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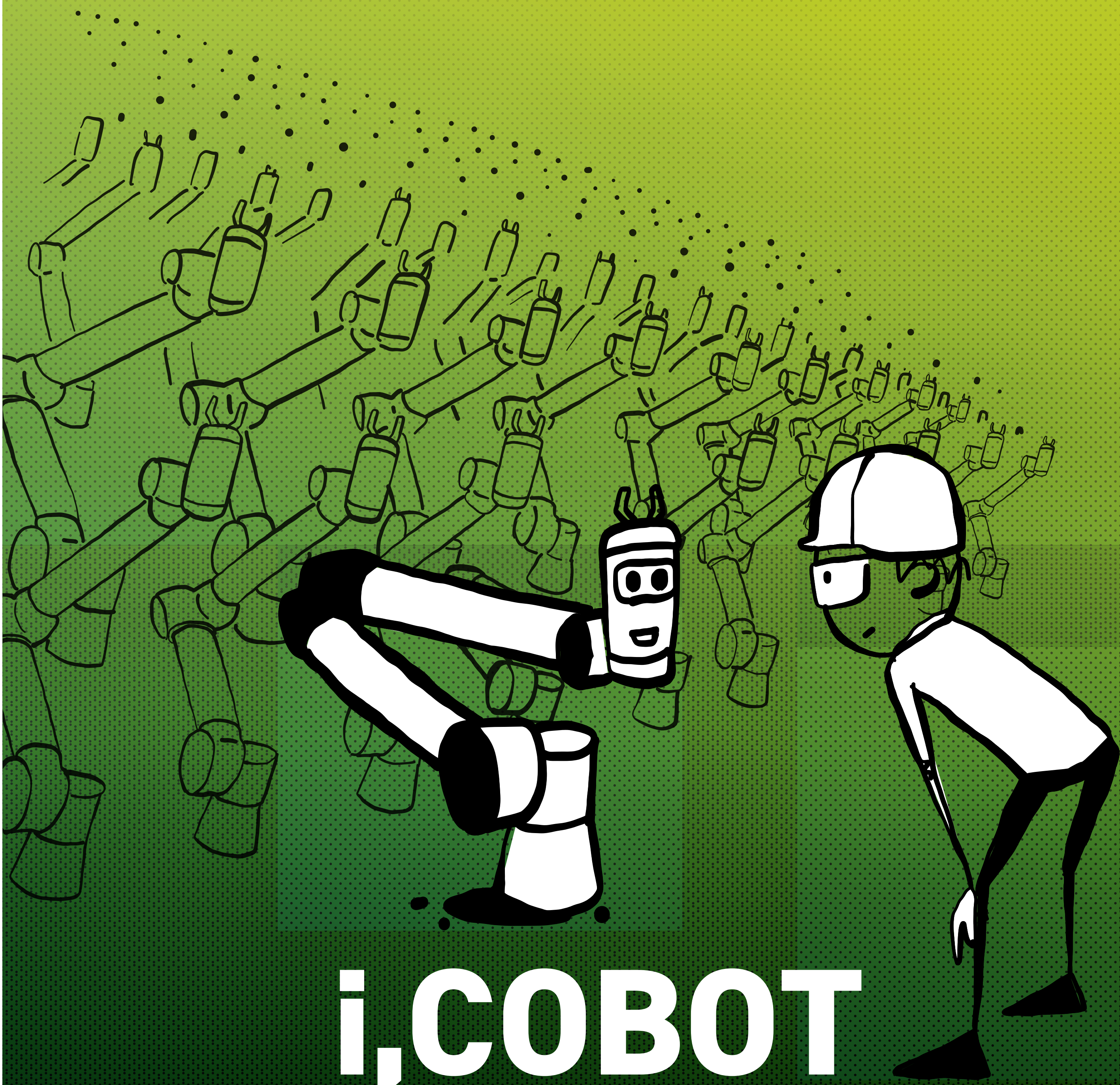

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Artificial intelligence and data analytics in Production

ROI EFESO
MANAGEMENT CONSULTANTS

CONTENT
ENGLISH EDITION
#63

Hans-Georg Scheibe, Managing Partner, ROI Management Consulting AG

BEYOND THE INCUBATOR

INDUSTRIAL DIGITALISATION IS ENTERING A NEW PHASE OF PRAGMATISM.
The past few years have been characterised by a test mode:
New forms of work, technologies, processes and operating models have found their way into companies, and initial experience was gained in pilot projects.

The time of proof of concept is over. Technology and infrastructures are no longer a bottleneck factor, numerous solutions are in operation and even the lack of digital experts is not slowing down the transformation. New questions are coming into focus: Which use cases can be scaled and industrialised? How can digitalisation create quantifiable benefits on a large scale? How can the right level of automation be achieved to efficiently handle high product complexity and growing flexibility requirements? Can complex architectures be modularised to have the right design in the right place in the global production network? And last but not least, how can reliable planning be ensured in the face of the volatility and dynamics of the environment.

Artificial intelligence and advanced data analytics techniques play a crucial role here. “Prediction replaces planning” is how one of our project partners described this change. However, there are other facets, such as the question of the business assessment of the data stock, the design of an AI governance, the automation of the supply chain, the establishment of digital production twins or the integration of MES solutions into modular IIoT platforms. In the current issue of ROI DIALOG we have looked at this process from different perspectives and examined both the possibilities of AI in production practice and the prerequisites for data analytics to unfold its transformation potential.

TOP 10

FIELDS OF ACTION FOR THE DATA AGE

Prof. Dr. Werner Bick and
Dr. Sebastian Grundstein, ROI-EFESO

THE TRIUMPHANT MARCH OF ANALYTICS TOOLS, IIOT PLATFORMS AND AI SOLUTIONS HAS BEGUN.

But what exactly does the industry's entry into the data age mean? Which developments will be particularly formative in the coming years and generate the greatest pressure to adapt? We have compiled ten fields of action that companies will have to deal with.

1. GLASS BEADS

THE ESCALATION OF TRANSPARENCY

Optimisation processes can only be initiated if there is comprehensive clarity about the state of the production network. In supply chain risk management, access to all relevant indicators at the meta, macro and micro levels can lead to a significant increase in forecasting accuracy and also to the potential disruptions in the supply chain being identified at a very early stage - if the data from the entire supply chain is available. The use of data analytics tools helps here in particular to define early indicators and integrate them into an overall picture that enables cross-company optimisation.

