PROSTEP
integrate the future

WHITEPAPER

CHALLENGES OF THE DIGITAL TWIN: **MAKING DIGITAL CONTINUITY WORK**

Manufacturing companies expect the ability to monitor and optimize their manufacturing and service processes with the help of digital twins to bring about significant cost reductions. When it comes to designing digital twins, however, the challenges involved are considerable. In most cases, existing process and system landscapes will have to be expanded to provide the digital twins with the information they need.

This white paper, published by PROSTEP AG, outlines some of the key issues that need to be addressed when implementing digital twins. In this context, the concept of Digital Continuity becomes a crucial success factor.

Contents

Preamble

PROSTEP AG is celebrating its 25th anniversary this year – 25 years of staying on top of digitalization, which is progressing ever faster. Manufacturing companies are constantly having to deal with new topics, and one of the hottest topics is the digital twin. It lies at the heart of the digitalization debate because it links the digital and the physical world via the Internet of Things. Companies expect to reap considerable benefits from the ability to monitor and optimize the behavior of physical products and production systems with the help of digital twins or develop new business models based on operating data.

What role does the digital twin play in the development of new digital business models? How can companies systematically digitalize their business processes and information flows?

Strictly speaking, digital twins can be created for all smart, connected products. But for which products do they really make sense and how can they be created most efficiently? These are the questions that companies face today. Merely "fishing" in a huge data lake with the help of artificial intelligence will not achieve the desired aim. You have to know what you are looking for. That is why, in this white paper, we focus on the importance of Digital Continuity. We give thought to a number of aspects that need to be given due consideration in the context of implementing a digital twin. This applies in particular to the question of what information should flow into a digital twin, how this information might be structured, and what role the cloud and platforms play when it comes to the digital twin.

The digital twin is, so to speak, the supreme discipline of digitalization. As a vendor-neutral PLM consulting and software company with many years of experience in the field of system implementation and integration, we are the ideal partner to provide customers with advice and support comes it to digitalizing their business processes and information flows.

We are involved in a number of the prostep ivip Association's research projects and initiatives and are very familiar with the latest technological trends and topics of the future, such as artificial intelligence.

It is no coincidence that our motto is INTEGRATE THE FUTURE.

Bernd Pätzold


Engineering
Systems Engineering
Digital Twin
Internet of Things
Industrie 4.0
Operations
Manufacturing

Challenges of the digital twin: Making Digital Continuity work

In recent years, digitalization has been the key topic of the future for German industry. Manufacturing industry in particular is shaping the digital future of production with numerous initiatives, often inspired by the forward-looking Industrie 4.0 project launched by the German government in 2012. Industrie 4.0 is the variant of the digital transformation process that focuses on manufacturing and which needs to be successfully designed for society as a whole. The digital future of capital goods in particular, which used to be dominated entirely by mechanics, is generating a constant demand for innovation. It is not only in the automotive industry that future business success will depend to a large extent on new, innovative business models. It is therefore necessary that product development and manufacturing be adapted accordingly and good support be provided for digital utilization concepts.

Modern car sharing offerings and Everything-as-a-Service models like those Rolls Royce provides for its engines are inconceivable without digital representation of the respective product. The global availability of real-time data for every product instance via the Internet of Things (IoT) is a key driver of innovation in this context. Use of the term "digital twin" has established itself when referring to these digital representations.

The digital twin is one of the key innovations that enables companies to successfully shape the digital transformation.

The forms that the digital twin takes are as diverse as the different products that manufacturing industry creates. And the information required in the digital twin is as different as the business models on the market. Linking manufacturing information with information derived from actual use of a product is, however, extremely important for many digital twin concepts. In a best case scenario, the service engineer servicing an elevator optimized using predictive maintenance mechanisms is provided with a BOM of the parts actually installed in the elevator in question before leaving the service center.

But product development also wants to share in the digital twin. Information on an unusually high incidence of failures in certain components should quickly be fed back into the further development of the product. Skillful use of this feedback could improve product quality and reduce service costs, which are particularly relevant to manufacturers with as-a-service concepts, faster.

An end-to-end digital process chain that provides the right information in the digital twin quickly, reliably and automatically must be created if the full potential of the digital twin is to be exploited.

