



DIGITAL INDUSTRIES SOFTWARE

The power of low code in PLM

Accelerating innovation and achieving more value from
your IT landscape

Contents

Executive summary	3
Introduction	3
Extending the value of PLM with low code	5
Connecting domains and systems using low code	6
Valuing low code for product development and engineering	7
Empowering product developers and engineers using low code	10
Putting it all together with Adient	13
Conclusion	14

Executive summary

For manufacturing companies to flourish amid today's complex forces and fluctuations, your digital industry solution must accomplish two objectives. First, leverage the capabilities found in disparate digital systems across your enterprise; systems that previously met specific domain needs within your company must now meet cross-domain needs. Second, your digital assets must provide rapid visibility and access to up-to-date resources across

the value chain. The goal is to provide your team with tailored user experiences (UXs), enabling them to perform efficiently regardless of the source system. With this approach, you will achieve the speed and performance needed to gain and keep your competitive edge. This requires a low-code, multiple-experience development solution with a powerful and flexible product lifecycle management (PLM) system.

Introduction

Manufacturing businesses today must manage an escalating pace of new product introductions (NPIs), expansive calls for customization and a rapidly growing number of product variations, all while meeting demands for an ever-shorter time-to-market. For your company to thrive under these conditions, you need a transformational approach to product development and engineering, one that begins with a robust PLM solution.

Using Teamcenter® PLM software, which is part of the Siemens Xcelerator business platform of software, hardware and services, can accelerate the planning, development and delivery of innovative products. As a leading choice in PLM, you can leverage Teamcenter as a digital thread backbone that connects people across your value chain. You

can automate and streamline product lifecycle processes with visibility for everyone to make innovative product decisions. By connecting and optimizing processes for design, system development, software, simulation and visualization, using Teamcenter brings together the digital twin of your product. This enables your team to analyze and predict performance before you invest in physical parts and production.

Using Teamcenter helps you make decisions based on up-to-date product information across departments and disciplines, even externally with customers, suppliers and partners. Teamcenter is easily accessible from a web browser, on any device and within the design tools and office applications you use every day.

Rather than burdening your information technology (IT) team with traditional, labor-intensive, customized coding tasks to tailor PLM capabilities to your unique business processes, using Teamcenter empowers them with simple configuration tools to deliver an adaptive PLM environment. By taking advantage of administrative tools to simplify IT management and maintenance, you can reduce ownership costs and focus resources on the most important strategic business priorities for Teamcenter.

Thus, leveraging Teamcenter provides the digitalization and visibility you need to accomplish NPI, customization and product variation projects in a timely manner. Beyond these PLM capabilities, Siemens Digital Industries Software offers tools that allow you to derive more value from your IT landscape, especially with the Mendix™ Low-code

platform, which is also part of the Siemens Xcelerator business platform. This is a low-code, multiple experience development solution.

To gather the information and workflows for their specific responsibilities, engineering and product management teams have become adept at manually navigating multiple digital systems across your enterprise, including PLM. However, searching in this increasingly complex IT landscape has become progressively more difficult and time-consuming. Manual navigation is becoming untenable for many companies, no matter how skilled their teams are.

What if team members could instead quickly develop their own bespoke applications and extensions to access what they need from anywhere in the IT ecosystem, all on one screen?



Extending the value of PLM with low code

With Teamcenter, customers are beginning to capitalize on a set of composite capabilities with the power of Mendix:

- During a transition from 2D model-based definition (MBD) documents to a 3D MBD approach, CNH Industrial (CNH), a leading global heavy equipment manufacturer, recognized an inefficiency it wished to eliminate. Concerning the 2D MBD documents, the company's 30 research and development (R&D) centers (servicing 42 plants worldwide) were duplicating information authored in other systems. Ending this duplication would save R&D time and resources, but business users (both internal and along the supply chain) would have to retrieve needed information from multiple sources, which is a time-consuming and frustrating task

