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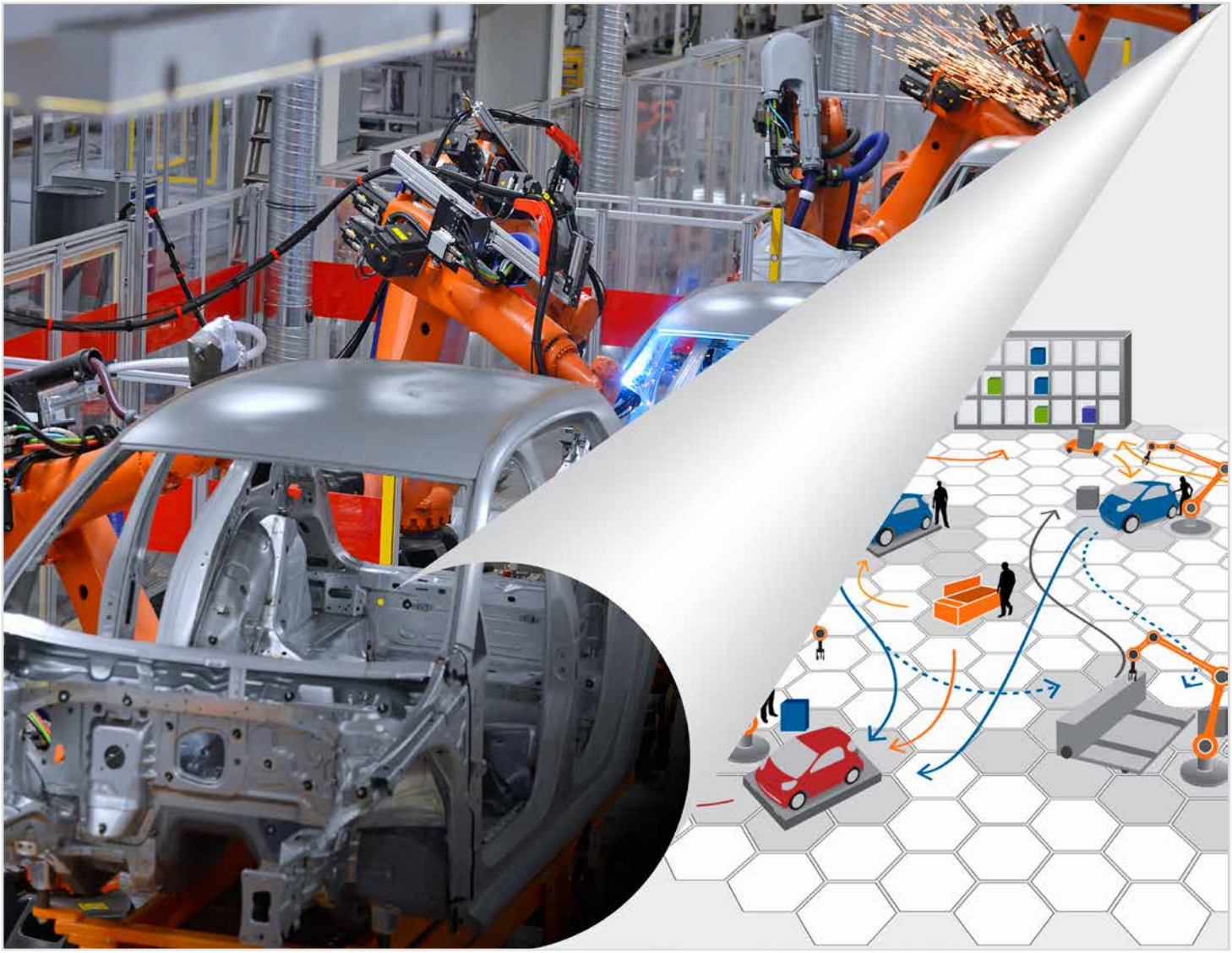
PRODUCTION manager

Magazine for logistics & production



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EDITORIAL

Dear readers,

In a self-organising production process of an Industry 4.0 scenario the organisation of this process and its corresponding decision-making paths won't be determined by a physically fixed manufacturing structure in such a strict manner as in case of a classical assembly line. Instead, automated guided vehicle systems will move partly finished orders within a manufacturing structure of working stations that can be flexibly modified. Even though the individual workstations have their determined positions and functions, too, these will change far more often depending on the specific order structures and manufacturing requirements. The orders themselves will decide dynamically and "on demand" to which workstation they will move next and what will happen to them when they get there.