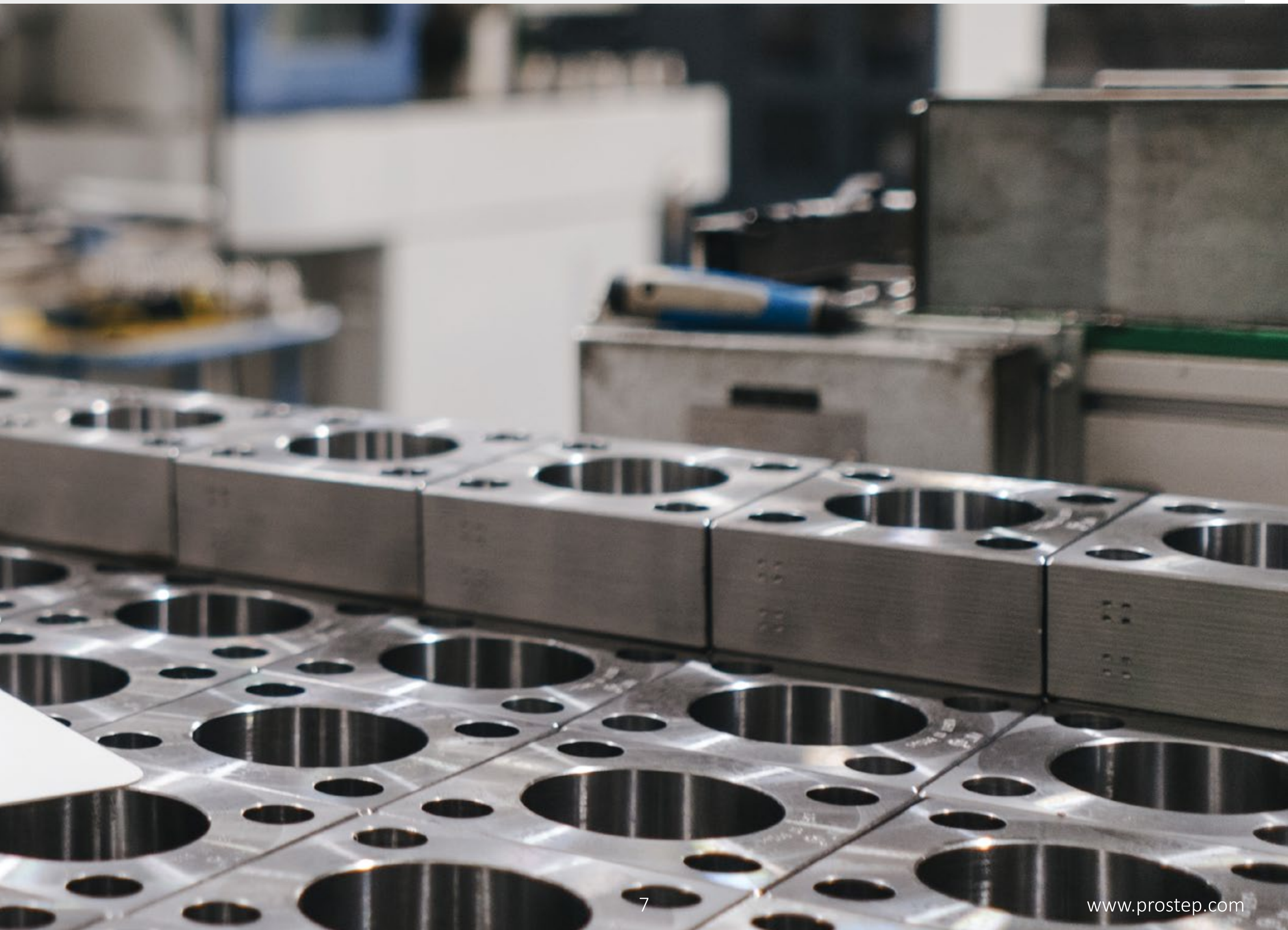
A particular challenge when it comes to the digital twin is the fact that the data needed comes from a variety of sources. During the use phase, the status data is ideally available via an IoT solution. It could, however, be the case that data from production relating to the specific product instance is also needed. Ideally, it should also be possible to access to information from product development.

These areas, referred to here for simplicity's sake as product development and production, are in turn characterized by a large number of information systems and are themselves under great pressure to change, driven by the topics systems engineering, Industrie 4.0 and Industrial IoT.

In this challenging situation involving the various aspects of the digital twin, decision-makers are faced with the question of how to make Digital Continuity work in a highly complex infrastructure.

This question quickly leads to other, closely related, issues:

- What impact do the emerging platform infrastructures have on this process?
- How do you find a suitable cloud strategy?
- What are the most important skills needed to design this kind of end-to-end process chain, which spans multiple independent and individual platforms?
- What architectural concepts are needed to provide these capabilities and enable the creation of a sustainable design for this landscape?
- And last but not least, How do I get there from where I am now?




Prediction based Decision
Linking distributed Information
Combining Development and Operation
Modelling Complexity
Digital Twin
Security and Privacy Protection
Global Availability
Verification and Validation
Direct Interaction
Innovation Driver
Artificial Intelligence
Cloud based Infrastructures
Ubiquitous Computing
Configuration Management
Agility
Model Based Enterprise
Augmented Reality
Platform Technology
PROSTEP Concepts and Technologies
Heterogeneous and Open Architectures
Data and Interface Standards
Linked Data
Model Based Systems Engineering
Product Structur Management
Enterprise Architecture Management

PROSTEP AG has been developing and implementing end-to-end digital processes in product development since it was founded 25 years ago. This experience offers great potential when it comes to helping our customers make a success of the 4th industrial revolution.

