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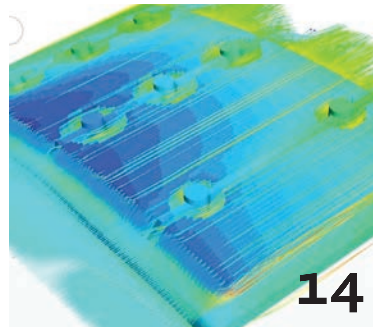



# INSIDE



Photo: Getty Images



## Columns





# Flying Hybrid

With the official debut of the APMA's Project Arrow prototype this year, plus the controversy over subsidies provided to VW and Stellantis-LG for new battery plants, it's understandable attention in electric transportation has focused on EVs.

However, the push to electrify is nearly as active in the skies over Canada as on its roads. Like Project Arrow, an aerospace initiative has similarly pulled together a group of Canadian aviation players and federally and provincially funded projects to make commercial electric-powered flight a reality.

Launched in the summer of 2021, the hybrid-electric flight demonstrator program, initiated by De Havilland Aircraft of Canada and Pratt & Whitney Canada, has also picked up speed this year. Partly supported by the federal and Quebec governments, the program looks to integrate a 1MW motor, developed by Collins Aerospace, with a PW&C high efficiency thermal engine. The hybrid propulsion system is scheduled to be installed on a De Havilland Dash 8-100 flight demonstrator in early 2024.

To hit that target date, PW&C and Collins' parent company, RTX, announced at the Paris Air Show in July that the program achieved an important milestone – namely, a rated power test of the demonstrator's 1 megawatt electric motor. Since then, RTX says testing of the combined hybrid-electric propulsion (HEP) system has continued at Pratt & Whitney Canada's facility in Longueuil, Quebec throughout 2023. According to the company, its HEP technology aims to achieve a 30 percent improvement in fuel efficiency and CO2 emissions compared to most advanced regional turboprop engines.

To power those electric engines, H55, a Swiss maker of electric propulsion and battery management systems, announced in early 2023 that it would join the project. The company specializes in lightweight, modular energy storage for electric aircraft propulsion systems. Backed by a $10 million interest-free loan from the Canadian government, H55 began construction in mid-October of its Canadian headquarters at Saint-Hubert Airport near Montreal. The company says the facility will begin battery pack production next year.

It's true that e-mobility projects like the hybrid-electric flight demonstrator program are still in the testing phase. In fact, it may be years before such efforts result in commercial hybrid aircraft entering service. Even so, it's clear that major players and governments are betting heavily on an electrified future, especially as Canada strives to reinvigorate its historic strength in transportation manufacturing. **|DE**

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ROBOTICS

## ROCKWELL TO ACQUIRE CLEARPATH ROBOTICS

Rockwell Automation announced it has signed a definitive agreement to acquire Kitchener-based Clearpath Robotics Inc. Founded in 2009, Clearpath got its start offering robotics technology to the global research and development markets.

In 2015, it launched its OTTO Motors Division which produces Clearpath's AMRs and fleet management and navigation software. According to Rockwell, the addition of OTTO Motors' AMR products will allow it to create a complete portfolio of advanced material handling solutions.

Paired with data from Rockwell's offerings, Clearpath's AMRs will be harnessed by AI-powered Software as a Service information management applications, such as Rockwell's Plex and Fiix businesses. With this, Rockwell says it will deliver a unified solution for manufacturing and amplify Kalypso's production logistics consulting practice.

"Rockwell and Clearpath together will simplify the difficult and labor-intensive task of moving materials and product through an orchestrated and safe system to optimize operations throughout the entire manufacturing facility," said Blake Moret, Chairman and CEO, Rockwell Automation. "The combination of autonomous robots and PLC-based line control has long been a dream of plant managers in industries as diverse as automotive and consumer packaged goods."

According to Rockwell, the acquisition will be funded by proceeds from the sale of its investment in PTC. Subject to regulatory approval, the acquisition is expected to close in the first quarter of Rockwell's fiscal year 2024. At close, Clearpath will report to Rockwell's Intelligent Devices operating segment.

**www.rockwellautomation.com**
**https://clearpathrobotics.com**


***The heavy-duty OTTO 1500, created by Kitchener-based Clearpath Robotics.***

Photo credit: Clearpath Robotics

AEROSPACE

## AM IN AEROSPACE, DEFENSE MARKET TO REACH $8B BY 2030

According to analysis by Straits Research, the global 3D printing in aerospace and defense market, valued at US$1.35B in 2021, will reach an expected value of US$8.66B by 2030. In the market analysis firm's latest report, the sector is projected to experience a CAGR of 26.1% between 2022–2030.

Driving the market expansion, Straits' report says, is increased acceptance of 3D-printed parts in aerospace supply chains and the advantages of 3D printing, notably the decrease in processing and manufacturing costs.

By application, the report says the market is segmented into Aircraft, Unmanned Aerial Vehicles and Spacecraft with aircraft accounting for the largest market share and largest projected growth rate (29.7%) until 2030.

As to build materials, the special metal segment accounts for the largest market share and is estimated to grow at a CAGR of 24.4% but plastics like ULTEM has gained popularity due to its heat resistance, the report says. Aerospace companies are increasingly utilizing polyetherimide, commercially known as ULTEM, to produce the inner shells that comprise all required mounting components.

Regionally, the report finds that Europe commands the market and is estimated to grow at a CAGR of 24.4% to 2030. Of European nations, the UK is a center of R&D for innovative materials for the aerospace industry, and the existence of numerous aerospace incumbents generates a consistent demand for advanced composites.

North America is expected to see the strongest growth at a CAGR of 25.2%, due to the presence of key industry players, such as Boeing, Lockheed Martin, and NASA, which have embraced 3D printing technology, the report says.

Asia-Pacific is the third-largest region, the report finds and points out that the Chinese government has designated aeronautical equipment and 3D printing as important growth drivers for Chinese manufacturing industries under the Made in China 2025 vision.

**https://straitsresearch.com**

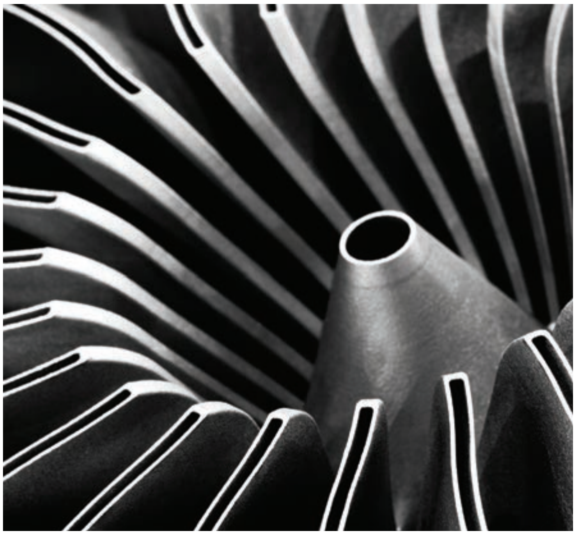

Photo: Matveev_Aleksandr/ iStock / Getty Images Plus/Getty Images.