However, this development has a dark side. Because "cross-company" also means that the upstream partners in the value chain must lower their protective shields to a very high degree and grant their customers insights into their processes.

The interest in turning the supply chain into a string of transparent glass beads decreases the further down you go in this chain - for understandable reasons. Because the transparency created in the context of digitalisation exacerbates the already existing power differentials - which in turn are brought into play when transparency is created.

Can the tension between the optimisation potential that can be raised for all partners and the concern about exposing oneself too much to the customers be resolved? Finding convincing answers to this question is one of the most important tasks of the coming years.

> *"The data economy is changing the nature of communication and process design in a serious way."*

2. THRUST REVERSAL

THE NEW DIRECTION OF INFORMATION FLOWS

Factors such as data availability and the use of AI tools have a direct impact on management structures in companies. This affects both established management routines and daily interaction. The main reason for this lies in changed framework conditions: Information and knowledge are no longer the exclusive knowledge of a few managers and experts. Rather, they are omnipresent in the organisation and can be accessed by anyone at any time on any device.

This changed structure leads to a change in the direction of communication and information cascading. Impulses for problem identification and for problem-solving sprints come from the team. In particular, the use of AI-supported analytics tools helps to identify weak points very effectively. However, this reversal of thrust does not mean that expert and management roles lose their relevance. After all, information is initially only a description of the problem. Background knowledge and process expertise are still indispensable, as is the ability to prioritise issues. New expert knowledge is also required, for example on the deep interpretation of data. And finally, original management tasks are still critical: Focusing on the goal, taking responsibility for results and decision risk, orchestrating and motivating the team. So the data economy is not turning corporate structures upside down. But it does change the nature of communication and process design in a serious way and therefore requires new leadership and management techniques.

3. VELVET REVOLUTION

THE SENSORISATION OF THE VALUE CHAIN

The ability to ensure comprehensive connectivity and networking within production, to acquire more and more data and to interpret it using AI, opens up completely new efficiency and risk management potential. This development is gradually changing our entire perspective on industrial value creation - what we perceive as evolution today will very likely appear as a revolution in retrospect. However, AI solutions can only have their effect if they have data - and far beyond their own company, all the way to the digital synchronisation of the entire value chain and the integration of all functional areas. This type of networking, however, requires


SERVICE & MAINTENANCE AUGMENTED REALITY


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very profound networking of sensor technology - so that it is recognisable throughout the entire chain if, for example, a critical production line at a supplier could become a bottleneck. With a shared, cloud-based data reservoir and an integrated data model, such early indicators can be used to detect potential problems in real time using AI.

“What we perceive as evolution today will appear as revolution in retrospect.”

An exciting future perspective is the use of semantic interpretations, so that even unstructured information can be automatically evaluated and used for qualitative forecasts. For example, the knowledge filtered out from social media that part of a supplier’s team is flirting with switching to the competition can lead to appropriate risk measures being taken. However, the hurdles here are not primarily of a technological nature. This is because comprehensive sensorisation of the value chain requires a governance model that is trustworthy for all partners involved and that protects against both (power) abuse and external attacks.

4. INFINITE LOOP

PRODUCT DESIGN IN DIGITAL ECOSYSTEMS

In terms of the total product life cycle, manufacturing is only the executive, accounting for about one-third of the costs. Engineering and design phases contribute the rest. Errors and deficiencies that are already inherent in the product design have a disproportionate impact on production costs and can only be corrected at a later date with great effort. For decades, people have therefore been working on digitalising product development and exploiting more and more simulation possibilities. The path leads from a two-dimensional drawing to virtual crash tests. But the exponentially increasing availability of computing and storage capacities, access to more and more data and the power of AI and analytics tools offer completely new possibilities for simulation and prognosis.

“Sensorisation of the value chain requires a trusted governance model.”

Product behaviour, life cycles and, above all, the performance of products in the market can be mapped by digital product twins. Algorithms help to understand which usage scenarios lead to failures and errors, which product features are particularly successful, and in which areas an overload occurs. Which product features are particularly successful, and in which areas overengineering can be prevented. The structures and patterns that are recognised over the entire life cycle can flow directly into the further development of the products and prevent cost drivers and quality problems. Product design thus becomes a cluster in a recursive control loop supported by AI and analytics - and changes the perspective on the entire manufacturing process.

5. DECODING THE MATRIX

POTENTIALS OF THE SEMANTIC WEB

The more data available, the better AI solutions work and the faster insights can be gained. But where does this urgently needed information come from? The data-driven economy requires access to heterogeneous, unconventional sources - only then can processes be substantially accelerated. What is needed is data from the market - from customers, suppliers, competitors, research institutions and potential users. In this way, valuable experience can be incorporated, mistakes do not have to be made more than once and some wheels do not have to be invented twice.

However, a large part of the data needed for this is not in structured databases with standardised interfaces and authentication concepts - especially not if you want to recognise trends at an early stage. Rather, this data is not available at all - it flows through threads in social media, posts on community boards, communication platforms, publications in magazines and blogs. The automated perception of such signals requires the use of intelligent solutions and filtering algorithms based on semantic web technologies that detect with high sensitivity when signals combine to form relevant patterns and flows.

The ability to use the semantic web effectively and creatively will become one of the most important levers in the coming years to differentiate oneself from the competition and to develop business models quickly and effectively. It goes without saying that companies that have gained early experience with the use of corresponding logics and tools over many years and are particularly good at exploiting the potential of the solutions will have a strong advantage.

6. PROCESS ENGINEER 4.0

DATA COMPETENCE AS BASIC KNOWLEDGE

Profound changes in the Smart Factory are also reflected in the communication between companies. The exchange of process-relevant information and documents via traditional EDI solutions is reaching its limits for various reasons. On the one hand, an integration of IT between the value creation partners causes high harmonisation efforts. On the other hand, with the current status quo of technologies, a full digital integration of the IT worlds is enormously costly.

Blockchain technology and its core application, smart contracts, offer a way out. These are programmable scripts that ensure the automated flow of business logic across company boundaries, control partner interactions and document them in a forgery-proof manner, as well as manage data access rights. The use of quickly implementable and scalable smart contracts thus reduces the costs of data exchange, optimises tracking and data transfer, for example in order entry, and creates the basis for new, token-based business models such as pay-per-use. The first resilient experiences gained with the use of blockchain technology also show that smart contracts can provide benefits not only between the individual partners in the supply chain. More and more companies are discovering valuable application possibilities within their own production landscape as well.

