Part 8 of the PIC 4.0 Series: Flexible Infrastructures Facilitate Access to Innovative Services

Adaptable Structures for More Innovation

Innovation management affects many areas, which now increasingly include digital services in addition to classic product and process innovation. Beyond the continuous reassessment of technical setups, a platform is being established for the consistent provision and further development of software services and dedicated analysis algorithms. Thereby, services are being provided to generate new ideas from the application and to facilitate the transfer of technology into industrial practice.

The outer skin of the PIC 4.0 is closing, inside the design of the demonstration cells is in full swing. © IKV

The adaptability of a company and its departments is an increasingly important characteristic for economic success. Megatrends such as digitalization and global competition mean that companies have to react ever more quickly to customer demand and implement new developments in a shorter time. Rigid structures both in the handling of business processes and in the organization of production directly or indirectly hinder the ability to react adequately and to maintain a short time-to-market for new developments [1–3].

As construction work progresses and the outer shell of the Plastics Innovation Center 4.0 (PIC 4.0, **Title figure**) completes, the focus is shifting to the development of production cells and processes in the subsequent active operation in the technology center. Analogous to the challenges in industry, flexible structures are also needed in research in order to be able to conduct publicly funded or bilateral research projects with industrial partners. Megatrends and challenges in industry also influence research institutes insofar as new research potentials arise and a multitude of heterogeneous inquiries arise that explore possible forms of support in industrial product and process development. Frequently, a simple recombination of existing resources (technology management), for example by linking available machine and plant technology, is not sufficient to address current issues. Instead, new developments and findings must be consistently transferred into demonstrators in order to generate ideas for transfer projects.

In the industrial context, innovation management mostly refers to the management of new developments up to entrepreneurial success on the sales market [4]. On the research side, an innovation can be understood according to a general systems-engineering definition as a renewal of structures and processes that represents an advanced solution to a problem and has a sustainable benefit [5]. This concerns the cost-efficient realization of testbeds and the institute-wide provision of software solutions and algorithms developed in numerous research pro-

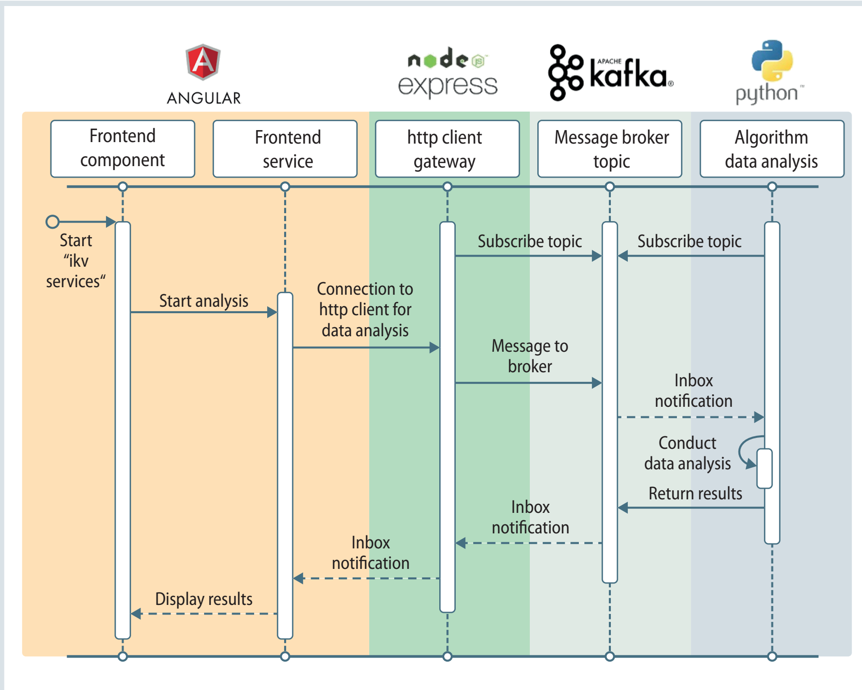

Fig. 1. Various open source technologies enable the development of a scalable service platform.
Source: IKV; graphic: © Hanser

jects. Targeted innovation management thus promotes technology transfer, the development of new ideas and the identification of challenges in industrial practice.