The solution: With Mendix, CNH built a web application called Digital Product Data (DPD) that ties together data from a multisite Teamcenter PLM implementation, an enterprise engineering bill-of-materials (BOM) system and a legacy drawing document management repository. CNH's engineers are now able to pull information from a single system to construct a model-based package for collaborating with business users. Using the DPD reduces system clicks by 85 percent and the effort required to understand a component's nature by 50 percent. Visually coupling 3D images with data from multiple systems improves communication of technical content and streamlines supplier communications by automating

data extraction. Importantly, CNH developed DPD using low code in just 11 weeks, something that would have easily taken a year with conventional coding

- Early in an original equipment manufacturer's (OEM's) new product development, a major task is to collect, review and manage critical information for a large volume of newly introduced parts. To efficiently accomplish this task, the program manager needs deep collaboration with various teams, automated workflows, data fidelity and control and the right analytics. Of particular importance is collaborating with new suppliers at this early stage to help the OEM plan the quality steps required to implement product innovations and reengineering. This approach, known as plan for every part (PFEP), requires data from an extensive BOM, Teamcenter PLM, enterprise resource planning (ERP) and other sources

The solution: Using a highly adaptable low-code Mendix app enables the program manager to support data gathering and approval with an automated PFEP workflow and deep collaboration capabilities that leverage all information sources. Users can validate part attributes against configurable objectives. Additionally, using the PFEP app enables diversity in viewing a large, complex BOM with part status and provides analytics for reports and dashboards that allow the program manager to efficiently manage the plan behind every new part

- Another company, Mercury Systems (Mercury), provides mission-critical technologies to the aerospace and defense (A&D) industry, such as radar systems and mission computing. Like many manufacturing organizations, Mercury serves customers that have an IT landscape consisting of disparate digital systems, each originally deployed to support a particular domain within the organization but now need to meet cross-domain

requirements. Mercury is helping its customers create a digital thread to unify these systems, which includes Teamcenter PLM, but must do so while adhering to strict A&D security standards

- **The solution:** Using Mendix enables the company to support a cloud-native environment, provide robust security and governance features and employ computer-aided design (CAD) visualization

Connecting domains and systems using low code

Until recently, digital solutions in circumstances like the ones described above required the expert services of frontend software developers, possibly on staff but often from a software vendor or a certified third-party integrator. Conventional coding by these specialists is costly, not only in terms of financial expense but also development time. Coding is a labor-intensive process, especially when it involves multiple integrated systems that must tailor data and workflow representation to individual personas based on their responsibilities and needs.

Moreover, talent that is in short supply must perform the coding. A global shortage of software developers, combined with considerable growth in demand for customized applications, means your requested applications may sit in the queue of a developer's job list, which could be too long to truly benefit your end-users. Meanwhile, your constantly evolving business demands may render the application obsolete before the developers assemble it.

CNH, Mercury Systems and other Siemens customers have overcome these difficulties by

bypassing frontend coding of adapted and extended applications using the Mendix low-code, multiple experience solution. Low-code application development is a visual, model-driven way to build and deploy software applications. It employs a drag-and-drop interface with the ability to add more complex programming as needed.

Business users and professional developers of all skill levels can build apps that bring new functionality and interconnectivity to existing or new systems so they can continue to provide value.

Using Mendix creates a business layer that non-IT specialists can wield to build value-driven applications. By abstracting the complexities of the underlying technologies and data infrastructure, leveraging the low-code solution enables data connectivity and process automation with workflow simplicity. With the low-code solution's simple tools, you can empower your workforce to quickly bring their ideas to realization.

To turn your product developers and engineers into low-code citizen developers and enjoy new efficiencies and productivity, three elements are essential:

1. Digital support to collaborate across various IT domains that have historically been siloed. This includes ERP, PLM, supply chain management (SCM), homegrown point solutions and more.
2. Rapid customized and/or cross-domain application development to support timely change management.
3. Low-code, multiple experience solution tools to enable agile collaboration and development.

This white paper explores the market and technological forces spurring this transformational approach to product development and engineering. It then describes the novel capabilities of low-code adaptation and extension for our Teamcenter PLM solution. To prompt innovative thinking about your specific needs, we apply this solution to illustrative issues that real companies are tackling. Your product and process initiatives, powered by the rich capabilities of Teamcenter and implemented on our Mendix low-code solution, promise to spark new business vitality both today and into the future.