7. DATA VALUE

INFORMATION AS AN INDUSTRIAL PRODUCT

Production data is only valuable if it is used. Data is particularly valuable when its use offers advantages not only for the company itself. At the same time, however, data are also critical assets. They affect the core substance of a company as well as its operating and business models. In order to realise the potential of integrated, data-based industrial value creation, marketplaces for data will therefore have to emerge in the coming years. These Industrial Data Spaces, which are also the focus of several public research projects, will become hubs of secure, rule-based data exchange. Different models are likely. In addition to the pure sale of data, business models will also emerge in which data is delivered together with the core product or temporarily released for inspection. At the same time, it can be assumed that customers will increasingly demand that their suppliers provide data on their solutions in real time. Regardless of which scenarios take effect, one thing is certain: Companies must build technological infrastructures and organisational models in order to collect product and process data in real time.

and process data in real time, process them in high quality and then be able to exchange them in a process-safe manner.

8. COLLABORATIVE SYSTEMS

THE NEXT WAVE OF AUTOMATION

Automation has been a defining theme in production for decades. However, advanced tools and the digitalisation of almost all are - as of the company are opening up new directions. On the one hand, with approaches such as Robotic Process Automation (RPA), more and more indirect functions, for example in the administrative and commercial areas, can be automated with a reasonable expenditure of resources and know-how. On the other hand, in the direct area, the trend towards collaboration with intelligent assistance systems is increasing - and is leading further and further beyond the boundaries of the factory. In these scenarios, which are designed to have a broad impact, AI and analytics systems show their pragmatic side above all, in that they are both

clearly measurable economic contribution as well as compensating for resource and personnel bottlenecks. At the same time, the first resilient use cases are emerging today for automation solutions that aim for a "vertical" effect and extend the limits of human performance. In the medium term, however, such systems will mainly be used in other areas, such as surgery.

> *"The effective and creative use of the semantic web is becoming an essential lever in competition."*

9. AI MANAGEMENT

PROCESSES AND STRUCTURES FOR INTELLIGENT SYSTEM LANDSCAPES

Study results and project experience show that companies see the greatest potential of AI systems in increasing productivity and efficiency. However, these goals can only be achieved if the use of AI is not seen as a project, but as a learning, permanent process that encompasses more and more company functions. This poses the task of organising the industrialisation of AI solutions and constantly developing them further. This is pioneering work, because it is becoming apparent that conventional IT processes and structures cannot be directly transferred to the management of an AI landscape.

A key buzzword and focus of research initiatives in this context is "Explainable AI". Typically, decisions and conclusions of neural networks are difficult to understand, which leads to a dilemma with implications for numerous service processes. One example is release management: how can an AI-based software product be tested, verified and released whose functionality cannot be traced line by line of code? Processes are required that differ significantly from classic software development and that can also deal with the fact that some aspects cannot be explained.

Last but not least, the applicable liability guidelines remain in force, so the question of which processes, services and products may be outsourced to an AI system also gains legal explosiveness.

"In AI development, processes are needed that can cope with the fact that some things are not explainable."

10. DIGITAL BACKSOURCING

THE RETURN OF TECHNOLOGY TO THE COMPANY

In the course of digitalisation, companies are also changing the way they look at the management of digital technologies. More and more processes are taking place within the company - conception, development, operation. This is a consequence of the dramatically changed importance of data for operating and business models. Data are core assets and handling them should increasingly take place within the company's own sphere of access - a remarkable trend reversal, after decades of outsourcing technology issues to external service providers. How robust this development is and whether we are at the beginning of a new paradigm of technology management remains to be seen. What is undisputed, however, is that the classic architectures, whose backbone was formed by powerful ERP and MES systems for decades, will not shape the digital future of industry. Modular platforms as the basis for scalable individual production worlds are better suited to the growing importance of data. And they fuel the return of technology competence to the company, where it has become an essential part of value creation.

FROM PREDICTIVE TO PRESCRIPTIVE

THE ANALYTICS EVOLUTION IN THE SMART FACTORY

INTERVIEW WITH THOMAS RICHTER

Thomas Richter,
Principal, ROI-EFESO

DIALOG: Mr. Richter, how can you imagine the analytics evolution in production?

TR: Predictive analytics starts with error patterns, such as the overheating of a machine, and shows the conditions and parameters under which these patterns occur. From this, the foresight of potential process errors can be derived. This creates an AI-supported, self-learning system that can be called an intelligent early warning system. It is no longer necessary to interpret the multitude of data, as is the case with classic condition monitoring. Machine learning creates the possibility of automating the interpretation of the conditions of machines and tools and even entire production systems, and it is also possible to observe completely new correlations that were previously not recognised.

The next evolutionary stage that is increasingly coming into focus is prescriptive analytics - the transition from machine learning to machine reasoning. When you know which errors will occur, there are always several coping strategies to choose from, problem-solving scenarios that are the operator's essential know-how. With predictive analytics, the software now develops AI-supported autonomous problem-solving scenarios, which is why one can also speak of self-optimising processes here. This step helps to significantly increase speed. When a problem potentially arises, the possible solution scenarios are run through, the best solution strategy is selected and automated processes are triggered, e.g. ordering tools or spare parts or organising preventive maintenance teams.

DIALOG: In which areas are prescriptive analytics applications already being used?

TR: There are already concrete applications, especially in the context of production planning and scheduling, which is an ideal field of application for machine reasoning methods. The need is particularly great in the automotive industry, but also in consumer-packaged goods, where there are sometimes very complex supply chains. The technical challenge here lies primarily in the intelligent networking and integration of distributed planning systems such as APS, ERP, Scada or MES.

DIALOG: What are the possibilities for controlling a self-optimising process when the operator no longer makes the decisions and cannot comprehend the system's decision-making calculus?

TR: Neither is the case in this form. First of all, such systems cannot function without the operator's know-how. The system initially needs an intelligent library that contains the relevant process knowledge; this is how it starts to learn. The solution strategies proposed later are based on this knowledge; they are not new to the operator. In addition, machine reasoning and machine learning in general use the "next best option" strategy. This means that the solution strategy that has the greatest probability of success is also proposed in a prioritised manner. In the end, the operator responsible for a particular process decides for himself whether he takes the next best option or decides in favour of another option based on experience and knowledge. In principle, he is only supported in the speed of decision-making - which is also necessary with increasing complexity and networking of processes.

