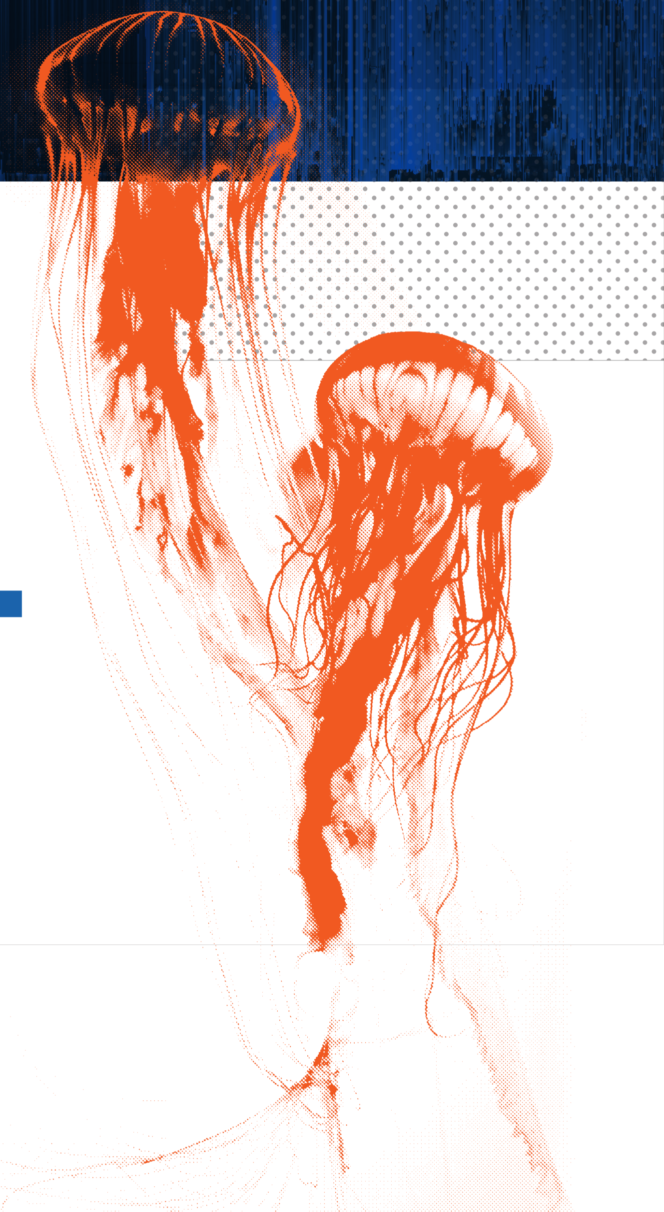
LOOKING FOR THE „DEEP BLUE“ MOMENT



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GROWING FUNCTIONAL RANGES AND AN INCREASING NUMBER OF VARIANTS HAVE MADE THE DEVELOPMENT OF NEW PRODUCTS MORE COMPLEX AND TIME-CONSUMING.

At the same time, new technologies and tools promise radical leaps in efficiency. But are these sufficient to make the increasing complexity in smart product development manageable? And where does product development currently stand when it comes to AI-enabled R&D?

In pharmacology it is assumed that there are about 1060 molecules with a biological effect. More and more pharmaceutical companies are using smart data analytics and intelligent algorithms to independently compare billions of possible molecule variants in order to determine the chemical compounds that could be used as active ingredients in the treatment of diseases such as cancer or Alzheimer's disease. This reduces the time required to identify potential active ingredients from years to hours. In view of this development, experts are already talking about the "deep blue" moment in pharmaceutical research.

The search for efficiency gains is particularly important in an industry that otherwise suffers from poor research statistics. It still takes an average of twelve years and costs two billion dollars to bring a new medication to the market. On the way there, the failure rate in the preclinical phase is 99%. According to a 2017 study, projected returns on investment in research and development fell to their lowest level in eight years at that time, while spending increased.

SMART PRODUCTS AS COMPLEXITY DRIVERS

Also in other industries, such as the automotive industry or mechanical engineering, the costs for the development of new products have been rising constantly for years. The main reasons for this are the increasing range of functions and the increasing variety of digitally enriched products. But also more complex dependencies with external requirements, e.g. regulations, globally distributed competition and customers with frequently changing offers and needs. As a result, the pressure on companies in the manufacturing industry to bring product updates to the market in ever shorter cycles is increasing considerably.

