PROSTEP
integrate the future

WHITEPAPER

SMART ENGINEERING: THE IMPACT OF INDUSTRY 4.0 ON PLM

Industry 4.0 offers companies considerable opportunities but also presents new challenges. Without smart connected products, there can be no digital factories and also no digital transformation of business process and business models. The development of smart products requires the intelligent linking of engineering processes across different companies and across different domains. That is what we mean by „Smart Engineering“. A prerequisite for Smart Engineering is an overhaul of existing PLM architectures and end-to-end digitalization of the entire product lifecycle.

This white paper describes the challenges posed by Industry 4.0 when it comes to PLM processes and systems and presents you with possible approaches for mastering these challenges.

Contents

Preamble

Industry 4.0 challenges the status quo and creates new opportunities as a result of the digital transformation of business processes and business models. Humans, machines, systems, logistics and products will be able to communicate and collaborate directly with one another. Development processes, production processes, logistics processes and service processes in companies and between different companies will be intermeshed intelligently, making end-to-end processes even more flexible and efficient. This revolution presents companies with an opportunity that they cannot afford to overlook.

But what impact will these changes have on the processes, methods and IT systems in product development and engineering?

What challenges and opportunities will they bring?

What strategies and approaches will provide a means of mastering the challenges and exploiting the opportunities?

This white paper, entitled „Smart Engineering: The Impact of Industry 4.0 on PLM“, takes a look at the impact that Industry 4.0 will have on future engineering and PLM processes and draws conclusions as to the further development of PLM. The challenges and opportunities are then placed in the context of the range of consulting services that PROSTEP AG currently offers.

Industry 4.0 and the associated digital transformation will bring about dramatic changes for our customers. Thanks to our wide-ranging consulting expertise and our many years of experience with PLM integration and implementation, we are fully equipped to provide you with support you need. Our involvement in numerous of the ProSTEP iViP Association‘s research projects and initiatives means that we are always at the forefront of innovation.

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

Bernd Pätzold

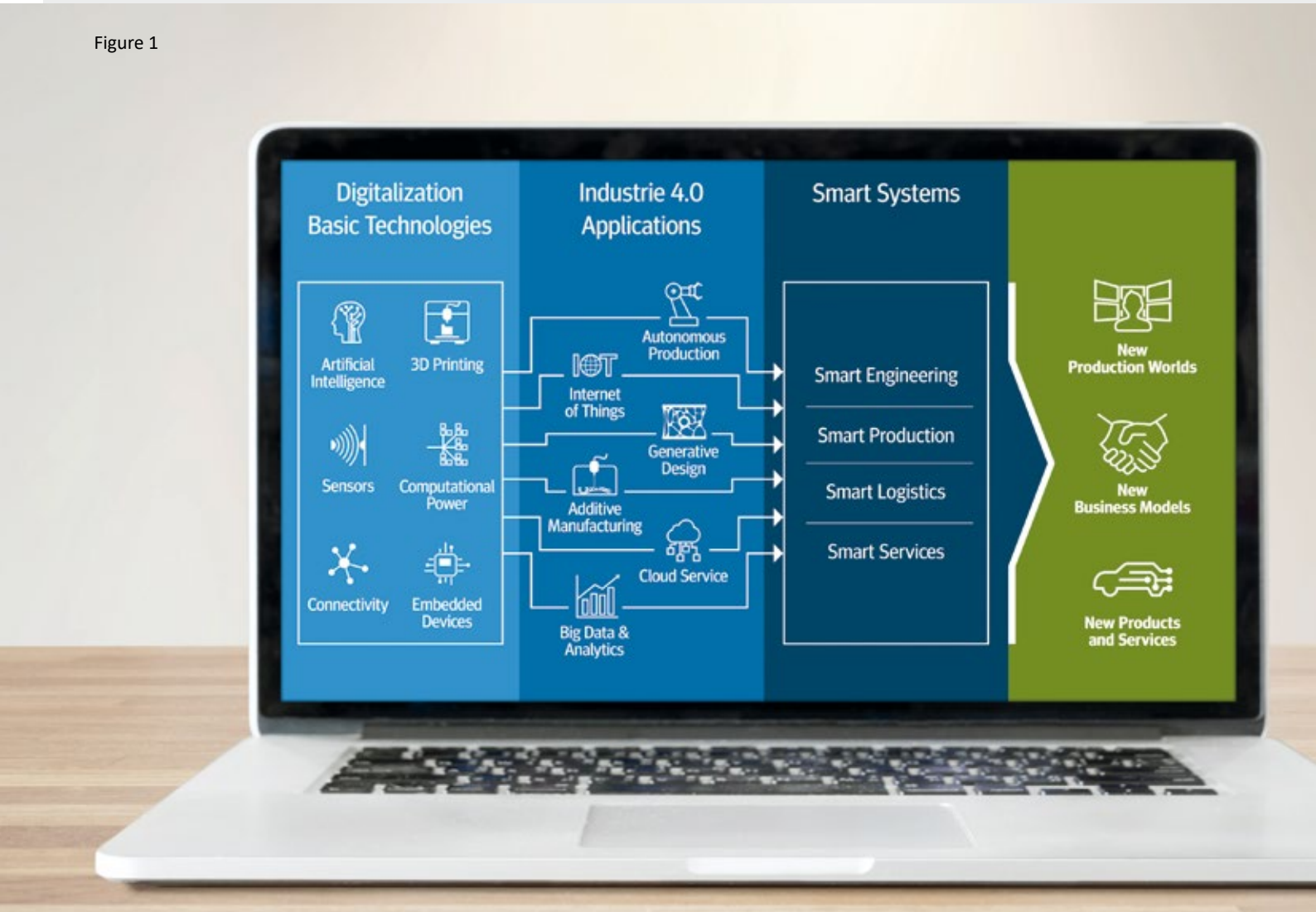
The challenges posed by Industry 4.0 and Smart Engineering