*EcoProBM, SK On and Ford are planning to invest C$1.2 billion to build a cathode manufacturing facility in Bécancour, Québec.*
Photo credit: Ford Motor Co.

**AUTOMOTIVE**

## FORD, SK ON TO BUILD CATHODE PLANT IN QUEBEC

Ford Motor Co and its South Korean partners, SK On and EcoProBM, announced a CAD$1.2 billion investment to build a cathode manufacturing facility in Becancour, Que. The 280,000-square-meter facility will provide materials that supply batteries for Ford's future electric vehicles.

According to Ford, production will begin in the first half of 2026. Once operational, the site will have the capacity to produce up to 45,000 tonnes of cathode active materials (CAM) per year. The car maker says the facility – its first in Québec – will support production of up to 225,000 EVs annually and is part of the automaker's plan to localize key battery raw material processing in regions where it produces EVs.

EcoProBM subsidiary, EcoPro CAM Canada LP, will oversee the day-to-day operations of the facility, which will manufacture Nickel Cobalt Manganese (NCM) cathodes for rechargeable batteries based on EcoPro's core shell gradient (CSG) technology. SK On and Ford will become investors once the deal is closed; the joint venture is subject to closing conditions and regulatory approvals.

"Through the cathode JV, the three companies can have a stable supply of battery raw materials in North America," said SK On Chief Commercial Officer Min-suk Sung. "We will continue to work with our partners to lead electrification of the global auto market."

"We are building the foundations of an industry that will allow Quebec to become a leader in the green economy in North America and the world," Quebec Premier, François Legault.

"With the energy transition, we have the chance to make a name for ourselves in the new economy, to become richer all while reducing global GHG emissions."
**https://corporate.ford.com**

Photo: imaginima/E+/Getty Images.

**ROBOTICS**

## STUDY EXPLORES STATE OF CANADIAN ROBOTICS MARKET

HowToRobot.com and the Association for Advancing Automation (A3) have released a market study that offers an overview of Canada's robot and automation suppliers. According to the report, most of the automation industry in Canada is tied to the manufacturing sector; however, other sectors are becoming increasingly important, including healthcare (20%) and energy (19%), the report finds.

In total, the study identifies 249 Canadian robot and automation suppliers, including 142 integrators, 49 sub-component suppliers and 33 robot manufacturers. Additionally, the study identifies 16 advisors and 9 distributors supplying systems and components to the industry.

Geographically, the market analysis says Ontario and Quebec are home to 81% of the robot and automation supplier offices and accounted for nearly 69% of the Canadian manufacturing industry's revenue in 2021.

Application areas targeted by most robot and automation suppliers include handling and picking (130 suppliers), inspection and quality control (90 suppliers), and packing and palletizing (89 suppliers). The industries served by most robot and automation suppliers are the robotics industry itself (141 suppliers), metal and machinery manufacturing (108 suppliers) and the automotive industry (89 suppliers).

According to the report, the robot brands used by most suppliers include Fanuc (64 suppliers), ABB (44 suppliers), and KUKA (39 suppliers).

The Association for Advancing Automation, a global advocate for the benefits of automating, is composed of 1,160 automation manufacturers, component suppliers, system integrators, end users. HowToRobot.com is a leading global automation marketplace.
**HowToRobot.com**
**www.automate.org**

**MOTION CONTROL**

## EMERSON ACQUIRES ELECTRIC MOTION COMPANY, AFAG

Emerson announced it has acquired Afag Holding AG, a manufacturer of electric linear motion, feeding and handling automation solutions. Headquartered in Zell, Switzerland, Afag customer base includes battery manufacturing, automotive, packaging, medical, life sciences and electronics.

According to Emerson, the acquisition enhances the company's factory automation portfolio by combining Afag's electric linear motion solutions with Emerson's pneumatic motion technology.

"Afag brings exciting technology that will enable Emerson to accelerate growth in our existing $900 million factory automation business," said Emerson COO, Ram Krishnan. "As discrete and hybrid customers continue to accelerate electrification across their manufacturing processes, Afag's technology is ideally suited to provide improved energy efficiency and performance gains."

**www.emerson.com**
**www.afag.com**

**AUTOMATION**

## VENTION UNVEILS CO-ORDINATION MOTION TECHNOLOGY

Vention announced the launch of Coordinated Motion, a robotic control solution that synchronizes the motion control of a six-axis cobot with a 7th external linear axis. Developed in collaboration with Universal Robots, the technology enables precise Tool Center Point (TCP) trajectory execution through multiple waypoints, Vention says.

"This new innovation exemplifies Vention's and Universal Robots' commitment to providing our users with cutting-edge solutions that streamline operations and enhance productivity," said Anik Roy Trudel, VP of Product Line Management at Vention. "We are excited to empower our Universal Robots' customers with Coordinated Motion and looking forward to sharing the impact it will have on their automated systems."

According to Vention, Coordinated Motion will officially be available within the next six months.

**https://vention.io**

Photo credit: Vention

***A visualization of the EV battery gigafactory Volkswagen intends to build in St. Thomas, Ontario.***
Photo credit: Volkswagen AG

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**AUTOMOTIVE**

## EV BATTERY DEALS WILL TAKE 20 YEARS TO BREAK EVEN, PBO SAYS

The Parliamentary Budget Officer (PBO) released an analysis of the funding agreements struck with Stellantis-LG Energy Solutions and Volkswagen to estimate the period over which government revenues generated from their EV battery manufacturing plants will equal the subsidies announced by the governments of Canada and Ontario.

In June, PBO released a report that examined Canada's support for Volkswagen's electric vehicle (EV) battery manufacturing plant. Since this publication, the federal government and the government of Ontario announced new production subsidies for the Stellantis-LG Electric Solutions (LGES) EV battery manufacturing plant. Based on the federal government's estimates, this brings federal and provincial production subsidies for Stellantis-LGES and Volkswagen to $28.2 billion by the end of 2032.