What does this scenario mean for the organisation and management of the industrial production processes?

Our featured article describes how the PSI Group is prepared for the upcoming paradigm shift not least thanks to Qualicision® technology and the KPI-driven optimisation. As an example, the optimisation of production processes in the automotive sector is discussed. Additional articles that focus on the topics of logistics, the ERP and MES systems and solutions for metal industry provide further insights into current developments within the PSI production management sector.

Best regards

Dr Rudolf Felix
Managing Director
F/L/S Fuzzy Logik Systeme GmbH

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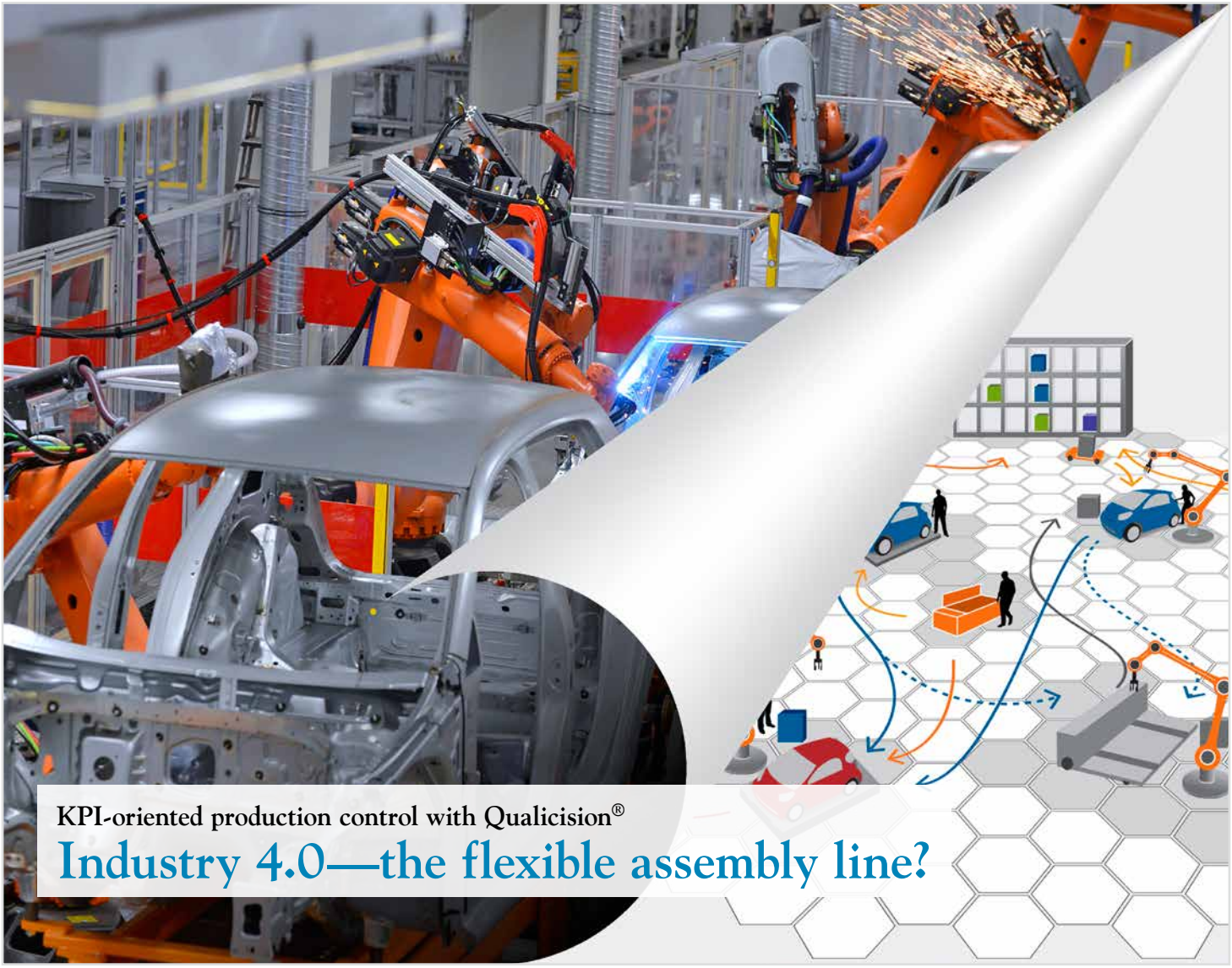