Based on the experience gained, we have compiled a number of issues in this white paper that companies need to tackle in the context of the challenges posed by the digital twin and which we examine in individual contributions from our consultants. These issues are:

- **The product structure model**
  It forms the skeleton of the digital twin and is the key to Digital Continuity.
- **Model-based systems engineering**
  Smart products require smart engineering methods. Model-based methods allow product knowledge to be used throughout the entire product lifecycle. Model-based systems engineering brings these two aspects together.
- **Configuration lifecycle management**
  Keeping track of the product configurations and ensuring the traceability of the configuration versions is a major challenge for manufacturing industry. This becomes particularly important in the context of the digital twin.
- **Platform concepts**
  Digital infrastructures are home to the digital twin. They are not made any easier to get to grips with by what are often competing system worlds. The platform concept is therefore increasingly pushing to the fore. It is of particular interest because, in addition to its technical value, it also has a largely economic value that almost eclipses the technical aspects.
- **The role of the cloud**
  For the most part, digital twins will exist in the cloud. This makes the Digital Continuity challenge somewhat more complex.
- **Agile project implementation**
  Projects involving digital twins are often large IT projects that need to be implemented reliably and on budget. An agile approach is the perfect method for making a success of even large projects.

Martin Strietzel

The digital twin as the link between the virtual and the physical world

The term digital twin is used to describe the virtual and real-world representation of a product, system or process. It represents the link between digital development and planning models and the physical world. To what extent digital twins need to represent reality will depend on the use case in question. There are numerous variants depending on the lifecycle phase involved.

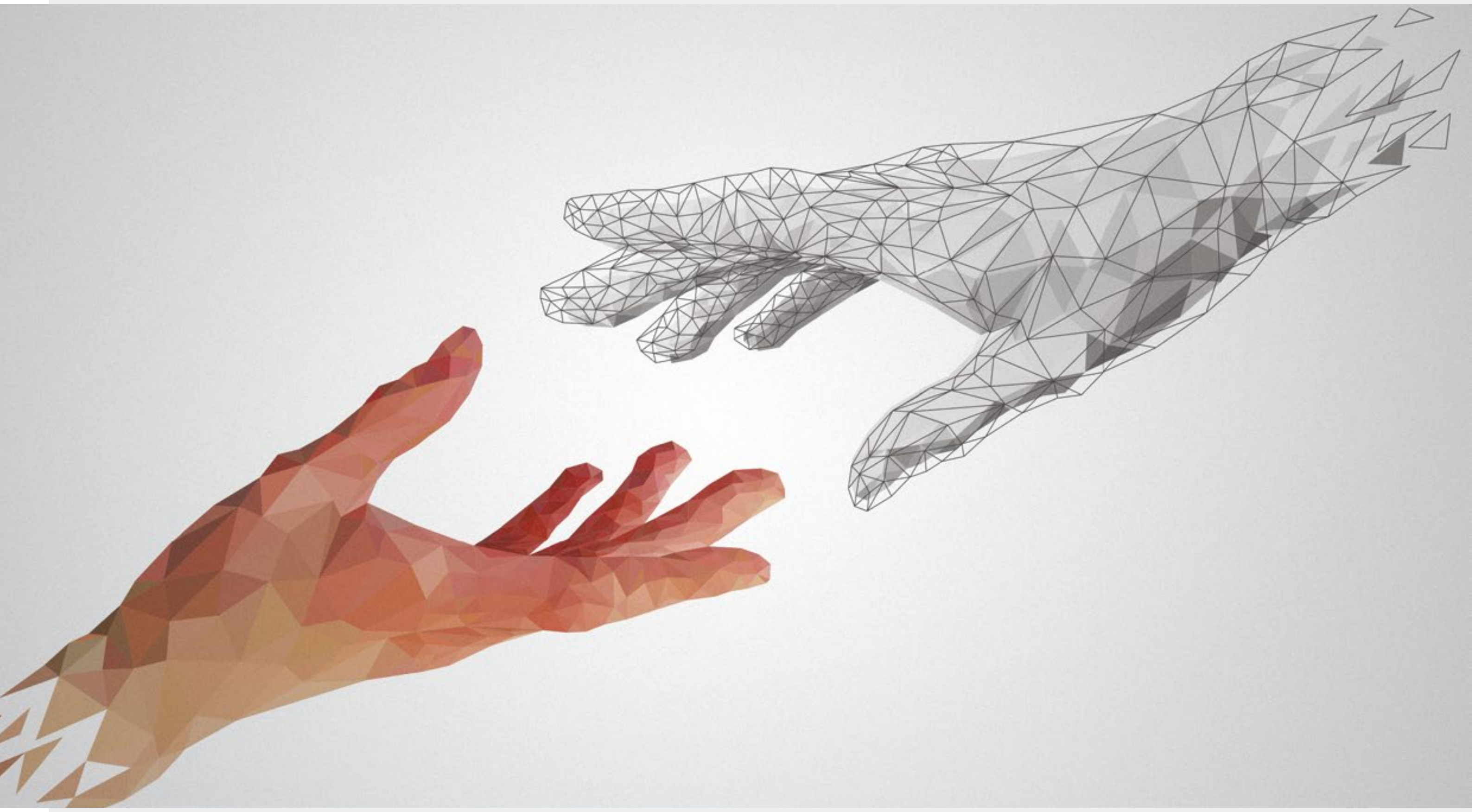
> "What does your digital twin application look like
> and do you have an appropriate sustainable architecture for it?"