Industry 4.0

In a wider sense, Industry 4.0 means the intermeshing of the value chains in development, production, sales and service using state-of-the-art information and communication technologies. The force driving this development is the increasingly rapid digitalization of business and society. It will fundamentally change the way we develop, manufacture and work in the future: First came steam engines, assembly lines, electronics and IT, now it is smart production, smart engineering and smart services that are driving the fourth industrial revolution.

What are the key basic technologies involved and what impact will they have on future business processes and business models?

Figure 1



The technical foundation is provided by new, inexpensive and powerful technologies in the fields of sensor technology, embedded systems, artificial intelligence, networking and 3D printing, among others, combined with the huge increase in available computing power (see Figure 1).

These technologies make smart, connected systems with largely self-organized production possible: humans, machines, systems, logistics and products communicate and collaborate directly with one another in the age of Industry 4.0. Development processes, production processes, logistics processes and service processes in companies and between different companies will be intermeshed, making end-to-end processes even more efficient and flexible.

This will give rise to integrated, interlinked value chains that include all the phases of the product lifecycle – from the initial idea for a product to its development, manufacture, use and maintenance through to recycling. On the one hand, this will make it easier for customers to contribute their own wishes and, on the other, for companies to be able to manufacture products that are tailored to the customers' individual requirements. Customized manufacturing and preventative maintenance of products can become the new standard.

These options will give rise to new business models. At the same time, the speed of this transformation and the resulting competitive pressures for established companies will increase further.

Smart Engineering

Smart Engineering is intended to provide support for the development of smart products and services, as well as a networked production setup that includes the associated production systems, over the entire product lifecycle. The objective is an end-to-end digital value chain.

What concrete changes can be expected? What opportunities does Smart Engineering offer?

The digitalization of business processes requires a complete digital product model that not only maps the development process but also the entire product lifecycle (digital master and digital twin).

Smart, connected products require interdisciplinary engineering. If it is to be possible for different development partners to work together on the system properties, a cross-discipline definition is needed. Model-based systems engineering closes this gap and makes possible a complete digital representation of a product over its entire lifecycle.

Product data today is still managed in data silos, i.e. in separate ALM, PLM and ERP systems that are only partially integrated, if at all. What is needed is secure and efficient access to consistent and up-to-date product data over the entire product lifecycle.

Inexpensive, high quality additive manufacturing processes (3D printing) allow for technical product complexity that meets the exact design requirements and is no longer constrained by restrictive production processes. Furthermore, the use of embedded software, sensors and actuators makes product customization easier while at the same time reducing the number of physical variants.

The Internet of Things (IoT) and Big Data allow data from the entire product lifecycle to be analyzed and utilized. Access to data relating to wear and tear, operating parameters, usage statistics and to service data not only enables predictive maintenance but also ensures fast feedback regarding customer benefits and expectations from the after-sales phase of the development process. This facilitates and accelerates product optimization in terms of functionality, cost and quality.

Challenges

The force driving these changes is the increasingly rapid digitalization of business and society. It will fundamentally change the way we develop, manufacture and work in the future.

What challenges to these changes pose? What aspects must companies master in the future in order to fully exploit the new potential?