KPI-oriented production control with Qualicision®

Industry 4.0—the flexible assembly line?

Since the early 20th century, car production has been identified with the production or assembly line—a "road" on which vehicles are manufactured in a physically fixed sequence of assembly workstations as a line. However, other potential methods of organising production are increasingly being seen in settings of highly flexible Industry 4.0 production scenarios.

Within the context of digitalisation, the automotive industry is also investigating the question of a deep paradigm shift—moving away from the proscriptive, physical structure of the assembly line and towards a self-organising form of production in which orders self-dependently make their own decisions on the way through a more freely organised shop floor of workstations. This could lead to a new scenario in which the assembly line is being gradually replaced by a new, flexible logic of how the orders are moved along flexibly placed workstations. This new organising principle promises to solve, in the future, the apparent contradiction between the growing individualisation of (mass) products and the goal to increase the flexibility of production processes.

Assembly line versus variant diversity

As mentioned, the automotive industry is facing a continuously increasing demand for flexibility in production in the light of the variety of options how customers are able to configure their vehicles.

Depending on the model over a billion variants are possible. Until now, the industry has addressed this complexity more or less universally by planning assembly lines for a given model and then controlling the production sequences

by optimising them with respect to more or less physically motivated process restrictions and KPIs. The assembly line—once designed—remains essentially unchanged throughout the life cycle of the car model the line was organised for. In this way, of course, the assembly line with its physically fixed arrangement of production resources strictly determines the intralogistical processes of the whole production and supply chain.

Self-organising cyber-physical system at Fraunhofer IML.

This production control and optimisation, known as sequencing, is directly subject to the ordering power of the physically fixed production line structure. Through its physical restrictions and requirements, this structure of the line strongly influences the connected supply processes and the necessary logistics. For example, the physically fixed production line results in the specification of minimum distances in the assembly sequence that must be kept between orders (vehicles) with particular features.

Despite the obvious advantages of the controllability of this organisation—controllable, as once the line is established, it will not be changed for several years over the entire life cycle of the model—it would lack the necessary flexibility for smaller series and significantly shorter life cycles of car models. For a hypothetical lifecycle of only three months instead of six or seven years, fixed production lines would lead to increasing costs and decreasing efficiency. A highly flexible production process organized within the inflexible structure of an assembly line would be doomed to failure, and the evaluation of its economic Key Performance Indicators would just confirm it.

Self-organising production—a vision of the Industry 4.0 age

The dream of an extremely flexible production structure would be that workstations are standing freely in the production hall grouped by certain production functions. The orders would navigate autonomously from workstation to workstation guided by their own working plans and by both efficiency and engineering KPIs. They would communicate as cyber-physical systems with both, the working stations and the entities providing the necessary material.

If the workstations were also designed to include redundancy, the flexibility would increase a lot. The Industry 4.0 scenario offers the opportunity of digitalising objects via the Internet of Things (IoT) and connecting self-organising orders and workstations. So far so good.