However, they fall into three basic types:

- The digital product twin is a virtual representation of all the product instances used to feed information gathered during operation back into product development. This makes it possible to draw conclusions from the operating behavior, improve the product or evaluate the impact of product changes on real instances.

- The digital production twin is a virtual representation of the production process that supports the planning, control and optimization of processes and production systems and makes autonomous production possible in the context of Industrie 4.0.

- The digital operations or service twin is a virtual representation of an operational product instance that is used to support services such as maintenance, updates or retrofit measures by data analytics, predictions and decision support.



The first major challenge when developing a digital twin application is achieving end-to-end digitalization of the information across the boundaries between operational technology (such as sensors, actuators, etc.) in the physical entity and the virtual world of the corporate IT landscape. A variety of different integration solutions are available on the market for this purpose, from SCADA solutions provided by automation system integrators to IoT platforms from software vendors, which focus here on the integration of physical entities and software-based apps.

Once this first hurdle has been cleared, inconsistencies in the mostly heterogeneous IT and PLM system landscapes must also be eliminated, which in itself is difficult enough due to the lack of standards and proprietary interfaces. In addition, instance-based information from the physical entities must be compared to the development and planning models valid for the whole type of entities.

Information from physical entities that is available digitally can be used to create transparency using appropriate analysis methods and visualization tools. This, together with the linked planning and development models, forms the basis for making predictions about the behavior of the system, product or process and, in the next step, work out proposals for optimization or even enable autonomous decisions.

Initially, it is impossible to maintain an overview of the numerous possible digital twin applications. Companies need to gain a clear understanding of which use cases should be supported. This provides a basis for determining which processes, information and technologies need to be designed for the digital twin. PROSTEP uses a model-based approach taken from enterprise architecture to plan digital processes, end-to-end digitalization of information, and the technologies for the digital platform. An architectural model of these three levels is used to identify inconsistencies between the individual components of the digital twin and eliminate them by taking appropriate measures. At the same time, the architectural model serves as a blueprint and basis for the roadmap for implementing the digital twin.

Architectural planning makes the digital twin – a new quality of complexity – manageable.

Lars Wagner

No **end-to-end digitalization** without product structure models

End-to-end digitalization provides the basis for implementing a digital twin concept. This refers to the ability to merge all the digital product data required for the digital twin and, if necessary, link it with the operating data from the actual product lifecycle. The foundation for end-to-end digitalization is provided by consistent, end-to-end data structures across the entire product lifecycle and configuration management functionality that is based on them. In principle, the digital twin represents a specific view of the product, namely that of the delivered configuration.

What demands does a digital twin make on product structure management?

A particular challenge that companies face when it comes to ensuring end-to-end digitalization is the fact that the product data from the individual disciplines is distributed across a large number of data silos (TDM, PDM, ALM, ERP systems, etc.) and is managed in different structures. The structure of the development and manufacturing BOMs for the mechanical components are not identical and, in many cases, are separate from each other, which means that they have to be kept synchronized. In the context of end-to-end digitalization, it must be possible to bring these different views together without media breaks. The product structure model is the key to doing this.

The task of product structure management is the non-redundant description of products and product families, including all mechatronic components and variants, in the form of a cross-disciplinary product structure model. It links the partial structures of the various data models and structure nodes using a network of logical relationships that know what type of relationship is involved. Because the product structure model consolidates all the product-relevant information, configuration management can be used, for example, to generate specific views and document the period of effectivity. One of these configuration views is the digital twin.

How is this product structure model created? The starting point is the creation of a system-neutral information model that maps the relevant information objects, their connections and their information flows. The information model is used to derive a conceptual data model, which is converted into a logical data model that takes account of the PLM infrastructure while at the same time serving as a guide for the future PLM architecture.

PROSTEP uses a standardized method based on value stream analysis to analyze information flows and identify bottlenecks without needing to run in-depth process analyses. What is crucial here is that the information model is initially created independently of the current IT infrastructure, e.g. in the form of a UML schema that can very easily be implemented in the IT systems involved. The advantage of the system-neutral description is that the information model can also be used to adapt the product structure model if changes are made to the IT infrastructure.

The product structure model provides the basis for managing product configurations across all phases of the product lifecycle. It forms the backbone of an integrated product data model for all the departments and all the views of the product. As the first view, it covers the MBSE requirements and functional structures used in MBSE. At the same time, it provides a basis for optimizing the communication processes and the system interfaces. In other words, it is impossible to optimize the PLM architecture or achieve end-to-end digitalization without a product structure model.

End-to-end digitalization without a product structure model and PLM architecture is like building a house without a foundation or structural analysis.

Peter Wittkop

Digital twin basis: **model-based systems engineering**

Digital transformation builds on the end-to-end digitalization of business processes and information flows in companies and the entire value chain. As far as product development is concerned, this makes it possible to use digital information at a much earlier stage to validate how products or production systems function in the system context and thus speed up the entire development process. Model-based systems engineering (MBSE) is the key to increasing the degree of product maturity in the early phase of product development. It requires not only the implementation of new methods and IT tools, but also organizational changes and changes to collaboration processes.