Valuing low code for product development and engineering

The shortage of IT resources and the growth of digital system customization are direct drivers prompting manufacturers to implement low-code capabilities. The broader context of the manufacturing marketplace helps explain why a low-code solution is a suitable option for adapting and extending your digital capabilities while keeping your core systems intact.



One aspect of this broader context is the digital technology convergence phenomenon. Historically, digital systems are developed and deployed to accelerate engineering, manufacturing or business functions for specific applications. These systems typically focused solely on one technological area: information processing and management, product creation and engineering

technology or monitoring and controlling production operations technology.

Today, the demand for cross-domain data and processes has blurred these distinctions and created a need to leverage capabilities from numerous disparate systems across these three technological areas.

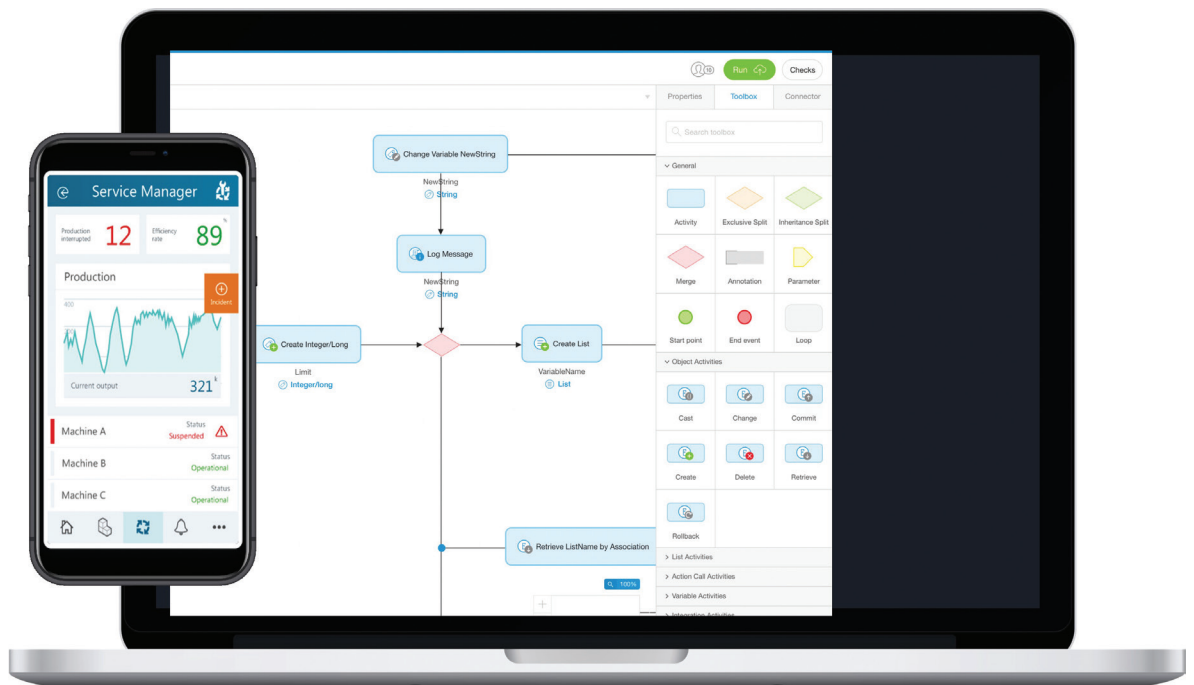
At CNH, for example, typical engineering workflows span several critical engineering technology (ET) and IT systems. Prior to deploying the DPD app, engineers had to access the engineering BOM, 3D visuals and 2D drawings to act on a complete information set for collaborating effectively with suppliers on an assembly. This time-consuming and error-prone process required users to query and interact with the enterprise change management system, an internally developed document management system, and Teamcenter PLM. Using the DPD system enables cross-domain visibility on one screen.

