



INDUSTRY 4.0 WHITEPAPER

Step 1 | What Is Industry 4.0 –
Where Is the Journey Heading?

Preface

There is no question that Industry 4.0 has become a media hype. The topic has long since gained widespread support beyond the professional world and has now spread to virtually all media channels. More and more new authors are analyzing and evaluating the opportunities and potential of Industry 4.0 and suggest appropriate actions. What added value does this whitepaper series offer; how does it differ from the many other articles on the market?

The buzzword Industry 4.0 requires a pragmatic classification and a practice-oriented reflection, because it is precisely such an orientation to practical reality beyond all ideologies that will be important for the success of Industry 4.0. Production companies are quickly discouraged by target scenarios and procedural concepts if they do not match the reality they experience. This is exactly the problem: Since they differ greatly from reality in almost all respects, they are difficult to implement and are therefore not addressed.

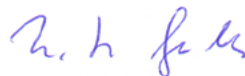
This whitepaper series aims to provide manufacturing companies, regardless of size and industry, with a realistic and therefore usable guide on how to approach and successfully implement the topic of Industry 4.0.

Moreover, a realistic guide also needs a realistic objective. One problem with many Industry 4.0 whitepapers is that there are many myths and misconceptions around the

term. Certainly – we can already look back on considerable progress made with regard to digitalization as the basis of Industry 4.0. Nevertheless, we still have a long way to go, which is often downplayed or not addressed at all.

A realistic assessment, e.g. that progress is usually better in many small steps than in a few too large leaps, is the safest way to avoid disappointment and expectations that are too high. This attitude and forecast may not be as attractive as the media hype, but it prevents frustration.

What exactly does that mean for Industry 4.0 projects? The key success factor is first of all setting appropriate goals, taking one step at a time, and relying on the right partner.



Dr. Karl-Heinz Gerdes, Founder of FASTEC GmbH



About the Author

Dr. Karl-Heinz Gerdes is the founder and former Managing Director of FASTEC GmbH and has been active in the field of computer-integrated production for over 30 years. During his studies he was already working on microprocessor-controlled automation solutions. The development of decentralized control and networking solutions for interlinked plants with master computers was ultimately the guiding principle for the founding of FASTEC GmbH. The MES solution FASTEC 4 PRO, which is distributed by FASTEC today, was developed on this basis and has become even more sophisticated due to the experience gained from many complex customer projects.

Maximum Decentralization Without Central Coordination = Good News for Industry 4.0?

Many of the Industry 4.0 ideas are not new at all. More than 25 years ago, interest was already growing in the ideas of decentralized and autonomous decision-making processes that were emerging at the time. As part of our own research work, a concept was developed in which all machines and systems were to be equipped with supplementary „intelligence.“ These were to take over planning, control and monitoring processes for each machine and were referred to as intelligent objects. In addition, so-called „agents“ acted as information brokers with the task of distributing information, bundling responses to it and evaluating it (see Fig. 1 and 7). However, there were several issues. In this concept, communication „exploded“: Each intelligent object communicated with many others. New coordination was necessary again and again, as not all information was bundled from the beginning, but was created gradually and then distributed. With increasing field experience in reality, it also became clear that decentralized structures also have disadvantages. In particular, this applies to planning due to the fact that all information should be known at the beginning in order to achieve the best possible planning result. In addition, decentralization brings with it critical aspects for IT security, because the dangers of sabotage and manipulation grow with end-to-end networking and decentralized responsibility.

Inevitably, the complexity of the systems increases and with it the susceptibility to errors. Nevertheless, if you take

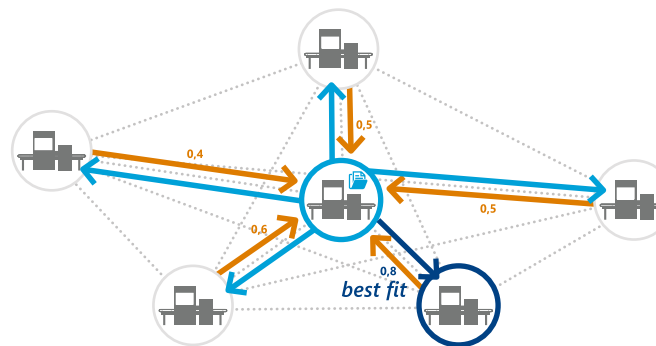


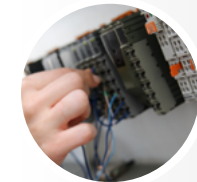
Fig. 1: Decentralized approach without central coordination – also see chart on page 5, Fig. 2