The development of cyber-tronic systems is a highly interdisciplinary process. Not only must the engineering disciplines traditionally involved in mechanical, electrical/electronic and software development be integrated in the development process at an early stage but also new stakeholders to ensure that due consideration is given to the different requirements relating to the entire system lifecycle: the production planning department, which has to develop the appropriate systems, the service department, which will be offering the product as part of a service package, and perhaps also external partners, with whose systems or platforms the products are to be connected. The common denominator for this interdisciplinary process is systems engineering (SE), an approach matured in the aerospace industry.

Is your product development process ready for the challenge of virtual validation?

SE is an important tool for mastering the complexity associated with the digital transformation of business processes and models and addresses three key challenges:

- It closes the semantic gap between the different disciplines and makes interdisciplinary collaboration possible.
- It establishes a granular relationship between individual requirements, functions, components, etc. and makes the impact of any changes transparent.
- It supports traceability and the automated, simulation-based validation of functionality at component, subsystem and system level.

MBSE, which is derived from SE, extends this approach with the consistent use of digital models. The interlinked models form the digital master, i.e. the order-neutral description of a product with all its variants from which the digital twin is derived as a concrete representation of the real product. In this respect, MBSE is the basis of the digital twin.

Cross-disciplinary requirements management, which is integrated in the development process in such a way that changes to the requirements and their impact can be traced throughout the entire product lifecycle, provides the foundation for implementing MBSE. Secondly, this development process needs to be expanded and standardized to ensure that discipline-specific subprocesses can be mapped and collaboration across different departments is possible . Thirdly, a modular and flexible PLM infrastructure is required to provide IT support for this collaboration. And fourthly, simulation methods must be integrated in the MBSE-based development process as a self-evident process step.

The implementation of MBSE is therefore a massive change of process, that impacts on the entire organization. Companies should take advantage of the support provided by experienced consultants with the appropriate process, method and integration know-how, when integrating the tools and methods used in MBSE in their development process and when building an end-to-end digital product model.

Systems engineering is an important means for mastering the complexity associated with the digital transformation of business processes and models

Steven Vettermann

Keeping on top of things: **configuration lifecycle management**

Smart, connected products and production systems generate a growing flood of digital data during development, manufacturing and even operation. This data is typically isolated in each of the domain's partial data model. The relationahips that develop between the partial models can be mapped in a cross-disciplinary product model. Each domain can independently generate different views of the digital product model over the course of the lifecycle, maintain consistency of the views and document the period for which they are valid. However, flood of data is only made manageable by using cross-system and cross-disciplinary baselining in combination with powerful configuration lifecycle management (CLM).

Without CLM, companies are never in a position to immediately determine what information represents the digital twin. CLM provides the tools needed to search, sort, filter and combine product data across domains to baseline and control all digital artifacts.

A prerequisite for cross-disciplinary CLM is consolidation. The information from the different domain systems must be consolidated by integrations and state-of-the-art technologies like linked data. With CLM, a user can access any aspects of the product model that interests them. They select one or more criteria, such as order, milestone, design phase or delivered product instance, and receive the requested information immediately. This applies to the respective baseline for all criteria, from simulation results to an overview of the available spare parts. The results defined for the baseline can then be linked directly to the information in the master data system sources, displayed with the required properties like maturity level or date of last change, and compared with other deliverables from the project.

Have you gotten to grips with your numerous variants and the challenges of product complexity?

Maintaining configuration parameters is an important prerequisite for the successful use of CLM. The required configuration data must be coordinated throughout the enterprise for the entire lifecycle of the digital twin. The data must also be coordinated during all individual sub-processes such as purchasing, production and service, and must be made available as linked data sources.

The complexity involved with the number and variety of parameters, their logical connection, and the number of resulting variants presents an additional challenge in CLM. These parameters must also be validated and maintained throughout the lifecycle.

How can these challenges be mastered? Coming to grips with complex, high-variant products first requires an in-depth analysis of the variability and the means of measurement and management. Our standard PROSTEP methodology toolbox can be utilized to this consulting task. Software for evaluating the configuration data is also required. This software must be able to:

- Analyze extremely large and variable amounts of data using mathematical methods
- Display graphical representations of the dependencies between variants, options, and configurations
- Identify and isolate inconsistencies, gaps and redundancies in the configuration
- Link product models from different disciplines, such as engineering, sales or service
- Optimize product configurations and find the configuration with the lowest cost, shortest development time or most expedient test effort

Together with the product model, these methods and tools are a great help when creating a consistent configuration lifecycle management system that allows for efficient, coordinated and binding decisions.

A prerequisite for cross-disciplinary CLM is consolidation of the information from the authoring systems used by means of existing integrations and state-of-the-art technologies for linking data.

Lutz Lämmer

Promoting the network effect: **the platform economy**

Led by Amazon and Co., the platform economy is growing without restraint. Even though the best-known success stories are essentially transaction platforms for the B2C sector, digital platforms are also beginning to unleash their disruptive force in the B2B market. An important driver is the digital twin, which makes it possible to use data from the actual product lifecycle to develop new value-added services or optimize the products. A good reason to take a closer look at the platform economy.