In order to make the resulting complexity manageable, companies in these sectors are more and more using new technologies and methods in their product development (cf. Fig. 1 on page 22). They start where cost- and time-intensive cost drivers have arisen due to the changed requirements and processes in the context of digital product development, for example at the interfaces between the various departments involved in the development process or the different release timing in hardware and software development.

ANALYTICS FOR BETTER DECISIONS

This begins with the conception of a new product portfolio. Companies face the challenge that the evaluation of customer requirements and business cases based on these has become considerably more complex. On the one hand, because "smart products" have additional components (software, electronics, connectivity, etc.) whose development efforts and manufacturing costs must be included in the overall view and coordinated across departments. On the other hand, because digitally enhanced products no longer have to be considered only up to the start of production (SOP), but over almost their entire life cycle, e.g. the total sales potential. New features and revenue opportunities that are added to the product during operation must also be taken into account. In addition, product-related services generally follow other revenue mechanisms for which model calculations do not yet exist in many industries. This results in a complex system of multiple cross-dependencies.

As a result, the exploration period for industrial products, such as vehicles, is now two to three years. Big Data Analytics or Decision Analytics (cf. Fig. 2) can make an important contribution to achieving better and above all faster decisions in this interface management with the aid of artificial intelligence. The prerequisite for this is that the entire process is standardized and backed up with well-founded data and models. This includes a variety of different data sources, such as social media analytics, current usage or forecast data, which must be integrated into a data model. In this way, the time required to calculate a total business case can be reduced to one year or less.

COMPUTER-AIDED DEVELOPEMENT

In addition to the loss of time at the interfaces, the different pulsing in hardware and software development represents a further challenge in the development of smart products. To avoid delays, such as when hardware components on which a software function is to be tested are not available in time, various design and construction methods can be used to significantly reduce the time required to provide testable prototypes.

A particularly promising approach, which is becoming more and more important, is the so-called generative design. This is a design method for constructions in which a software program independently generates designs using algorithms and logical calculations. The designer simply enters the planning goals and constraints into a CAD program and defines parameters such as material type, load capacity and costs. The program then calculates thousands of different variants with which the specified parameters are met and performs an independent performance analysis. This shortens the construction time many times over, since designs no longer have to be carried out manually and simulations and tests are already integrated into the design process. In addition, this process enables the creation of completely new geometries with improved properties, which partly seem to contradict the designer’s intuition.

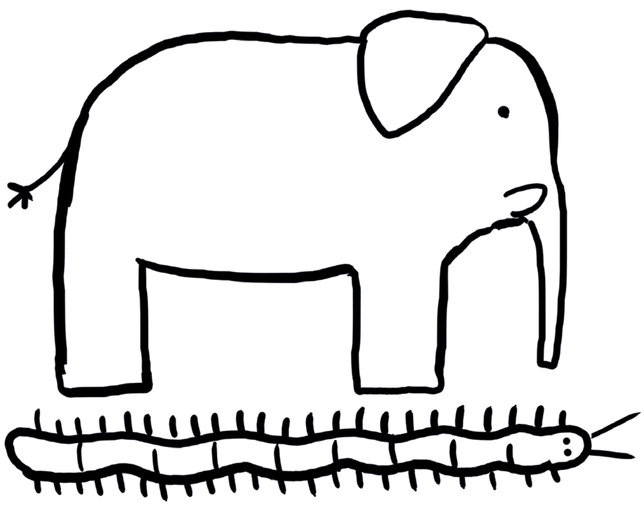
ELIMINATE DEVELOPMENT LOOPS WITH LEARNING SYSTEMS

Another way to shorten the development time for hardware components is to use self-learning systems. They can significantly reduce expensive and time-consuming optimization loops in the subsequent adaptation of components. This is where high costs and time losses often occur in practice, for example when special tools are required. To minimize this type of waste, companies use a combination of simulation and 3D printing techniques, for example. The latter enables rapid prototyping of the components. Instead of manufacturing completely new components for each optimization loop, additive manufacturing is used to create prototypes whose properties are in turn fed back to the digital model. From the comparison between the prototype and the digital model, the system learns in each loop how the best model must be designed in order to map, so to speak, the real production in comparison to how it is digitally available. With the help of this semi-intelligent, learning system, the development time of corresponding components could be considerably reduced, sometimes more than halved.

