The PIC 4.0 as Part of the Internet of Production

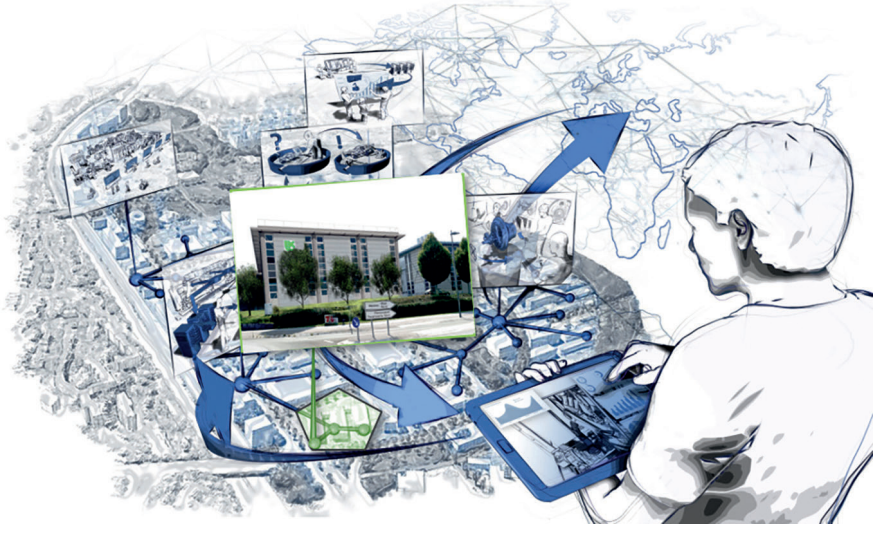
IKV Offers an Application-Oriented Demonstration Platform for Excellent Research

The cluster of excellence "Internet of Production" at the RWTH Aachen University conducts research on structures, chances and necessary services to realize a "Google of Production". Therefore, a reference architecture will be developed to enable cross-domain cooperation and data exchange. The Plastics Innovation Center 4.0 in particular serves as demonstration platform to present real-world solutions of this future-oriented research topics to the industry already today.

The cluster of excellence „Internet of Production" at the RWTH Aachen University, Germany, is an interdisciplinary research project funded by the German Research Foundation DFG (project-ID 390621612). In the first funding period from January 2019 to December 2025, 25 research facilities and institutes at the RWTH Aachen University collaborate to describe and optimize complex procedures in production technology by data-driven approaches as well as to uncover still unknown correlations of basic physical models.

On the one hand, the consistent integration of information technology into production technology processes is intended to enhance basic scientific models by targeted data analytics. On the other hand, the application of scientific approaches in production is to be simplified through cross-domain data exchange. Thereby, a purposeful optimization of the economic performance of a production system in real-time can be achieved ("scientification" of production). Besides research on smart devices and materials in plastics processing, also the necessary infrastructure to combine physical and data-driven (e.g. artificial intelligence) approaches and provide agile solutions are in the focus.

Developments of the Cluster of Excellence often concern fundamental approaches whose comprehensive industrial application is still in the future. However, many industrial partners would like to see the scientific approaches quickly tested and implemented in industrial practice. The Plastics Innovation Center 4.0 (PIC 4.0) provides the platform for this and will be part of a World Wide Lab starting from the Campus Melaten, Aachen, Germany (**Title figure**).



The Plastics Innovation Center 4.0 as part of a network of research facilities at the Campus Melaten, Aachen, focused to production technology © Riedel/IKV

Smart Infrastructure for Digital Shadows in Plastics Processing

The central concept of the Cluster of Excellence research is the digital shadow. It describes a contextualized data trace that describes a real process. In contrast to a digital twin, which is regarded as a complete digital representation of a real system, the digital shadow contains only a subset of the accessible data that corresponds to a specific problem (**Fig. 1**).

In the Cluster of Excellence, the conceptual foundations and data structures for digital shadows are being elaborated so that concepts can be used across domains and semantically consistently in various branches of industry. In the PIC 4.0, on the other hand, the focus is on specific applications and the challenges to a digital infrastructure in plastics processing to address these. A large number of virtual models of plastics processing technologies are already set up as part of the project [1]. The covered use cases of the PIC 4.0 thereby allows to evaluate the application potential of the digital shadow and subsequently to test system requirements for industrial application of this future concept [2]. »

Testing on the Testbed for Heterogeneous Machinery

The basis for the acquisition of digital shadows and their application in the monitoring and optimization of production processes is comprehensive data availability. For this purpose, a dedicated software infrastructure exists at the IKV, which was compiled on open source software and can also be applied and scaled up industrially. With the help of the software infrastructure, a wide variety of machines and systems of different ages and functionality are connected to IKV's network and process data is recorded. Based on current developments in communication standards like OPC UA as well as the plastics technology specifications Euromap 77 (data exchange between injection molding machines and master computer system) [3] and Euromap 84 (data exchange between extruders and master computer system) [4], proprietary data interfaces are also successively served in order to integrate older machines into the institute's network.

Up to now, four Arburg injection molding machines built in 2007 (Allrounder 520 A 1500–400), 2010 (Allrounder 370 A 600–170/170), 2014 (Allrounder 270 A 350–70) and 2016 (Allrounder 520 A 1500–800) are already feeding the IKV database via the available OPC UA interface. In addition, there is direct communication via the OPC-UA-based Euromap 77 to an IntElect2 100/470–250 from Sumitomo (SHI) Demag and to an e-motion 440/160 TWP from Engel, both built in 2020. The successive expansion of data acquisition then extends to other available machines that can only be addressed via the former Euromap 63 interface, such as a SmartPower 240/1330 Unilog B8 from Wittmann Battenfeld built in 2017 or a KraussMaffei 160–1000 CX from 2008. In addition, a Demag Ergotech system 800/420–310 from 1999 continues to be part of the machinery.

