COMMENTARY

CIMdata®

Connecting Service to Engineering

Leveraging a Digital Thread between Digital and Physical

Key Takeaways

Asset and service data can provide a wealth of valuable insights to help improve design, reliability, uptime, customer experience, and quality—yet it is often unavailable or not readily accessible.

Greater product complexity, such as smart products, is driving renewed interest in gaining better access to service information to unlock new business models, such as those based on output.

Manufacturers should extend digital thread initiatives to field service operations to unlock this data to make it more easily accessible and actionable as part of a digital strategy.

PTC's Service Lifecycle Management (SLM) solutions can help companies implement comprehensive asset management and service driven by a closed-loop digital thread.

Introduction

The lack of accurate data availability across business domains continues to be one of the major challenges facing companies today. It hampers the ability to make informed decisions, collaborate effectively, and results in a broad range of inefficiencies. This is further amplified as product complexity increases as more disciplines and teams become involved, each using different applications and data creating a web of digital product data as opposed to a path of data across the product lifecycle.[1]

The demand for higher asset availability (uptime) at lower service cost has driven significant advancements in service and asset management. Many advances have been made to address challenges in this area, in large part due to emerging technologies such as the internet of things (IoT), augmented reality (AR), as well as advanced artificial intelligence (AI) and machine learning-based (ML) analytics. Investments in innovative technologies have heralded a new era of data collection,

Digital Thread

A Digital Thread is a communications framework that connects data flows, which can be used to produce an integrated and holistic view of an asset's status and performance from physical and virtual systems (i.e., its digital twin) throughout its lifecycle across traditionally siloed functional perspectives.

[1] Research for this paper was partially supported by PTC.

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resulting in the availability of far more product-related design and operational intelligence than ever before.

Today, the problem isn't whether the data exists, but rather how to quickly gain access to the right data to understand and act upon it despite the wealth of data that is being continuously collected. Unfortunately, much of the asset and service data currently being generated in design and engineering, collected in the field, or via service interactions, is grossly underutilized across the organization. Service stakeholders often don't have access to all the design and engineering data necessary to maintain assets, impacting parts stocking levels, workforce efficiency, and overall first-time fix rates. Similarly, much of the service data collected via service interactions is not shared with product design or engineering teams—missing opportunities for product innovation. Typically, this data is siloed—disconnected from development and production and not being shared across the enterprise in ways where the right people can access and use the information in a timely and meaningful way.

What is required is a better way to access, aggregate, and make sense of this wealth of service and asset data. CIMdata believes organizations need to bridge the gap connecting the physical world of in-service assets and the digital world, with a digital thread integrating engineering, production, and service operation processes in a continuously updated, closed-loop system.

The Disconnect Between Service and Engineering

A transfer of product definition and configuration data has long existed as part of the product design and manufacturing process. Requirements flow into engineering where the product is designed. At a minimum the output includes a manufacturing Bill of Material (mBOM) and a service Bill of Material (sBOM) to ensure the product can be built and maintained to specifications. Many complex products (e.g., planes, ships, heavy machinery, etc.) are expected to have a useful life spanning many years with a service and maintenance plan to maximize that life. This information provides the basis for building and maintaining a digital history of the product's lifecycle.

As assets are put into service, a new set of data records are compiled based on the data that is collected to service and maintain the asset. Traditionally, an sBOM and its data may not be readily available beyond the field. If it could be consistently created and shared, then this data could provide enormous value in terms of providing design, production, reliability, and quality insights to be used in future product versions.

There are several challenges that often prevent this data from being shared. One of the most common is that data related to assets are often stored in disconnected, siloed systems. The data can also be fragmented or out-of-date, which leads to incomplete or inaccurate insights, resulting in missed opportunities. If not remedied, over time the configuration definition data coming from an asset will diverge from the engineering definition that was part of the asset's original design. The lack of timely access to service data makes it challenging to monitor and detect such deviations, take corrective actions, and improve the quality, reliability, and performance of the asset over its useful life.