Problem-solving approaches in machine reasoning are geared towards multiple connected events and can handle this complexity efficiently. The system helps to reduce the time between the occurrence of a potential process failure and the initiation of the appropriate resolution strategy. This becomes even more critical when an entire supply chain needs to be kept in view. There, choosing the right coping strategy is even more complex and any delay leads to losses. Systemically supported, I am able to initiate the right measures immediately, to start the automated process. The operator remains responsible for the overall process efficiency. This is the collaboration between man and machine.

DIALOG: The optimisation of a supply chain is likely to encounter problems other than complexity. What are the main challenges in using intelligent systems and predictive analytics in the value chain?

TR: Especially where extremely process-heavy and capital-intensive technologies are in use, efficiency of use is of central importance. Here, many companies have their supply chain in mind together with suppliers and there is a common understanding that it is important to *share data. The challenge lies more in the fact that many of the technologies used are not network-enabled. Enterprise systems are often still in use here that are not layer-based. However, such systems are needed to introduce appropriate layers for process and data integration. Cloud-based systems and a hybrid cloud architecture are also required. There are certain critical processes that require a private cloud; other processes, such as supplier connectivity, need a public cloud solution. In some cases, certain "deep" core processes are not cloud-enabled at all.*

In addition, in terms of overall process efficiency, decisions would have to be made that also affect production sites for which we have no decision-making authority. We are already well networked at the data level, but not at the process level. At least not in such a way that autonomous interventions can be made across companies. Consequently, the prescriptive AI system of an OEM would have to intervene in the systems of its suppliers. I can't imagine that happening in the foreseeable future. There are currently no advanced governance models for the automated control of an end-2-end supply chain.

Another aspect is the lack of operational models. While I can use very advanced systems for decision support and process automation in my own system - there are good solutions for this today that can be implemented quickly and without any special programming effort - the problem lies in the scaling to the entire supply chain that is needed for full automation. So the question is no longer how to bring technologies into my smart factory, but how to bring them in in an industrialised and scalable way. The operating models and organisational concepts for this are missing today - questions such as governance, architecture, technology stack, defined process organisation and mapping of services.

DIALOG: How should one deal with these hurdles, especially with the topics of governance and operating models?

TR: There are essentially two approaches here. One is to start where digitalisation can have the greatest positive impact and where the barriers to entry are relatively low. In the process industry, for example, the business model depends largely on the effective use of the installed assets. The money is earned - to put it bluntly - with the OEE. It therefore makes sense to initially focus digitalisation initiatives on strengthening the overall effectiveness of the factories. There, these topics - up to and including Prescriptive Machine Reasoning - can be developed, the workflows digitised and viable Operating Models built, consisting of five components: Organisation, Governance and Data Security, Quality Management, Technology and Processes. This creates the basis for further topics such as service, operations and competence building.

Another scenario is when one's own factories are running stably, but the supply chain is particularly vulnerable or disruptions have a major negative impact, for example when a plant that supplies a critical primary product is affected. Here one should focus on approaches for which there are use cases. For the reasons mentioned above, machine reasoning cannot yet be applied here, but predictive analytics, automation and risk management can. If, for example, a risk is identified somewhere in the supply chain that will lead to a supply bottleneck in a few weeks, you have to quickly switch to an alternative source of supply. There are a lot of activities involved in such a process - factory inspection, sampling, accreditation of transport routes, customs duties, etc. This can be done through intelligent process automation. This can be supported by intelligent process automation in such a way that nothing is forgotten and the quality and speed of the processes are significantly increased.

In both scenarios, success depends heavily on operating models and the industrialisation of services. That is why it often makes sense to bundle these services end-2-end in shared service organisations, where processes and technologies are managed and further developed and made available as services. This relieves the functional areas, ensures security, efficiency, quality and automation of the processes - and the advantages of digitalisation can really take effect.

DATA EXC

By Dr. Sebastian Grundstein, ROI-EFESO

THE TOP 5 OF INDUSTRIAL DIGITALISATION
THE MOST IMPORTANT APPROACHES FOR SMART PRODUCTION

THE USE OF THE COMPANY'S INTERNAL DATA RESOURCES AND THE CONFIDENT HANDLING OF THE MOST IMPORTANT DATA-DRIVEN TECHNOLOGIES ARE THE BACKBONE OF INDUSTRIAL DIGITALISATION.

THEY ARE THE PREREQUISITE FOR IMPROVING OPERATIONAL EXCELLENCE, AGILITY AND PLANNING ACCURACY, REDUCING COSTS AND RISKS AND GAINING TRANSPARENCY OVER COMPLEX SUPPLY CHAIN NETWORKS. BASED ON STUDY RESULTS, CURRENT APPLIED RESEARCH AND PROJECT EXPERIENCE, FIVE TOPICS CAN BE DEFINED THAT ARE HIGHLY RELEVANT FOR THE DIGITAL TRANSFORMATION IN INDUSTRY AND FORM THE FOCUS OF THE ROI ANALYTICS LAB.

1. BUSINESS INTELLIGENCE & PROCESS MINING
2. PREDICTIVE ANALYTICS
3. MODEL PREDICTIVE PROCESS CONTROL
4. SIMULATION & OPTIMIZATION OF PROCESSES
5. ROBOTIC PROCESS AUTOMATION

BUSINESS INTELLIGENCE & PROCESS MINING

Business Intelligence (BI) and Process Mining are particularly effective tools for gaining a comprehensive insight into actual process events and sustainably increasing efficiency - for example by discovering process steps and interfaces where time losses or irregularities occur. For this purpose, log data from IT systems (ERP, CRM, MES, CAQ, ...), but also from other structured and unstructured data sources, are first extracted, integrated and prepared for data analysis. The prerequisite for this is that processes leave a digital trace, for example through time stamps, IDs or documented activities. Based on this, actual process flows are reconstructed and visualised. This creates an objective and complete picture that serves as an optimal starting point for process adjustments.

At the same time, this is the basis for automating process management (e.g. through automated report generation and distribution or KPI-dependent alerts). Particular added value is created in cross-departmental and cross-functional processes.