Platform-based business models use network effects, i.e. their benefit is generated from the contributions of all participants and increases in line with the number of participants. They depend on a critical mass and, according to the winner-takes-all principle, lead to a concentration of market power on just a few platforms.

New IT platforms, characterized by a modular structure with separate core and application modules, provide the foundation for platform-based business models. Standard interfaces allow the platform to easily be expanded to include additional modules and connections to other platforms to ensure Digital Continuity. A key feature of a digital platform is the use of a cloud infrastructure with a Software-as-a-Service (SaaS) model, which is the prerequisite for centralized management of the platform and the applications based on it, as well as for centralized orchestration of the entire ecosystem according to uniform governance rules.

What does “winner takes all” mean for your digital twin strategy?

In this sense, many PLM solutions that are positioned today as product innovation platforms are not yet truly representative of the platform economy. However, the impact of the winner-takes-all concept is so serious that the platform concept, with its opportunities and risks has a significant influence on the development of the PLM market.

Applying the platform concept to the core area of product development represents a dramatic cultural change in the direction of an open innovation culture for companies. They must become willing to open up their innovation process to the outside world in order to integrate ideas, technologies and feedback from external partners (outside-in process), but also in order to disclose part of their internal knowledge (inside-out process). The combination of both processes is likely to be crucial to the success of any platform ecosystem. The protection of intellectual property plays a key role in this context. Binding rules for usage rights, the distribution of revenues arising from use, and the right to make changes to the product information must be agreed on for all the parties involved.

Platform-based business models are gradually establishing themselves throughout all industries and on all levels, with focus in industrial environments placed on the digital factory (Industrie 4.0) and the development of new, data-based services. The key driver is the Internet of Things (IoT), which has laid the foundation for the networking of smart products and production systems, in conjunction with the new possibilities offered by big data analytics. There are now dozens of IoT platforms, but according to market researchers only a few of them will reach a critical mass.

In the PLM context, IoT platforms are the key to building digital twin applications that accompany the product or production system throughout its entire lifecycle and make information from the operating phase available for their further development. The digital twin may be born in an PLM or ERP system but it ultimately lives on an IoT platform. It is therefore an integral part of any sustainable IT infrastructure that supports the digital transformation of business models and processes. This is something that companies should take into account when defining their future PLM architecture and when restructuring their existing PLM landscapes.

Platforms rely on a critical mass and, according to the winner-takes-all principle, lead to a strong concentration of market power.

Florian Lüßen

Virtual life – the role of the cloud

In recent years, the cloud has developed into an engine room for the Internet of Things (IoT) and many professional Internet services. The cloud also plays a crucial role in manufacturing industry's digitalization strategies.

This means that it is not possible to talk about digital twins without examining the role of the cloud more closely. Just as the configuration of the digital twin depends on the use case in question, the importance of the cloud for the development and operation of a digital twin application also varies.

While an on-premise cloud solution might be the right choice for the digital product twin as an individual virtual prototype in product development, thousands of wind turbines installed worldwide or hundreds of thousands of autonomous vehicles require a cloud-based IoT infrastructure with a high level of availability, performance, scalability and flexibility.

What demands does the digital twin make on a cloud-based PLM architecture?

Because the digital twin depends on the availability of data from a variety of very different platforms and systems, this raises the question of how these systems can communicate and exchange data within the framework of a cloud-based operating model. In this context, the cloud concepts chosen will be crucial to the success of end-to-end digitalization.

At most companies, the PLM platforms on which the digital master takes shape are still installed on-premise. The first manufacturing companies are, however, already moving their PLM processes to multi-tenant systems in public clouds. PLM manufacturers are particularly interested in positioning cloud-based applications in new customer business. However, the offerings vary considerably. The spectrum ranges from standardized SaaS (Software-as-a-Service) models from a public cloud to custom PLM applications that are hosted on a cloud-based infrastructure (IaaS) and which may be managed by the software providers. It is not always easy for potential users to assess which cloud model best meets their requirements in terms of functionality, data security and cost.

But the cloud does not make traditional IT-related considerations regarding integration and data exchange between different systems a thing of the past. Specialist integration expertise is still needed to master these aspects. Every digital twin infrastructure requires a sound concept as to how the exchange of information between the various subsystems can be organized. This is already a challenge in a company's own data center, which requires a high level of technical skill on the part of the IT team. But if the ERP system is in the SAP cloud, the Office portfolio in Microsoft Azure and the PDM system is managed by the preferred PLM provider, the complexity increases because it is necessary to link several clouds together. Different communication and integration strategies are therefore required depending on the type of cloud application.

This is why companies with existing PLM applications in particular need to analyze very carefully the extent to which they can map the expertise inherent in their product data and processes in the cloud and under what conditions it pays to migrate their on-premises solutions.

One thing is certain: your cloud strategy must be well planned and should already include end-to-end digitalization as a key component.

Your cloud strategy must be well planned and should already include end-to-end digitalization as a key component.

