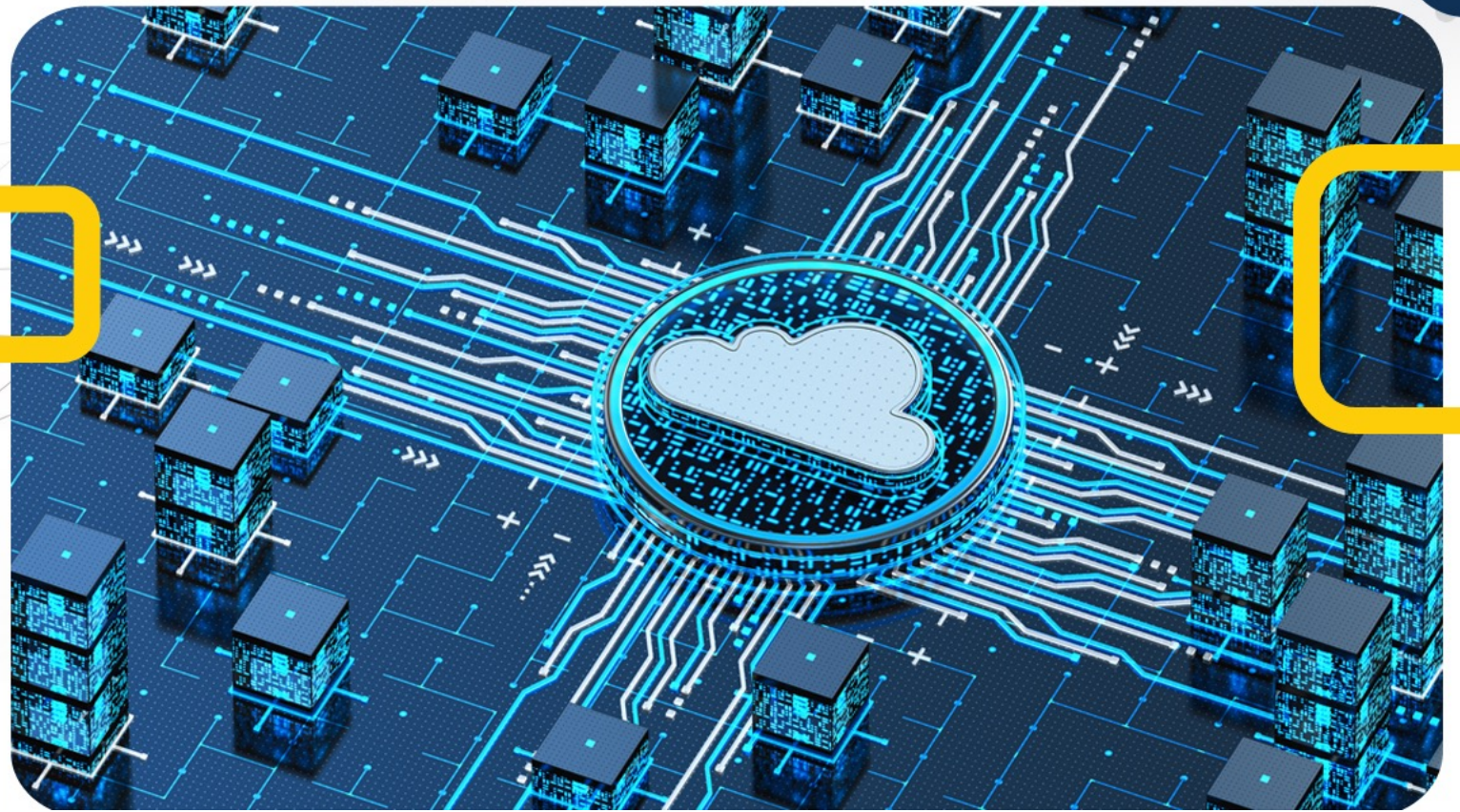
Tech-Clarity

Reconsidering the Centralized Digital Thread



Jim Brown, President

Table of Contents

Rethink the Product Digital Thread

The Digital Thread Imperative

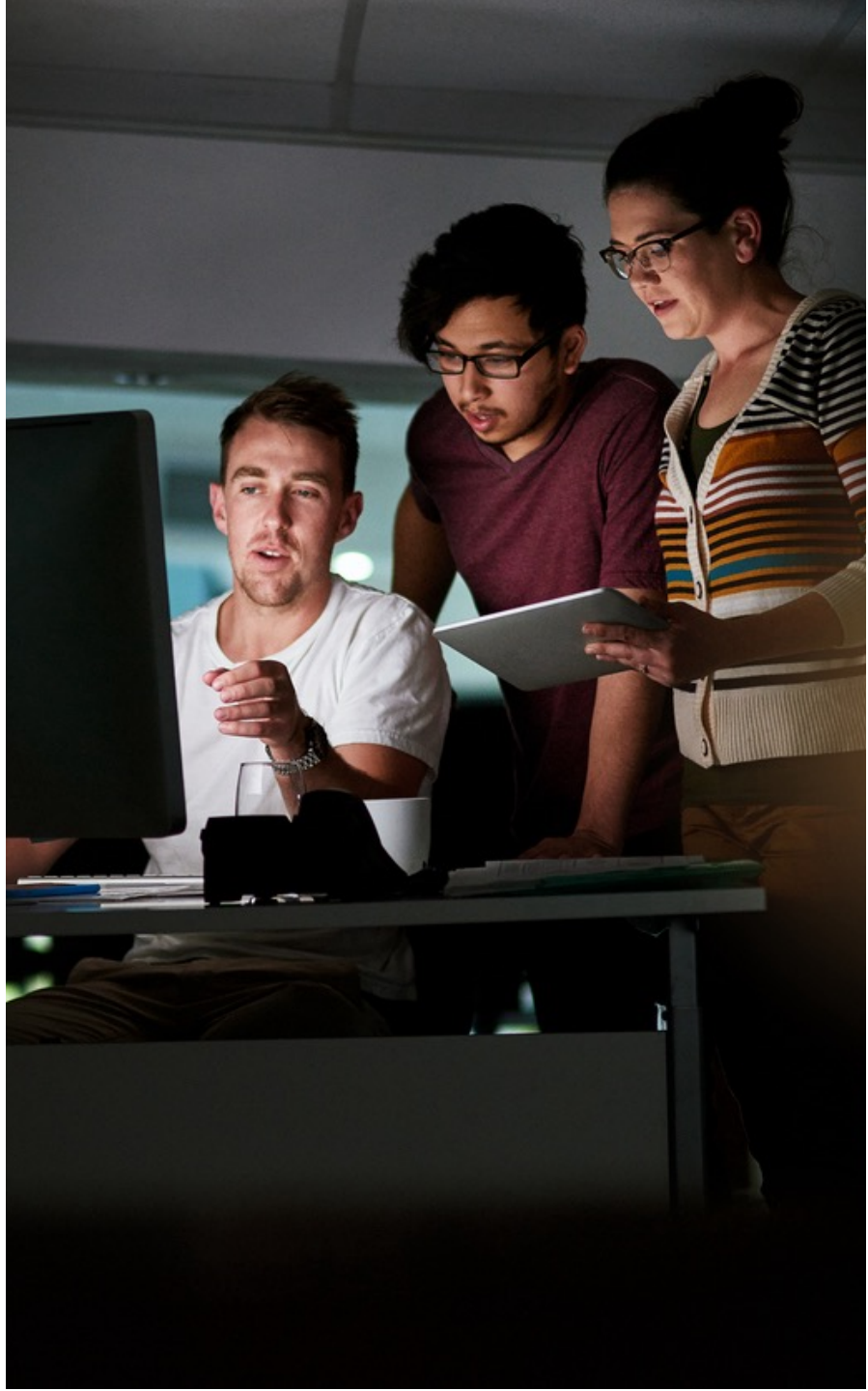
Our research finds that the digital thread is critical to effective product design and development and, in turn, crucial to driving product success and profitability.[1] We'll go into more detail shortly, but for now it's important to understand that the digital thread plays two critical roles:

- It creates *data continuity* by integrating product data, decisions, and history together in a structured way
- It leverages that data continuity to *streamline product development processes*

However, creating a complete, cohesive digital thread is challenging, in part because data is spread out over an ecosystem of specialized or "best in class" solutions used in product innovation and engineering. Given their diverse systems landscape, how can manufacturers create a digital thread that spans their product lifecycle and supply chain?