PREDICTIVE ANALYTICS

The correlation of different parameters and their influence on processes and quality repeatedly proves to be a black box in production. As a result, important tools for reducing losses and achieving sustainable improvements are missing. With the predictive analytics approach, all relevant parameters can be uncovered, their correlations analysed and integrated into a dynamic, learning data model. This creates the basis for identifying process-related weak points, reducing maintenance and quality costs, improving decision-making quality and controlling production in real time with foresight. This requires a circular approach in which business model analysis, data preparation (understanding, integration, preparation), data modelling, evaluation, implementation and ongoing adaptation are intertwined. Typically, the successful development of a predictive analytics solution requires the cooperation of several experts. These include in particular process experts from the departments concerned, data scientists and data engineers as well as the IT department.

MODEL PREDICTIVE PROCESS CONTROL

Model Predictive Process Control (MPC) is an intelligent and lean method for optimising processes in real time on the basis of dynamic models, especially for the process industry. Based on a real-time-capable IT infrastructure, the focus is on the next production sequence in each case, while at the same time the overall process is taken into account. MPC allows effective, predictive control even without setting up significantly more complex digital process twins. The method is particularly helpful in accelerating the start-up of production processes, mastering new technologies and processes, and reducing losses and waste.

SIMULATION & OPTIMIZATION OF PROCESSES

Simulation studies for complex or cost-intensive processes help to make better decisions and to estimate the long-term effects of the process design. The approach is based on the construction of alternative scenarios that take into account dynamic influencing factors such as seasonality or disruptions in the value chain. For example, investment decisions, dimensioning of buffer stocks and logistical capacities or value flows can be simulated. The decisive factor here is a continuous, methodically supported simulation process that ranges from the definition of goals and problems to the design and validation of the simulation model and the collection of data to the visualisation of results. The availability and validity of the data used and the choice of the right methodology for building the simulation model prove to be critical factors. In addition, only the combination of a powerful but lean software solution with comprehensive technical and process expertise guarantees that the objective is precisely formulated and the results are correctly interpreted.

ROBOTIC PROCESS AUTOMATION (RPA)

RPA solutions automate processes by imitating human activities. In doing so, they directly access systems such as ERP, CAD or even mail programmes. Interesting fields of application for RPA arise where process automation with a comprehensive solution does not pay off. In production, this is particularly the case in indirect areas, such as reporting. For example, in the context of shop floor management, key figures from different sources, such as Excel spreadsheets or ERP and production systems, have to be merged. Tasks like these are typically error-prone and resource- and time-intensive. In such contexts, RPA solutions help to reduce headcount and costs, improve the quality and auditability of workflows and achieve high process scalability. Today, there are numerous powerful and user-friendly tools for the implementation of RPA projects that do not require excessive IT expertise. Rather, success depends on effective interaction between process analysis, process design and software, as well as effective interdepartmental collaboration.

Dr. Sebastian Grundstein, Principal, ROI-EFESO

“THE INTELLIGEN
OF DECISION-MA
STAYS WITH US”

CE
KING

Dr. Thomas Ramge, business journalist and author of several books on artificial intelligence and data economics, on the roles of AI as intelligence amplifier and intuition assistant.

The publicist ***Thomas Ramge*** *is a multi-award-winning non-fiction author. In his books, he regularly addresses the topic of artificial intelligence and the human-machine relationship. After the works „postdigital“ and „power machines“ published in 2020, this is also the focus of his current publication „Augmented Intelligence. How we make better decisions with data and AI“. „When it comes to decisions under high uncertainty, no computer can help us.*

DIALOG: Mr. Ramge, what shapes our relationship with "Artificial Intelligence"?

TR: Misunderstandings and ambiguities. Our ideas about artificial intelligence are strongly influenced by science fiction: machines that decouple themselves from humans, subjugate them or wipe them out. But according to the state of science, these are completely absurd scenarios. We know of no technological development path on which this could actually happen.

In addition, the term "artificial intelligence" is imprecise; there is no real common sense. This is also reflected in the fact that we overestimate the future performance of AI and at the same time underestimate that of computers or systems that already work with machine learning. After all, the term "artificial intelligence" also implies that computers would be subject to the same limitations as human intelligence. This is not the case either - in computing, in storing knowledge and many other things, technology has of course long been superior to us.

DIALOG: Why do you prefer to speak of "augmented intelligence"?

TR: The term "augmented intelligence" refers more precisely to a crucial aspect of the relationship between humans and technology. It is intended to show what systems that learn from data are suitable for: augmenting human intelligence.

That is the core of the idea: to get out of the hype that AI will become infinitely smart and do our work for us. Rather, it's about understanding that systems that learn from data can support us humans in more and more areas to do things better, faster, cheaper and more precisely, even to the point of automating routine decisions. So what if we think of AI not as a technology that replaces human intelligence, but enhances it? In fact, this was already a core idea of early AI research in the 1960s, which is receiving renewed attention today.

> *"When making decisions under high uncertainty no computer can help us."*

DIALOG: So, in the near future, an AI could accompany us as a "personal assistant", giving us advice even on more serious decisions than compiling a playlist?

TR: The assistant role describes it well. But when it comes to decisions, you have to differentiate. There are decision-making situations in which data-learning systems have a good data basis to predict with a high degree of probability which is the better option - see route planning as a classic example. In such situations, we are well advised to delegate the decision to AI.

But as soon as it comes to decisions under high uncertainty, no computer can help us. At least not until it has been able to record enough comparable situations to calculate a forecast of what the future might look like. This is much easier with your playlist than, for example, with the question of which degree programme you should choose. Decisions are essentially simulation or projection exercises. We project ourselves into variants of the future and then consider whether future A or future B is the more interesting or better path for us. But neither the computer nor we know the future.

DIALOG: What do you see as the strengths of AI then?

TR: In the more mundane help than the big philosophical questions. AI can help me work on my options. An example: On the one hand, we are often overwhelmed by the information overload and the options that computers give us. At the same time, however, IT systems with taxonomies, i.e. filters, can help us to narrow down the choices. By using recommendation algorithms or search grids, a decision-making assistant helps us to work out the options for a decision in the first place. However, this is also where the limits of AI's capabilities become apparent. A machine or technology can assist us in searching for something. It can even help us to refine the search. But as a rule, it cannot tell us what we should be looking for in the first place. But that is the core of decision intelligence.

DIALOG: Now you may be overestimating human capabilities ...

TR: Of course, one should always question the human sense of responsibility and the human ability to make decisions. And from an AI perspective, humans may indeed be a weak opponent. We constantly fall into decision-making traps where all kinds of things get in our way: our biases, our emotions, our short-sightedness, or our greed - all factors that do not occur in well-programmed machines.

DIALOG: Yet we make better decisions ...