Another part of the broader context driving low-code application development is the rise of business technologists, employees who report outside of IT departments and create technology or analytics capabilities. Gartner reports that business technologists now make up 41 percent of all digital technologists.¹ Another 49 percent are technology end-users, leaving only 10 percent inside the IT department. Business technologists within a product development and engineering team are tech-savvy, but they typically are not high-end software

developers. A low-code solution makes it possible for these employees to develop applications that adapt or extend core system capabilities.

Finally, manufacturers recognize the competitive advantage they might enjoy if they could create meaningful, open access to both the industry and tribal knowledge of their employees and the massive data generated within their facilities and across their industries daily. Most companies have long appreciated the valuable firsthand knowledge their employees possess regarding detailed aspects of complex projects. They also see the potential for new business opportunities fueled by the data explosion they are experiencing. This includes regulatory and sustainability data, supplier material and component data, manufacturing data and customer and field use data.

Low code is a critical enabling technology for data capture and access to tribal knowledge, which companies can leverage for product innovations and improvements, process improvements and equipment upgrades. By providing democratized access to these untapped resources, low-code technology



empowers your domain experts to participate in creating tailored applications so that they can make better, faster decisions about business operations and innovations.

Consider how program management could benefit if each program stakeholder had a home page and dashboard that included all – and only – the information needed to look holistically at their responsibilities within the program. To make realistic commitments to a particular program regarding timing and deliverables, what if a custom-built app showed a buyer, for example:

- An overview of the parts on hand and needed for all programs the buyer is serving
- Supplier request for quotation (RFQ) status, current demands and any issues being encountered
- Engineering drawings, critical characteristics and special material requirements
- Target pricing
- Target dates
- Procurement status

Without a specialized app, the buyer would have to access information from multiple systems – PLM, manufacturing execution system (MES), CAD, ERP and others – before developing a realistic delivery schedule and communicating it to the program manager. Buyers typically do not have time for this labor-intensive data collection for every part associated with each program they buy. Instead, the buyer

often provides the manager with a commitment based on incomplete information and intuition. With all the interdependencies within and among a manufacturer's programs and projects, even one inaccuracy may cascade into major program delays. Better, faster decisions based on comprehensive information from a tailored app are highly valuable and using a low-code solution makes rapid application development possible for each program stakeholder.

Additionally, innovative ideas for new or enhanced products your team members generate are more easily and quickly realized when companies provide direct access to data outside the core system in a tailored UX. For example, imagine that you hired a materials scientist to investigate lighter-weight materials for a vehicle component that you make. Imagine that new hire having immediate access to all pertinent information – in a digestible format – from the existing component's design files, materials database, testing data, production quality data, part weight, field testing data and all other information on the material under consideration. Further, they can access a list of suppliers for material test coupons and prototype component fabrication, availability and costs, and the data and forms they need to generate purchase orders. Instead of spending the first few weeks learning how to extract this information from multiple digital systems, they can promptly begin the work you are paying for. Using a low-code solution enables rapid development of this specialized app.

Empowering product developers and engineers using low code

Using a modern PLM like Teamcenter already has the powerful functionality and flexibility to drive your business into an innovation leadership position in your industry. To accelerate this competitive advantage, low-code adaptation and extension tap your digital technology ecosystem's wealth of data and workflows across disparate digital systems. The resulting UXs are custom-fitted to the distinct needs of each team member, enabling them to develop and engineer products efficiently.

How can your managers and engineers gain the power of customization without the long delay of an IT backlog? First, leveraging low code helps

eliminate the backlog by accelerating IT specialists' work. Depending on the availability and skill sets of your team members, your IT department will continue to head up numerous adaptation and extension projects. With low-code tools, they can collaborate more closely with domain experts and make changes quickly, often without software vendor assistance, which they might have previously required. Additionally, the IT department will continue to oversee business-critical IT, ensuring that citizen developers work within established governance and security.



Second, companies can remove some digital customization projects from the IT queue and hand them off to citizen developers. For example, business technologists within a product development and engineering team typically are not high-end software developers. Using a low-code solution makes it possible to give these employees the responsibility to build customized apps for their teams. Additionally, the person seeking the customized app may also possess the requisite skills to assemble it with low-code tools.

