PRESS RELEASE

Experiencing the added value of networked production: from Machine 4.0 up to Human-Robot-Interaction

Digitization is introduced into manufacturing – machines will become smart, will be linked to one another and work autonomously. Yet many manufacturers are uncertain about what to expect: How will this new connectivity work? Which specific benefits will it provide? Researchers of Fraunhofer IWU answer these questions by using a miniature forming press and its digital twin. At Hannover Messe (April 23-27, 2018, Hall 2, Booth C22), they will demonstrate the possibilities, which digitization can provide for manufacturing, under the heading of "Touching, Experiencing, Utilizing". In Hall 2, Booth C28, the focus lies on safe Human-Robot-Interaction that has already been industrially implemented.

Life without a smartphone? Today this is inconceivable for many people. How will you hook up with friends, when you're out and about? And how will you know when the next bus is coming? Or check out the traffic on the highway? In the world of industry, digitalization is also set to usher in major changes. It is a process that's already well under way in certain sectors of business as well as in society as a whole. Yet in the world of manufacturing, many companies are uncertain what it will mean for their everyday operations. And that's not really surprising. After all, manufacturing companies are good at manufacturing, but not necessarily at IT.

Increasing machine availability, extending service life

The Fraunhofer Institute for Machine Tools and Forming Technology IWU will be in Hannover to showcase the Machine 4.0 concept. In a live demonstration featuring a fully operational miniature forming press and its digital twin, they will show how manufacturing can become highly successful with digitization. "By demonstrating this Machine 4.0, we show that our research project Press Plant 4.0, which we presented virtually at the HMI two years ago, has become reality", says Prof. Matthias Putz, Director of Fraunhofer IWU . Standing two meters tall and weighing in at 1.5 metric tons, the miniature forming press operates at a force of 15 metric tons to punch, deep draw and cut to size all

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kinds of components. This is not new. The focus lies on the advantages digitization provides for this type of machining: It provides seamless monitoring of the process, the machine and the tool itself. This, in turn, offers the possibility of substantial increases in machine availability and service life as well as a significant reduction in tool setup times.

Real and virtual sensors

Sensors mounted on various parts of the miniature forming press measure variables such as forces, machining paths and expansion rates. In effect, this means that the machine monitors itself. Rather than being separately analyzed – as is customary – this data is fed into a software module by the name of Smart Stamp. This generates a digital duplicate of the forming press, i.e., a virtual twin, which can also be seen at the booth of the Fraunhofer Group for Production (Hall 17, Booth C24) and addresses the topic of condition monitoring in more detail. Here the data is fused and analyzed. Does the press operate within the normal range? Or is the ram, which the upper tool is mounted to, slightly tilted so that the workpiece is not properly formed or the tool wears out more quickly? "Sensor data from discrete sources is often not particularly meaningful, but data fusion gives us a precise answer to such questions", explains Dr. Tino Langer, Division Director of "Smart Factory" at Fraunhofer IWU. Various solutions of visualization provide machine operatives with relevant data on the production process. These solutions may include the use of intuitive technologies for augmented reality (AR) and virtual reality (VR). Thus, visitors can see all important information on the current condition of the "Machine 4.0" via a tablet which can be positioned freely in front of the forming press – the real world merges with the virtual world.

However, it is impracticable to mount sensors in some areas of the press, either for reasons of inaccessibility or because the installation would be too complicated and expensive. This may mean critical gaps in data on the process or production machinery. But here Fraunhofer researchers have also come up with a solution: virtual sensors, which exploit the readings provided by real sensors mounted at different places on the machine. Based on this data, an algorithm calculates the reading that a real sensor would have delivered, were it installed in a relevant but inaccessible location. This kind of virtual sensor is very good at depicting the degree of bending in the press frame, for example. "In the EU project iMain, we showed that the readings calculated with our virtual sensor correspond very closely to those of a real sensor," Langer says.

Thinking in process chains

The Machine 4.0 concept involves thinking in terms of a process chain. At the beginning of the process chain the material to be processed is analyzed, since material properties such as thickness or strength may vary. At Hannover Messe, the demonstration unit of the miniature forming press scans the incoming metal strip live. Subsequently it is formed into the test components: "Machine 4.0" detects various material parameters which in turn influence the process, and reproduces them in the virtual twin. The tool also contains integrated sensors whose data is transferred to the evaluation system. Together with the machine data and the material properties, the process can be designed in a much more transparent manner by using this method. However, the utilized data cannot only be accessed locally, but it is also globally available since it is stored in the highly secure data cloud called Virtual Fort Knox (VFK), which has been jointly developed by several Fraunhofer institutes. Thus, a press plant, which has not analyzed the used materials, can integrate material parameters into its manufacturing by accessing VFK. The main Fraunhofer booth also shows VFK as an individual exhibit in direct vicinity to "Machine 4.0". The data is transferred to the cloud live and in real time.