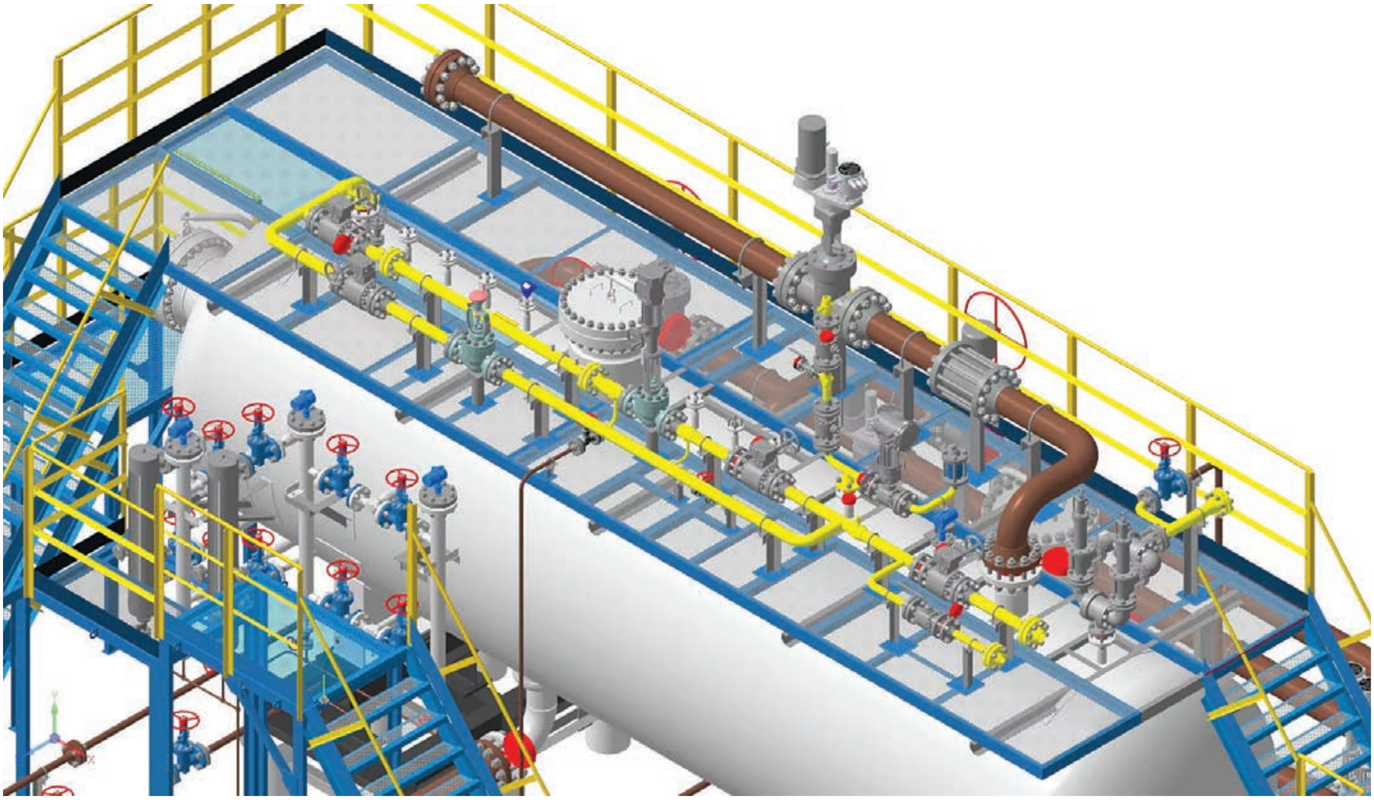
The federal government also announced a cost-sharing agreement with the government of Ontario under which the federal government will cover two-thirds of the production subsidies for Stellantis-LGES and Volkswagen ($18.8 billion), while Ontario will now cover one-third ($9.4 billion).

"We estimate that federal and provincial government tax revenues generated from the Stellantis-LGES and Volkswagen EV battery manufacturing plants over the period 2024 to 2043 will be equal to the total amount of production subsidies," says PBO Yves Giroux. "That is, the break-even timeline for the $28.2 billion in production subsidies announced for Stellantis-LGES and Volkswagen is estimated to be twenty years, significantly longer than the Government's estimate of a payback within five years for Volkswagen," said PBO Yves Giroux.

**www.pbo-dpb.ca**

# MCAD in the Second Cold War

*How trade sanctioned countries work-around embargoes of Western design software.* **BY RALPH GRABOWSKI**



***3D piping design made with Kompas-3D from Ascon Group***

Photo credit: Ascon Group

Russia's invasion of the sovereign country of Ukraine is despicable, but the subsequent Western embargoes, designed to hobble the Russian war economy, instead had the unintended side effect of accelerating Russia's self-sufficiency. Its official "import substitution" (*zamena importa*) program replaced Western products with homegrown ones, whether no-longer-Mcdonalds hamburgers, IKEA-like furniture or geometric kernels in CAD software.

Even before the embargoes began, Russia already had a strong subset of CAD programs, mostly AutoCAD-workalikes for general CAD and parametric history-based CAD systems for mechanical designs. This is due to the strength of Russian mathematicians, who also founded CAD programs now considered indispensable to the West, such as Pro/Engineer from PTC (renamed Creo) and Revit from Autodesk. Russian CAD is also strong in the areas of P&ID and vessel design (needed for their hydrocarbon and pipeline industries) and the design and decommissioning of nuclear power plants.

On the other hand, its architectural and BIM software is, in my opinion, weak. By weak, I mean that the few that exist are not as capable as Revit or AutoCAD with add-ons, because the two American brands had dominated the market in Russia. PLM software, which runs Russian manufacturing firms through product lifecycle management, is, for the most part, Teamcenter from Siemens.

Under the hood, many Russian CAD programs rely on the Parasolid geometric kernel, also from Siemens, while AutoCAD work-alikes need APIs (application programming interfaces) and translators from the USA's Open Design Alliance – ironically, programmed largely by Russians.

As Western software firms withdrew from Russia, their software kept operating – for a time. Some ground to a halt after a year as licenses ran out, or when servers were blocked, or when security patches lagged too far into the past. Even hardware is affected; Mercedes blocked its servers from assisting repair shops in diagnosing and updating its automobiles in Russia.

On the other hand, according

to the Russian ministry for digital development, approximately 100,000 programmers have left the country since the start of the war. Even though the government countered with inducements, such as not being drafted into the war, programmers continue to be extricated by Western software companies, desperate for their skill set.

### *The Situation in China*

In contrast to Russia, China depends more so on Western CAD software but hasn't been able to independently create its own AutoCAD or Solidworks-level of design programs, in my opinion. Whereas Russian mathematicians keenly constructed original algorithms since Soviet times, China has taken a different route – copying software, rather than engage in original works.