- New products, services and business models lead to increased competition. Surviving in this environment requires product ideas that are even more innovative and efficient value chains.
- Global networking and global access to information and services mean that different process skills are needed to ensure that companies select the resources that are the least expensive and best suited for their business processes from the plethora of different resources available.
- The shift from traditional products and systems to cyber-physical products and systems, which incorporate software and electronics and are also interconnected, demands interdisciplinary know-how not only when developing the products but also when designing the processes.
- Product customization results in a larger number of variants and a higher level of product complexity. In most cases, this gives rise to more complex development, production and service processes. Appropriate strategic approaches and solutions are needed if this complexity is to be made manageable.
- The need for a global market presence, the increase in product complexity and the dynamics resulting from increased competition reduce the length of time that requirements and other terms of reference remain valid. The ability to think and act in an agile manner and deal with contradictions is becoming an increasingly important factor in a company‘s success.
- The growing use of IT systems and the availability of digital information across all phases of the product lifecycle offer an opportunity to increase efficiency potential through the cross-disciplinary integration of data and to further boost the value added and the benefit to customers.
- The wide range of engineering services offered in the global network reduces costs, speeds up development and makes know-how more widely available. The use of collaborative methods, systems and processes will therefore be a crucial factor in determining the ability to compete in the field of engineering.

PLM and Smart Engineering

The IT systems referred to by the umbrella term „product lifecycle management“ (PLM) play a crucial role when it comes to organizing a product engineering process that is geared to innovation. The PLM world, which has expanded greatly in recent years, is therefore a natural and powerful instrument for achieving the goals associated with Smart Engineering and Industry 4.0. PLM has a vital role to play in the digitalization of value chains and the implementation of smarter engineering processes.

Are existing PLM infrastructures adequate for meeting the new challenges? What extensions are suitable and make sense? What PLM architectures and technologies are best suited for this?

If you look at today‘s development processes with a view to the challenges posed by Smart Engineering, you will see that mechanical, electrical/electronic and software development at many companies is still rooted in different organizational units. This often means that the same tasks, such as change management or functional modeling, for example, are performed using different IT systems in different processes.

This wide range of systems, in particular, is a challenge for which modern PLM concepts provide solutions. It is, however, important that the right course be taken and that the approach best suited to the individual circumstances be selected when designing the architecture.

In general, we need strategic approaches which, where possible, reduce the complexity of the PLM architecture and make the dynamics of the changes involved in the restructuring manageable. They should also be capable of dealing with fuzzy future requirements and other terms of reference.

It can be assumed that process innovations will result in a significant increase in efficiency when developing, manufacturing and servicing smart products. If these opportunities are to be exploited and, at the same time, the risks minimized, the aim of creating new and more efficient PLM processes should be approached step-by-step and on an iterative basis.

Figure 2

The following strategic PLM-related subject areas have been identified as areas of activity (see Figure 2):

- Agile processes and modular PLM architectures
- Integration of ALM, PDM and ERP systems
- Systems Engineering and Model-based Systems Engineering
- Interdisciplinary variant, configuration and change management
- Collaborative PLM processes
- Implementation of the digital master model

Existing PLM solutions cannot be used to address these areas of activity or only with a high level of implementation and administrative overhead. Most PLM experts agree that what we need are federated systems with a modular and open architecture. A modular, multilayered architecture allows data to be linked across different systems.

The creation of a digital workspace, which provides every user with the information and functions they need to perform their respective task in a uniform user interface, is a key prerequisite for making the growing complexity of the systems and processes involved in the interdisciplinary development of smart products manageable. Intelligent algorithms provide support here and allow fast, personalized access to information via role-based graphical user interfaces.

From Industry 4.0 to new business models

Industry 4.0 involves far more than increasing efficiency and flexibility in manufacturing through the intelligent networking of machines, systems, workpieces and IT systems. First and foremost, it involves the development of smart, connected products, which, in the view of a plant engineer, also includes the machines. And it involves the development of new, service-oriented business models that allow maximum benefit to be derived from this networking and value chains to be extended.

How can a company develop new business models and increase its value added by intelligently linking its products? Are you prepared for the digital transformation?

Small and midsize companies, in particular, are faced with the question of how to harness the disruptive force of the Internet of Things and use it for the evolutionary further development of their existing business. Many, for example, already have products that are equipped with sensors, but they are not yet exploiting the potential offered by the sensor data.

The development of new products and ideas for the age of Industry 4.0 will have a significant impact on the future business objectives of a company. It is impossible to develop a future-proof PLM strategy if these business objectives are not known. If, in the future, a company wants for example to use digital twins to monitor its products while they are being used or to optimize future generations of products, this will affect the PLM architecture and how the PLM processes are designed. It is therefore recommended that companies first analyze their level of Industry 4.0 readiness.

Agile processes and modular PLM architectures

The development of products and production systems that are linked via the Internet places new demands on how PLM processes are organized and what PLM system landscapes look like. The integration of not just the different engineering disciplines but also the development and manufacturing planning departments or the development and service departments is becoming increasingly important. PLM is becoming multidisciplinary. This is something that companies must take into consideration when formulating their PLM strategies.

What does a PLM strategy that enables an interdisciplinary and efficient development process for smart products and smart services look like?

A modern PLM strategy must anticipate future changes, i.e. it must be proactive, innovative and flexible. Providing support for new, service-oriented business models requires, for example, the tighter integration of digital data from development and production with information relating to product utilization in order to support predictive maintenance and smart services. In this digital information loop, PLM is not always the owner of the information but it is the broker.

