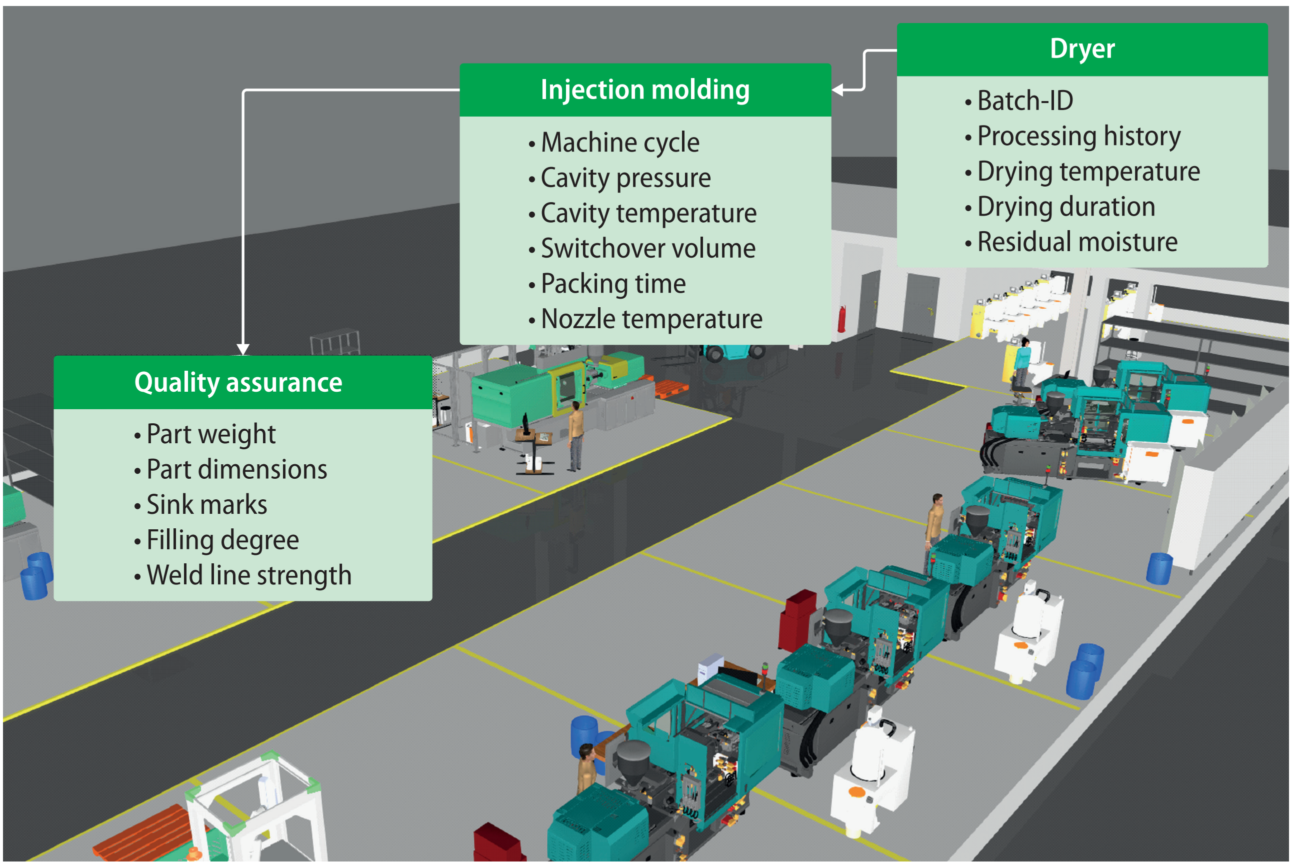
To Get the Information Flow in a Row

Standardization Guarantees High Data Quality for Future Applications

A consistent flow of data and information is essential for digital solutions and meaningful analytics. The introduction of potential solutions is therefore often associated with high costs for data preparation. Part 3 of the report on the Plastics Innovation Center 4.0 (PIC 4.0) at RWTH Aachen University describes information flow planning, which ensures a consistent database for future process optimizations as well as increased transparency.