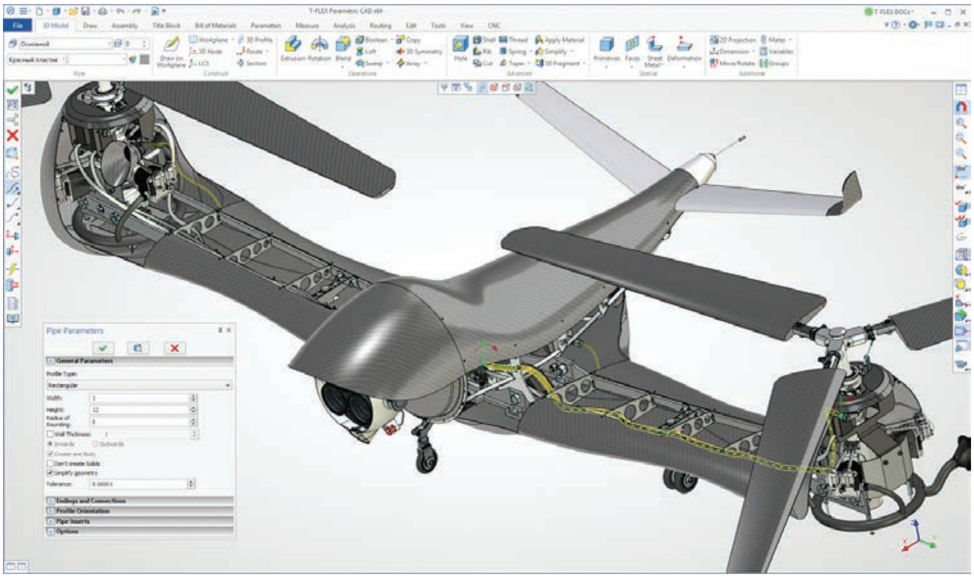
The Chinese government raised copying to legal status by requiring Western firms, wishing to do business in China, to integrate with local partners. Those local partners then benefited from "technology transfers" – which I see as legalized theft of intellectual property. According to the Wall Street Journal, 20% of wind turbines illegally use control software developed by American Semiconductor. Further, FBI director Christopher Wray testified in July that China requires foreign-owned companies to host internal political cells. In addition, Wray said the CCP government "exploits" these cells and joint business ventures to gain access to companies' intellectual property.

To keep up with Western advances and to avoid having their exports blocked, Chinese firms over the decades have purchased, licensed or invested in Western ones. ZW3D, marketed by Chinese-owned ZwSoft, is the old VX MCAD, still being programmed out of Florida. Gstarsoft's GstarCAD general design program is an IntelliCAD-based AutoCAD workalike that runs on ODA's APIs. One of China's PLM makers, CAXA, owns the USA's IronCAD.

As for operating systems, Windows dominates in Russia and China due to widespread bootlegging. Attempts to replace it with homegrown desktop operating systems based on Linux have wallowed, as elsewhere in the world.

### *Replacing the Kernel in Russia*

Private firms and the Russian government have a variety of tactics to transition Western software to local versions. For instance, Ascon Group of St Petersburg, Russia's biggest CAD vendor, offers a 30% discount on its CAD products to those with now-canceled AutoCAD licenses.



***Completed model made with T-flex CAD from Moscow-based Top Systems***

Photo credit: Top Systems

The geometric kernel is the core of every CAD system, and so a decade ago the Russian government funded an early version of import substitution with the Russia Geometric Kernel. The RGK failed due to the dominance of Parasolid – why go from an excellent kernel to an immature one? But with last year's newfound urgency, RGK has been resurrected. The lead developer is Top Systems of Moscow, which gained its knowledge by first working with ACIS and then with Parasolid in its T-Flex CAD software.

There's no mystery as to what functions the RGK still needs; it must match Parasolid. "Top Systems sets itself the task of reaching the level of existing Western world leaders in the field of geometric modeling as soon as possible, and possibly surpassing this level," the company has boasted, but admits the project will take years to complete.

The only other home-grown kernel is C3D, an off-shoot of Ascon Group, which has been successful in commercializing the kernel Ascon wrote in-house for its Kompas-3D MCAD program. C3D lacks the imprimatur of the Russian government, but nevertheless found success internationally, such as in Altium's PCB design software. [Disclosure: *I* provided editing work to C3D Labs prior to the invasion.]

### *Replacing PLM*

A more urgent task is to replace Western PLM. Ripping out PLM systems and replacing them with different ones is more painful than replacing kernels. While a kernel operates in many areas of CAD programs, PLM runs the operations in many areas of manufacturing.

PLM is a multi-user database that reads (through translation) all kinds of CAD file formats, and then displays them with linked drawings, data and other documents – all the while managing workflows in manufacturing, installation, operations and decommissioning. So, it ought not to be difficult to replicate, but Russians are finding it is. The problem may be that Russians are not that good at the grunt work of data translation, plus most firms that specialize in data conversion are in Europe.

In July, the Russian-language *Isicad* magazine, now relocated to Tel Aviv, published the experience of a firm looking for Russian replacements for Teamcenter. Russian PLM had to work with legacy Creo and AutoCAD files, as well as any Russian CAD program, doing things like reading attributes, recognizing family tables, and handling electronic signatures.

According to *Isicad*, the firm's options turned out to be sub-standard. For one Russian replacement, the firm would have to pay to have a Creo translator written; another lacked product configurations; the third supported only Russian-language products, and no English ones (like Creo), along with providing poor support.

The firm's conclusion was severe: Russian "vendors' marketing claims that give the impression of a wide range of system capabilities and ease of data transfer do not stand up to scrutiny. The biggest stumbling block was importing PLM data, which is done easily with Western PLM, but doesn't work well with Russian PLM."