a sober look at the basic ideas and analyze the potential critically and in relation to your own application, companies today must take the path toward Industry 4.0, because the productivity potential to be achieved is enormous. However, concepts such as complete decentralization and workpieces that move independently through the manufacturing process can only be implemented to a very limited extent, especially with regard to optimized and reliable process coordination. This idea, proclaimed as an Industry 4.0 cure-all, is rather unrealistic from my point of view. This approach would only be feasible with processes that do not require set-up in combination with low capacity utilization. Whether it would also make sense economically is another matter. Without an overview of the entire production, it is impossible to achieve optimal planning

results or to carry out holistic analyses. At the same time, however, increasing complexity and agility in production argue for decentralization. The solution to this dilemma is a combination of both approaches:

So it is not „maximum decentralization“ or „maximum centralization,“ but instead, it is „intelligently networked decentralization“

▶ But what form does this solution concept take?



MES and Industry 4.0: Why One Cannot Work Without the Other



The Question Is: How Do You Implement Intelligently Networked Decentralization

A look at nature helps to understand how highly complex systems evolved in the course of evolution and why they are so enormously successful: Single-celled organisms with low functionality and complexity became multicellular organisms that continued to use the basic functionality of single-celled organisms but refined it through specialization. These cellular components later gave rise to organs with a high level of specific functionality and autonomy. The nervous system emerged as a network that took over the coordination of the organs, controlled by an increasingly powerful central unit – the brain. If you follow this model, you end up with decentrally organized functional units, controlled and monitored by a central authority. In the first step, the task is to create well-functioning decentralized structures that are then (centrally) networked. The flow of materials links the production processes on a physical level, the flow of information on the information technology level – these are the two starting points.

There are still too many manufacturing companies that work with many individual units without automated information and material flow. The good thing about this is that carefully weighed investments are not an end in themselves, but highly profitable measures with a convincing ROI.

The consistent introduction of an MES (Manufacturing Execution System), for example, quickly leads to significantly increased productivity without additional investments in new machines or more personnel.

- **The Key to Success:**

In addition to a pragmatic solution that initially focuses on the greatest benefit, a pragmatic approach that builds on what is already in place and thus gradually brings success is also crucial. With this approach, many companies have already succeeded in optimizing their production in the direction of Industry 4.0. What makes these companies different from others? Above all, the awareness of its functionaries and their continuous striving for optimization. For them, there is never a state in which everything is achieved: Every goal is just a stopover on a never-ending path. This consistent focus is a necessary, but not in itself a sufficient condition for success. These „visionaries“ are only successful because they also choose the goal and path in such a way that it is feasible. The formula for success is to set an ambitious, far-reaching goal, but not to take too big steps to get there. The approach of intelligently networked decentralization outlined above optimally supports such an approach. But beyond technology, the crucial factor for success is getting everyone involved. Without their full integration, these investments are pointless. The involvement of staff and employee engagement

determines the pace at which a company advances. Information technology integration is usually the first, simpler and generally also more cost-effective step before material flow integration. If you wait too long, you will not only lose time, but also money and in the long run you will lose touch with the latest developments from a competitive point of view. Ultimately, the overall scenario is decisive, in which the ultimate goal cannot be the displacement of humans, as is the case with CIM.

▶ **Instead, the goal must be a new partnership between people, machines and systems, in which the efficiency of machines and systems is combined with the flexibility and experience of workers.**



Comparison of Decentralized Versus Centralized Planning

Maximum Decentralization Without Central Coordination

Follow-up operations are assigned by the predecessor to the best successor. However, each disruption leads to a re-evaluation of the assignment. This creates a domino effect not only for follow-up operations, but for a number of subsequent orders on all machines!

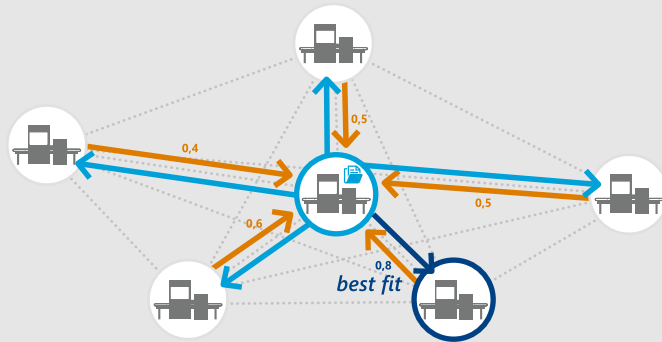


Fig. 1 | Decentralization on the Wrong Path: Local Planning

High communication, suboptimal plans, security breaches

 Step 1: Make out follow-up operation

 Step 2: Return of the offers, approximation of the optimal value (max. = 1, min. = 0)

 Step 3: The machine with the lowest cost is selected

 Synchronization of the machines with each other

Decentralization and Central MES

The MES evaluates and controls the distribution of orders and operations to autonomously operating components from a central perspective and takes corrective action in the event of disruptions in the production process.

