Press

North America: Digital Design and Automation Influence Molding Productivity

Among trends shaping the North American plastics industry are growing use of advanced digital design and manufacturing software and increased automation of production lines and downstream operations such as assembly.

Recent developments in software and automation give companies throughout the product chain – designers, manufacturers, molders and toolmakers – more ways to optimize operations, speed products to market, increase competitiveness and expand business opportunities. As a result, companies that add capabilities in these areas are better equipped to deal with cost pressures, offshore competition and shifting consumer market trends that mandate product modifications than those that do not.

Software, of course, has long played a vital role in product and mold design, and automation has always been a way to increase production efficiency. What is different now is that more design software incorporates high-tech features such as 3-D simulation and analysis and even virtual reality (VR) imaging, this last made possible with emerging wearables technology such as Oculus Rift by Facebook and HoloLens from Microsoft. These capabilities help users to develop and rapidly fine-tune the performance and manufacturability of parts and molds before any money is spent cutting steel or setting up machines. These features can be extended to create a “digital twin” of machine lines and factory design, to assure optimum productivity, efficient product flow and worker comfort in secondary operations, all before money is committed.

In automation, the trend is primarily one of molders and other product makers adding increasingly affordable robots to their lines. For years many robots were “cage machines” – large, fast, specialized systems that for safety reasons operated apart from workers, were costly to acquire and required expertise to program. In what can be called a “democratization of automation,” the cost of many robots in North America has been declining, making them affordable to even the smallest molders.

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At the same time, programming and control are simpler – in many cases these actions can be done away from a factory floor or off-site from almost anywhere using a smart phone or a laptop or tablet computer. And in one major advance, “collaborative robots” have been developed that are safe enough to work alongside humans and simple to program.

A number of factors influence the gains in design software and robotics. One of them is the digital revolution that is leading to the “Factory of the Future,” a concept in which all of a company’s operations and locations will be interconnected for real-time supervision, diagnostics, quality reporting and other functions that increase productivity.

Another is the growth in use of advanced materials that may combine counterintuitive properties in one formulation, such as extremely high strength and very light weight. Since unconventional designs are often required to realize the full potential of these materials, engineers need software that allows them to experiment with and produce groundbreaking designs.

The need is so great, in fact, that a U.S. military research organization, the Defense Advanced Research Projects Agency, or DARPA, started a program called TRADES (Transformative Design) to develop the mathematics and algorithms necessary to improve the structural and functional design potential of such materials. “We have reached the fundamental limits of what our computer-aided design tools and processes can handle, and need revolutionary new tools that can take requirements from a human designer and propose radically new concepts, shapes and structures that would likely never be conceived by even our best design programs today, much less by a human alone,” says Jan Vandenbrande, a DARPA program manager, in a statement announcing the initiative in April 2016. While it could be a while before software emerges from the program, developments could soon ripple through industries including plastics.

Rethinking Design

Examples of suppliers that aggressively pursue advanced digital design and manufacturing capabilities include Siemens, whose NX PLM software provides multiple features in a growing list of program offerings. NX software is a platform to which designers, molders, toolmakers and others add on

integrated software for a range of applications throughout product development.

Among the programs available are product design capabilities with 3-D simulations to analyze properties; software that compensates for warping, cooling, shrinkage and deformation in part and tooling designs; manufacturing software for mold development, fixtures or EDM electrodes; costing tools that determine the price of a mold, die or other fabrication device; NC software for full machine programming; CAM software for production; and coordinate measurement for quality control.

Siemens says the NX platforms assure data integrity and work with other CAD, CAE and CAM software. Importantly, the company states that NX software can reduce design time by an average 30% and thereby speed products to production and to market, increasing return on investment. Another benefit of NX software is that it can be used collaboratively by design and engineering teams around the world. Secure access allows real-time inspection and modification of designs, and keeps personnel in the loop about product development.

Paul Brown, senior marketing director for the NX Product Engineering Unit, says that software integration lets users move seamlessly from design to product qualification, mold development, and machine setup and production. “Integrating the entire development process is becoming more important for plastics users,” he notes.

Injection molding and moldmaking are major end-uses for NX software, Brown adds. The efficiencies and cost savings in moldmaking especially can make a business more competitive with offshore mold sources in Asia and elsewhere. “For a number of years many companies were talking about offshoring as a way to save money when ordering molds,” he says. “Now we are seeing a resurgence in local tooling companies and their business.”

One reason for this is the growing availability of software that permits rapid and low-cost mold design. By allowing the development and qualification of part and mold designs before steel is cut, Brown says companies can bring projects in at much less cost and faster than by going offshore. Most users of NX software are large or medium-sized operations, Brown acknowledges. However, Siemens does work with firms of as few as 5-10 people that use the

platform. Upcoming plans for Siemens include rolling out cloud-based computing that will improve digital collaboration and design capabilities.