The key objective of a PLM strategy, namely making uniform, binding and up-to-date product information readily available, must therefore be rigorously expanded. But not in the sense of a giant data storage, where all the information is managed according to the same guidelines. Monolithic system architectures are not flexible enough to keep pace with dynamically changing requirements. The increasing complexity of interdisciplinary product development can only be handled by a modular overall architecture, comprising federated subsystems with intelligently linked information. A modular architecture creates scope for adapting and redesigning process and reduces the effort involved in doing this.

Key requirements for the adaptability of this modular PLM architecture are openness and support for standards, as it is these standards that make it easier to exchange individual subsystems. When planning the new IT architecture, it is therefore important to always make sure that system suppliers and integrators observe the Code of PLM Openness (CPO). An open PLM architecture supports agile and flexible processes

The transformation of existing system landscapes is a major challenge. Companies not only need to find the IT architecture best suited to meet their needs but also define a strategy for its gradual implementation. To achieve this goal, companies need a good overview of the solutions available on the market, on the one hand, and the integration know-how needed to incorporate them in their existing landscapes and migrate existing information, on the other.

Modular PLM architectures comprising federated subsystems with intelligently linked information offer the best support for Smart Engineering.

Peter Wittkop

Integration of ALM, PDM and ERP systems

Today, a variety of different management systems control the processes involved in mechanical and software development as well as logistics and production: ALM (application lifecycle management) for the software, PDM (product data management) for the mechanical systems and ERP (enterprise resource planning) for manufacturing control. The ability to access, at any time, up-to-date and binding information about a product has always provided the basis for making sound business, economic, technical and organizational decisions. Industry 4.0 and the digitalization of products make the end-to-end availability of information about a specific product crucial to, for example, being able to offer services over the entire product lifecycle.

What is important when it comes to integrating these data management systems and what are the resulting requirements?

The lack of data integration between systems and departments in an enterprise and across value and supply chains is a major obstacle when it comes to establishing new business models. Responsibility for collecting data and managing the data logistics usually lies with the process owners in the respective organizational units. At the interfaces between development, production, service and maintenance, however, data passes between different systems, is thus represented differently, and ownership of data changes. This has always resulted in the need for automated data transfer in both directions so that, for example, it is possible to identify those products in which a defective part has been used or which software version has been installed on a certain controller.

The growing influence software is having on key product characteristics raises additional requirements regarding the integration of ALM, PDM and ERP, especially if parallel handling of multiple product variants is necessary at different speeds in mechanical and software development. Mechanical parts require a long lead time before they are available, especially when they are manufactured with complex tools. Software allows for late changes, which however also have to be tested and documented. System integration must support both read and write access and search operations for documentation purposes, which results in data networking. The lightweight integration of multiple systems in a single cockpit is one of the attractive options. It must also be possible to manage data ownership despite the changing status of the information objects.

It would be an illusion to think that a single management system alone could be expanded to create a general purpose data hub. It would not be able to meet the requirements relating to secure data management nor would it offer the flexibility needed for agile processes and innovation. The best solution is a network comprising ALM, PDM and ERP systems that allows the entire lifecycle of a digital product representation to be mapped. The integration of the data sources needed for the development and manufacturing of smart products will be implemented by means of a powerful integration platform. It ensures the highly efficient linking of data without any need to overhaul the existing ALM/PDM/ERP landscape.

