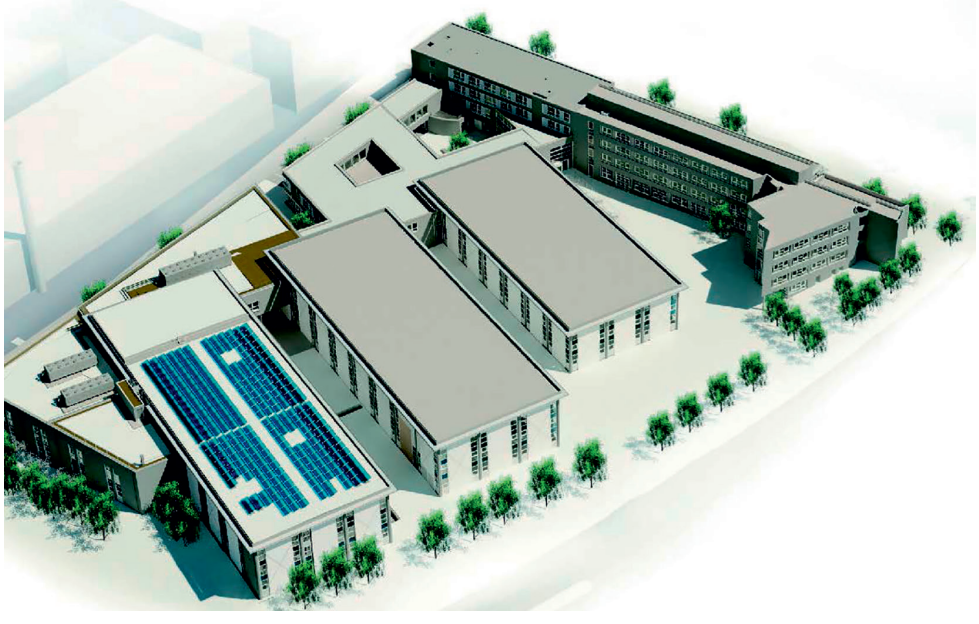
Use Cases of Digitized Plastics Processing

PIC 4.0 Elaborates Holistic Solutions for Industrial Demands

While the use of assistance systems in production is increasing, the range of digital solutions continues to grow. However, the number of pragmatic approaches and real examples of implementation is still small, and the actual benefits of digitization are difficult to quantify. Part 2 of the series on the Plastics Innovation Center 4.0 (PIC 4.0) at RWTH Aachen describes the procedure by which industrial use cases of a Smart Factory are identified and converted into real testbeds within the PIC 4.0.



The PIC 4.0 extends the infrastructure of the Institute for Plastics Processing in Industry and Craft at RWTH Aachen University

With the Plastics Innovation Center 4.0 (PIC 4.0), the Institute of Plastics Processing (IKV) in Industry and Craft at RWTH Aachen University, Germany, is building a fully interconnected research infrastructure by the end of 2022, following the big picture of a smart factory. On the more than 4200 m^2 gross floor area of the building project, various production technologies along a complex value chain are to be interconnected and optimized for real industrial application [1]. For this purpose, the project is organized into the three areas Complex Value Chain, Digital Engineering and Global Connectivity.

Technology Transfer by Pragmatic Solutions to Real Problems

Previous to the PIC 4.0 project, extensive research and interviews with industrial experts were conducted at the IKV in order to determine the requirements and obstacles of the German plastics industry and to align the research questions of the PIC 4.0 with these. Industry representatives from various branches – from material suppliers to machine manufacturers and processors – state the greatest obstacles in the concern about system integration or data loss as well as uncertainty about their own strategic development in the environment of digitization (**Fig. 1**). Moreover, the actual benefits of existing stand-alone solutions often cannot be determined, which is why more urgent tasks in daily competition are prioritized.

The requirements and needs identified by the industry representatives surveyed are in line with many industry-independent studies [2–4]. According to these studies, standardized interfaces and open systems are mandatory to expand co nnectivity and communication capability of production systems (**Fig. 2**). Far from the technical implementation, however, there is a general lack of transparency with regard to the opportunities

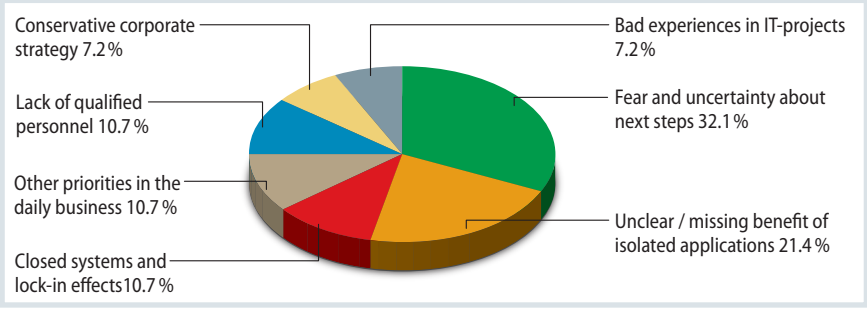


Fig. 1. In a survey of industry representatives (n = 28), the IKV identified factors that make the implementation of digitization projects in plastics processing difficult Source: IKV; graphic: © Hanser