TR: Not necessarily, but that is of course a very limited way of looking at it. What actually constitutes the performance of AI? We are talking exclusively about repetitive tasks, i.e. situations that occur again and again and can be easily reproduced digitally. Wherever this is the case, intelligent machines are well on their way to topping human decision-making intelligence and, as a rule, to taking over previously human activities. Wherever this is not the case, we currently know of no technologically sensible ways to realise this.

But what really makes human intelligence is the ability to figure out what to do when we don't know what to do - as cognitive scientist John Piaget aptly put it. So to speak, to move in a "data-poor" space with our human curiosity. At the moment, this is also the limit to which AI can help us.

> *"One of AI's strengths is in performing repetitive tasks."*

DIALOG: At the same time, the algorithms will continue to improve themselves. How should we deal with that?

TR: We have to be able to recognise whether machine assistance is really useful to us or not. That is the crucial competence we need to develop - in line with the concept of augmented intelligence.

This frontier will shift further and further towards the machine in many areas, which is good news per se. It can make our lives better, safer, healthier. This includes relieving us of routines that we don't feel like doing or that are difficult for us. This in turn gives us space, time and energy for things that machines cannot support us with.

DIALOG: What about human intuition - can it be represented in code?

TR: In fact, AI is often quite intuitive. Intuition is basically an unconscious decision-making mechanism, based on the experiential knowledge we gather in the course of our lives, supported by "rules of thumb" that we know explicitly or feel implicitly, but in any case, no longer run cognitively consciously.

However, this means that we are generally in the field of patterns or pattern recognition and thus in an area where machines that learn from data can help us, for example by challenging us with artificial intuition, in the sense of an intuition assistance. It is conceivable to have a computer that reflects our thoughts, in the sense of: "Something is not right here. I don't know what it is either, but think again." That would also be a great help that could support our human intelligence in our striving to know more, to decide more intelligently, to develop new things.

FROM MES TO PRODUCTION PLATFORMS

Interview with Gernot Schäfer, Partner, ROI-EFESO

To achieve best operating conditions in production, MES solutions must become app clusters on integrated IIoT platforms - with profound consequences for architecture, data management and operating models.

DIALOG: Mr. Schäfer, what changes in the MES environment do we have to prepare for?

GS: The decisive keyword is Best Operating Conditions (BOC). This is about the question of how to monitor the ongoing production process and optimise it on the basis of relevant parameters. In other words, as much data as possible about quality and specifications, supply chain, production processes, physical conditions of material, machines and environment must be collected, correlated and interpreted. On this basis, different parameters can be continuously adjusted, especially in real time, and a self-optimising process can be initiated using cognitive systems. The result is an AI-based control loop that is designed to achieve an optimal operating state, i.e. the best operating conditions. MES solutions must be geared towards this task in the future.

DIALOG: How significant is the progress that can be achieved?

GS: A good example is the reduction of rejects or start-up optimisation. These topics are very important in the context of best operating conditions due to the small batch sizes and the large number of specifications. If you reduce the four to six weeks that are necessary to run in the machines and set the tools to two weeks, then that is not only an enormous cost saving in the production start-up, but also improves the market position.

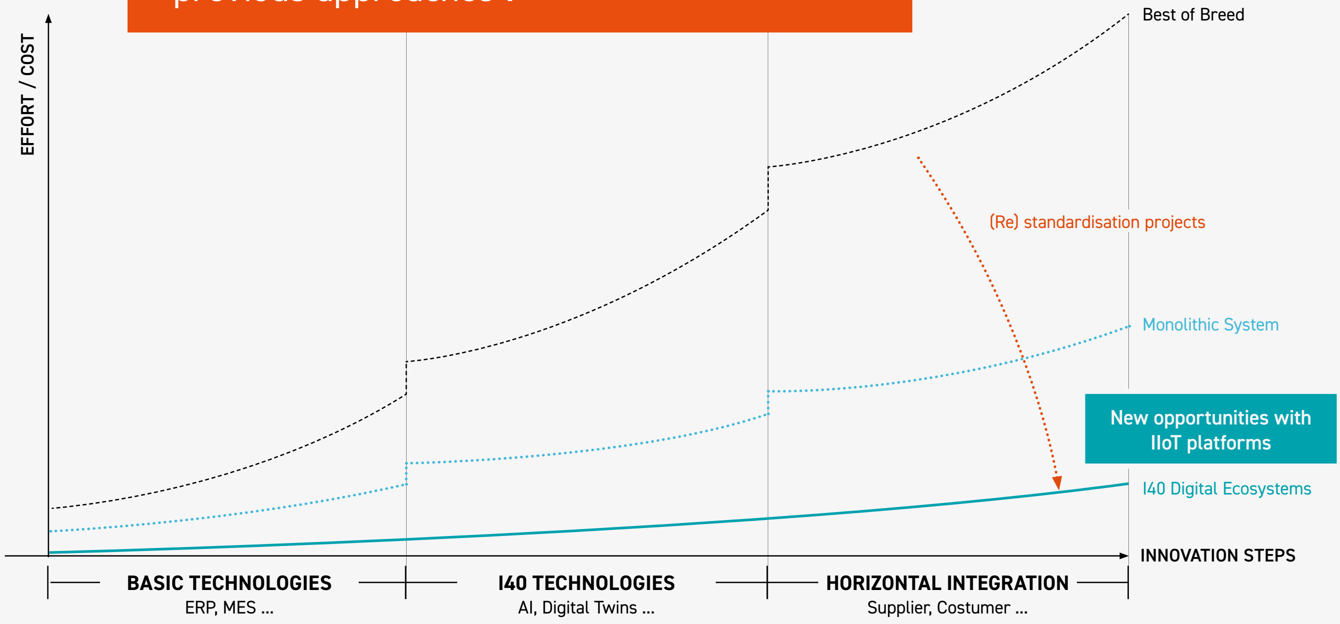
DIALOG: Doesn't the scenario outlined go well beyond the classic MES?

GS: Exactly. If you want to make production self-optimising, the data, data spaces and data models of the MES are not enough. You need diverse structured and unstructured data on every area of production, on every process, every machine and every factory floor, which come from MES and ERP solutions, QA systems and other data sources - and not only from your own production environment, but also from suppliers.

DIALOG: What consequences does this development have for the architecture of MES and what role do AI systems play in this?