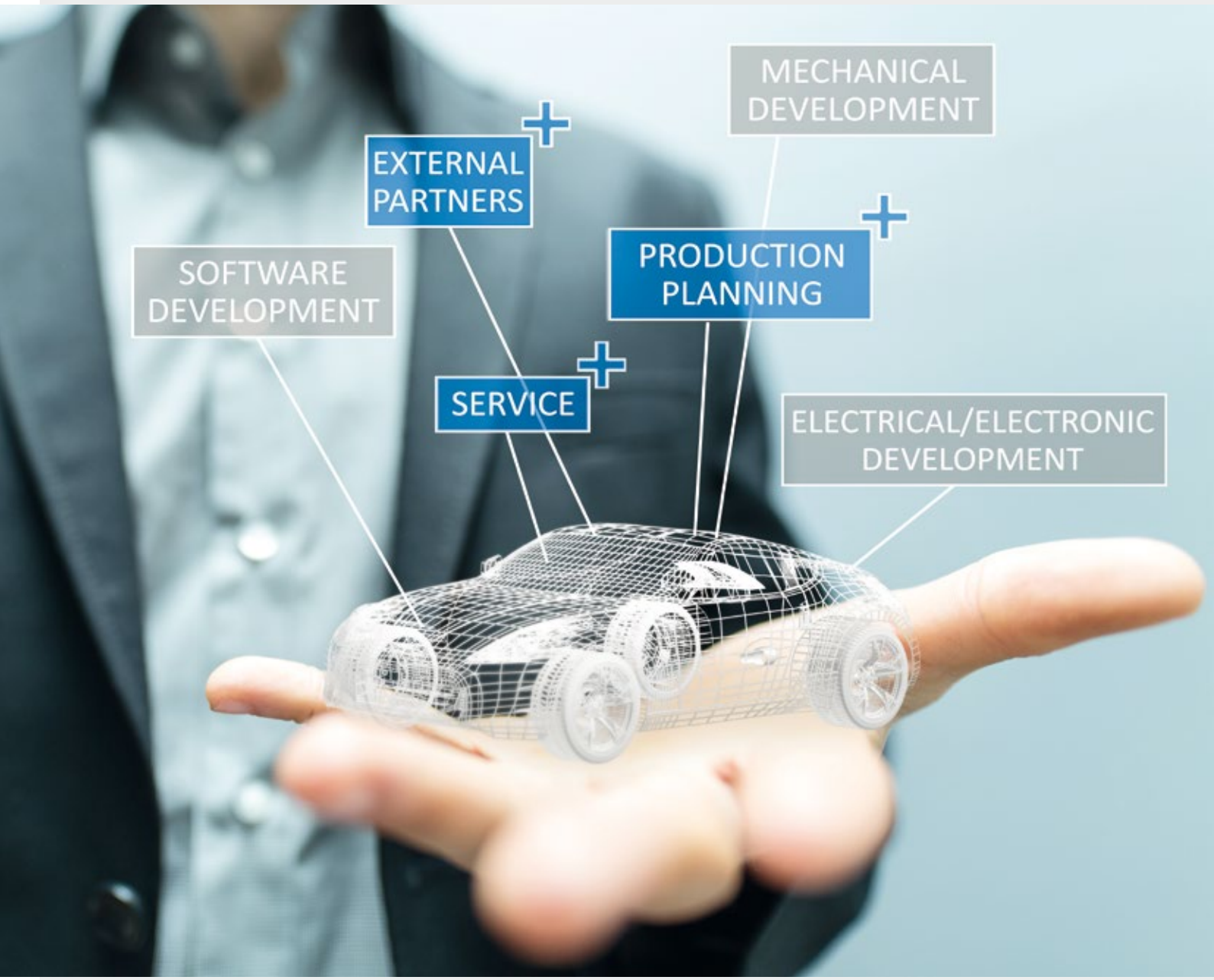
The increasing proportion of electronics and software in smart, connected products requires tighter integration of ALM, PDM and ERP.

Lutz Lämmer

Systems Engineering and Model-based Systems Engineering

The development of smart, connected products 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 , so that their various requirements can be incorporated: 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 external partners, with whose systems or platforms the products are to be connected.

How important are Systems Engineering (SE) and Model-based Systems Engineering (MBSE) in the context of Industry 4.0 and what role do they play?



Domain-specific IT tools and methods provide little support for this interdisciplinary process. One recommended alternative is Systems Engineering, an approach used in the aerospace industry. It supports all the disciplines involved in development throughout all the phases of the product engineering process, independently of the procedural model being used – regardless of whether it is based on the classic V model or on agile approaches. The requirements and functions of the system and its subsystems, as well as their interaction, are modeled, simulated and validated in abstract form on the basis of the stakeholder analysis.

An SE-based methodology that is becoming increasingly popular in industry is Model-based Systems Engineering with the help of SysML. MBSE formalizes the methodology employed for system modeling and system validation, making it easier for models to be exchanged with other participants in the process and reused.

Although Systems Engineering methods and tools are already being used at many companies, their use generally takes place separate from the discipline-specific development processes. On one hand, the challenge involves establishing a cross-discipline development process for smart, connected products and, on the other, integrating the tools and methods in the PLM processes in such a way that traditional functions such as version, change and configuration management can be used on the MBSE artifacts. MBSE also has a major impact on how companies are organized and requires a new type of employee with new skills, which is why support for its implementation should be provided by competent partners.

Developing smart, connected products is an interdisciplinary process. It can only work if all those involved speak the same language.