Exemplary information flow across several steps of the value creation process in injection molding(Work-Center-Layer) © IKV

Due to standardized interfaces and increasingly uniform communication protocols, data acquisition is still an important and necessary field of development but no longer a major challenge. Modern machines and peripherals as well as software systems are able to provide a large amount of data that has to be analyzed and archived. The disillusionment is all the greater when the collected data hardly offers any added value. The reasons for this are often found in a lack of consistency and missing data points, which prevent a semantic linking of data to information as well as an automated analysis of data [1, 2]. It is therefore not uncommon that data preparation takes up to 80 % of a data scientist's working time before the actual analysis of the data begins.

Necessity of a Consistent Information Architecture

For data to become information, it must be semantically linked to a use case or analysis focus and prepared in a way that can be interpreted by a decision-maker. If individual data packages are missing or have been labelled differently by another person, this makes interpretation »

RAMI 4.0

The Reference Architecture Model Industry 4.0 (RAMI 4.0) was defined in 2016 in DIN SPEC 91345 and describes a reference architecture in the form of a cubic layer model for the representation of technical systems and objects in a smart production environment. Via its three axes (architecture axis; progression axis; hierarchy axis) it describes the interaction and the mandatory information exchange of interconnected objects across the value chain [3].

The Authors

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

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The Series Continues

In the following article, the authors report on the importance of the PIC 4.0 as a demonstration platform for industry-related developments in the Internet of Production. Presumably, it will be published in issue 03/2021. The previous parts have been published in issues 5/20 and 7/20.

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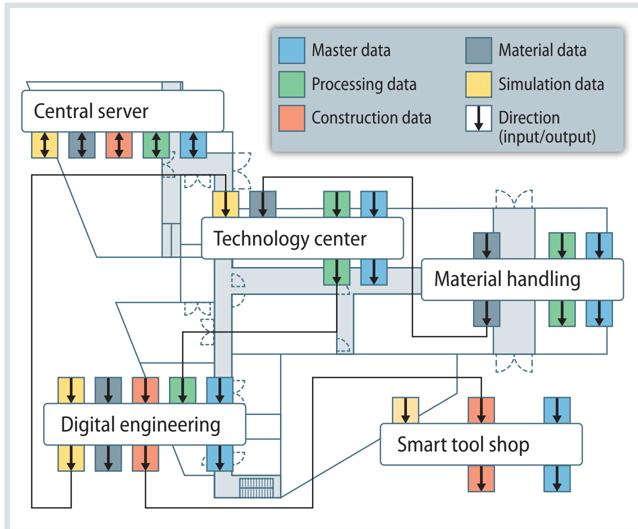

Fig. 1. General perspective of information flow planning in the PIC 4.0 with exemplary links between separated domains of a Smart Factory (Enterprise-Layer) Source: IKV; graphic: © Hanser

more difficult. Examples of this are production data such as processing temperature or pressure that are not assigned to an equally continuously measured quality feature, or the sequence in which the cylinder temperature zones are labelled starting from the nozzle or material feed. In particular, the individual perspective of different operators and handwritten machine logs, which are subsequently digitized at great effort, increase the potential for interpreting individual data points in a database incorrectly or not at all.

Although the PIC 4.0 only represents a research infrastructure for the development of intelligent production systems for plastics processing, the challenges of consistent data and information structures in science and industry are similar. In order to illustrate a consistent and expandable labelling of the gathered data as well as a consistent interaction of all linked systems and objects in a Smart Factory, the Institute for Plastic Processing (IKV) at the RWTH Aachen University implements an information architecture in the PIC 4.0 after the model of the Reference Architecture Model Industry 4.0 (RAMI 4.0) [3].

Cross-Domain Information Flow throughout the Value Chain

The information flow can and must be considered and modeled on different levels of abstraction (**Fig. 1**). When linking the individual departments of a smart manufacturing system, a distinction can be made between different types of data, which are exchanged via direct M2M communication along the value chain or via information exchange with a central server.

Master data refers to identification and general data for the production or test order as well as other data that are unchangeable over time or are considered as unchangeable, e.g. mold and target product dimensions or the characterization of the machine and peripheral equipment used. Material data are mandatory at many points along the value chain, such as for mold design in product and process development or for targeted process control in the technology center.

