

# A Major Opportunity and the Response to the Smart Factory

## Industry 4.0 from the Viewpoint of an Injection Molding Machine Manufacturer

Industry 4.0 is the buzzword. For some people, everything seems to be 4.0; for others, this topic is just hype. For injection molding machine manufacturer Engel, Industry 4.0 is a vision of the future – albeit a future that has already arrived in some areas. For years now, many processors have already been using products and solutions that substantially improve productivity, efficiency, availability and flexibility in manufacturing through the systematic utilization and networking of data. Now Engel is continuing to expand its offering in this area under the new “inject 4.0” brand name.

The buzzword “Industry 4.0” stands for the fourth industrial revolution, although to us, the word revolution doesn’t seem very appropriate. The changes that we are currently experiencing in the industry and that we are actively shaping in our own field are more of an evolution.

The first three industrial revolutions all resulted in a considerable boost in productivity, but also an increase in complexity. The fourth is no exception; it is, however, the first to directly include a solution for this increasing complexity. Industry 4.0 provides us with the tools we need to master complexity.

Another important benefit becomes evident in the area of flexibility. In the three previous industrial revolutions, production experienced substantial losses in terms of flexibility. Thanks to Industry 4.0, it will again be possible – for the first time in 200 years – to boost flexibility up to or even above the level of purely manual craftsmanship (Fig. 1). Industry 4.0 thus gives us the means to solve some of the major challenges of the future.

### Leveraging the Full Potential of Machines and Production Cells

Globalization and urbanization, the depletion of raw materials and energy sources, the lack of qualified staff and the loss of know-how are megatrends that are also reflected in the challenges the plastics industry is facing. Some of the side-effects accompanying this include



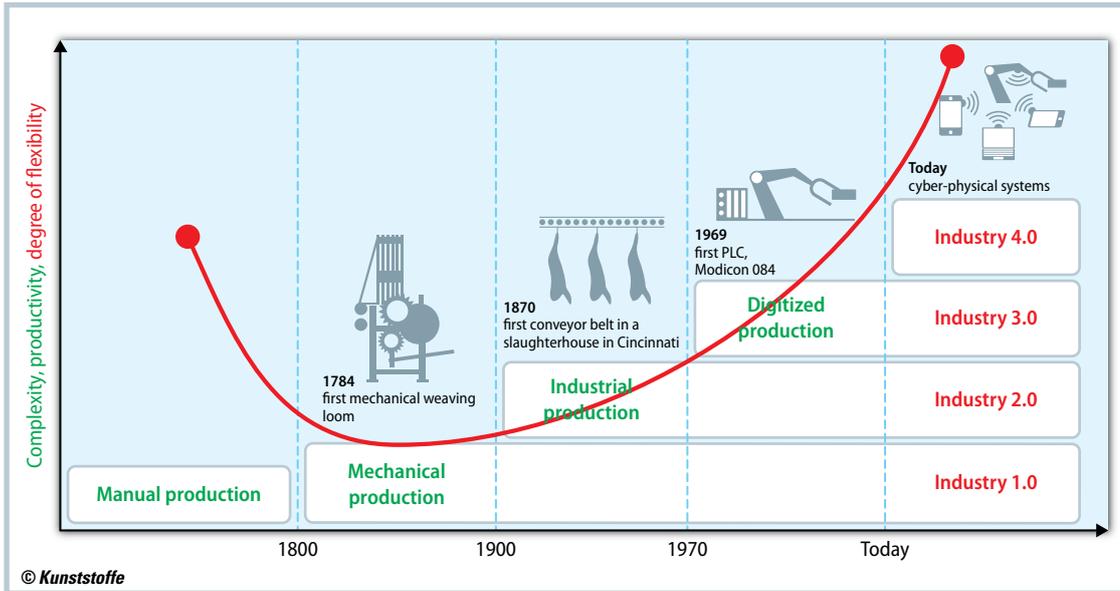
“Engel e-factory” empowers smart production for injection molders. By providing transparent access to all pertinent machine and process parameters, the MES makes it possible to plan capacities better and generate statistics more easily (figures: Engel)

the fact that users are expecting increasingly efficient, yet at the same time easier-to-manage processing methods, components are being designed to combine more and more functions and are becoming increasingly complex in their form, and the demand for customizable products is increasing while batch sizes are dropping.

