAI in Numbers - Gartner and Forrester Predictions | Blog | Frends iPaaS, accessed April 16, 2025, https://frends.com/ipaas/blog/analysts-on-genai-gartner-and-forrester-predictions

[40] Generative AI for Risk Management - XenonStack, accessed April 16, 2025, https://www.xenonstack.com/blog/generative-ai-risk-management

[41] Exploring Practical AI Use Cases in Product Lifecycle Management - English Blog - Aras, accessed April 16, 2025, https://www.aras.com/community/b/english/posts/exploring-practical-ai-use-cases-in-product-lifecycle-management-612845924

[42] PLM: The New Digital Transformation Platform - Aras, accessed April 16, 2025, https://aras.com/en/blog/plm-the-new-digital-transformation-platform

[43] (PDF) Intelligent Risk Management in Capital Markets Harnessing Advanced AI for Integrated, Real-Time Risk Mitigation - ResearchGate, accessed April 16, 2025, https://www.researchgate.net/publication/390701810_Intelligent_Risk_Management_in_Capital_Markets_Harnessing_Advanced_AI_for_Integrated_Real-Time_Risk_Mitigation

[44] Product Lifecycle Management Evolves To Underpin Smart Manufacturing - Forrester, accessed April 16, 2025, https://www.forrester.com/blogs/product-lifecycle-management-evolves-to-underpin-smart-manufacturing/

[45] Generative AI for Software Architecture. Applications, Trends, Challenges, and Future Directions - arXiv, accessed April 16, 2025, https://arxiv.org/html/2503.13310v1

[46] arxiv.org, accessed April 16, 2025, https://arxiv.org/pdf/2312.10997

[47] [2503.04847] Role of Databases in GenAI Applications - arXiv, accessed April 16, 2025, https://arxiv.org/abs/2503.04847

[48] Data Engineering - IEEE Computer Society, accessed April 16, 2025, http://sites.computer.org/debull/A24dec/A24DEC-CD.pdf

[49] AI Assistants for Spaceflight Procedures: Combining Generative Pre-Trained Transformer and Retrieval-Augmented Generation on Kno, accessed April 16, 2025, https://elib.dlr.de/208621/1/SPAICE_2024_Enhancing_Procedure_Management_for_the_International_Space_Station_Using_Retrieval_Augmented_Generation_and_Knowledge_Graphs.pdf

[50] Learn to Build an AI Strategy for Your Business - Gartner, accessed April 16, 2025, https://www.gartner.com/en/information-technology/topics/ai-strategy-for-business

[51] Forrester: Over The Next Decade, Generative AI Will Be The Fulcrum That Accelerates Business Growth, accessed April 16, 2025, https://www.forrester.com/press-newsroom/forrester-generative-ai-advantage/

[52] Integrating PLM, QMS, and ERP to Solve Manufacturing Challenges, accessed April 16, 2025, https://research.g2.com/insights/manufacturing-challenges

[53] Enterprises Get Ready - The Generative AI Revolution is Coming - HCL Software, accessed April 16, 2025, https://www.hcl-software.com/blog/hclsoftware/enterprises-get-ready-the-generative-ai-revolution-is-coming

[54] Windchill PLM Software | Enterprise PLM System - PTC, accessed April 16, 2025, https://www.ptc.com/en/products/windchill

[55] Deloitte Davos Survey: Gen AI Projects Face Scale Hurdles | Technology Magazine, accessed April 16, 2025, https://technologymagazine.com/articles/deloitte-davos-survey-gen-ai-projects-face-scale-hurdles

[56] Generative AI and change management: Preparing your workforce | Baker Tilly, accessed April 16, 2025, https://www.bakertilly.com/insights/generative-

ai-change-management-preparing-your-workforce

[57] State of Generative AI in the Enterprise 2024 | Deloitte US, accessed April 16, 2025, https://www2.deloitte.com/us/en/pages/consulting/articles/state-of-generative-ai-in-enterprise.html

[58] Measuring the ROI of GenAI: Assessing Value and Cost - Gartner, accessed April 16, 2025, https://www.gartner.com/en/articles/take-this-view-to-assess-roi-for-generative-ai