Mario Leber

Agility as an integral part of workaday practice: how large IT projects succeed

In today's world, agile methods are the state-of-the-art when it comes to IT project management. Corporations also use them in large IT projects they implement together with service companies. The most common agile process model is Scrum, which has to a great extent replaced the conventional waterfall model and its variants. It does, however, require a redefinition of customer-supplier relationships.

Large IT projects involving external service providers are usually executed on the basis of service contracts and billed at a fixed rate. With agile methods, however, there is no longer a clearly defined scope of delivery, instead there is a rough target (product vision), a timeframe and a team.. This means that the customer's management must make an investment, rather like a declaration of intent decision: We will invest the sum of x euros next year in order to achieve a specific objective without knowing the detailed results in advance and without having a contractual basis for demanding the result should this become necessary.

This has a direct impact on the remuneration arrangement as measurable criteria for evaluating supplier performance need to be identified. There are basically two variants: billing for the number of hours worked (time and materials) or for deliverables (agile fixed price). The time-and-materials model is easier to implement from an organizational perspective, but it shifts all the project risk to the client. The deliverables-based model is in principle a fixed-price model with very small billing units (user stories), whose constraints are regulated by a framework agreement. It requires significantly more organizational effort when it comes to acceptance and billing but results in greater transparency and a more even distribution of risks.

Are you ready for agile implementation of the digital twin?

Scrum in itself is only designed for teams of up to nine people. Software relevant to industry in the context of implementing digital twins, however, often requires larger development teams, thus giving rise to the question of how collaboration between a more or less large number of Scrum teams can be organized efficiently. The approaches proposed in the literature, such as LeSS and SAFe, are typically based on a multi-level model, with operational work taking place on the lower level and coordination on the upper levels. This means that the operational teams send representatives to the respective upper level teams. If necessary, this model should be supplemented with other bodies to ensure that project-wide definitions are adhered to and that the focus remains on the overall objective.

Implementation of the digital twin in a company's extensive IT landscape is a large-scale and complex project. The use of agile process models poses a risk here: It is tempting to launch large projects without sufficiently clarifying the objectives and constraints and hope that it will be possible to clarify these points during the course of the project. Unfortunately, the methodology does not provide any clear recommendations as to what should be clarified and defined in advance and with what level of detail. The project participants must therefore make this decision based on their own experience and strike a balance between creative chaos and over-specification à la the waterfall model.

Experience shows that a lack of process knowledge and inadequate analysis of the data model in particular can result in expensive abortive developments, which could be avoided or at least reduced with a little more conceptual preparatory work. It can therefore be concluded – and this applies to projects involving digital twins in particular – that sufficient attention also has to be paid to the process and data model description when using an agile approach in order to ensure that a solid conceptual basis for implementing the desired functionality is available at an early stage.

With agile methods, however, there is no clearly defined scope of delivery, instead there is a rough target (product vision), a timeframe and a team.

Norbert Lotter

PROSTEP – Your partner for **digitalization and digital transformation**

PROSTEP AG is the leading, vendor-independent PLM consulting and software house. As an automotive think tank, we have been helping shape key PLM trends for 25 years and making them accessible to other companies. We know the PLM strategies, processes, requirements, solutions and costs in all sectors of manufacturing industry and maintain close ties to all the major players in the PLM community. Many customers have relied on our consulting and solution expertise from day one because they know that we deliver on our promises.