Ultimately, a low-code solution enables a transformed division of labor among IT, business technologists and the product development and engineering team.

Building each customized app quickly and cost-effectively requires a few simple visual steps using low-code assembly tools:

- **Templates** are prepackaged frameworks that provide a starting point for the application. In a few simple visual steps, users can customize the template to address a specific need
- **Snippets and widgets** are tools that simplify and speed up screen creation, starting from a set of reusable building blocks. These are graphical components and modular pieces of the UX created in Teamcenter and other enterprise systems
- **App services** provide domain-specific sets of capabilities. For example, using a 3D viewer app enables the user to view CAD drawings much like one would within the CAD program, like rotating, zooming in and more
- **Connectors** enable users to reach specific data and pull it into a workflow or experience

What is the scope of customization that these low-code tools enable? To this point, we discussed adaptation and extension together, but they constitute two capabilities powered by low code. To create a tailored app for Teamcenter (connecting PLM with other enterprise systems), like the program management app for the buyer that we described, you can leverage embedded Mendix capabilities within the

enterprise development tool set, enriching the development experience. The user creates a tab within Teamcenter to launch a low-code template where it assembles the desired building blocks. Next, the system pulls information from non-PLM sources into the Teamcenter PLM environment.

As a user employs these specialized tools, they can use Mendix behind the scenes to perform data extraction and workflow generation processes for the customized UX, processes that previously required high-level coding. Meanwhile, the enterprise system continues to host and power data-model definitions and business logic implementation.

The PFEP example above represents a low-code extension of Teamcenter to connect multiple sources of information in a simple portal or composite application view. For these applications, users may start with a template for the low-code solution itself. They can use connectors to pull data into their application from various digital systems. App services such as a 3D viewer provide the desired functionality. As the system pulls the building blocks into the composite app, users specify elements to include in a frontend dashboard. The user has now created a UX that interacts with all relevant information. Since the composite app interacts directly with the enterprise system, users are always interacting with live, up-to-date data from the enterprise backend thanks to standard OData protocols and REST APIs.

Another PLM extension that users can assemble using low code is a sales configurator. Configuration management comprises a critical set of functions that a modern PLM provides. For manufacturers making engineered-to-order products, configuration management automates product and process rules so you can address new requirements quickly and accurately while meeting the constraints your organization determines. For configure-to-order products, the PLM acts as a single source of configuration data throughout the product lifecycle. While the PLM sources all viable configurations, the sales



department may use a standalone configuration lifecycle management (CLM) system to create a subset of all configurations available for sale. By assembling a composite application, the sales department can create a unified UX that includes PLM data, configuration rules predefined by the CLM and data from sources like the ERP. This composite app enables them to configure, price and quote new product variations on one screen.

As a multiple-experience solution, leveraging Mendix also supports the use of low-code assembly tools to create a mobile UX. Companies can tailor this UX to the device a user employs and to that individual's specific responsibilities, for example, field service. Many manufacturing companies have developed a new profit center via service planning and delivery for products after a customer purchases and adds them to their portfolio of physical assets. Service programs are supported by the service lifecycle management (SLM) capabilities within the manufacturer's PLM. The software manages the complex web of information associated with a

finished product, reducing the cost and time needed to create and deliver critical service documentation while also improving the quality and efficacy of the information.

Field service engineers spend a lot of time on the road, replacing parts to keep physical assets running. Every field service engineer uses the ERP to check inventory levels to know whether a part is available. They must decrease the inventory level in the ERP whenever they use a part. They then have to access the PLM to update the serial number of the used part in the as-maintained BOM. Accessing the ERP and PLM to complete these tasks during every service call is burdensome, especially in the field. Using an application on the field engineer's mobile device, assembled with low-code tools, enables easy performance of these tasks. With one push of a button, the ERP inventory levels change, and the PLM BOM automatically updates. Additionally, users can design the app to collect data while offline and upload this data whenever the device connects to the system.