However, data connectivity is not only being continuously expanded in injection molding, but also in extrusion and rubber technology, and in some cases retrofitted with proprietary solutions. In the technology center for extrusion of the IKV, systems for blown film, flat film, profile and foam extrusion as well as production systems for stretch blow molding, thermoforming and elastomer and polyurethane processing are examined for this purpose. Challenges with regard to this heterogeneous machine park concern the targeted digitization through corresponding add-on modules, so that complex process control strategies can be digitally recorded and analyzed.

Peripheral Devices and QA Systems

Currently, data from a foam extrusion line consisting of three extruders from Gneuss Kunststofftechnik, Windmöller and Hölscher, and Oerlikon Textile, among others, is already accessible. In addition, a rubber extrusion line from TSM and an internal mixer for rubber from Harburg-Freudenberger Maschinenbau are also integrated into the network. In addition to OPC-UA-based interfaces, the control system is also accessed directly in order to record, for example, analog sensor signals or to read out the data from temperature and humidity sensors via separate recording systems and to determine the ambient conditions.

However, in addition to the pure machinery equipment, which already provides extensive heterogeneity for extensive research and development activities in such a testbed, there is also the need to include the respective peripheral devices. Dryers and temperature control units in particular often still communicate via serial interfaces, such as an RS-232 or RS-485,

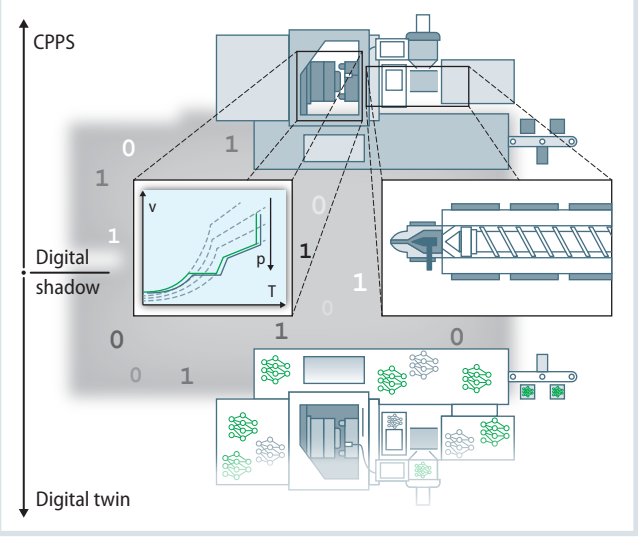


Fig. 1. Data traces of injection molding processes represent e.g. the material behavior during injection Source: IKV; graphic: © Hanser

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The Series Continues

The next contribution describes the specific research questions that IKV deals with by setting up complex testbeds in the PIC 4.0 technology center and how an agile knowledge management can be initiated. It appears in one of the next issues.

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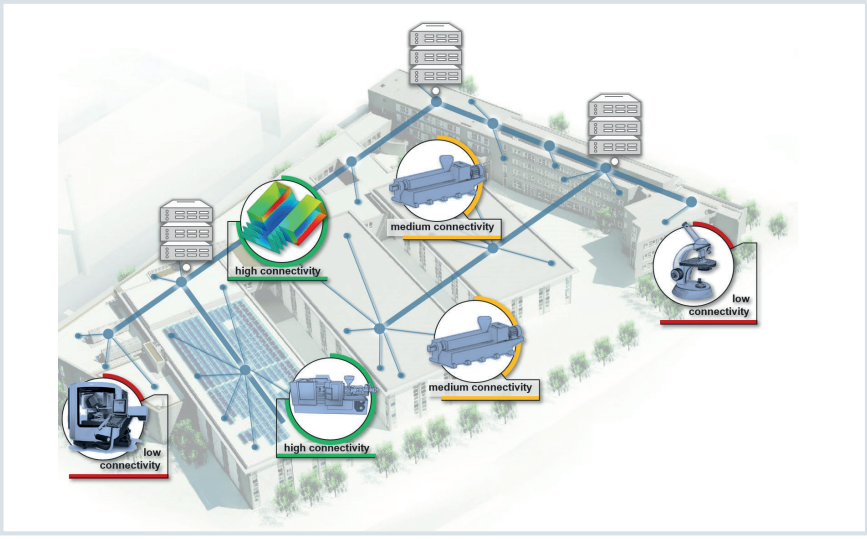

Fig. 2. Overview of distributed data-producing systems at the IKV embedded in a holistic system environment © IKV

and must be connected either to the machine or directly to another device in order to include the respective data in the digital shadow of the process.

The same also applies to systems for quality assurance, such as sensor data acquisition or data acquisition for weighing and camera systems. In particular, the synchronization of the respective data streams in the overall information system with the machine data provided on a cycle-by-cycle or continuous basis represent further challenges in the testbed to the heterogeneous machinery (**Fig. 2**).

IKV Shares Experiences in Data Handling for "Scientification" in Production

The previous work and developments about systems for data acquisition, storage and synchronization have in many cases increased the requirements for (re-)structuring the information system in the background. Questions about the usefulness of retrofitted interfaces with regard to the production orders planned on the respective cyber-physical production system can thus be answered and the investments required for this can be classified.

These experiences and methods for assessment as well as recommendations for action and obstacles in the step-by-step digitization towards smart manufacturing will be developed and prepared for industry partners in a real-world demonstration environment. This will ensure that promising methods of the Cluster of Excellence "Internet of Production" can also experience a rapid technology transfer to an industrial readiness level and support the plastics processing industry in the international competition. ■