The Changing Digital Thread Paradigm

The concept of a physically centralized, single source of truth capturing the full digital thread is losing support. Digital thread strategies are evolving to a more achievable approach where PLM actively integrates and orchestrates digital thread data and processes across a heterogeneous engineering and enterprise system ecosystem. As a Director R&D for an Electronic Device Supplier interviewed for this paper accurately reminds us, ***"PLM is not a system, it's a process. It requires multiple solutions to achieve it."*** Having PLM integrate and orchestrate the digital thread across an ecosystem of applications creates a level of data and process continuity and traceability that a single system can't realistically deliver. Let's explore the transition of PLM's role to digital thread orchestration versus a fully centralized model.



Understand the Digital Thread

Defining the Digital Thread

There are as many definitions of the digital thread. For the purposes of this discussion, we'll use the following:

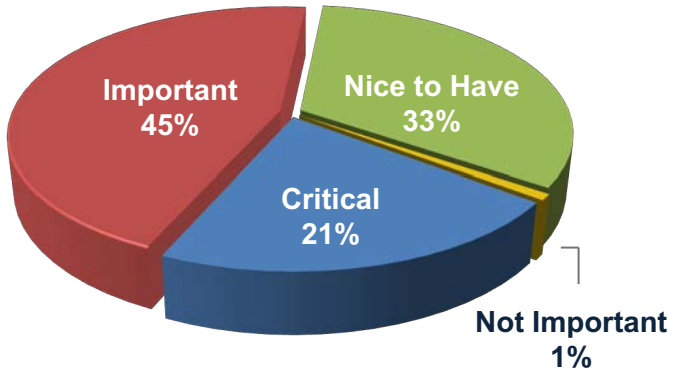
- The digital thread ties product information, decisions, and history together in a structured, integrated way that captures product innovation and knowledge throughout the product lifecycle. It establishes traceability from early in the front end of innovation through development, manufacturing, service, and field operation.
- The digital thread also streamlines product development by sharing and/or reusing design data across the stages of innovation. Digital continuity along the digital thread allows designers to add their information to a cohesive model, directly incorporating and extending data from prior steps.

The Value of the Digital Thread

From a data perspective, the digital thread creates continuity and traceability to track quality issues and drive continuous improvement.

From a process perspective, it creates repeatable, connected processes that drive efficiency. Further, it sets the stage for process automation. Our research shows that the resulting efficiencies benefit the business with reduced design cycle times, increased productivity, improved quality, and other opportunities to create new value from fully captured and searchable IP. This is why the digital thread is crucial to product design and development – and to company success and profitability.

IMPORTANCE OF PRODUCT DIGITAL THREAD TO SUCCESS AND PROFITABILITY[1]



Challenge Traditional Digital Thread Thinking

Complexity Complicates Traditional Thinking

Some time ago we published some simple diagrams showing the relationships between PLM and other systems including ERP, MES, and engineering systems including CAD. The view was always the same, with PLM as the "master" for some portion of the data with other data centralized in a small number of large, integrated systems. Now, these models make less sense because developing products like hardware devices is much more complex.

Reimagine the Digital Thread

The digital thread needs to evolve to support the transition from mechanically-centric designs to systems-oriented designs compromising electronics and software.

As the device supplier's R&D Director explains, ***"We started out as a hardware company with electronic products. Now, software is much more prevalent."*** PLM must now support electrical, electronic, software, industrial, mechanical, and mechatronic engineering disciplines and an ecosystem of best in class engineering solutions that handle unique and complex tasks. ***"We now have to support multisite development teams using multiple CAD tools,"*** shares the R&D Director. "***We have lots of other tools in the product development cycle, including three ECAD tools, one MCAD tool, and a variety of modules for simulations."***

This creates a dilemma. Does the vision of a centralized digital thread still stand true for today's complex products and engineering systems ecosystem? It's not a simple "yes or no" question, but we believe we're seeing digital thread approaches transform from "centralized" to "distributed, integrated, and orchestrated."

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Rethink PLM's Role

Recognize the False Hope

Let's face it, the digital thread is now too detailed and complex to be contained in a single system. Individual workgroups and disciplines require specialty design and engineering tools including one or more mechanical CAD (MCAD), electrical CAD (ECAD), and software development kit (SDK) solutions. Beyond these, specialists need best-in-class tools to design and analyze chips, digital communication protocols, interfaces, heat transfer, magnetic interference, and other intricacies of today's software- and electronics-drive devices.