When all these challenges are taken together, it becomes apparent that developing and deploying the best injection molding solutions is not enough; it is also

important to ensure that their potential is actually fully exploited. This is precisely the goal that we have set for ourselves with “inject 4.0” – a package including products and solutions that are available today and future advanced developments. We seek to achieve this through:

- The networking and integration of production systems.
- The systematic utilization of process and production data.
- The use of adaptive production systems at all levels.



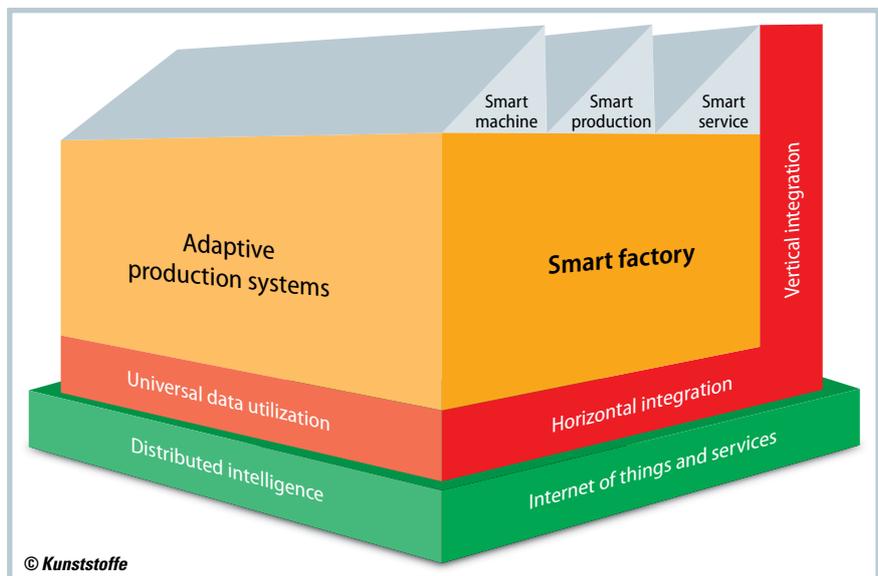
**Fig. 1.** Industry 4.0 – taking injection molding to the next level. Both productivity and flexibility will substantially increase (source: Deutsches Forschungszentrum für Künstliche Intelligenz)

With “inject 4.0” we provide support for processors in their drive to boost productivity, quality, availability and flexibility in their operations. Optimization in production starts with the individual machines and can continue all the way up to the global production network.

**Smart Factory: Systems Optimize Themselves**

The smart factory is the central aspect of “inject 4.0.” The smart factory continuously optimizes itself or signals the need for optimization and is at the same time characterized by a high level of flexibility. The “inject 4.0” approach means turning injection molding production into a smart factory. In doing so, the focus is deliberately not placed on producing smart products. This is the processor’s domain. However, Engel does provide the respective injection molding solutions needed to be able to meet future requirements in the scope of Industry 4.0 that many today are not yet aware of.

“Smart factory” includes the following three elements: “smart machine,” “smart production” and “smart service” (Fig. 2). Engel offers solutions corresponding to each of these three areas. “Smart machine” solutions boost the process capability of injection molding production lines without requiring the operators to acquire special skills. In the future, the human-machine interface will play an even more important role. The objective is to be able to set up and control a complex



**Fig. 2.** The smart factory is based on systematically utilizing process and production data, the networking and integration of production lines, machines and components, and the use of adaptive production systems (source: VDI)

process like the injection molding process in a way that is as simple and intuitive as possible. To achieve this, the machine operator is supported by a variety of assistance systems.

For example, the “iQ” software products from Engel continually analyze specific process parameters in order to identify and immediately compensate for deviations even before rejects are produced. While “iQ weight control” keeps the injected melt volume and the viscosity constant throughout the entire injection molding process including the holding pressure phase, the new “iQ clamp control” software utilizes mold breathing to

continually readjust the clamping force. Both software solutions substantially boost process consistency and ensure continuously high product quality.