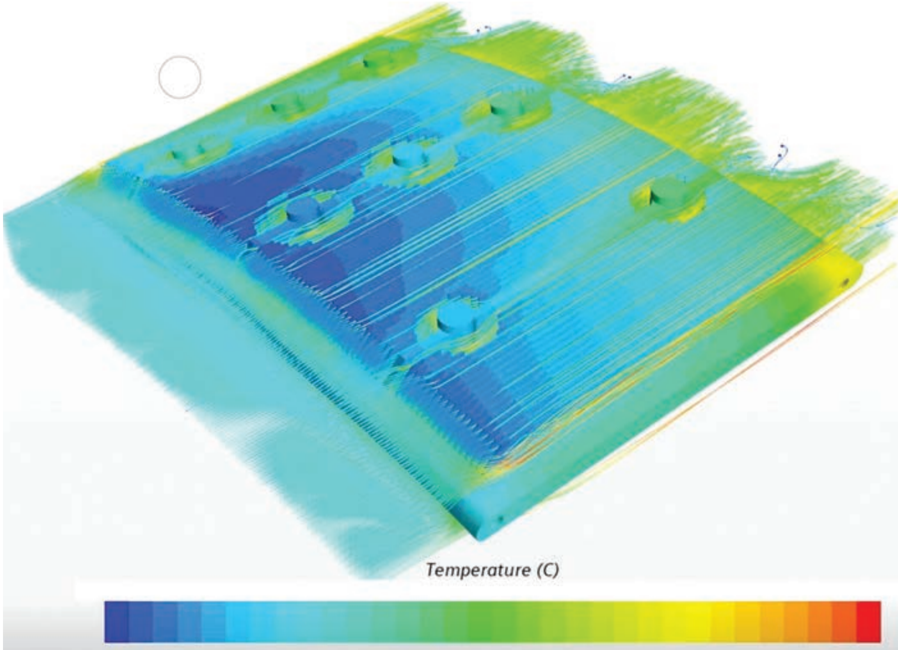
Pulling out of Russia was relatively easy for most Western CAD firms, particularly since the cost of doing so was low; Russia typically represented only 2% of global revenues. In China, however, some Western firms are increasing their investment. For Volkswagen, for example, China represents 40% of the German car maker's global revenues, but has seen its EV market share fall behind Chinese competitors, like BYD Co. and other local brands. Others, like Apple, are sensibly looking at India and Vietnam to reduce their dependence on China.

While the West depends on the capabilities of Russian programmers to write software cheaply, many have emigrated to the West. On the other hand, the West still depends on Chinese factories to make stuff cheaply. That doesn't bode well, especially if the Taiwan defense minister's prediction that China could mount a "full-scale" invasion of Taiwan in 2025, the year by which China hopes to be 70% self-sufficient in manufacturing. **|DE**

***Ralph Grabowski*** *writes on the CAD industry on his WorldCAD Access blog (www. worldcadaccess.com) and has authored numerous articles and books on CAD and other design software.*

# A POWERFUL SYNERGY

## *AI-driven CFD simulation solves difficult design problem in Velo3D's Sapphire XC 3D printer.* BY ROBIN TULUIE




***CFD simulation of the thermal behavior of a conformal heat exchanger, used widely in jet-engine cowlings, for a Tier 1 supplier. The company used PhysicsX to replace a traditionally manufactured heat exchanger with a 3D printed one.*** (Image credit: PhysicsX)

In the digital design-engineering world, AI's "deep learning" has the potential to transform how the world makes products. There's an urgent opportunity to fully exploit the tools of computer-aided engineering (CFD, FEA, etc) using the capabilities of AI. That means design optimization, but automated by machine learning, enabling a speed and level of precision far beyond what can be currently accomplished by most manufacturers.

AI tools, for example, can cut simulation times from hours to only seconds, employing deep learning to automatically evaluate, and then incrementally modify, the geometry of a part to create specific outcomes. The resulting, final design achieves the ideal combination of whatever attributes its makers have prioritized: lighter weight, stress and fatigue reduction, optimum fluid flow, heat exchange, conductivity, durability, part consolidation, and more.

Of course, there's no escaping the laws of physics; engineers still have to do their design diligence, using whatever CAE tools are appropriate. But what AI software can add is the ability to work within existing simulation tools and reduce the need to calculate every single differential equation involved.

AI accomplishes this feat by solving the CFD or FEA equations in a non-traditional way: Machine learning examines, and then emulates, the overall physical behavior of a design, not every single math problem that underlies that behavior. This uses far fewer computational resources while achieving an extremely robust evaluation of the design in every applicable environment.

Hundreds of thousands of design candidates can be simulated and evaluated in less than a day. Bottom line: Applying AI amplifies the typical 10-20% performance improvements of simulation tools alone—up to 30% and higher. Of course, it follows that real-world testing of finished parts remains an essential task to ensure that all quality and performance metrics are met.

### *A unique opportunity for AI*

While machine learning can certainly benefit the design of products that are produced via any type of manufacturing process or technology, it's with additive manufacturing (AM) that AI is perhaps the most complementary.

Machine learning can fully explore the AM-design space, identifying the true limit of every type of physics that will apply to a specific component. This unleashes AM's unique power to deliver whatever level of geometric complexity will enable the most creative and cost-efficient solution to a difficult engineering challenge.

This combination of additive manufacturing and AI has now been successfully applied to optimize and improve the performance of such disparate parts as a 3D-printed heat exchanger used on jet engines, a championship-winning motorbike and the impeller blades of a cardiac pump.

What's more, certain AM-system makers have also recognized the value of this capability to improve their own machines – saving time, boosting performance and fine-tuning the accuracy of their prints.

Here's an interesting example of one AM equipment provider that used deep-learning software to optimize their 3D printer. Several years ago, California-based Velo3D began designing its larger-volume Sapphire XC 3D printer to include eight 1,000-watt lasers, four times as many as its original Sapphire machine.

There was just one problem. Lasers produce soot when they melt metal powder material inside an AM build chamber. During this process, some of the material vaporizes and condenses into very small particles that can occlude the lasers as they target the powder bed. The solution for this is to provide a constant flow of an inert gas like Argon to sweep away the soot as it's generated.

Sometimes, however, particles can escape this flow and land on the windows through which the laser light enters the chamber, causing contamination and heating that can distort the window itself. This creates what's in effect an unintended "lens" in the optical path, bending the laser light from its intended direction and defocusing its spot size on the material bed. As this understandably affects build quality, it's imperative that the laser windows remain clean throughout the build.

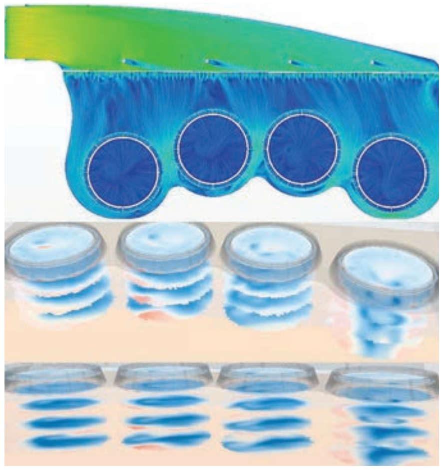
### *Solving the challenge of going bigger*

Velo3D had already thought through the optimum gas flow for its bigger machines' build chambers overall. But they knew that the longer powder bed, greater interior volume, and tighter packing of more lasers would be a challenge when creating optical window nozzles for their XC system. It was anticipated that the amount of soot generated by the new machines would be about four times as much as the original ones.