Each of the tools engineers use creates valuable data. They develop too much detailed information, in varied formats, with their own individual lifecycles, to manage centrally. Instead, engineering teams may consider workgroup orchestration and design data management and centralize only the results. ***"The PCBAs we design have rich component information, but in the ERP world they are a BOM line item because we manufacture out of house,"*** says the R&D Director. ***"But we need to have that information available because we need visibility to the high value components on the board to be able to manage things like component shortages."***

Centralize Selectively for Control

Not all detailed data needs to be centralized and managed, but some information should be centrally available in order to manage change and release management. Take software development as an example. PLM should be concerned with released software but few would suggest it controls software sprints. Instead, PLM can manage the big picture so that device engineers, developers, and manufacturing resources are kept aware of progress and how changes impact different disciplines.

Evolve PLM's Role

PLM as a Digital Thread Orchestration

PLM systems are very effective at providing a product data and product development backbone. As a VP Engineering for a company that designs modular office devices we interviewed explains, ***"Having a system that can handle parent/child relationships natively has caused a huge improvement in BOM accuracy."*** PLM is now typically part of a much broader ecosystem. That ecosystem may even include multiple PLM offerings playing different roles at the workgroup or at the enterprise level. The dream of replacing best in class solutions with a single solution has faded. Instead, PLM can serve as a platform that orchestrates data and processes through integration and selective synchronization.

Beyond design tools, this integration must extend to other enterprise applications such as ERP, QMS, Sourcing, Supply Chain, and component databases to reflect a comprehensive digital thread and to provide engineers with the data they need to support their processes.

Define PLM's New Requirements

To support today's complex products and product development lifecycles, PLM's role must change from trying to control everything to playing three vital functions: integration (and selective synchronization), process orchestration (and automation), and collaboration.

In this way, PLM becomes less about digital thread centralization and more about consolidation, search, and selective synchronization through a publish / subscribe paradigm. This revised approach offers the best of what centralization promised in a way that is feasible with the heterogeneous tech stack needed to design and develop today's complex products. Beyond that, it creates a virtual data repository that creates a rich data foundation to support artificial intelligence (AI) and machine learning (ML) initiatives.

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- Process orchestration (and automation)
- Collaboration

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Design data can be consolidated by pushing designs and drawings from design tools into a BOM in PLM, and once consolidated pushed to ERP. You have to remove the human element from the workflow for efficiency and to prevent errors.”

Director of R&D
Electronic Device Supplier

Integrate the Ecosystem

Leverage PLM to Integrate Data and Processes

PLM should take the lead on integrating the product digital thread across the various systems that support it. ***“We use a variety of tools for engineering and product development, including MCAD, rendering, task automation, cloud storage, and PLM,”*** shares the VP of Engineering. ***“That information also needs to integrate with manufacturing tools like CNC, configuration management, BOMs, quality reports, corrective actions, and more.”*** The digital thread should integrate internal information like designs, drawings, and schematics but also connect with supplier data, information on sourced components, and commercial data to create a comprehensive, rich digital thread. For example, the representative from the electronic device supplier explains, ***“We can give a distributor’s manufacturing part number to a supplier and look up component costs and quantities. Then, it can automatically populate that information and create a rolled-up cost for the board.”***

While the source data may remain in underlying tools and formats, critical elements should be imported into PLM. This information, such as BOM data from CAD models, is typically embedded in tools like MCAD, ECAD, or other best in class solutions. This data may need to be accessed either on-premise or in the cloud. Fortunately, integration has gotten easier due to more mature approaches. PLM should support a variety of integration approaches to fit different scenarios, such as APIs, JSON, or webhooks. Digital thread integration should be transparent and traceable with an integration audit trail.

Design Example

PLM can take on the role of synchronizing data in a publish and subscribe integration model. For example, PLM may be embedded in design tools like MCAD / ECAD and extract data automatically during design and check-ins. Then, that data can be further enriched in PLM from supplier data, and the resulting design and part data can be shared downstream for testing in the context of the right revisions.

Adopt Process Orchestration

Leverage PLM to Orchestrate Processes

PLM doesn't have to do everything itself. The idea of a single system that meets everybody's digital thread needs is no longer seen as an effective approach. In fact, companies appear to be more open to using best in class solutions to fill the gaps, especially if they are cloud offerings that don't require a lot of IT overhead. But companies can't afford to have these systems operate in isolation. So, instead of doing everything, PLM's role can shift to coordinating things, including workgroup PLM applications. It can also add a measure of control, for example tracking file transfers and creating an audit trail of activities across applications.