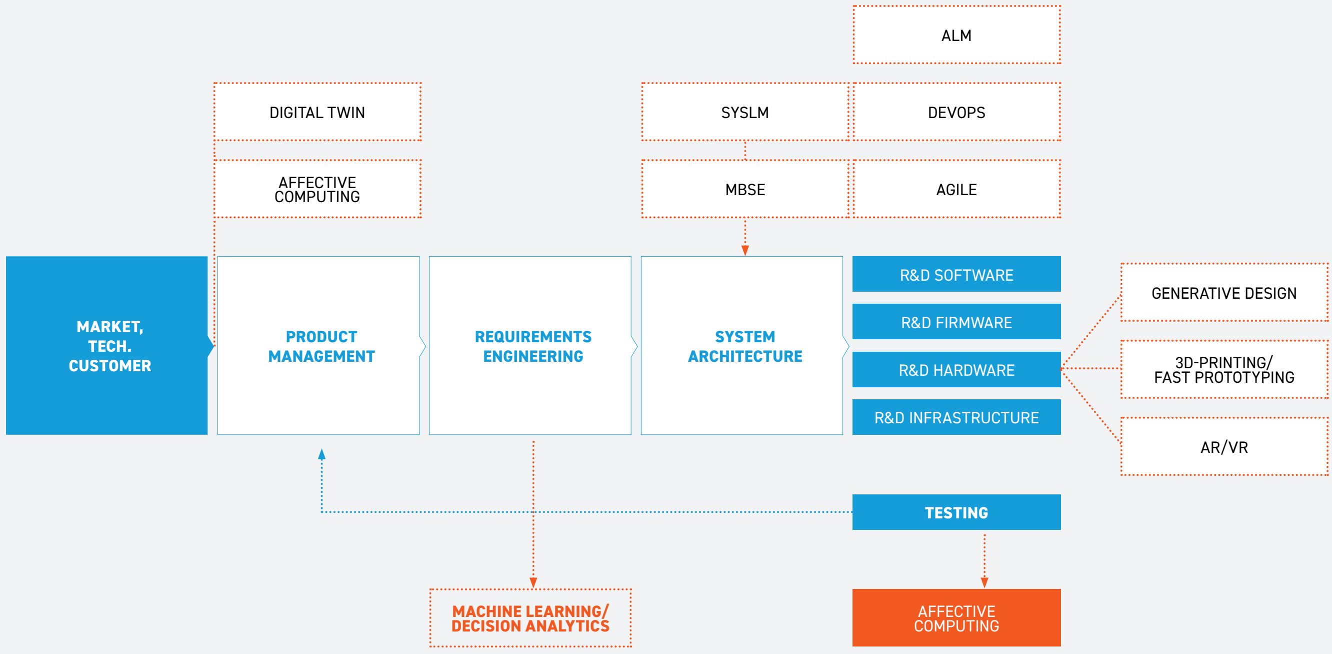
INTELLIGENT MANAGEMENT OF THE SYSTEM LIFE CYCLE

In addition to the optimizations in the individual phases, the greatest challenge in the development of smart products is to map the various interfaces, functional and process-related dependencies in an overall model. This is precisely where approaches such as Model based Systems Engineering (MBSE) or System Lifecycle Management (SysLM) come in by providing a development platform that is able to demonstrate the effects of individual parameters, such as a software feature, in the overall system. Due to the large number of possible variations and interfaces in the hardware and software, this cannot usually be achieved by humans. For this reason, the use of artificial intelligence holds enormous potential here.
Only if development systems are able not only to map this complexity but also to make it manageable, continuous product development, which goes beyond the SOP and, for example, incorporates user data from digital twins into the continuous further development of products in ongoing use, can be implemented. Currently this vision fails in many cases due to the IT infrastructure and the continuity of the various, networked and dependent tools and systems (e.g. PDM/PLM and ERP). In particular, the harmonisation of interfaces is a necessary basis, which in turn requires an intelligent, coordinated design of the associated processes, but which is anything but trivial.

In other words,
INDUSTRIAL PRODUCT DEVELOPMENT IS WAITING FOR ITS “DEEP BLUE” MOMENT.