Putting it all together with Adient

Adient, a leading automotive seating company with 208 manufacturing facilities globally, adopted Mendix to support its product design, engineering, manufacturing and delivery IT landscape. The company's digital enterprise includes numerous systems handling product demand, engineering, production and warehousing/logistics. Like many Tier 1 suppliers, Adient must also account for various governmental regulations and OEM specifications as they employ their many digital systems to develop and engineer each product. The IT department is tasked with keeping the whole digital enterprise working cohesively.

As Adient began investigating low-code options, its digital systems within each domain were well integrated. For example, Teamcenter and NX™ software, which is also part of the Siemens Xcelerator business platform, are well-connected within the engineering domain; however, cross-domain projects were not well supported digitally. Adient recognized that it handled most cross-domain connections in a spreadsheet, an approach that created delays and costly errors. Despite a well-staffed IT department,

Adient simply did not have the bandwidth to create adapted and extended applications to make direct cross-domain connections.

Traditional IT development at Adient required full-stack developers and a business analyst to work with each business segment to understand its requirements. They would create a user story and bring it into development and testing before going live. As such, the IT department's process focused on digital technology and only indirectly on the business solution. Adient wanted a way to involve team members within the business segment from the beginning, working collaboratively with the IT department to mark up screens, look at solutions and do some development work. In other words, the IT department was looking for a solution that allowed them to focus on business enablement instead of traditional IT functions.

By integrating Mendix, the company achieved this collaborative synergy and efficiency. It has also positively influenced the digital development culture at Adient. Having the product development and engineering teams work directly with IT cultivates a sense of ownership and diminishes any perception of IT forcing a solution on the business segment. Using Mendix also enabled Adient to build core system connectivity without altering the core. With a low-code solution, it serves as a business layer, bringing the various digital pieces together.

Another Adient use case that pairs Mendix with Teamcenter is the company's issue tracker. The engineering, quality and manufacturing departments can initiate an issue with a part. The issue tracker is available on mobile devices, so as soon as it detects an issue, it takes a picture, and the issue automatically goes into the central dataset



associated with the part and is fully visible in Teamcenter. Using the composite issue tracker app enables collaboration among departments to resolve the issue, rendering the previous spreadsheet collaboration mechanism obsolete.

Mendix extends and differentiates Adient's enterprise systems by:

- Enabling apps to be built five times faster
- Keeping the core clean by generating future-proof extensions rather than costly customizations

- Leveraging out-of-the-box (OOTB) integrations with Teamcenter applications and other digital systems
- Building in governance, security, high availability and scalability

The Adient team emphasizes that built-in security is especially beneficial. Since the security team has already approved the use of Mendix, apps built on the solution are not required to go through the entire approval process every time.

Conclusion

Outpacing the competition has never been as challenging for manufacturing companies as it is today. To thrive, they must respond by accelerating innovation, modernizing legacy systems, increasing operational efficiency and improving the digital experience of employees, customers and suppliers. By employing a low-code solution to support product development, engineering and other critical functions within your manufacturing ecosystem, you will gain a competitive edge as you tackle unique industry and marketplace demands.

Importantly, the kinds of customization suggested in this white paper support what is known as a human-centric approach to digitalization. Meaning you develop solutions to business problems that make the user's work easier, rather than requiring them to manually negotiate their way around and through multiple digital systems. By listening to

employees and codeveloping solutions with them, we found manufacturing companies experience greater enthusiasm and buy-in from their managers and engineers, accelerating product development and time-to-market.



Another important aspect of leveraging Mendix for Teamcenter is that it represents an entry point for low-code technology. Manufacturing companies today are looking across their enterprises for ways that low-code solutions will accelerate digitalization. Having a low-code PLM initiative at your company may serve as a springboard to more widespread use of low-code technology, beginning with the efficiency and accelerated time-to-market you realize by applying low code to PLM-dependent processes. All in all, low-code technology represents a watershed opportunity to increase agility, accelerate innovation and maximize productivity for greater business vitality.

By leveraging the rich and mature PLM functionalities of Teamcenter, combined with low-code capabilities in Mendix, you can create a landscape to support your entire team's individual information and functionality needs in a way that is unrivaled in today's market.

Reference

1. <https://www.gartner.com/webinar/4005892>.

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