GS: AI is the key to recognising correlations in the overall picture in real time and to identifying optimisation approaches. Such complex interrelationships are not accessible with the classic analysis procedures, methods and tools, as these only focus on individual reports that are drawn from databases. For the integration of MES into such AI-based control loops, digital twins are necessary that go far beyond the actual MES. The AI engine must be able to access a complete data pool, if possible, in real time. It is therefore not enough for the MES solution to simply have interfaces to ERP systems in order to pass on production order progress or to machines in order to control them. The MES must be integrated into a platform that organises the overarching data management of structured and unstructured data beyond the MES world and forms the basis for the use of AI-supported solutions. Further microservices, i.e. industrial apps, will be integrated into these IIoT platforms, which fulfil specific tasks, e.g. for material sequencing, material disposition, real-time location, or camera systems that, supported by AI solutions, examine the material and derive quality indicators. In this way, company-specific production worlds are built, whereby the orchestration of the platform, processes and data flows between the individual apps is of central importance. MES are thus becoming app clusters on integrated IIoT platforms, which means that interoperability, connectors and interfaces must be reflected in the architecture of MES systems.

> "New IIoT platforms form the basis for an I40 Digital Ecosystem that eliminates the effort and cost traps and cost leaps of previous approaches".



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DIALOG: Such a platform then resembles an app store for smartphones, doesn't it?

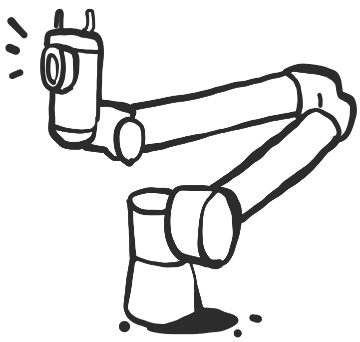
GS: At first glance, yes. The big difference is that the apps for weather forecasts, hotel bookings, share prices or news are not connected at either the process or data level. In production, it's different. Here we need a common data model for product and process twins and have to synchronise the data completely with each other - in a matching process that also has to be modelled. Here we are already talking about a different level of complexity and a different know-how that is necessary.

DIALOG: Has the market already followed the trend towards production ecosystems around MES? already followed?

GS: There is a movement away from monolithic solutions in the direction of so-called Manufacturing Integration Platforms (MIP). They enable customers to integrate individual apps in order to build up individual architectures. Even large providers see the need to build their solutions modularly in order to allow apps from special providers, for example for topics such as AI-based optical defect detection. For the customer, this makes the architecture design more demanding, as individual IIoT stacks have to be built: Layers, connectors, databases, data modelling. Infrastructural requirements must also be created, whereby the topic of edge computing plays an important role, because with these data volumes, appropriate latency times can only be realised in distributed computing clusters. At the same time, however, solution development, implementation, operation and further development will become much easier compared to conventional architectures. It can be assumed that there will be three types of providers in the future: First, those that can offer total platforms that include both the classic MES modules and the IIoT platforms. Some of them will also provide the orchestration layer itself. On the other hand, there are those who will focus on special topics, whether quality inspection, scheduling procedures or coordination of AGV swarms. They will focus on individual microservices. And finally, there will be providers who will provide the platform and the orchestration layer, but have the apps delivered to them. This requires a certain market power and position, which is mainly held by the large OEMs and the global cloud services providers.

DIALOG: What competences are necessary to safely shape the change from classic MES solutions to integrated, modular production worlds?

GS: You have to combine methodological, technological and production expertise. That is the prerequisite for knowing which data you can typically get from certain types of machines and how the technical integration is done, how the solution stack can be built so that the interaction works smoothly. And one should know the market well in order to bring together the right apps for the production platforms and ensure that adequate service is guaranteed on the part of the providers.



THE CIO BEING THE ORCHESTRATOR

Interview with Dieter Wittbecker, Principal, ROI-EFESO

> "In the future, the bridge between the CEO's vision and its creative technological implementation will shape IT more than maintenance & delivery. As a result, the role of the CIO is also changing profoundly."

DIALOG: How serious is the pressure exerted by the digital transformation?

DW: I would not speak of pressure in the context of digital transformation because the term falls short. Digital transformation is not a one-time measure, it is not a project. It is here to stay. You could call it a new operating system that companies have to deal with in the long term - technologically, organisationally, culturally, processually.

This means that the changes we observe today in connection with digitalisation will shape the interplay between managers, employees and the structures surrounding them from now on and for a very long time. The rapid change in technology, the emergence of purely digital business models, new ways of working and competencies, new work culture - these are all elements of this ongoing optimisation process. This perspective is helpful in classifying the scale and quality of the changes. At the same time, there are managers who are particularly affected by this change, this new operating model. This includes the CEO, of course. But above all the CIO.

DIALOG: To what extent is the role of the CIO changing in the context of digitalisation?

DW: The change is substantial. In an ideal-typical scenario, ideas for new digital or digitally supported business models, new market, product or innovation descriptions emerge at the top management level of the company. These are delegated to the CIO to check their feasibility and realise pilots. IT thus becomes an incubator and a site of creativity. This is diametrically opposed to the focus on maintenance and delivery that characterised the IT sector for decades.

The CIO thus becomes the central interface between the requirements that come from top management and the innovation push that is necessary to implement them quickly. This role brings with it a whole new set of tasks. For example, an ecosystem of freelancers, consulting service providers and external experts must be cultivated. Many companies, including many CIOs, have done this in a rather fragmented way so far and have not strategically developed either the quality and density of the network or the intensity of cooperation.

DIALOG: What does it take to fulfil this changed role?

DW: Decision-making and assertiveness, the ability to keep an eye on milestones, objectives and requirements. At the same time, however, the CIO must act much more as an orchestrator who motivates, integrates individual excellence, creates a sustainable framework and provides orientation. Of course, this is not about copying or adopting the attitude or general mindset of the young digital natives - but about finding a common language, being credible, authentic, motivating and convincing. The CIO must continue to be very well informed about the essential fields of technology - but he no longer needs to know the bits and bytes in detail and, given the market and technology dynamics, he can't do that at all. And he has to create a good connection between the people in management who develop visions for new business fields and strategies and the team that has to implement them in the end. This connection simply has to be created in a healthy way.

DIALOG: Will digitalisation also make the CIO a candidate for the CEO role in the future?