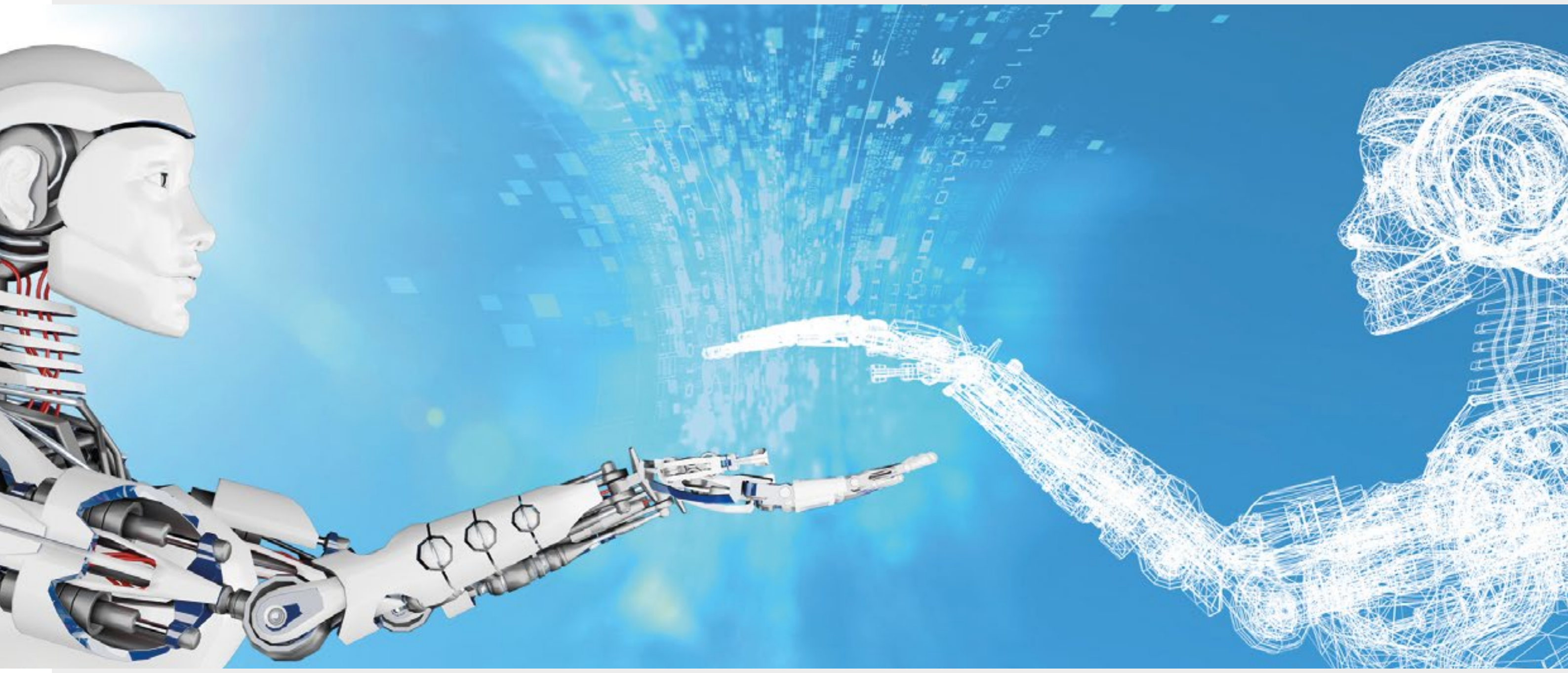
Although digitalization and digital transformation offer companies tremendous opportunities to increase their value creation, they also present them with major challenges. We provide you with advice and support when defining your strategy for digital transformation, implementing Industrie 4.0 initiatives and developing new, data-driven business models.

These new business models are driven by smart, connected products and production systems whose development requires new tools, methods and processes for interdisciplinary collaboration. The key is model-based systems engineering (MBSE), which enables early simulation and validation of functions in the context of an overall system. We help you integrate tools and methods used in MBSE in your PLM processes and systems.

MBSE forms the nucleus of the digital twin, which establishes a link between the digital and physical world and accompanies the product through to the operating phase. We work together with you to define appropriate applications for the digital twin, create an end-to-end product structure model that brings together all the necessary information in a digital master and implement cross-disciplinary configuration lifecycle management for managing the respective configuration of the digital twin.

The creation of a digital twin usually requires the restructuring of existing PLM landscapes. Our experts provide you with vendor-neutral advice when defining a target architecture and the corresponding implementation roadmap and lend their support when selecting an appropriate system. We also take account of the requirements that arise from the trend towards multi-platform architectures and the advantages that cloud-based operating models offer your company. Taking an agile approaches to a project guarantees fast implementation of the requirements and ensures the success of the project.

Our motto „PROSTEP - Integrate the Future“ is more relevant than ever.
We make you fit for the digital future.



Digital twin: the supreme discipline
What we offer

1. **Strategy consulting for digital transformation**
   - Development and validation of your strategy for digital transformation in the context of your corporate strategy
   - Smart engineering assessment and Industrie 4.0 readiness check
   - Enterprise architecture management

2. **Concepts for the digital twin**
   - Definition of use cases for the digital twin
   - Product structure model for end-to-end digitalization
   - Cross-domain configuration lifecycle management

3. **PLM process and architecture consulting**
   - Development of a PLM architecture for the digital twin
   - Vendor-neutral consulting and requirements analysis
   - Benchmarking and selection of PLM systems

4. **Model-based systems engineering**
   - Design of new processes, methods and tools for model-based development
   - Development of the digital master as the basis for the digital twin
   - Vertical integration from requirements management across all disciplines and domains through to validation

5. **Cloud concepts and the platform economy**
   - Evaluation of costs, benefits and operating concepts
   - Integration of cloud and on-premise solutions
   - Transformation from PLM to product innovation platforms

6. **Agile methods, Scrum and DevOps teams**
   - Take advantage of the experience gained from large-scale projects in the automotive industry.
   - We strike a balance between creative chaos and the waterfall method.
   - Our DevOps teams exploit synergies offered by development work and operational experience.

Karsten Theis

PDF version of the white paper:
www.prostep.com/whitepapers
or scan the QR Code

PROSTEP
integrate the future

Do you have any comments or questions?

We look forward to your feedback at
infocenter@prostep.com

PROSTEP AG
Dolivostrasse 11 · 64293 Darmstadt · Germany
Telephone +49 6151 9287-0 · Telefax +49 6151 9287-326 · E-mail info@prostep.com

PROSTEP INC
300 Park Street Suite 410, Birmingham, MI USA
Telephone +1 877.678.3701 Telefax +1 877.678.3702 · E-mail info@prostep.com

Legal Notice

Published by
PROSTEP AG

Contact:
Martin Strietzel
martin.strietzel@prostep.com

Edition 1, 2019