Creating the Engineering to Service Digital Thread

Every organization utilizing complex machinery or equipment stands to benefit from having a digital thread connecting each physical asset to a virtual digital representation of the as-running asset in the field—its in-service digital twin. Creating a data feedback loop or "closed-loop" between physical and digital across a communications framework is key to a complete digital thread. As each product is designed, the output should include not only an engineering Bill of Material (eBOM)—but an mBOM and

sBOM to support future service requirements, including the work instructions on how to service and maintain the asset once it is deployed.

Each of these BOMs need to include a history of what materials were used and which processes were performed to design, build, and maintain each product. Digitally linking this intelligence creates the digital thread enabling engineering and service information to be shared between functions in a format that can be easily acted upon. With access to this data, service planners can plan for resource needs in people hours or part availability to support the predicted maintenance requirements of assets in the field. Execution-focused service stakeholders such as service technicians can benefit by having greater insights as to what product performance and service specifications were incorporated into the product to help them diagnose service situations and apply the appropriate parts or work instructions. This maximizes their efficiency and scale, extremely vital in this time of dwindling service resources.

More importantly, customers and end users gain higher value from their purchase—be it in the form of better asset utilization, lower total cost of ownership, or fewer resources required to maintain. Taking it a step further, one could argue that this is the best way to establish a customer-centric relationship that delivers a consistent, recurring, positive customer experience and relationship.

Creating an asset-centric strategy is an excellent approach to addressing this issue. This entails creating an asset system of record used within a comprehensive asset work execution and management process. This type of approach should include the eBOM, mBOM, and sBOM information linked to the asset hierarchy and system of record, which can then be used to:

- Enable a customer-centric product lifecycle with more effective predictive and remote support coordination
- Inform service and maintenance activities, based on model-based content, capable of being directly integrated with engineering and design applications
- Optimize resource needs for service events that can be orchestrated across internal and external service channels
- Provide data-driven insights across the product lifecycle to improve asset quality and performance while supporting new business models, such as outcome-based services

An asset-centric strategy enabled by a closed-loop digital thread can enhance service intelligence by supporting predictive maintenance using AI/ML technologies to help identify trends in service demand, resource planning, and acquiring after-sales service parts from an organization's supply chain. Such a solution could leverage actual resolution results to enhance future solve rates and result in simplifying warranty claims between the users and suppliers. One of the key capabilities is to enable complete traceability of product changes, service activities, and user profiles to ensure accurate collection of field asset data. This approach would provide role-based usage detail and consumption to deliver insights that enable upselling and cross-selling opportunities based on customer usage and profitability.

Value of a Digital Thread Between Service and Engineering

Access to data from the field enables engineering to improve designs, creating more reliable, serviceable, and sustainable products. Without knowledge of a product's in-service performance and any operational issues, it is impossible to make appropriate design enhancements that result in better quality and improved in-service reliability. Better service visibility and coordination not only improves the product, but also improves the customer experience—a differentiator that is increasingly required as competition for customers becomes more intense. Regulatory and environmental trends for sustainability are also

increasing, driving the need for a more circular and sustainable design and service operations through life, that is impacting the need to design for sustainability, which includes operational and service factors.

Market forces are also contributing to the potential for new value. The younger, digitally native workforce expects knowledge sharing to be intuitive and highly accessible. This is increasingly important as new engineers have a greater impact on future smart, connected products.

These smart, connected products result in an increase in product complexity, which is driving organizations to gain better access to service data enabling them to unlock new output-based business models such as Product-as-a-Service. This can't be accomplished without complete visibility of how products perform in the field. CIMdata believes to accomplish this companies must take an asset centric approach powered by a closed-loop digital thread.

Establishing a digital thread between engineering and service has a direct impact on top-line revenue with increased product innovation, better market differentiation, more product personalization, and higher customer satisfaction. Feedback from the field using a digital thread provides insights that reveal how products are used (or not used) and where new opportunities exist to create innovative and competitive new product introductions and upgrades to existing products. Organizations that have service intelligence data will gain quality insights, identify and understand feature omissions, and better understand other issues enabling them to gain market differentiation resulting in a more competitive offering.