If the miniature press were not at the booth at Hannover Messe, the finished component would now be subject to quality control via image-analysis using XEIDANA, a software for quality assurance, which was also developed by Fraunhofer IWU. "We check the material properties, the forming parameters, other press-related properties and product quality in a holistic manner," Langer summarizes. "And in the future, we want to be able to feed this information back into the machine's control unit."

Various automotive manufacturers are already using individual elements of the Machine 4.0 concept. And, in a further development, researchers are now working on ways of using sensor data for products machined in a process chain. In this way, should the finished component have any quality defects, it will be possible to trace the source of the problem and quickly take appropriate action.

Colleague heavy-duty robot: Human-Robot-Interaction in industrial applications

Once the components have been manufactured in optimum quality by using digital technologies, they can be combined into assembly groups. So far this task has been performed by heavy-duty robots in specific working spaces that have been completely enclosed for safety reasons, thus "locking out" humans. Thanks to the research of scientists at Fraunhofer IWU, these enclosures can be dropped soon. This will allow humans and heavy-duty robots to work even more efficiently and especially more flexibly as a team. The solution lies in a differentiated safety concept defining various levels of interaction: the closer the interaction, the higher the level and the stricter the safety rules. While this concept had only been used in the testing facilities of Fraunhofer IWU at the time of Hannover Messe 2017, it has now entered industrial reality: a manufacturer of sanitary facilities in the region of the Ore Mountains in Saxony uses this concept to spare the employees from heavy-duty work. The four colleagues made of steel sort heavy steel frames onto transport frames. As a result, the cycle time of the plant has been reduced by 50 percent and the ergonomic aspects have been considerably improved. Visitors of Hannover Messe can see the convincing safety concept at the booth of the Fraunhofer Group for Production (Hall 17, Booth C24) and at the booth of the Federal Ministry for Economic Affairs and Energy (Hall 2, Booth C28). Using virtual reality, visitors can enter the factory of the manufacturer for sanitary facilities in order to interact with the colleague heavy-duty robot.

Adaptronic components for future production

The scientists exhibit further highlights of smart production technology at the booth of the Fraunhofer Adaptronics Alliance, for example concepts on wireless energy transfer, concepts on plastic composites that can change their shape, and an ultrasonic vibration system. The latter can be used to process fiber-reinforced plastics and ceramics in a way that reduces tool wear by up to 50 percent and energy expenditure by up to 40 percent compared to conventional processes.
For further information, please also read our press release on adaptronics: "Intelligent materials, components and systems": https://www.iwu.fraunhofer.de/en/press/intelligent-materials-components-and-systems.html.

Images

Uninterrupted monitoring of processes and machines can be achieved by digitization, which may significantly increase machine availability as well as service life, and considerably reduce tool setup times.
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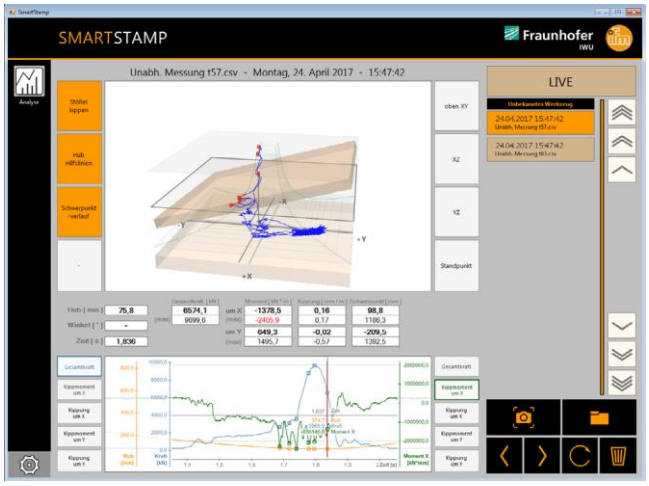

"Smart Stamp": virtual twin of the press detects the tilt of the ram.
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