



Optimised injection moulding

Andrea Sánchez-Valencia of Smithers Rapra provides an introduction to PREVIEW

Over the past few decades, injection moulded products have been in high demand, populating the shelves of supermarkets and retailer stores by providing commodity items ranging from food packaging to children's toys and kitchenware. The success and popularity of injection moulding manufacturing can be accredited to its versatility and high volume production numbers. Since last century, polymers have started replacing glasses, ceramics and even metals to become the preferred material of choice for their relative low production costs, light weight, and low temperature processing attributes.

As the global demand for injection moulding is expected to grow with Asia emerging as a dominant manufacturer, and materials science enabling more polymer applications in the fields of cosmetics, pharmaceutical and household chemicals, the need for developing stable and self-sufficient injection moulding represents a first order priority. This, added to the current political and economic reinforcement of environmentally friendly production practices and sustainable manufacturing fits in line with the sought development of smart factories and industry 4.0 models.

A consortium of experienced European injection moulding manufacturers, leading technological industrial partners and academic research institutes identified the potential to merge state-of-the-art data acquisition systems with machine learning techniques to deliver an inclusive portable device application for remote monitoring of injection moulding processes. The system, named PREVIEW, is capable of recognising process variations and timely executing alerts' notifications suggesting to the operator corrective actions to preserve optimum part quality. By doing so, it enables to keep the production process within part design tolerances preventing unnecessary material waste, shifting injection moulding from traditional manufacturing to smart manufacturing.

The need for smart manufacturing

The concept behind smart manufacturing is to increase process adaptability by benefiting from controlled computer systems. In injection moulding this can be translated to improved plant flexibility, e.g. running many products/moulds in parallel and low material waste (i.e. scrap parts). At present, latest models of injection moulding machines incorporate quality control mechanisms that can shut down production if the machine's injection moulding parameters deviate from those defined as optimum. Nevertheless, they fail to specify the resulting part defect or to provide individual part traceability. Additionally, it is known that machine parameters control the temperature and pressure experienced by the polymer as this enters the mould, in other words, the cavity temperature and pressure. The use of cavity sensors enable to monitor these parameters, and when combined with the injection moulding parameters of the machine (e.g. holding pressure, injection speed, cycle time), very high levels of part quality control can be achieved.

PREVIEW is a cyber physical system that benefits from the use of cavity sensors to develop a series of hardware and software innovative technological solutions (figure 1), that work together to ensure full injection moulding control of multiple machines running on a factory floor.



Figure 1. PREVIEW's innovative technological solutions

Data Acquisition System (DAS)



PREVIEW's data acquisition system, (DAS), is a hardware module responsible for the adaption, amplification and digitalisation of the electrical and mechanical signals coming from: a) the mould cavity and b) the injection machine. During injection moulding, the machine and mould features need to be monitored as these represent the means for determining the part quality and efficiency of an injection production cycle. Injection inside the mould is monitored via pressure and temperature sensors. At the same time, the DAS connection with the machine allows operators to retrieve real-time information of the machine parameters. The DAS is individual to each injection machine, and a large manufacturing floorplan can benefit from running many DAS units simultaneously.



Advanced Predictive System (APS)

The advanced predictive system (APS) is a software tool that serves to optimise the injection moulding process. This is done by providing quality control guidelines defined through numerical algorithms based on machine learning techniques that provide the operator with corrective measures to reset the injection moulding parameters and ensure the best possible process performance and part quality. The data collected from the DAS is transferred to the APS via the wireless network, and this is analysed against reference optimum parameters to provide the user with remedial process modifications. The diagnoses produced by the APS are stored in a centralised server called the content management system (CMS), and are sent via WiFi to the operator's mobile using the location based content delivery application.

Wireless Capability



In traditional manufacturing plants, most machine communication is achieved through Ethernet cabling and cumbersome electrical wiring. In this sense wireless networks are preferred, yet these are prone to interference, particularly in a metal dominant environment such as in a factory floor. Building wireless network implies handling and prioritising the wireless transmission of multiple sensor signals to ensure these are received and processed accurately. PREVIEW's wireless technology guarantees that the data sent by individual DAS units is transported and decoded successfully when reaching analytical systems (i.e. the APS). Novel transmission algorithms developed by the PREVIEW consortium are able to cope with the difficulties of a challenging manufacturing floor environment: Wi-Fi transmission interference due to metal surroundings, and the reception of Wi-Fi signals coming from individual injection machines that are placed at large distances from the main server. To ensure a stable network, each DAS unit is connected to an individual wireless communication node (WCN), in addition to a centralised WCN server that acts as a data collector and processes information for use by the APS.



Location Based Content Delivery (LBCD)

PREVIEW's full operation cycle is completed when the user, or machine operator, is able to access individual process information for each machine via a location based content delivery (LBCD) mobile application. This application can be easily downloaded from PREVIEW's website and grants access to real-time statistics stored in the CMS. The user is then able to identify via their personal portable device if a specific injection moulding cycle is running efficiently. The LBCD offers a variety of features that enable the user to interact with the monitored data in an efficient and friendly manner, for instance: a) access to injection moulding machines details (i.e. plant layout and process specifications), b) reception of notification alerts (from the APS), and c) other machine related information (e.g. machines' user manuals). As machine operators receive a virtual notification in their personal gadgets highlighting process inconsistencies they can timely readjust the injection moulding machine parameters to optimise the production process.

PREVIEW in action

The incorporation of PREVIEW in real manufacturing environments has been positively tested at different end-users' facilities: Smithers Rapra and Smithers Pira Ltd. (May 2016), PROMOLDING (October 2016, April 2017, July 2017), MPT (December 2016, July 2017), with final trials to be scheduled throughout the summer/autumn of 2017. Each end user representing a specific set of challenges and levels of complexities, as the models of injection moulding machines vary, in conjunction with the dimensions of the factory floor.

How are the results of PREVIEW benefiting the industry?

"The results obtained with the PREVIEW project enable injection moulding companies to better understand their manufacturing processes."

Jesús Pablo González, PREVIEW Project Coordinator

As a PREVIEW end user what are the benefits of using the system?

"Achieving the possibility for the operator of remotely controlling the performance of one or many injection moulding machines."

Giovanni Gaggio, MPT representative

Can you describe PREVIEW in 3 words?

"Well, if I'm limited to only three words I would say: Advanced data processing."

Tom Wagemakers, Researcher & Innovator, PROMOLDING BV



For more information visit: www.preview-project.eu

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