Another example of a decentralized self-adapting system is “Engel e-floMo” (Fig. 3). This temperature-control water distribution system autonomously compensates for temperature fluctuations in the mold, thereby also improving process consistency and reproducibility as well as reducing cooling energy consumption.

These are just three of a multitude of solutions in the “smart machine” area. But even this small selection shows how assistance systems facilitate the process »

of setting up injection molding machines, thus making it possible to substantially improve process capability.

### *Transparency in Operations and in the Global Production Network*

“Smart production” is all about boosting the productivity of the user’s entire machine park. This takes us to the domain of Manufacturing Execution Systems (MES). In the “Engel e-factory”, the company has its own MES in its portfolio that is specifically tailored for the requirements of the plastics processing industry and thus achieves an extremely high level of vertical data integration (**Title figure**). It even takes the number of cavities in the mold into consideration.

The MES improves transparency in local operations and in the global production network by supporting centralized access to all pertinent condition and process data and comparing these with quality parameters. Thanks to the networking of all machines and locations, it is easier for the processor to make better use of machine park capacities, query the status of all injection molding machines and create documentation as needed. In the future, the software will also include an energy management tool that facilitates optimization of consumption across the entire machine park.

Advanced solutions will increasingly presuppose pervasive horizontal and ver-



**Fig. 3.** The delegation of tasks to intelligent devices and systems in the form of multiple decentralized units improves overall process capability. Each unit optimizes a subsystem or sub-process, for example the Engel e-flomo temperature-control water distribution system

tical communication so that in the future, all machines, all peripheral components and all individual sensors will be able to exchange data. This will become more effective as the number of interfaces drops and as unified protocols become more widely used.

### *The Necessity of Defined Security Standards*

The third central element in the smart factory is “smart service” solutions, which Engel offers in addition to classical service products. Remote maintenance and preventive maintenance are already a matter of course for many customers. The new “Engel e-connect” customer portal has made collaboration even easier and faster. For example, spare parts can be identified online and ordered immediately. Service requests can be dispatched via smartphone and the user can keep track of the current processing status at all times.

When it comes to avoiding planned system downtime, we need to consistently work on load-optimized maintenance intervals. This is the only way to increase the service life of machines and individual system components. If we want to take this one step further, we would have to predict the remaining service life of the components, which would involve classic condition monitoring.

“Smart service” solutions make it necessary for Engel as a supplier to have access to specific customer data as released by the customer for that purpose. On the other hand, “smart machine” and “smart production” lie within the processor’s sphere of responsibility. Nobody would

want to share processing and quality data with a supplier. And there is no need for this.

For cases in which an exchange of data would be beneficial, more than mutual trust is needed. Defining security standards is one of the greatest challenges that the fourth industrial revolution entails. Market stakeholders are already working intensively on this, not only in their own development, but also at the industry association level.

### *The Time Is Ripe*

Engel has already been working on the topic of Industry 4.0 for many years. The result is “inject 4.0,” the tailored solution for Industry 4.0 in injection molding. Some of the ideas mentioned in this article are neither new nor revolutionary. Work has already been done on self-adjusting, networked injection molding machines for several generations. “Computer integrated manufacturing” (CIM) was the buzzword in the late 1980s and early 1990s. After only moderate success, the term CIM acquired negative connotations and became synonymous with over-engineering and excessive complexity in production.

Why are we so certain that it will work this time? Quite simply because many applications are only made possible by the use of state-of-the-art information and communication technologies. But only now has the time become ripe for this.

On the average, industrial revolutions occur every 50 years. We view it as a great opportunity to experience one and be involved in shaping it for the injection molding industry. ■

## The Authors

**Dr. Stefan Engleder** is the CTO of Engel Holding GmbH in Schwertberg, Austria; stefan.engleder@engel.at

**Dipl.-Ing. Dr. Gerhard Dimmler** is senior vice president of product research and development at Engel Austria GmbH in Schwertberg, Austria; gerhard.dimmler@engel.at

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