PLM orchestration allows PLM to coordinate product design and development processes across heterogeneous solutions. Orchestration supports workflows to support processes and data that span system boundaries. It can also offer automation to get the right information to the right people at the right time, and synchronize the right data from underlying systems to let PLM control the product lifecycle without controlling detailed activities in every workgroup.

Orchestrating Design Processes

Let's discuss orchestrating processes to centrally control the product lifecycle. Change management and engineering release are critical activities that must be coordinated across departments and the supply chain. PLM can collect the information needed to show changes, conduct impact analysis, and coordinate ECO execution across design and business systems.

Orchestrating Design Data

Let's look at how PLM orchestration can collect and synchronize data needed to make decisions. Component information, such as cost, leadtimes, sustainability, EOL, and technical specifications is critical to engineering decision-making. But it is also spread out across a host of enterprise systems, sourcing applications, and cloud data sources. PLM implemented in an orchestration model can make that information visible at the time of need and track where it came from. In a publish and subscribe model, PLM can also notify appropriate product stakeholders when costs, availability, or leadtimes of sourced content change.

> "We want to centralize compliance and certifications in PLM. We can subscribe to a service and then need to manage compliance and certifications by country and standards. Then during the lifecycle we might have to make some changes, like EOL of component, and have to assess whether it impacts something like EMC, document our actions and rationale, then track it and have an audit trail linked to a revision."

Director of R&D
Electronic Device Supplier

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“It's nice to have a notes field attached to a part that’s visible to everyone, where you can write things to future people that look into the part so that information survives individual employees and email chains.”

VP of Engineering
Modular Office Devices

Support Collaboration

Leverage PLM to Enable Rich Collaboration

When PLM is used as an orchestration tool, it has the right data and context to allow engineers and others to collaborate in the context of their product development projects, products, and releases. PLM can act as the place where designs from multiple disciplines come together. Centralizing the right data allows design teams to review the implications of their designs in the context of other designers and design disciplines, and a place to work through conflicts and optimize system performance.

PLM can also keep engineers informed of design changes that impact their work. For example, they could get an alert of a changed design through PLM or in a separate tool like Slack. This way, individuals within workgroups, across workgroups, and across the supply chain can be kept in the loop on changes they need to be informed about. PLM should also provide a forum for designers to share their feedback with each other and store that feedback for future reference, for example, for the next revision of the product.

Multidiscipline Collaboration Example

The Director of R&D for the electronic device supplier we interviewed for this research shares an applicable example. ***“When a PCBA is ready for a revision, it goes to PLM. That’s where the mechanical and electrical designs come together,”*** explains. ***“Then our MCAD picks up the PCBA and creates a joint view in our PLM and makes sure the dimensions of the fiberglass work.”*** Viewing design data in context helps companies uncover clashes or disconnects early to prevent integration mistakes across mechanical, electrical, and software components. It can also help Manufacturing see changes to design files and can provide feedback quickly if there is an issue that impacts manufacturability.