By better understanding customers, their behavior, and the asset usage patterns that are revealed across a closed-loop digital thread, a company can tailor solutions providing personalized products—a growing trend that can lead to increased revenue. Customer satisfaction is dependent upon the buyer achieving more value from products whose performance exceeds expectations. All aspects of a product value chain must work seamlessly to deliver this exceptional experience. This requires a strategy that is predicated on high quality engineering and production combined with a closed-loop digital thread that connects the physical asset with the digital enterprise to deliver reliable, user-friendly products to satisfied customers that become brand ambassadors and customers for life.

In addition to increasing top-line revenues, an effective closed-loop digital thread increases the efficiency, with which product data is used across the extended value chain, which improves bottom-line profit. Effective digital threads help optimize the product design and manufacturing processes while reducing material waste and inventory levels, which translates into lower production costs and higher profit margins. Service insights applied to engineering-driven process improvement, automation, and supply chain management can enhance an organization's operational efficiency, leading to cost savings and improved profitability. Access to field service data can greatly improve the accuracy of engineering analysis and testing to reduce the likelihood of quality defects, future product recalls, and the ability to avoid potential legal liabilities, which could impact the bottom-line. Lessons learned from service intelligence leads to better engineered products with longer lifecycles, reducing the need for redesigns or updates, leading to more consistent revenue streams and cost savings.

PTC's SLM Strategy and Solution

Service Lifecycle Management (SLM) by PTC enables service leaders to optimize the performance of physical assets across their lifecycles to maximize customer value while supporting critical outcomes for the business. SLM is the foundation that allows service leaders to:

- Scale their business resources with greater efficiency, including people, parts, and information
- Increase customer value by delivering the highest level of responsiveness and asset uptime

- Provide near real-time visibility into field asset performance
- Deliver profitability with better visibility into cost and revenue streams
- Unlock new service business models

CIMdata believes it is critical to intimately know assets down to their digital DNA—including an asset's unique configuration, operational, and service histories. This rich data set serves as the backbone of the digital thread. PTC's SLM solution portfolio, including Arbortext Service Information, PTC Warranty, Service Knowledge and Diagnostics, ServiceMax Field Service Management, Servigistics Parts Optimization, and ThingWorx Smart Connected Products deliver an accurate record of the as-maintained asset. This asset-centric approach provides the critical data to enable a service organization to be more commercially viable, to perform predictive service operations, to better optimize resources, parts, and inventory across channels, and to make better, data-driven decisions for improved profitability and customer outcomes.

CIMdata believes taking an asset-centric approach serves as a connecting point between the digital world of PLM and design and the physical world of SLM and field assets. This provides a platform to create a true closed-loop, model-based digital thread that helps enable successful digital and business transformation.

PTC's digital, model-based content from solutions such as Creo and Windchill deliver rich information and content that help enable service organizations to optimize their service actions while maximizing asset performance. This content comes in the form of dynamic service instructions and manuals, recommended parts lists, the service bill of material, and more.

In reverse, the record of the actual performance of the physical asset can also be consumed by upstream teams such as engineering, design, quality, and reliability, to improve and accelerate product development, reliability, quality, and serviceability to support better outcomes for the business.

Conclusion

Asset and service data can provide a wealth of valuable insights to help improve design, reliability, customer experience, and quality insights. The challenge is that it is often unavailable or not readily accessible. Greater product complexity, such as smart, connected products, are driving the need to gain better access to this intelligence to unlock new business output-based business models. CIMdata is impressed with the Service Max offering and the extensive complementary SLM offerings PTC provides. CIMdata strongly believes in the value of connecting physical assets with their digital representations in a closed-loop using a digital thread. Manufacturers should extend digital thread initiatives to field service operations to unlock this data to make it more easily accessible and actionable as part of their digital strategy. This intelligence can benefit both engineering and design teams as well as identify how best to service and maintain the final, as-built product, to establish long-lasting customer-centric relationships with end users. CIMdata recommends any company looking to connect their physical assets in the field with their digital twins consider PTC's ServiceMax and SLM suite of solutions in any technology evaluation.

About CIMdata

CIMdata, a global strategic management consulting firm, provides services designed to maximize an enterprise's ability to design, deliver, and support innovative products and services. For more than forty years, CIMdata has provided industrial organizations, providers of digital technologies and services, and investment firms with world-class insight, expertise, and best-practice methods on a broad set of product lifecycle management (PLM) topics and the digital transformation they enable. CIMdata also offers

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