Are there new challenges when facing such an innovative approach? Of course there are. The challenge is that a fully flexible production structure lacks an organising principle that until now has been provided by the physical structure of the production line. The revolutionary idea—and this is the challenge—is to replace the physical organising principle of the production process with a logical one. The autonomous decisions made by the orders themselves should follow technical and economic principles. This means that a new, a logical, organising principle is needed that replaces the physically given organising principle of the physically fixed production line. Said new organising principle shall follow the process KPIs and optimise the process accordingly instead of following the physical restrictions of the line. This is the hour of the Qualicision®-based KPI optimisation. Today, the underlying KPIs are designed to represent the physical structure of the production process. At present, order sequences are still predominantly formed according to the physical properties of the orders. In the future, the physical KPIs

are complemented by new Industry 4.0 KPIs. These KPIs will be a mix of technical restrictions and efficiency-oriented production goals.

First steps towards such an approach have already been taken. For example by those automobile manufacturers whose sequences are defined by workload and resource capacity expressed in working time. For the first time, working capacities are being used here to optimise sequences based on working time KPIs. The Industry 4.0 scenario goes even further in the new organisation of the production process, allowing the orders to make decisions on the basis of new Industry 4.0 KPIs. Partially finished vehicles (orders) move on automated guided vehicle systems and decide for themselves, which workstation to go to next, based on the KPIs. Supplying the workstations with material and parts is done similarly. Based on demand the stations even decide for themselves when they want to be supplied by the automated guided vehicle systems.

The paradigm shift

In fact, the process is already fully underway. The organising principle in the Industry 4.0 age will be KPI-oriented (Qualicision®-based) optimisation. Based on this, KPI optimisation implements the paradigm shift. In the future of Industrie 4.0 the rigid, physical order of the assembly line will be replaced by KPI-oriented optimisation.

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Questions backstage

The automotive industry sector is one of the pioneers when it comes to Industry 4.0 scenarios. This is proven by SMART FACE, a project within the Autonomik 4.0 programme funded by the German Federal Ministry for Economic Affairs and Energy. PSI's F/L/S Fuzzy Logik Systeme GmbH is a member of the SMART FACE consortium, which consists of the automotive and supplier industries, both logistics and IT providers as well as direct and applied research institutes. We spoke to the Managing Director of PSI's F/L/S Fuzzy Logik Systeme GmbH, Dr Rudolf Felix, about the project's goals and the idea that the current paradigm shift towards process KPIs is a basis for a new organisation principle in industrial manufacturing.

PM: Dr Felix, the SMART FACE project is a good indication that Industry 4.0 scenarios are no longer just visions. Can you briefly describe the project?

Dr Felix: By using the concrete example of small-batch electric vehicle production, SMART FACE is experimenting with the upcoming paradigm shift you have described: Towards production without the organising principle of a fixed assembly line.

PM: Can you explain why assembly lines in smart factories only have a future if made more flexible or could even be entirely replaced in the future?

Dr Felix: Because of the fixed physical structures of production lines until now the planning process in the automotive industry has taken place on several hierarchical levels. Beginning with the annual planning, continuing through rough-cut planning down to weekly and daily planning, the process determines what parts and components are required based on the bills of materials. This information is provided to the connected suppliers in the form of JIT and JIS orders. The stricter the physical structure of the lines the more complex the hierarchies and the smaller the possibility to influence the production sequence in a context of quickly changing demands and customer requirements. The future challenge will be to increase flexibility.

PM: So does that mean the solution to this challenge lies in increasing the flexibility to act?

Dr Felix: That is the goal, yes. And to achieve it, the current principle of optimising the sequences for a fix production line must be made more flexible or simply replaced with another principle. At F/L/S we say that the new organising principle will be the KPI-oriented optimisation based on the extended fuzzy logic decision engine Qualicision®. Within the SMART FACE project, planning and organisation are taken over by self-organising orders. The orders communicate independently with the assembly stations and navigate autonomously through the production area from working station to working station. The orders are moved on automated guided vehicles. Both orders and vehicles are implemented as cyber-physical systems. The navigation is optimised according to a set of physical and economical business process KPIs. In such an Industry 4.0 scenario the KPI-oriented optimisation is the new organising principle.