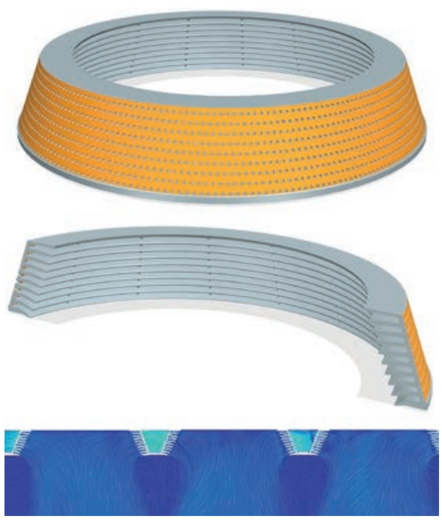
The company first tried some in-house computational fluid dynamics (CFD) simulations, then outsourced to a software provider as well—but the results fell short of their performance expectations. The time involved in setting up multiple CFD simulation iterations, while manually changing parameters like the diameters of the nozzle holes, was labor-intensive – essentially a lot of painful guess-and-check.

Velo3D requested PhysicsX to design and simulate a solution. PhysicsX has deep experience in simulation, optimization and designing for tight packages, plus proprietary simulation-validated tools that can automatically iterate on designs using machine learning/AI-based simulations.

The PhysicsX approach involves creating a loop between the CFD, generative geometry creation tools and an AI controller to train a geometric deep learning surrogate. The surrogate's speed, producing high-quality CFD results in under a second, is then exploited with a super-fast geometrical generative method in another machine learning loop, which deeply optimizes the design towards whichever multiple objectives the engineer decides are important. The fidelity of the deep learning tools and robust workflow enables a highly accurate solution for final validation of the results against the validated CFD model.



***Two CAD images of a patent-pending Velo3D Sapphire AM system window nozzle (full and cut views) designed and optimized by PhysicsX. The lower CFD analysis image shows a section view of the highly consistent flow distribution, the result of geometrical shaping and progression of the individual nozzle guide vanes achieved through machine learning.*** (Image credit: PhysicsX and Velo3D)



**Different orientations of flow images of one-half of the eight-window Sapphire XC, showing the consistent gas flow quality achieved despite the extremely tight packaging volume.**

(Image credit: PhysicsX and Velo3D)

In the Velo3D window nozzle case, a number of metrics were used to automatically quantify the fraction of the recirculating flow within the argon curtain that was traveling upward towards the window. PhysicsX benchmarked the Sapphire window solution at the start of the project, then applied the company's proprietary AI/machine-learning software, and ran huge volumes of simulations to optimize the final design. This resulted in a nozzle design that produced the optimum Argon curtain flow, while working within the manufacturing envelope of the additive machine.

The intricacy of the final turning-vane design would be a challenge to many conventional AM systems, but the Sapphire machine's ability to 3D print extremely thin, smooth and low-angle vanes delivered the geometry that allowed the nozzles to function as intended. The final design was optimized for and produced on an original Sapphire and the first-ever-manufactured Sapphire XC was run successfully with the new window-nozzle parts in place—an example of an AM machine printing its own parts.

This AM-nozzle-optimization example exemplifies the potential synergy between AI design optimization and 3D printing in a number of ways. No advanced-technology development can happen these days without computer simulation playing a role. Yet the simulation process still involves significant computing resources and hands-on optimization skills that slow process improvement.

Here is where AI can step in to intelligently accelerate and automate decision making for designers and engineers working in additive. In the case above, deep learning optimization not only transformed the geometry of a working 3D-printer component, but also improved the function of the key laser system that enables extreme acuity and therefore final product quality. These are the very attributes that the AM industry still needs to scale up and deliver on a global basis—what aerospace, automotive, science, medicine and other fields are looking for from the technology. Deep learning can be the accelerator that pushes the AM industry to achieve these goals. **|DE**

**www.physicsx.ai**

*Robin Tuluie is the founder and co-CEO of PhysicsX.*

Photo credit: Beckhoff Automation

# Modular Robotics

***Beckhoff's ATRO robotics system designed to address the shortcomings of industrial robots.*** **BY MIKE MCLEOD**

According to the latest World Robotics report by the International Federation of Robotics (IFR), the number of industrial robots installed in 2022 hit a record high of more than half a million. In total, the IFR report found that the number of operational robots globally reached approximately 3.5 million units, also a new record.

For all their popularity, industrial robots, especially those in the ~10kg payload range, aren't without their challenges. Beyond the upfront expense, integrating robotics with existing workflows and equipment can be a drawn out endeavor that may incur the costs of commissioning, custom programming, employee training. And that's assuming the robot's role doesn't change for the foreseeable future.

To address these and other shortcomings, Beckhoff Automation announced its ATRO robotic system last summer. In characteristic style, the company showed it wasn't content to be an also-ran in the market, as the ATRO incorporates innovative improvements on the typical small to medium six-axis robot.

First and foremost is the system's modularity. Instead of a pre-constructed arm, the ATRO system is composed of a base unit and variously shaped motor and link units that can be combined, added to and later repurposed as required. Each segment attaches to the next via a self-centering Hirth coupling held in place by a self-locking screw connection.

Mountable in any orientation, the base units incorporate the connection ports for the robot – more on this later – as well as its own servo motor, EtherCAT drive, holding break and double encoder. The motor modules come in two shapes (I-shape and L-shape modules), each available in five power sizes. Lacking drives, the link modules come in I-shape, L-shape and Y-shape, the last of which allows for more than one robotic arm to fork from a common base unit.

Whatever the configuration, the company says a complete robot can be constructed in place with little tooling by a single person since each segment is relatively light. Once connected, a ring light indicator verifies that the segment has been properly attached and recognized. An electronic nameplate in each segment allows the company's TwinCAT software to recognize the robot's kinematic pieces and configure a digital twin of the completed robot.

According to Beckhoff Motion Product Manager, Christian Mische, the philosophy of the ATRO is similar to the interconnected linear motors track segments of Beckhoff's XTS conveyance system. In essence, the approach allows customers to build the conveyor or robot they need and may need in the future rather than one they have to accept.

"If you buy a robot for a specific application, then it is what it is," Mische says. "If you want to change it later on for different applications, you can't make it longer or have a higher payload or something like that. The ATRO is flexible in that you can create two-axis kinematics now but, later on, evolve that to multi-axis kinematics by reusing the modules you've already bought."