TECHNOLOGY INNOVATIONS ALONG THE R&D PROCESS



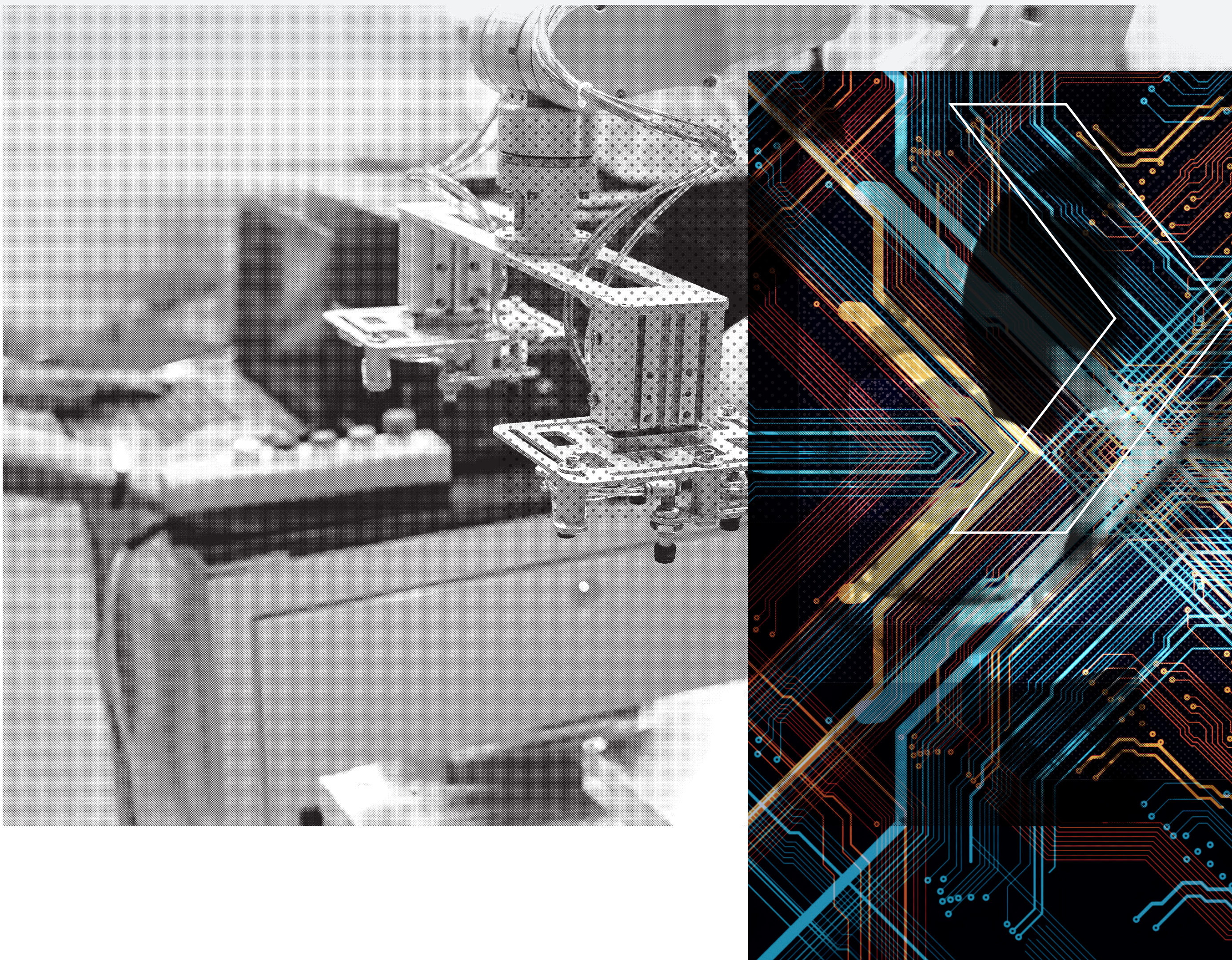
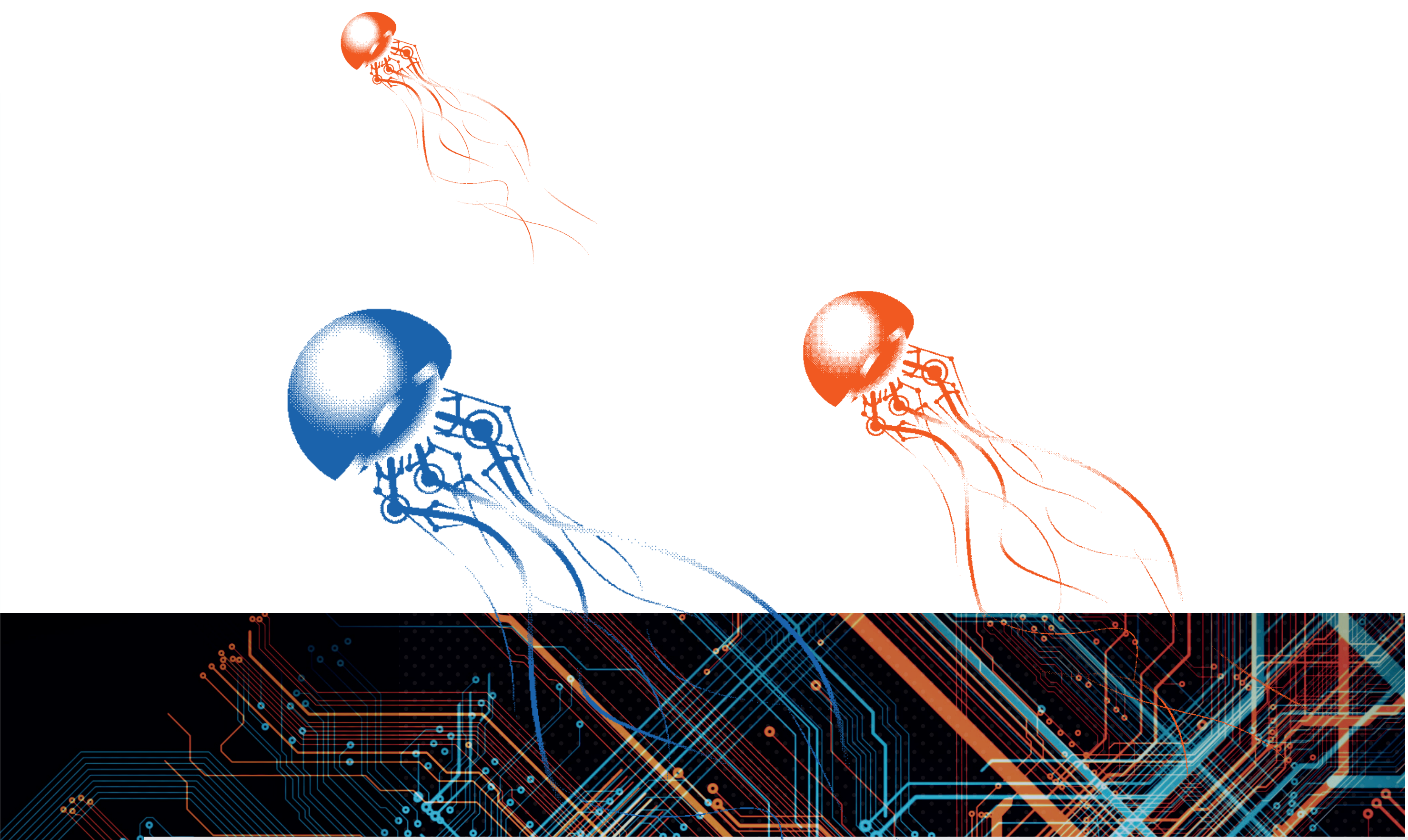


Fig. 1



DECISION ANALYTICS	
DESCRIPTION	• *Intelligent techniques for processing multiple data from multiple sources along the development process using advanced analytics to analyze complex cross-dependencies and accelerate decision making*
APPLICATION AREA	• *Requirements Engineering* • *System Architecture*
BENEFITS	• *Faster and better decisions in complex decision making processes* • *Shortening of the exploration phase by >50%*

GENERATIVE DESIGN	
DESCRIPTION	• *Design or construction method in which design drafts are independently developed and automatically tested by software using algorithms and on the basis of defined parameters*
APPLICATION AREA	• *Engineering* • *Hardware development*
BENEFITS	• *Shortening of the design phase* • *Avoidance of subsequent optimization loops through integrated testing* • *Development of new solutions for known design challenges*

SYSTEMS ENGINEERING	
DESCRIPTION	• *Engineering backbone concept for product development and lifecycle management within the framework of the Industrial Internet and for integrated and interdisciplinary Model-Based Systems Engineering (MBSE), Product Line Engineering (PLE) and Service Lifecycle Engineering (SLE)*
APPLICATION AREA	• *Comprehensive development process*
APPLICATION EXAMPLE	• *Greater transparency and controllability of complex development lifecycles*

Fig. 2