Markus Brandstätter

Model-based definitions and Digital Masters

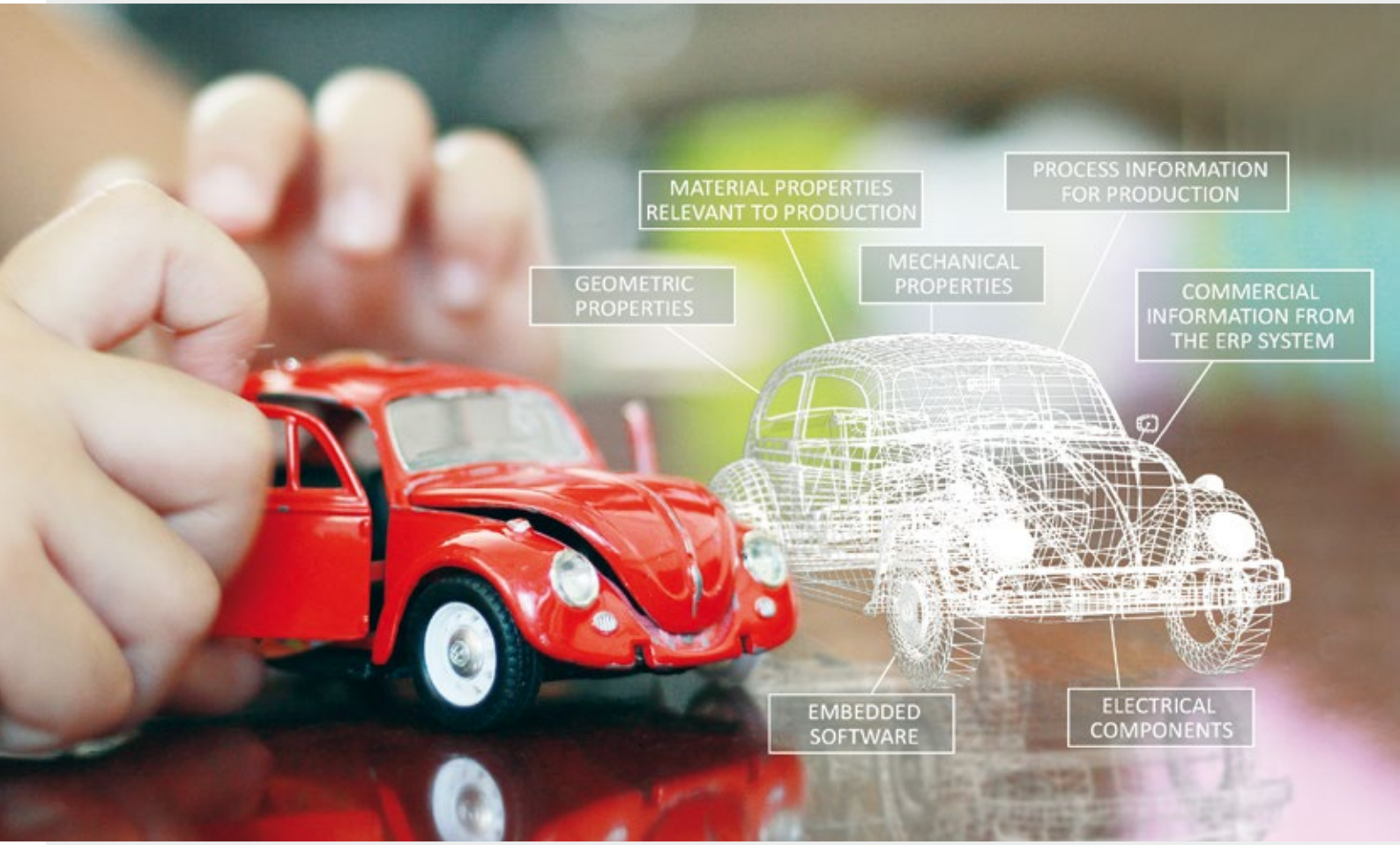
Ever since the introduction of the first 3D CAD systems, development departments have been pursuing the idea of replacing paper-based documentation with an entirely digital product description. Thanks to powerful visualization tools, geometric models are today also available in digital form outside of the development and engineering departments and can be used to optimize other business processes when embedded in 3D PDF documents. When product data is transferred to the work preparation department, however, paper drawings are often still being used.

The 3D master model provides the basis for end-to-end drawingless processes but confines itself to the geometrical and mechanical dimensions of a product. In the meantime, however, products that were primarily mechanical in nature now include an increasing number of software-controlled functions. They are perceived as being part of a system and must be developed as such.

The production process is also undergoing a profound transformation brought about by Industry 4.0. Flexible production systems respond dynamically to external influences and control production quality autonomously. To do this, all the product parameters relevant to production must be available in digital form.

What is a Digital Master?

What benefits can it be expected to offer?



The concept of a digital master takes the idea of a 3D master and develops it further, taking account of the new development and production requirements. A digital master is a complete, digital product model comprising all available product information. In addition to geometric and mechanical properties, this includes electrical components, embedded software, material properties relevant to production, process information for production and commercial information from the ERP system. The composition of the digital master changes according to the information relevant at any given point in time throughout the product lifecycle.

The digital master provides the basis for the digital twin and supplies all the processes with the information they need. While the digital master represents the complete, digital description of a concrete product, the digital twin includes other information that is relevant for simulation, production and service. Purchasing processes, technical documentation, audit and approval processes, as well as the marketing department, can use the digital master as the main product model. The challenge for companies is identifying the business processes that will allow digital masters and digital twins to deliver their greatest potential benefit.