Demonstrator Processes Get Organized as Testbeds

Machines and plants are often already planned and delivered as so-called turnkey manufacturing cells. Analogous to industrial order processing, the PIC 4.0 therefore also plans research units in the form of the topic-specific testbeds [6]. When planning project-specific trials to support a research hypothesis, a test cell should therefore always be assigned to a research area and a research question within PIC 4.0 and tracked in master data management. If a new research project is being processed, the persons involved can directly check whether the relevant research questions can be processed in an existing testbed or whether new testbeds have to be designed and set up.

In order to evaluate the testbeds and the digital solutions implemented, key figures will be developed within the framework of PIC 4.0 which, on the one hand, classify the scientific relevance of the testbed and, on the other hand, allow conclusions to be drawn about the industrial application potential of the solution. The establishment of an expert panel that represents a good cross-section of the plastics processing industry, for example by including industry members of the IKV's sponsors association, will be important for objective evaluation. Current developments in the industry and technology trends are thus identified at an early stage and can be taken into account directly when setting up a testbed and evaluating embedded digital services.

Institute-Wide Service Platform Provides Software Modules

A platform based on open-source technologies was set up for the institute-wide provision of digital services. The core of the platform is the structural concept for data acquisition already developed in the Cluster of Excellence "Internet of Production". For this purpose, data from the machines and systems available at the institute are queried via software modules and sent to a message broker [7]. Based on the topic, the message broker assigns the incoming data packages to the systems waiting for the data, such as a database for permanent storage, a monitoring system for direct visualization or a data-driven optimiz- »

Info

Text

Univ.-Prof. Dr.-Ing. Christian Hopmann has held the Chair of Plastics Processing as Head of the Institute for Plastics Processing (IVK) 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
Lukas Seifert, M.Sc. RWTH, has been working since August 2021 on data-based quality control in extrusion processes and on digital service infrastructures at IKV.
Ben Liu, M.Sc. RWTH, has been working since April 2019 on research questions of automated data-exchange and applications in digital engineering in injection molding at IKV.

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The Series Continues

The following article describes how test planning and analysis can be facilitated by a digital infrastructure and how test data can be consistently tracked in PIC 4.0. It appears in one of the next issues.