Simulation data is mainly generated in development and can then be used for data-driven process setup in the technology center [4, 5]. Process data of manufacturing processes and material handling, in turn, are gathered as digital shadows in order to implement a direct data-driven process optimization or to feed these data back into the development department for a targeted comparison of the simulated with the actual product quality.

On the next level, the generic data groups from the graphic (**Fig. 1**) can be more precisely considered along trial processing (analogous to order processing). Depending on the manufacturing process or separated process steps, quality and productivity relevant data are generated along the material flow during value creation of a product, which must be linked across all processes (**Title figure**).

According to the RAMI 4.0 hierarchy axis, the information flow is no longer considered on the company level, but on the level of the work centers e.g. across different manufacturing cells in production.

Due to the more detailed representation of relevant information and data flows across several manufacturing levels, semantic correlations to a specific application or to quality-relevant conclusions from process data can be intuitively mapped.

Both the basic categorization and the specific assignment to the respective production steps and data sources support the creation of meaningful databases and process-specific synchronization across several manufacturing levels.

Modeling the Data Flow with the Help of Activity Diagrams

The detailed modeling of the data flows of individual process steps in activity diagrams specifies the information flow of the respective manufacturing processes. An example from blown film extrusion shows extracts of the individual process steps before the subsequent calibration of the blown film on the cooling section, independent of the machinery equipment (**Fig. 2**). The respective setting values and measurable process parameters are directly assigned to the corresponding process steps and allow conclusions to be drawn about the relevant process section and the data source.

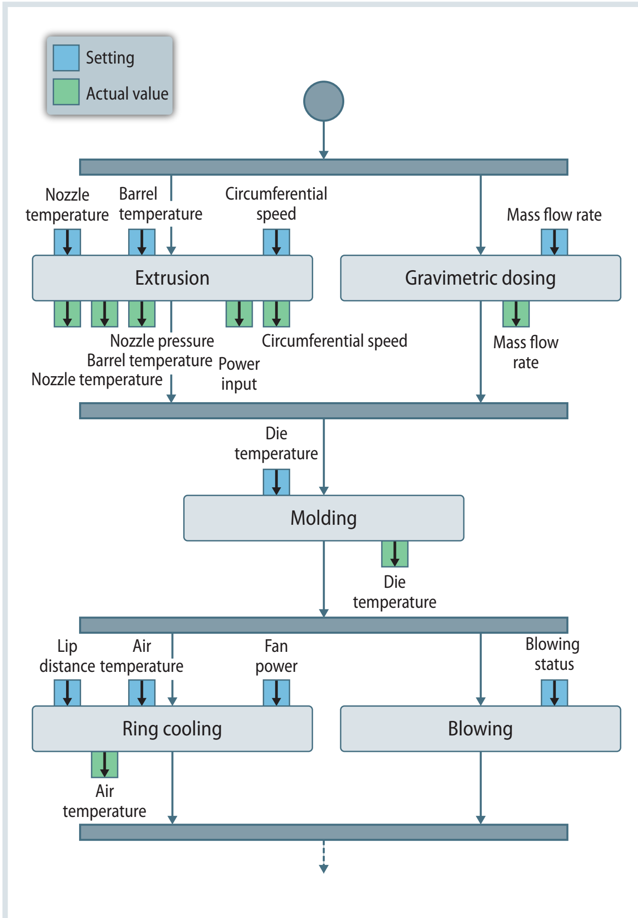

Fig. 2. Extract from activity diagrams of blown film extrusion with assigned input and output data (Station-Layer) Source: IKV; graphic: © Hanser

The activity diagrams of the PIC 4.0 processes are used to assign relevant setting and monitoring parameters in a process-specific manner and to consistently label the respective process parameters. Based on a uniform understanding of the variables in the process and the correlation between controllable setting parameters and relevant actual values, an information system can be set up that can be intuitively understood and expanded.

Through the object-oriented programming and implementation of an information architecture based on a reference architecture like the RAMI 4.0, data acquisition systems can be automatically configured in the future. Thus, it is ensured that gathered data can be interpreted for the employment of intelligent solutions in plastics processing continuously and with low effort. ■