The 3D master model provides the foundation for drawingless processes and is a first step on the road to an entirely digital product model, the Digital Master.

Alain Pfouga

Interdisciplinary Variant, Configuration and Change Management

Coping with increasing product complexity and ever-larger numbers of product variants is one of the main challenges that needs to be addressed within the context of Industry 4.0. The methods used to do this must also be able meet the challenges being faced in the field of Smart Engineering, such as agile processes, short development cycles, rapidly changing market conditions and consistently high demands placed on product quality.

In the age of digitalization, mastering product and process complexity is thus a core competence when it comes to product development.

How can companies master product complexity throughout the entire development process in order to gain a decisive competitive advantage?

Successful complexity management requires a suitable product model comprising a functional view and the product structure. If such a product model is to be made possible, the product architecture must be adapted accordingly and the product model created as a digital master. The digital master permits the efficient monitoring and control of product complexity within the process. This involves mapping not only the product artifacts (engineering data, software, documentation, simulation data) and product characteristics in an appropriate manner but also all the variant information.

With the help of suitable methods and tools [9], the digital master can be used as the basis for an extensive analysis of the consistency of the product description and characteristics and thus ensure quality.

These methods and tools allow product variants to be monitored and controlled throughout the entire process, which significantly shortens the change cycles. In addition, these methods and tools permit flexible change management as the repercussions of changes can be seen immediately.

Mastering complexity is thus of vital importance for a company's PLM processes and a prerequisite for the successful implementation of Industry 4.0 initiatives. It requires that product architectures be revised accordingly and that a digital master be implemented in cross-domain development processes in such a way that it maps the system properties for all the variants. At the same time, appropriate process methods and tools must be deployed that allow all those involved in the process to cope with product complexity easily and reliably.

Interdisciplinary Variant, Configuration and Change Management is a prerequisite for controlling complex products and processes in the product lifecycle.

Patrick Wischnewski

Collaborative PLM processes

Technological innovation in the context of Industry 4.0 increases collaboration across companies and domains. It is not only new partners, for instance in the service domain, but also completely new players that have to be incorporated in collaboration processes. Today's PLM systems are not designed for this, which is why a great amount of information is still being sent in unencrypted form, i.e. without any protection for intellectual property, via email.

The ability of utilizing PLM in collaborative processes will become increasingly important in the context of Industry 4.0. This should be taken into account as early as possible when defining the PLM strategy.

How can PLM systems better support the growing need for collaboration in the development of smart connected products?

Many industries will see the rise of innovative new companies that develop, manufacture and market products together. These companies will compete with established manufacturers. The partners to these companies assume responsibility for sub-processes in the product development process in a flexible manner and in changing constellations. This places increasing demands on the flexibility of the processes to be designed and creates a growing need for collaborative technologies and methods that can be utilized instantaneously.

Incorporating external partners and suppliers, that offer their services in a global network, requires collaboration solutions, that can be easily integrated in existing PLM systems. The PLM systems must provide support for very different scenarios, from occasional collaboration with sporadic data exchange to regular provision within the framework of a long-term partner relationship or joint venture. Not only reliability but also data security and the protection of intellectual property (IP) play a key role in collaboration scenarios.

Collaborative PLM processes are not, however, only a question of the technologies used, they also call for a holistic approach to organizational structures, technology and employees. The aim must be to design collaboration processes in such a way that the overall efficiency and effectiveness of people and systems is optimized. This is why current collaboration processes and future requirements must be analyzed closely before the relevant solutions are implemented.

With the interdisciplinary development of smart connected products the need for PLM in collaborative processes is growing even faster.

Mirko Theiß

PROSTEP – Your partner for Industry 4.0 and Smart Engineering

Industry 4.0 presents companies with major challenges but also offers them enormous opportunities. Many companies are faced with the question of where to start exploiting the potential offered by Industry 4.0. **PROSTEP's „Industry 4.0 Readiness Assessment" helps you evaluate your Industry 4.0 capabilities and identify additional potential.**

Industry 4.0 has repercussions for a company's global strategy and its business objectives. This gives rise to new requirements relating to PLM strategy, which usually make it necessary to adapt the PLM architecture. **Our consultants help you develop your PLM strategy, design your architecture, select an appropriate system and integrate your existing IT applications.**

Industry 4.0 and Smart Engineering require the end-to-end availability of the information about a specific product. Today, this information can be found in a number of different data sources. **With OpenPDM and OpenDXM GlobalX, we offer you a powerful platform for integrating your PLM, PDM and ERP systems and for linking the information intelligently.**

The interdisciplinary development of smart, connected products requires a shared understanding of the system. Model-based Systems Engineering methods offer the tools needed to achieve this. **We help you make use of MBSE tools and methods and fully integrate them in your PLM processes and systems.**

The objective of Smart Engineering is the creation of digital value chains based on a digital product model that maps the entire lifecycle of a product, including its operation. **PROSTEP helps you implement drawingless processes based on 3D PDF technology and a future-oriented digital master concept.**