To illustrate, Mische says customers could create a 1-axis indexing table from just an ATRO base unit. Later, with the addition of some motor and link modules, the base unit can be changed to a 3-axis delta bot, 4-axis picker or a 5-axis paletizer. Add in Y- or X-shaped link module, and the ATRO becomes a multi-armed robot with 7 or more axes. In addition, Beckhoff says the ATRO is easier to fix than a conventional robot, since a faulty module can be swapped out.

Given the extensive number of single- and multi-arm configurations possible, it would seem that the routing of power, data or pneumatic cabling could quickly become a tangled mess. However, this highlights the ATRO system's other defining feature. As mentioned previously, the ATRO base unit contains all the robot's ports; from there, all channels, including power, data and fluid, are contained internally within the robot arm.

"Usually, robots are limited because you have the cables on the outline of the robot," Mische explains. "If you are lucky, you can turn it by 360 degrees, but then you have to go back and unwind it. ATRO can turn 360 degrees in one or the other direction endlessly. And that could be helpful for some specific applications, because it saves time in that you don't have to go back the long way."

For control, the ATRO system taps into an industrial PC and the company's TwinCAT software for programming. As such, ATRO can easily integrate with the company's smart conveyance and vision systems, as well as TwinCAT's machine learning and analytics functions for predictive maintenance.

For less demanding tasks, the system can be configured using a teach pendant, but the company makes clear that ATRO isn't a cobot.

"The idea with cobots is you want to collaborate with it and if it hits you, it stops nicely," Mische explains. "The regulations to make that happen, however, require the cobot to not move as fast as a standard industrial robot. When we started designing [ATRO], we debated whether to focus on it being a cobot or on high speed. Through market research, we found that a lot of people were buying cobots, but then ended up putting them in a cage and running them faster, because they want more production out of it. At the end of the day, customers want to make parts, so we're focused on making a fast and efficient industrial robot."

It should be noted that ATRO has yet to be officially released. However, Beckhoff does offer evaluation kits, with defined module sets, to facilitate real world testing. Currently, there are three kits with escalating payload and reach capabilities: 3 kg/0.6m, 5 kg/0.9m and 10 kg/1.3m.

"We have prototypes running but ATRO is still in development," Mische says. "Because of its unique features, in that we have media running through all the motor and link modules, we need much more experience to get that ready. The plan is to release ATRO in 2025." **|DE**

**www.beckhoff.com**

# How Smart Devices Impact Manufacturing Productivity

***Smart, connected technologies are driving a seismic shift in manufacturing.*** **BY ERIC WHITLEY**

The transition from traditional manufacturing to this digital age is not merely a technological evolution but a paradigm shift that demands a rethinking of established norms and processes. The stakes are high, with the potential for significant gains in efficiency, quality and scalability, but also the risk of being left behind if one fails to adapt.

Engineers play a pivotal role in this transformation. They are the architects of this new digital landscape, responsible for integrating smart technologies into existing manufacturing processes.

This article covers the specific ways smart devices are revolutionizing manufacturing productivity, along with their challenges and opportunities. This section will dissect the role of smart devices in various manufacturing sectors.

### *Automotive*

The automotive industry has been a pioneer in adopting smart technologies to enhance manufacturing processes. For example, the use of passive and wearable vest exoskeletons in automotive manufacturing is a game-changer. These devices, designed to support the musculoskeletal system, enable workers to perform tasks with reduced physical strain. For engineers, the challenge lies in customizing these exoskeletons to suit specific manufacturing tasks.

The enhanced human performance of the technologies above also has a direct impact on quality control. Engineers are leveraging data analytics to assess the performance improvements brought about by these devices, thereby ensuring that quality standards are consistently met.

### *Design and Engineering*

Smart devices are also revolutionizing the way designers and engineers work. For example, connected worker technology, when integrated with augmented reality (AR), creates a collaborative environment where engineers can share real-time data and visualizations. This is particularly beneficial for OEMs who operate across multiple locations.

AR isn't just a tool for visualization; it's an optimization engine. Engineers use AR to perform virtual "dry runs" of designs, identifying potential bottlenecks or flaws before physical prototypes are built.

AR is also a powerful tool for training and skill development. Engineers can create immersive training modules that can be accessed remotely, ensuring that staff are uniformly trained, irrespective of their geographical location.

Prototyping with AR gives engineers the ability to project virtual prototypes into the real world and interact with their designs in a 3D space, making necessary adjustments before the product goes into production. This is a significant leap forward in reducing the time to market for new products.

Photo: gorodenkoff/ iStock / Getty Images Plus/Getty Images.

### *Biomedical Devices*

The biomedical sector is a high-stakes arena where precision and reliability are paramount. Smart devices are playing an increasingly crucial role in meeting these demands.

Robots equipped with smart sensors, for example, are becoming indispensable in the manufacturing of biomedical devices. Engineers are tasked with programming these robots to perform intricate tasks with micron-level precision.

Quality assurance is a critical aspect of the production process, given the life-saving nature of biomedical devices. Integrating smart sensors and machine learning algorithms to monitor the manufacturing process in real time allows for immediate corrective actions, ensuring that the end product meets all regulatory standards.

Smart devices generate a wealth of data that engineers can analyze to make informed decisions. Whether it's optimizing the manufacturing process or predicting maintenance needs, data analytics is becoming a vital tool for engineers in the biomedical sector.

Given the stringent regulations in the biomedical field, engineers are leveraging smart devices to automate the documentation process so that all compliance requirements are met without human error.

### *Electronics*

The electronics sector is characterized by rapid innovation and a constant push for miniaturization and functionality.

Automated soldering and assembly, using smart robots, is revolutionizing the way electronic components are assembled. Engineers are programming these robots to handle intricate soldering tasks to make sure connections are accurate and reliable.

Testing and quality control is another area where smart devices are making a significant impact. Engineers are using automated testing rigs equipped with smart sensors to perform a range of tests, from electrical conductivity to thermal resistance, ensuring that each product meets the required standards.

Real-time component tracking and inventory management, using smart devices equipped with RFID and barcode scanners, is particularly useful for managing complex supply chains and ensuring that the right components are available at the right time.

The next wave of innovations is already on the horizon. Some of these innovations include self-optimizing machines, decentralized manufacturing and further-augmented workers, all designed to support sustainable manufacturing.