Moving Forward with PLM

Take Advantage of PLM's Operational Value

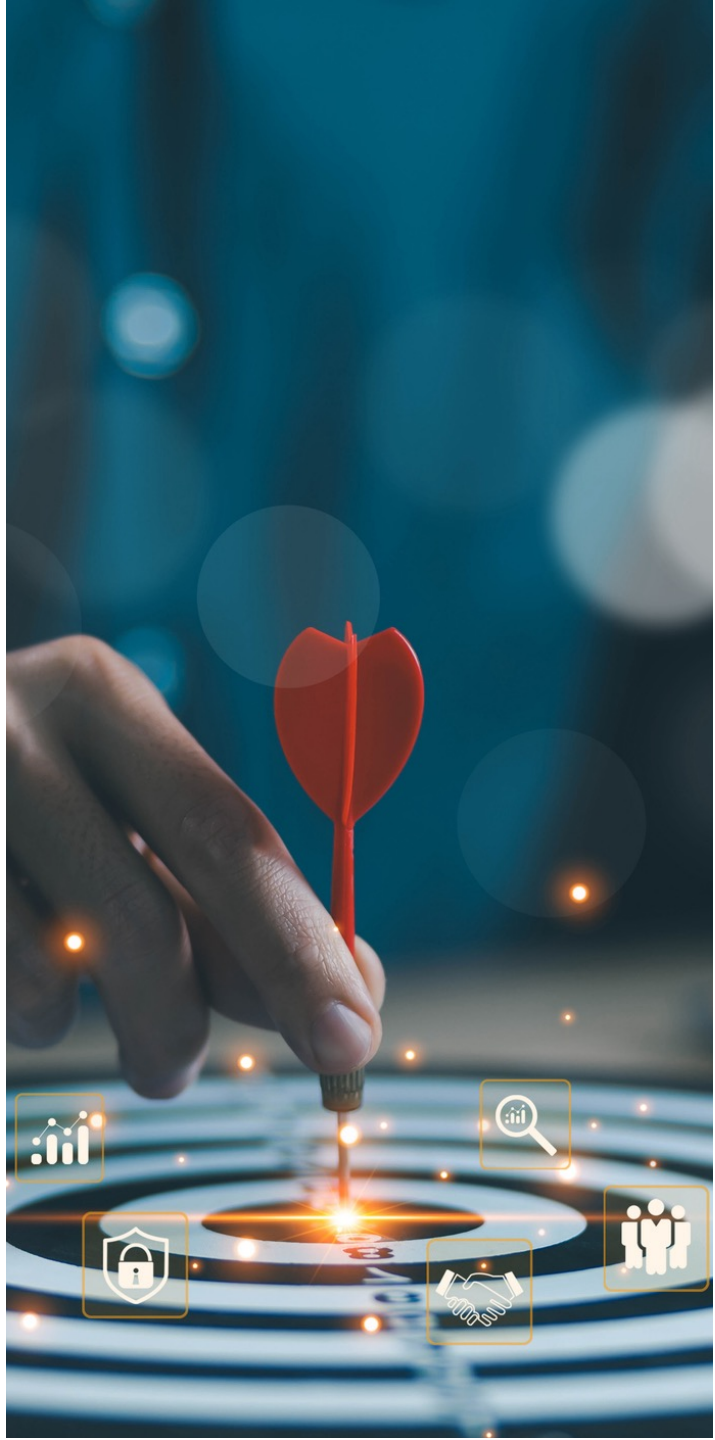
PLM can serve as a system for orchestration, but let's not forget it provides value on its own. PLM has expanded in multiple dimensions and although today's PLM offerings can't do everything for everyone, they provide extensive functionality that adds value to the business. Our research shows that PLM delivers significant operational value by streamlining the flow of information and processes. ***"We implemented automation in PLM that reduces tedious, unproductive tasks. Our engineers are more productive,"*** explains the VP of Engineering for the modular office device manufacturer. ***"We now have a much better single point of truth with PLM integrated, which makes implementing changes clearer. We likely could not have been successful on some projects without it."***

Take Advantage of PLM's Business Value

These operational improvements lead to both top-line and bottom-line business benefits (see graphic). These benefits are only extended as PLM plays a broader orchestration role. The Director of R&D for the electronic device supplier shares an example of both operational and business benefits by allowing them to make better decisions based on the data they need. ***"Designers can look for a component by searching ERP data for a part to see if it has been used to prevent duplication. We can also better manage the component lifecycle, for example, discovering an end-of-life component, doing a where-used, and assessing whether to make a last-time buy to avoid an expensive R&D board redesign."*** Our research confirms the business value, with over one-half of companies reporting faster product development, a similar number achieving better innovation, and one-half sharing PLM improves product quality.[2]

Look Beyond Centralization to Orchestration

It's time to take advantage of PLM's operational and business value but also recognize the need for PLM to adopt a new role to orchestrate the digital thread across a diverse ecosystem of tools. The R&D Director for the device supplier sums it up nicely, ***"When you have multiple teams and multiple tools, you need a PLM tool to create a central view of components and processes in the digital thread."***



Acknowledgements

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About the Author

Jim Brown founded Tech-Clarity in 2002 and has over 30 years of experience in the manufacturing and software industries. Jim is an experienced researcher, author, and speaker and enjoys engaging with people with a passion to improve business performance through digital enterprise strategies and supporting software technology.

Jim is actively researching the impact of digital transformation and technology convergence in the manufacturing industries.

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References
1. Jim Brown, Integrating Data and Processes Across the Product Digital Thread, Tech-Clarity, 2024.
2. Jim Brown, The State of PLM in CPG, Tech-Clarity, 2022.

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