DW: The question is whether the CIO wants that. These are often very different characters, it is not primarily a question of skills. The CIO's heart beats strongly for technology, otherwise he wouldn't have become CIO. But in any case, the task of creating the link between the think tank and the tech incubator brings the CIO closer to the CEO's issues. He usually knows the business model of his company - but not in all cases the relevant business processes. This will certainly change in the coming years. In future, the CIO must combine a fundamental understanding of the central business processes and use cases with knowledge of the technology required for them, both for existing and future business and operating models. Then he can confidently fulfil his role as mentor and orchestrator and optimally align his team and network to the new objectives. There are a lot of exciting opportunities in this - and this is exactly what motivates most CIOs.

WHAT MAKES ANALYTICS INITIATIVES SUCCESSFUL?

Interview with Ulrich Krieg, Partner, ROI-EFESO

Translating actual process problems into the analytics world, building horizontal data competencies and the ability to scale and industrialise use cases are critical for sustainable success and broad impact of AI initiatives.

DIALOG: Mr. Krieg, how do you experience the entry into the topic of data analytics and AI in practice? In which areas is it gaining importance?

UK: At the moment, we often see the topic in SCM projects, for example when it comes to optimising sales planning. In this environment - predictive demand planning, demand sensing - the intelligent use of data offers great potential. The aim is to combine different data reservoirs and to generate more precise demand forecasts from past, order and environmental data. If it is possible to use all the data that is available, demand patterns can be better forecast, resources can be better secured and inventories and delivery times can be optimised.

DIALOG: How critical is data availability in this context?

UK: Often there is more data available than you think, you can actually always find a start. It becomes interesting when, on the one hand, you include data that is not yet available in structured form, for example from communication processes, CRM systems, from the point of sales, and on the other hand also external macroeconomic data and forecasts or industry indices. We often discuss the question of which statistical data can be used in projects. Integrating such different data would be extremely time-consuming in the conventional world. In the meantime, however, very good tools are available that make working with restructured data enormously easier.

DIALOG: With data analytics, you enter an area in which the majority of companies have little experience to build on. How do you ensure that the entry is successful?

UK: There are several factors. If we stay with the example of demand planning, the first questions are very classic. Because regardless of new analytics possibilities, a robust backbone for planning processes is needed first. The basis must be right and correspond to established methods and best practices. Then AI tools and analytics solutions can build on it. And then it is a matter of cutting the projects as small as possible and tackling the topic in small steps, in sprints. This is about proof of concept, about trying things out and also discarding them in order to create empirical values. Of course, this *also requires a certain mindset in the organisation: the willingness to deal with a topic where the result is not completely predictable, where you don't know which approach will work. In many use cases, you find that you can't learn anything from the compiled data, that the algorithm can't do anything with the result. Then you just have to move on.*

DIALOGUE: What remains after a failed sprint?

UK: Lessons learned. You learn from each attempt what works and what doesn't, what you have to pay attention to, which sub-areas have potential. You can act more precisely in the next attempt. You gain experience and create the basis for future projects - that is also part of dealing with new issues. The art lies in designing these learning loops efficiently. In our analytics projects, it takes an average of six weeks for the team to achieve resilient results.

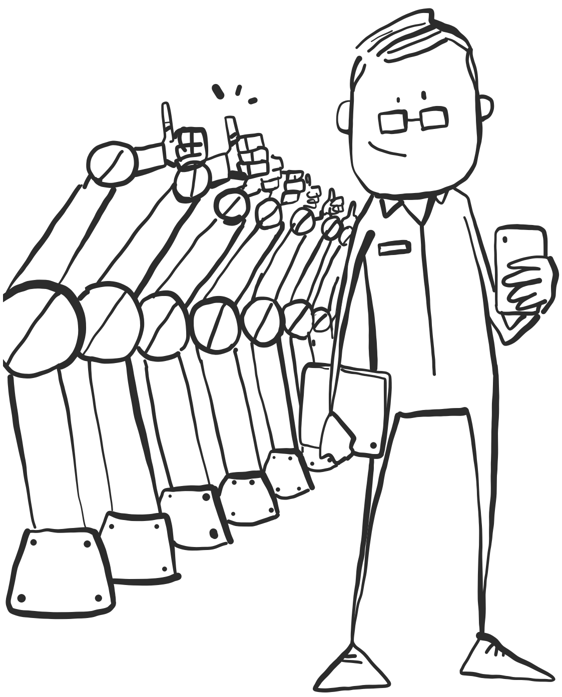
DIALOG: How should a project team be composed in order to increase the likelihood of success of analytics initiatives?

UK: If we stay with the planning example, then the representatives of the affected areas must be involved - sales controlling, marketing, product management, supply chain management, IT. They are supported by data experts. It is crucial that the two groups work together effectively. In analytics projects in the area of production, for example, it is important that so-called Citizen Data Scientists are involved, process engineers from the specialist departments who have basic qualifications in the analytics topic. On the one hand, they know their own processes exactly and on the other hand, they can understand the analytics experts. If you focus too much on data expertise, you approach the topic too technically, analyse large amounts of data and often end up with findings that are trivial. You absolutely need the process expertise to focus on the right question from the outset and on pre-selecting the data that could have an impact. Trial and error does not mean looking for a needle in a haystack.

So, the art lies in translating the actual process problem into the analytics world. Building this bridge between the process world and the data world is a key task and it is important to also use the projects to strengthen the horizontal data competence in the company. The algorithms, the technical implementation - there are more and more standardised tools and services on the market for this. That is not the hurdle at which initiatives fail.

DIALOGUE: What follows a successful analytics project? What needs to be done to build on what has been achieved?

UK: Above all, it is important to industrialise the topic of analytics. Setting up an algorithm once and getting it to work is a start, but not a solution. Because the process landscape continues to develop, the process parameters change. Therefore, you must train and change the models again and again. This requires a defined process, professional change management and an organisation that manages and follows up. Unfortunately, the opposite can be observed again and again. A big analytics initiative is launched, numerous use cases are identified, and some of them are tackled. But the overall framework is missing - and then there is no traction in the organisation, the project plans in the individual areas peter out, competences are not built up. The result is then a one-off, resource-intensive project with no long-term impact. It is therefore necessary to think about the organisation from the beginning, develop clear governance, demonstrate the benefits on the ground and initiate a continuous improvement process. Successful initial projects are also an opportunity to bring about a change in thinking so that a self-sustaining process emerges. The topic - like any change topic - is partly risky and thankless. You have to change roles and responsibilities, the way of working together, which is often unpleasant. And that is why management's far-sightedness, responsibility and leadership are particularly in demand.



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