Design and Mold Simulations

Another vendor of advanced software for design, tooling and manufacturing is Dassault Systèmes. Through 3-D simulation programs such as Catia, materials-heavy software like Solidworks (50,000 polymer grades including fiber-reinforced versions) and Delmia, a digital twin manufacturing program for build-to-order production lines, Dassault provides integrated capabilities that offer reductions in product development time – 20 to 50% in the case of Solidworks, says Lotfi Derbal, senior product portfolio manager.

Solidworks allows product design and simulation so parts can be tested and optimized before investments are made in molds and manufacturing. When it comes to mold design, Derbal says engineers can trial cooling channels, balance components, check mold flow and view part quality after molding with an eye toward refining a design to assure consistent production with no mold modifications.

Upcoming innovations include extending software capabilities to simulate machine operations and test molding parameters prior to production. Solidworks is partnering with an US university on this project and may have an announcement pertaining to development of software at the end of 2016.

Catia, meantime, supplies a number of 3-D simulation programs that are process oriented, says Fabrice Agnes, engineering portfolio management director. These include Plastic Mechanical Designer, which allows rapid iterations of current designs and changes to a product over its lifecycle. Simulations automatically compensate for features such as grills, ribs, reinforcements and bosses, and indicate how design changes affect filling, mold flow and other operations. Another application, Mold and Tooling Designer, allows experimentation with inserts, ejectors, cooling systems, parting lines, parting surfaces and other features to validate mold designs and demonstrate manufacturability.

A recent development, which could be on display at K 2016, is Functional Generative Designer, software that allows optimization of the cooling system of a mold, whether it is made by conventional metal machining or by additive manufacturing (also known as 3-D printing), to improve part production and

properties. “This approach will let designers develop and effectively mold a range of surprising shapes,” Agnes says. Compression molding software for 3-D design and simulation of automotive and other composites is due in the next year from Catia, he notes, and a bit further out is 3-D software for rigid packaging and flexible pouch packaging design.

Friendly Robots

Most robots sold are fast, repeatable and consistent. They also operate well away from machine personnel for safety. “A robust robot that is able to move fast is not suitable to work beside humans,” says Sonny Morneault, U.S. national sales manager of Wittmann Battenfeld, which sells robots and other auxiliary machines and primary equipment like injection presses. Morneault confirms that he sees growing demand among his customers for robots, mostly machine-side systems that place inserts in molds, label parts and packaging, and perform high-speed part removal. “The latest high-speed technology allows robots to remove parts faster than gravity could free-fall them,” he notes.

Nevertheless, there is a trend toward collaborative robots—lightweight platforms that move slowly, are ideal for repetitive tasks like assembly, picking, placing, loading and unloading, and packaging, and which interact safely with humans.

A handful of companies produce them. Some are startups that licensed technology from universities to design and program the platforms. One such is Rethink Robotics. The company developed two humanoid-style robots, Baxter and Sawyer. The robots are low cost, lightweight, and can be programmed by workers who simply teach them arm movements and press an “enter” button on a control pendant. Baxter has two arms, 7 degrees of freedom. Sawyer has one arm, 7 degrees of freedom. Each lifts up to 4 kg.

The robots are mobile and can be wheeled by workers around a plant. Features include: location recognition and automatic set-up of jobs at particular stations; Series Elastic Actuators that use springs for force control; arm sensors that measure spring deflection during motion and adjust the arm motor to compensate; and self-programming. They also have sensors that detect if a worker comes too close; if so, the robots will stop operation for safety. The company says the return on investment with the robots is usually

measured in months. Both models are in use by companies that never considered conventional robots.

The collaborative robot trend is spreading to conventional suppliers, as well. Fanuc developed the CR-35iA, which is not only rated safe to work around employees, but is engineered to lift relatively heavy loads – 35 kg. The company claims it is the only collaborative robot that lifts such a load. Consequently, it is suitable for heavy payloads, for palletizing and carton handling, and for other lifting operations that might injure a worker. The robot can be equipped with Fanuc's latest vision system to "see" what it is lifting, will stop if it comes into contact with a worker, and can be safely pushed away, if necessary.

Conventional robots are becoming more versatile. One area cited by Morneault is in the collection and transmission of production data for process oversight and system status. He notes, however, that few customers use this technology, and usually only for internal use in a plant. The ability of robots to collect and transmit process data would fit in with the idea behind the interconnected Factory of the Future.

In any event, when it comes to such areas as process monitoring and diagnostics and efficient capacity utilization, the consistency of robots during operations is critical to production. "Fluctuating cycles cause fluctuating quality," says Morneault, which can defeat all the preparations expended in development to assure product quality.

Advances in design software and robotics offer just a snapshot of the activity underway in the North American plastics industry. Yet the impact they are having and the potential they create for developments such as the Factory of the Future and other productivity-enhancing trends is considerable. These capabilities, which will be on display at K 2016, could well lay the foundation for greater levels of productivity and economy the industry will continue to require.

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