When it comes to smart, connected products, the many different variants are increasingly being mapped via the software to reduce the cost of the variance. This makes variant and configuration management an interdisciplinary task. **Our consultants help you optimize your product architectures and create a cross-domain variant system.**

Collaboration in global value chains will continue to grow as a result of Industry 4.0 and will increasingly include non-engineering disciplines such as service and participants from outside the industry sector involved. **PROSTEP provides you with advice on designing your collaboration processes and offers you the leading integration and data exchange solutions OpenPDM and OpenDXM GlobalX.**

In the age of Industry 4.0 and Smart Engineering, our motto **„PROSTEP – Integrate the Future"** is more relevant than ever.

The challenges posed by digitalization are many.
The consultancy services and solutions we offer will
help you make a success of the 4th industrial revolution.

Martin Strietzel

Industry 4.0 and Smart Engineering – What we offer

Industry 4.0 Readiness Check

- Readiness workshops to help you identify your Industry 4.0 potential:
  - We show you how prepared you are for digitalization.
  - Find out whether your product strategy can meet the challenges posed.

PLM strategy consulting

- We develop and validate your PLM strategy in the context of Industry 4.0 and Smart Engineering.
- We make a recommendation for an appropriate PLM architecture.
- Take advantage of our experience when determining your PLM core processes and your requirements.
- We create the tender documents and select an appropriate system for you.
- We identify the concrete need for action in your product development process within the framework of future-PLM assessments for Smart Engineering.

Systems Engineering

- We provide you with assistance when introducing a development process based on the V model.
- We structure the V model in line with your company's departments, processes, methods and tools.
- Take advantage of our help when selecting and further developing the appropriate methods, tools and formats for your company.
- Profit from the advantages of a system lifecycle management infrastructure that brings together your ALM, PDM and ERP processes.

Integration of ALM, PDM and ERP processes

- We integrate your data and processes within the framework of your PLM strategy.
- Overcome system boundaries with our help and operate across different disciplines.
- We organize your system lifecycle management.
- Take advantage of our experience when integrating your data management systems.

Model-based definition / Model-based enterprise

- Profit from digital product models in your production processes.
- We develop a digital master strategy that is tailored to your needs and implement the necessary tools.
- Optimize your build-to-print process using our 3D PDF technology.

Cross-company collaboration

- Use OpenDXM GlobalX and OpenPDM for secure data exchange and partner integration.
- Implement a secure and agile collaboration infrastructure based on our tried-and-tested solutions.
- We help you define and implement your collaboration strategy.

PROSTEP publications

[1] C. Eckl, Dr. M. Brandstätter, Dr. A. Pfouga, Dr. J. Stjepandić: „A Comparative View to Model-based Systems Engineering Technique in Space and Automotive Development“. TMCE 2016, 2016

[2] Dr. M. Brandstätter, C. Eckl: „Einsatz von Model-based Systems Engineering in der Automobil-industrie“. Tag des Systems Engineering 2015, 2015

[3] C. Eckl, Dr. M. Brandstätter, Dr. J. Stjepandić: „Using the „ Model-Based Systems Engineering „Technique for Multidisciplinary System Development”. Konferenz CE 2015, 2015

[4] Dr. M. Strietzel: „PLM, Industry 4.0 and the Digital Master”. ProSTEP iViP Symposium 2016, 2016

[5] Dr. K. Theis, PROSTEP AG, Dr. D. Trippner, dreiconsult GbR: „CPO – The Key Element to an agile PLM strategy – Observations from the perspective of users and system integrators”. ProSTEP iViP Symposium 2016, 2016

[6] Dr. K. Theis, PROSTEP AG, Dr. D. Trippner, dreiconsult GbR: „Agile PLM Strategy Development – Methods and Success Factors”. eee2016 Konferenz. Dresden 2016

[7] A. Biahmou, C. Emmer, A. Pfouga and J. Stjepandić: „Digital Master as an Enabler for Industry 4.0”. Konferenz TE 2016, 2016

[8] P. Wittkop : „Future PLM als Enabler für Agile Produktentwicklung“. Konferenz Agile PEP Minds 2016, 2016

[9] Christopher Junk, Robert Rößger, Georg Rock, Karsten Theis, Christoph Weidenbach, Patrick Wischnewski: „Model-Based Variant Management with v.control“. ISPE CE 2015: 194-203

PROSTEP
integrate the future

Do you have any comments or questions?

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

PROSTEP INC
300 Park Street Suite 410
Birmingham, MI 48009

Phone: +1 877.678.3701 Fax: +1 877.678.3702

LEGAL NOTICE

US Contact:

Paul Downing
Paul.Downing@prostep.com

Published by PROSTEP AG
Responsible for content
Martin Strietzel

Edition 1, 2017