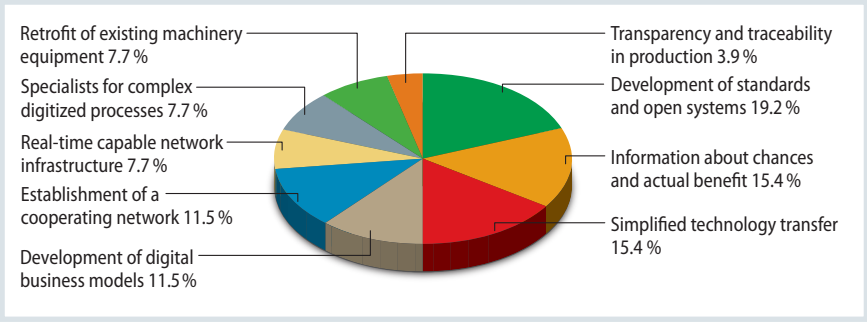


Fig. 2. In the survey, industry representatives (n = 26) described from their point of view specific demands of the plastics industry regarding digitization Source: IKV; graphic: © Hanser

and actual benefits of digital systems in order to be able to assess the benefit of corresponding projects and also to motivate coworkers to make the changeover.

Furthermore, the frequently expressed wish for a simplified technology transfer, which translates academic approaches into pragmatic and industry-oriented solutions, raises the importance of the PIC 4.0 to become an application-oriented research infrastructure. Therefore, industrial use cases for digital support in production are already being identified during the construction of PIC 4.0 and researched in real testbeds.

Screening and Evaluation of Use Cases by Industrial Partners

In information technology, testbeds represent a realistic hardware-software environment that is used to test separated system components and overall system requirements [5]. They add a software component to the classic production test rig and emphasize the importance of interacting systems. Based on the testbeds to be developed, various smaller use cases are combined and analyzed in a comprehensive system environment.

In a first step, the PIC 4.0 will collect relevant use cases of plastics processing, covering all domains of plastics processing (materials management, process and product development, injection molding, extrusion, quality assurance, etc.). Considering the hierarchical axis of the Reference Architecture Model Industry 4.0 (RAMI 4.0) the use cases will be categorized (**Fig. 3**).

Thus, depending on the level of detail of the use case under investigation, different system boundaries for further consideration arise. For example, the planned elaboration of testbeds for mold maintenance or sensor calibration (Field Device Level) includes more reduced test beds than an agile capacity planning (work center), which has to react to interactions of the entire production, e. g. with regard to ambient temperatures or material fluctuations.

The screening of general and relevant use cases and their categorization is followed by an assessment of industrial relevance. The IKV receives support from other industry representatives who enrich the project with their individual competences in recurring coordination meetings. This accompanying innovation advisory board makes it possible to identify from the large number of operative and strategic use cases those that should be realized and analyzed in a PIC 4.0 »

The Authors

Univ.-Prof. Dr.-Ing. Christian Hopmann has held the Chair of Plastics Processing as Head of the Institute for Plastics Processing (IKV) in Industry and Craft at RWTH Aachen University, Germany, since 2011. **Pascal Bibow, M.Sc. RWTH,** has been working since September 2016 on intelligent production systems at IKV. Since January 2020, he has been Managing Director of the Plastics Innovation Center 4.0;
pascal.bibow@ikv.rwth-aachen.de

Thanks

The construction of the Plastics Innovation Center 4.0 is funded by the State of North Rhine-Westphalia and by the European Regional Development Fund (ERDF).

Call to the Readers

Please participate in the evaluation of the use cases or inform us about further relevant use cases. Thereby, you can take a look the entire catalog for this survey. Numerous contributions to the evaluation or renaming of relevant use cases is of great value to the authors. To the online survey:

↘ **https://forms.gle/oTQ3k6Q8jZQYGUST6**

or via QR code:

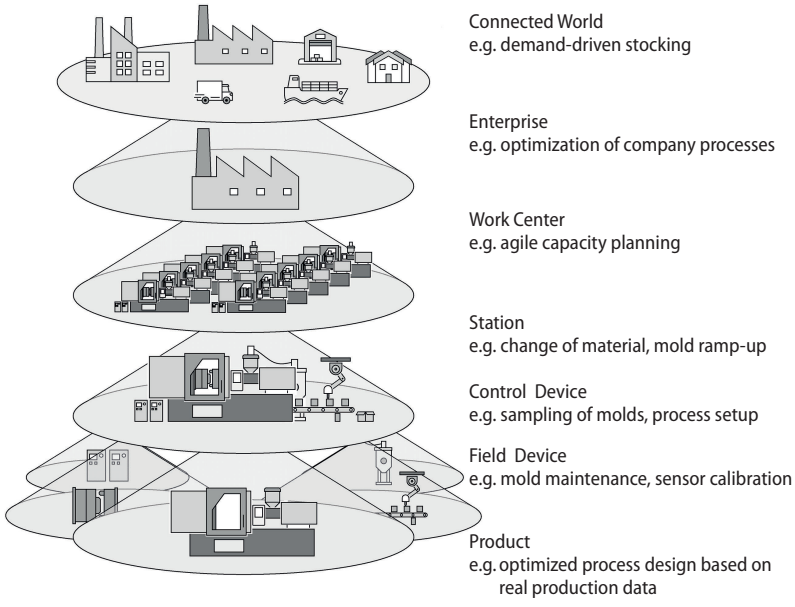


Fig. 3. Different use cases are categorized on different levels along the RAMI 4.0 hierarchy axis

Source: IKV; graphic: © Hanser

testbed due to their practical relevance for initial implementation.

From Use Case to Research on the Real Testbed

The further detailed elaboration is based on the IEC 62559–2 Use Case Methodology of the International Electrotechnical Commission. This international standard offers a template to describe use cases and enhanced application scenarios [6]. For each of the use cases selected by the advisory board for initial implementation and further research within PIC 4.0, step-by-step analyses of individual scenarios are listed, together with the actors involved and interacting system components.

Based on the preceding analysis of demands, a testbed "Heterogeneous Machinery" has already been defined in the Global Connectivity area, which focuses on the development of interfaces to expand the communication capability of machines and systems (**Fig. 4**). The IKV's machine park therefore provides the basis for investigating the communication capability of machines from different manufacturers and of different ages. Previous interface development activities, which were already presented at K 2019 [7], among others, are seamlessly integrated into further research in the field of interface development based on established communication standards.

In addition to research activities on interface development, the testbed "Heterogeneous Machinery" offers the opportunity to implement use cases of shortening setup procedures for injection molds according to "Plug&Produce" concepts. It also lays the groundwork for data-based approaches to machine comparison or transfer learning in order to use knowledge about machine and process behavior already during the initial sampling of new molds and to shorten the ramp-up phase.

Feedback of Real Process Data into the Simulation

Other testbeds already planned focus on component and process development, in particular the feedback of real process data for the automated determination of simulation quality, as well as the targeted analysis of interactions in a complex value chain from material preparation to quality assurance. In the area of conflict between production and information technology, the material and information flows of a Smart Factory must be modelled consistently and coordinated with each other. ■

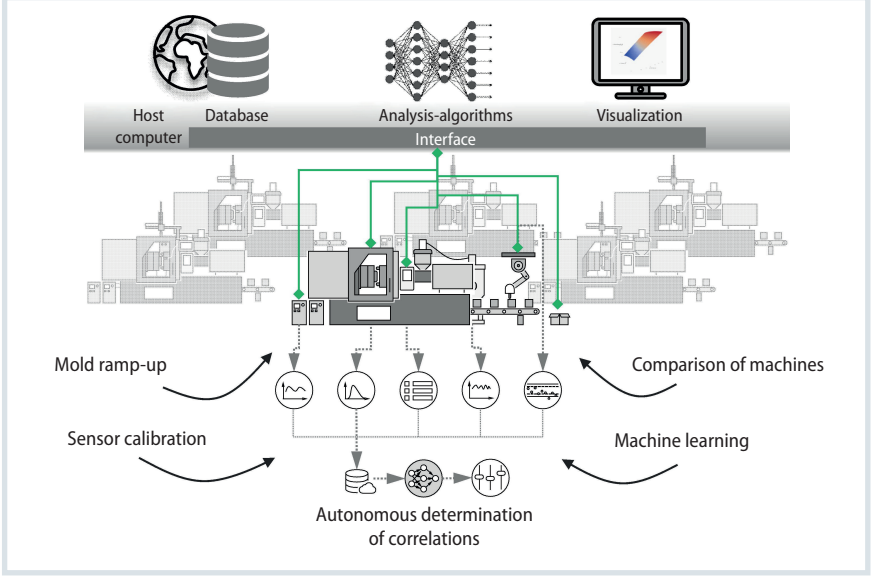


Fig. 4. The testbed "Heterogeneous machinery" offers further possibilities to analyze relevant use cases Source: IKV; graphic: © Hanser

The Series Continues

In the following article, the authors report on information flow planning in the PIC 4.0. The article appears presumably in issue 12/2020. Part 1 (Central Hub for Digitization in Plastics Processing) appeared in issue 5/2020, pp. 7–9.

References & Digital Version

- You can find the list of references and a PDF file of the article at *www.kunststoffe-international.com/2020-7*

German Version

- Read the German version of the article in our magazine *Kunststoffe* or at *www.kunststoffe.de*