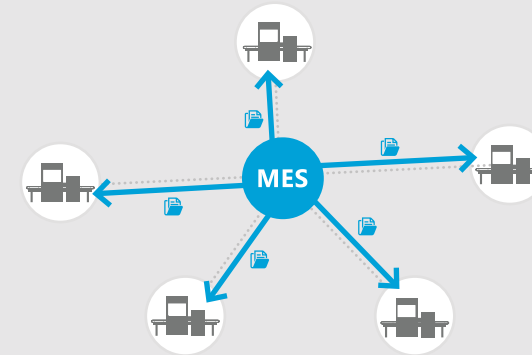


Fig. 2 | The Productive Scenario: MES-Based Planning

Decentralization and networking through an MES with a fast ROI

 MES distributes work operations

 MES/individual machine synchronization

How Is Industry 4.0 Practiced Today?



As an MES provider, FASTEC has had the opportunity to work with many innovative companies over the past years and decades and to implement their visions together with them.

What Has Been Done and What Has Been Achieved?

If we look at the result, we see how well-organized sub-processes are flexibly interlinked to form a variant-controlled overall process, for example by means of an automated material flow. Here, data is recorded at many process-relevant points (process and tracking data). Necessary data such as work instructions, drawings or parts lists are made available to the employees at the workstation or on the line in real time in relation to orders, articles and work operations, or the integrated controls are supplied with recipes or DNC data based on variants. Processes are automated by workflows, variants are produced by different routing in the material flow. And the bigger picture is taken care of by a higher-level planning that regulates the overall coordination of the orders. Any disruptions are recognized immediately and reported to the responsible maintenance staff without delay. The resulting time delays flow back into the planning.

A continuous flow of information integrates all employees involved in the production process, creating maximum transparency and enabling processes without friction

losses. In short, the E in MES, the Execution, has been given sufficient priority. Starting with the planning, production is expanded into a functioning control loop by controlling the processes and monitoring them, with the material flow being integrated with equal priority.

From what has just been described, it is clear that I 4.0 is a broad cross-cutting issue in which software expertise and distinctive know-how in the MES area represent only one facet, but one that is very essential. Control-related expertise is also necessary, because it is important to link information and material flow in a meaningful way, i.e. to control the material flow by means of information and to intervene in processes, e.g. for process interlocking in the absence of approval from quality assurance (QA). In order to create adaptive, highly flexible production systems, plant engineering must also leave the traditional paths and become an active component of the Industry 4.0 approach. Otherwise, the adaptability required in the long term cannot be achieved.

But I 4.0 is still being developed further. The final vision (for the time being) is consistency from product development to the end of the product life cycle, including recycling. However, many companies still have a long way to go before this happens. Still, it is advisable to start quickly with the obvious. In order to tackle I 4.0 projects, production companies need a competent partner who is able to

control complex processes and at the same time combine them with a high degree of adaptability. You need information and automation systems that can be configured to flexibly adapt to changes in the product and production environment. It is obvious that all providers of software for industrial production support the trend towards Industry 4.0 intensively, because the rush to Industry 4.0 offers enormous potential for new, complex IT projects.

▶ **But to what extent have manufacturing companies dealt with Industry 4.0 so far? What are the effects of the digitalization to be expected in the course of Industry 4.0?**



Change of Perspective: Industry 4.0 From the User's Point of View

Users are to be defined here as companies that are confronted with the task of implementing Industry 4.0 in their production environment or have already done so. The German Federal Ministry for Economic Affairs and Energy (BMWi) published a study on this topic back in March 2015, which examined the macro- and microeconomic factors for Germany as a location in terms of the impact of Industry 4.0. At that time, just 22% of the companies surveyed had a high level of digitalization in their vertical and horizontal value chains. A Bitkom study from 2014 has already shown that productivity increases of around 78 billion euros are possible in six economically important sectors alone by 2025. According to the study, an average of 1.7% additional gross value added could be achieved per year and sector.

