

High-performance special-purpose machine for the construction sector builds on PC-based control and drive technology

# Fast, precise production of large-scale construction components with 3D printing

3D printing allows even complex structures to be created in concrete, with few geometric limitations.

Digitalization may have moved front and center in numerous industries and aspects of daily life, but the construction sector largely remains a domain of traditional manual skills. With the advances of innovative 3D printing technology, though, construction is now taking a major step forward toward a digital future. Engineering company LCA Automation AG (LCA) prints large-scale construction components with quick-drying cement supplied by building materials maker Sika, and is relying on universal, open automation technology from Beckhoff to put its ideas into practice.

Sika AG, headquartered in Baar, Switzerland, is globally active in specialty chemicals and a leading pioneer in the field of 3D printing with concrete. The company has mastered all of the processes involved in using concrete to print on an industrial scale. LCA, based in Küsnacht am Rigi, Switzerland, develops production systems and equipment, mostly for large, global companies in the automotive sector. Together with concrete and cement maker Sika, the engineering company has set about transforming the construction industry with a new product: a 3D printer that can make complex, large-scale construction components in quick-drying cement – precisely and with almost no limits on geometry. This 3D printing technology won Sika a special “World of Concrete Europe” prize at the Intermat Innovation Awards in Paris in 2018.

“The 3D printer was developed based on trials conducted by Sika under near real-life production conditions,” says Christoph A. P. Rennhard, LCA’s owner and CEO. “The system is large and rigid, which makes it precise, and it’s fast as well. With the quick-drying cement, it can use these advantages to the full.” The printer works at a rate of 1 m/s. An extruder head specially designed and patented by Sika introduces a careful balance of additives to the cement to make sure it hardens quickly and binds well to existing layers.

Construction components for printing are designed on a computer. Once a component’s design data has been sent to the printer, building contractors can watch as the component is created. The system has clear benefits: The digital data is quick and reliable to transfer. The printer can repeat components precisely, which means it can be used to print entire series as well as individualized components. No formwork is needed to pour the concrete, and there is no fluctuation in component quality caused by variance in manual skills. And not only can the printer produce complex forms and structures, it can even add color to the construction material as well.

“We’re at the nexus of IoT, AI and digital transformation. Our machines are connected; we monitor them and assess the data collected. This data-centric approach is becoming increasingly important because it enables us to analyze outages and optimize processes,” says Rennhard.

## Flexible procedures in harsh conditions with open control technology

LCA provisions procedures for printing construction components on the control system in the form of recipes. Operators set key parameters when selecting a

recipe but cannot alter a procedure to the point that the final result is at risk. "The open interfaces available with PC-based control were a key factor in our decision to use an automation solution from Beckhoff. These allow us to easily integrate peripheral processes that are crucial to achieving an optimum overall result. We were also persuaded by the comprehensive consistency of the entire Beckhoff portfolio," Rennhard explains.

The technology deployed had to be fairly robust to work in harsh conditions too: Key requirements included being dust and water tight (IP 67 rated), robust, and capable of operating in temperatures ranging from 5 °C to 40 °C. All sys-

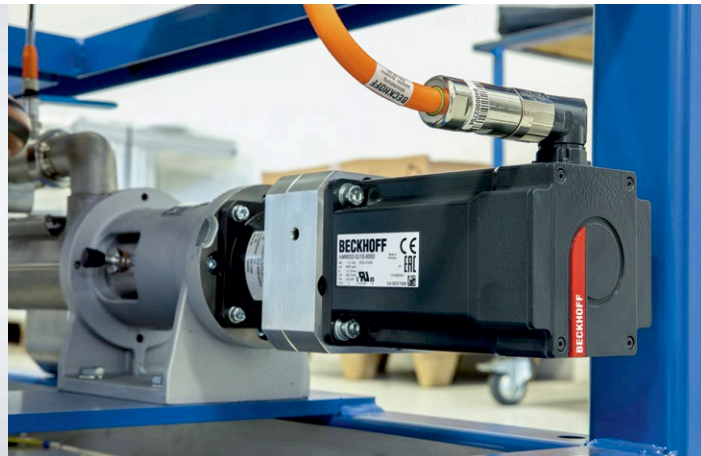
TwinCAT 3 paves the way to developing systems of our own – such as a camera system, for example, that we can integrate ourselves."

LCA has deployed Beckhoff automation components from end to end throughout its project so as to maximize the benefits of working with a universal system, and is using motion technology from Beckhoff as well as the Industrial PC and EtherCAT Terminals. The universal and consistent portfolio aside, another reason for this decision were the AM8000 servomotors with One Cable Technology (OCT), which require a minimum of effort to wire up and install. "We also like the extensive capabilities offered by the AX5000 servo drive's



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The servomotors with One Cable Technology require less cabling and space, and also reduce the risk of wiring errors.



tem parts, according to LCA, need to be corrosion-proof and comply with the technical safety requirements in the intended countries of use. A C6930 control cabinet IPC, designed to operate at up to 55 °C, was chosen as the controller hardware. It features a compact enclosure with a 3½-inch motherboard that accepts Intel® Celeron® or Core™ i3/i5/i7 CPUs. The C6930 IPC also has a SATA RAID controller to mirror hard drives for enhanced data protection.

#### EtherCAT for high-speed data communication

As is common with digitalization projects, 3D printing involves moving large amounts of data quickly. Here, the fact that Beckhoff offers an end-to-end automation solution based on high-performance EtherCAT was another significant factor in its favor. Fast real-time Ethernet is available in every I/O module, through the EtherCAT terminals, and the high-speed AX5000 Servo Drive enables fast and precise motion control.

"The high performance of EtherCAT is really important when it comes to process execution," says LCA's CEO, Christoph A. P. Rennhard. "For us as specialty machine builders, it's also really valuable knowing that such a broad and diverse range of EtherCAT-enabled equipment is available. It gives us immense freedom of choice when it comes to selecting third-party components."

#### TwinCAT 3 opens up new possibilities

LCA, one of Beckhoff Switzerland's earliest customers, is a long-standing TwinCAT 2 user. With TwinCAT 3, though, the company now has the option of encapsulating its own machine functionality in software and integrating it onto a scalable hardware platform. This integrative model, as it is known, was the main reason why LCA switched to this version, says Rennhard. "The move to

safety functions, and we're looking forward to the arrival of the new version of the AX8000 high-performance multi-axis servo system, which will incorporate them as well," Rennhard notes. When it came to user input, LCA opted for the CP39xx multi-touch Control Panel because of its innovative design and excellent balance of cost and performance.

#### Local support

Beckhoff Switzerland has a comprehensive support network with six regional offices across its territory. Guidance and rapid technical assistance are important, not just during project implementation but subsequently, too, as Christoph A. P. Rennhard points out: "Beckhoff in Zürich supported us throughout the implementation phase. They listened to our suggestions, assessed and adapted our input, and then implemented the product accordingly. Our specialists rely on ready access to flexible and responsive support. The expert knowledge of support staff plays an essential role here because questions frequently crop up at the setup and commissioning stage, and the answers are crucial to our ability to continue working. One of the main reasons for using Beckhoff components is the outstanding service we get from the team here in Switzerland – with their personal touch, technical expertise and passion for innovation."

More information:

[www.lca.ch](http://www.lca.ch)

[www.sika.com](http://www.sika.com)

[www.beckhoff.ch](http://www.beckhoff.ch)