References & Digital Version

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

German Version

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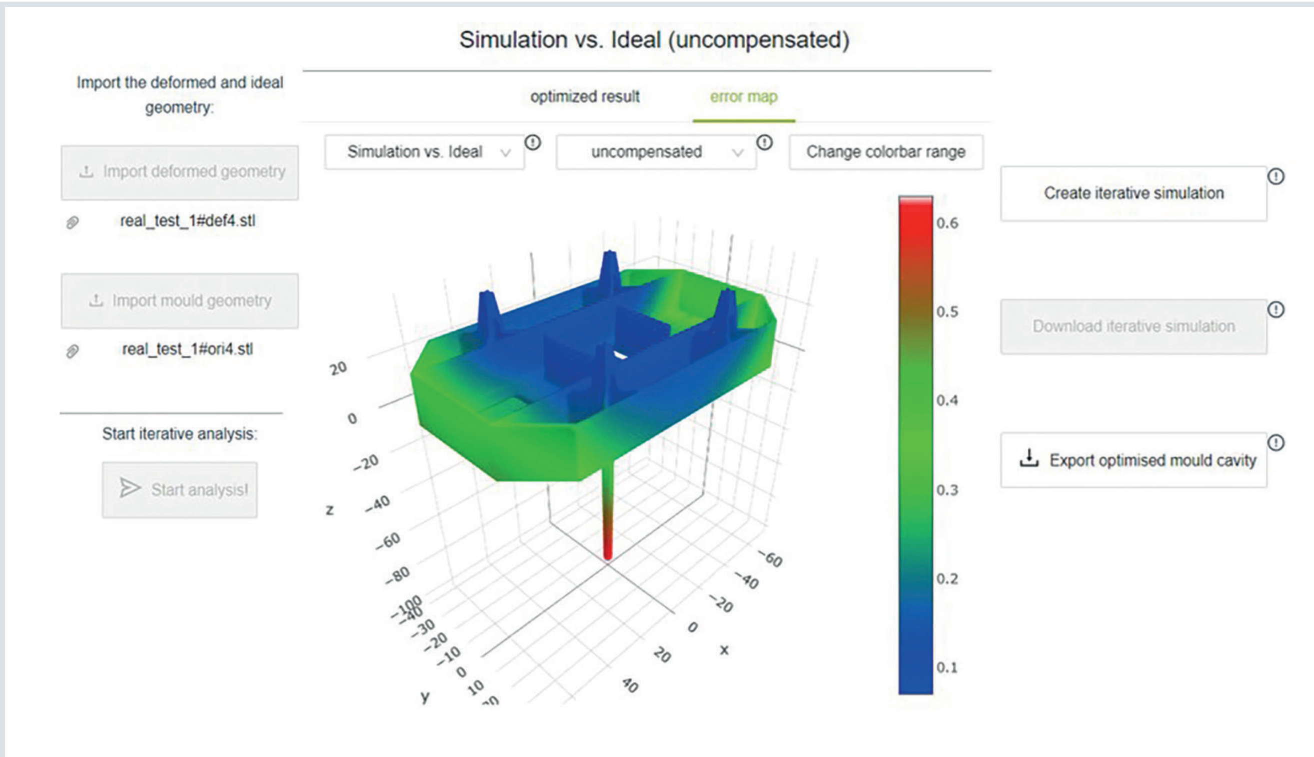

Fig. 2. The software service shows a deviation of the warpage optimized part geometry compared to the target dimensions. © IKV

ation algorithm. A simplified flowchart of a data analysis shows how data is entered or read in the frontend, which can then be efficiently processed in the backend using dedicated Python algorithms, for example (**Fig. 1**).

The starting point for the service-platform known as "ikv services" is the Angular web development framework, via which data packages entered or read-in by the user are sent to the Kafka message broker after connection to a gateway. This allocates incoming data packages to the evaluation algorithms and returns the corresponding results as a response until they can be output and visualized in the frontend, analogously to the services of data acquisition.

The advantage of the structure described lies in its modularity and the associated possibility for scaling and expansion. Further project-specific solutions developed in the numerous research projects of the institute can thus be easily added to the service platform and made available within the network. All that is required is to set up a frontend module in the form of an Angular component and its frontend services that is suitable for the application and the respective research project and is used to input and output data packages.

In the backend, the evaluation algorithms required for the research activities can be developed and updated independently of this. For communication between the front-end module and the potentially numerous and also variable evaluation algorithms, the gateway and the message broker retain their functionality. It is thus conceivable that analyses in Labview or Matlab as well as algorithms in other programming languages also wait for incoming data packages and return results after the analysis. Through the integration with the message broker, a connection with various data sources such as real plants or other message brokers such as MQTT is possible. This is achieved via logically separated modules.

Accelerated Benefit in Industrial Practice

An example of such a software module is shown in **Figure 2**. The central research question was to find out what geometric adjustment would be necessary for a plastic component to warp into the appropriate target geometry due to shrinkage and warpage. To do this, a simulation had to determine in several iteration steps what warpage to expect in order to modify the initial geometry accordingly.

In PIC 4.0, the evaluation algorithm and the service for data exchange between different simulation systems were transferred into a web application [8], which can now be made available as one of many modules in the service platform and thus institute-wide for the processing of further projects at the IKV. In this way, these and other (micro) services from research projects can also be made available to industrial partners in the future.

A further simplification in the implementation of additional services and software modules is the delivery as containers, with the help of which individual applications can be transported and installed together with all the necessary background programs and libraries. This also enables a sustainable technology transfer of services available at the institute and successively developed into a robust solution into the production environment of a company. Structured innovation management ensures consistent versioning and guarantees rapid added value in industrial practice. ■