A new Bitkom study from 2020 shows that the digitalization of industrial companies in Germany is making significant progress. 59% of industrial companies with more than 100 employees in Germany use special applications from the Industry 4.0 area, compared to 49% two years ago. At the same time, the proportion of companies for which Industry 4.0 is not an issue at all has decreased from 9% to 1% since 2018. Another 22% are specifically planning to use special applications for Industry 4.0 and 17% can imagine doing so in the future – according to the study (Bitkom: Industry 4.0 - This Is How Digital Germany's Factories Are/ Original Title: Industrie 4.0 – so digital sind Deutschlands Fabriken).

Surveys and analyses on the topic thus show great unanimity regarding the relevance and the high growth potential that can be tapped thanks to Industry 4.0. But despite the widespread optimism, there is also skepticism on the part of small and medium-sized enterprises (SMEs): This is due to the complexity of the topic, (often only assumed) high investment costs, and security concerns. Companies lack well-founded calculations that demonstrate in advance that the productivity gains achieved justify the investment costs. Admittedly, an assessment is not easy for manufacturing companies as it contains many factors, some of which are still unknown, that make the subject more complex. They find themselves in a dilemma: On the one hand, they feel compelled to initiate processes in the direction of Industry 4.0 in order to keep pace with latest developments. On the other hand, a lack of knowledge regarding the procedure, the right provider, a suitable solution, as well as security concerns and the fear of high investment costs raise understandable doubts. Therefore, we should try to find a solution that addresses the concerns, but does not stand in the way of development. The solution is to reach the goal in small, steady steps.

„Think big. Start small.“

The first step is to create a consistent flow of information. It forms the basis for everything else. As already mentioned, an MES is the information system for production today. There are MES providers who have developed precisely this step-by-step approach as their solution concept. This gives users enough time to familiarize themselves with an MES and its benefits. Small entry-level MES solutions enable customers to record and visualize production data at a cost-effective entry-level price. In this way, our customers learn to understand production data and can derive needs for action from them. With increasing know-how, the MES solution can then be expanded – all in all, small but important steps towards Industry 4.0.



“The decisive factor in Industry 4.0 is to first set appropriate goals, to take one step at a time and to trust the right partners.”

Dr. Karl-Heinz Gerdes, founder and former
Managing Director of FASTEC GmbH

The Complete Industry 4.0 Whitepaper Series From FASTEC

FASTEC provides manufacturing companies with MES solutions for discrete manufacturing. As a leading MES provider, FASTEC has implemented a wide range of customized solutions in many projects since it was founded in 1995 – each unique in terms of the production processes and manufacturing methods involved. Our systems are used nationally and internationally in various industries.

We work in a practice-oriented, efficient manner and ensure that our projects lead to lasting benefits for our customers. Together with you, we develop suitable solutions for your requirements, which we then implement precisely, quickly and cost-effectively on the basis of our MES standard software, which can be configured in many ways. Our customers benefit from our wide range of experience. In the end, there is a result that convinces our customers: A flexible and easily expandable system with sophisticated functions. FASTEC users are enthusiastic about the numerous features of the software and its usability in everyday use.

Decide on FASTEC 4 PRO – for a custom-fit MES solution with maximum customer benefit.

We take you on a journey into digital manufacturing; our whitepaper series serves as a guide.

- Step 1:** **What Is Industry 4.0? Where Is the Journey Heading?**
- Step 2:** How Do I Find the Right Partner on the Way to Industry 4.0?
- Step 3:** 10 Tips for MES Implementation – What You Should Keep in Mind.
- Step 4:** Focus on Transparency:
The Modules MDA, PDA, Monitoring Etc.
- Step 5:** Focus on Optimization:
Key Figures and How to Work With Them.
- Step 6:** Focus on Traceability:
The Many Unknown Benefits.
- Step 7:** Focus on Planning:
Save Time and Resources With Effective Planning.
- Step 8:** Functional Networking as the Basis of the Self-Regulating Factory.



Stay Competitive in the Long Term – With Us.

FASTEC GmbH is based in Paderborn, Germany and specializes in the digitalization of production processes based on the in-house developed Manufacturing Execution System (MES) FASTEC 4 PRO. The modular standard software can be configured across industries, is compatible with future releases and operated intuitively.

FASTEC has been accompanying its customers on their way to digital transformation since 1995. Around 400 companies in over 20 countries use FASTEC 4 PRO in over 10,000 production facilities. Work processes are optimized and costs are reduced in the long term thanks to the holistic digitalization of production.

We would also like to give you a good advice personally!

Our sales department will be happy to provide you with further user reports and information material! Or else, make an appointment with our sales department for a presentation at your location, in our company or via web. Of course, you can also experience FASTEC 4 PRO live and on site with our customers.

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Additionally, we offer videos of our software and customer solutions in our YouTube channel:

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