AUTOMATED ADDITIVE MANUFACTURING

Digital tools such as simulations, additive manufacturing, and data collection are now shaping the engineering world. We are capable of collecting data from different manufacturing technologies and digital tools by networks and reciprocally exchange information. This has led to a change in the way conventional production processes work and communicate. Moreover, there is a permanent and seamless share of information, allowing machines to operate based on (historical) data. Now we are on the verge of the next phase: connecting the different manufacturing technologies to allow for integration into the overall production system, resulting into the mapping of the physical world into the digital world. This is especially critical for technologies like additive manufacturing.

For years, AM has functioned in a stand-alone mode. In order to make AM as an integrated part of a overall production system, automation is required. Through automation, AM can be deployed at a production-scale and thus better find its place in production environments. Within the Advanced Manufacturing Center (AMC) located in Enschede, an automated approach will be demonstrated, including steps as (3D) scanning, subtractive machining, and surface treatment.

Additive Manufacturing Automation

By its definition – “the process of joining materials to make parts from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing and formative manufacturing methodologies “, AM establishes a straightforward connection between the digital and physical product. AM starts from the digital 3D representation of the object to manufacture, then the object is oriented, sliced and paths for the laser, nozzle, or inkjet nozzle are generated. Thereafter the physical actions take place: printing, remove the printed object from the AM machine, and post-processing.
These steps heavily rely on engineers for choosing the correct orientation, removing the printed object from the machine, refilling the feedstock, and performing post-processing operations. Automating this procedure will allow this technology to enter the market on an industrial scale.

Automating additive manufacturing requires the combination of AM, robotics and/or automated handling systems for providing a degree of automation to this technology. In this sense, four main directions are currently targeted:

Design automation

AM data sharing automation

Post-processing and handling automation

Automatic AM order handling

Design Automation

The first level of automation is achieved in the design phase. Automating the selection of the optimal build orientation based on different criteria (for instance, minimization of support structures volume) is in the researchers' attention for a long time. Different algorithms and solutions were proposed. There are also software applications or plug-ins offering suggestions regarding AM parts' orientation. Other options regarding layer optimized or automatic infill based on part's geometry and functionality or automatic temperature setting as function of material also started to be included in AM software for supporting designers' work. Making the AM design steps less manual signals the continued maturation of the 3D printing industry. Design automation will help AM adopters reduce the time and costs associated with manual design processes.

AM Data Sharing Automation

The AM industry is becoming more open. The domination of closed, proprietary systems is coming to an end, as more solution providers are looking to create integrated, interoperable 3D printing workflows. One trend supporting this is the use of open Application Programming Interfaces (APIs). API is a software intermediary that allows one software application to communicate with another. APIs play a critical role in integrating disparate systems. In AM, where the workflow can be quite complicated and siloed, the industry players are recognising the importance of providing a set of APIs that enable automation and expand the use of data.

Post-Processing and Handling Automation

Regardless of whether it is a prototype, piece of tooling or an end-use product, most AM parts require some level of post-processing. This may be as simple as removing support material, but can also include sorting, dying, polishing, as well as other processes, before the final product is ready for use. Most of the post-processing tasks are almost entirely reliant on manual labour. Thanks to recent advances in machine learning and post-processing hardware and software, it is now possible to automate almost every part of AM post-processing, reducing labour costs and significantly improving process efficiency.

New systems are entering the market that allow parts to be extracted from a 3D printer's build platform automatically and then moved with the help of guided vehicles to the next post-processing station. Automating post-processing in AM completely changes the economics when scaling up the use of technology. It enables much higher flexibility in the factory layout and makes it feasible for manufacturers to adopt this technology for digital, rapid production.

Automatic AM order handling

In addition to direct costs associated with manual post-processing, there are also hidden costs such as worker's time for quoting parts and handling AM orders and operator's time for scheduling print jobs. Calculating part costs, entering data into spreadsheets and scheduling production using clunky solutions can take several hours a day of worker's time, limiting the productivity of AM. An automated AM production management process is necessary to ensure scalable growth, and greater production efficiency.

Fully Automated AM Production Line

Automation of AM processes, from design to finishing, has tremendous potential for capital savings by reducing labour costs and increasing productivity. Furthermore, automated manufacturing can introduce more consistency into the process by minimising human errors and scrap. The Advanced Manufacturing Center located in Enschede highlights the automation solutions for AM technologies and flexibility. Additive Manufacturing combined with robots and software solutions are showcased and can be used to test new production concepts, develop knowledge, starting up production concepts and develop innovate manufacturing solutions in a realistic production environment. With this, the next steps towards integration of additive manufacturing in production environments is taken, shaping the future of manufacturing. ■