The manufacturing landscape is rapidly evolving due to smart devices and technologies. The above is just a glimpse into what lies ahead and how engineers and OEMs will be central to these changes. **|DE**

**www.l2l.com**

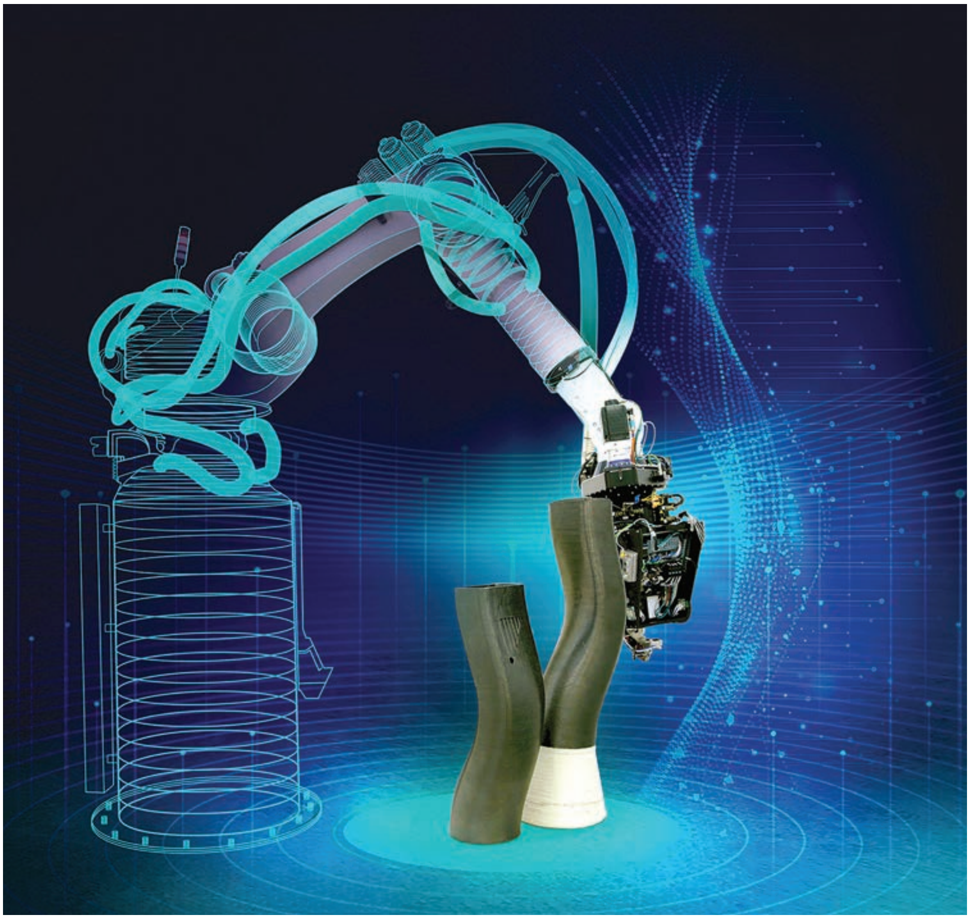
*After an extensive career as a reliability and business improvement consultant, Eric Whitley joined L2L, where he currently serves as the Director of Smart Manufacturing.*

# PUSHING THE ENVELOPE

## *Electroimpact continuous fiber-reinforced 3D printer enables rapid fabrication of aerospace-grade integrated composite structures.*

Aerospace and defense design engineers, and the complex components they develop, require true manufacturing agility. Shepherding ideas from seeming impossibilities to groundbreaking products can be both exhilarating and maddening. To iterate quickly using additive manufacturing, aerospace engineering teams are looking to Electroimpact's SCRAM system.

The Seattle-area company's system combines an in-situ out-of-autoclave thermoplastic Automated Fiber Placement (AFP) process, an advanced Fused Filament Fabrication (FFF) 3D printing process, a Fused Granulate Fabrication (FGF) 3D printing process, and subtractive machining into a unified Scalable Composite Robotic Additive Manufacturing (SCRAM) system. The result is an industrial, 6-axis continuous fiber-reinforced 3D printer that enables tool-less rapid fabrication of aerospace-grade composite structures.



### *True 3D Printing*

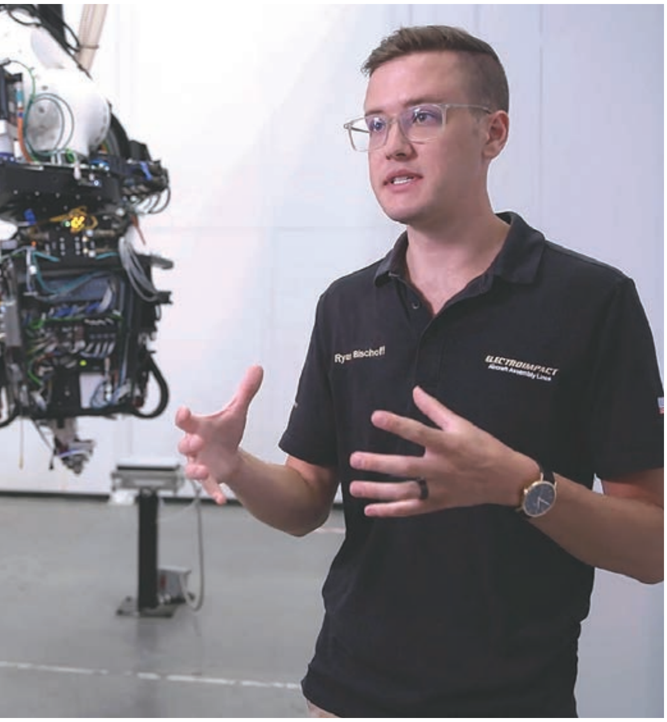
Most 3D printing processes are more accurately described as 2.5D printing. The material is deposited successively in flat slices that, when stacked together, form a 3D object.

In contrast, the SCRAM process renders true 3D printing. The system is an integration of multiple additive and subtractive processes, enabled by Electroimpact's patented robot, a rotating build platform in a climate-controlled build chamber.

Layers of continuous fiber-reinforced thermoplastic are crafted into shapes with complex contours, including aerodynamic surfaces and ducts for fluid flow. As a 6-axis process, fiber orientation within each layer can be tailored to the specific application, providing optimal strength and appropriate stiffness distributed throughout the part, much like a conventional AFP system.

In addition to the continuous fiber-reinforced thermoplastic

Photo credit: Electroimpact



*Ryan Bischoff, Electroimpact engineer, discusses the capabilities of the SCRAM system for prototyping and low volume production of complex carbon-fiber components.*

printing process and the FGF support tool printing process, SCRAM cells are also fitted with two FFF nozzles optimized for deposition of thermoplastic material reinforced with short or "chopped" fiber.

A proprietary laser heating system is incorporated, producing exceptionally strong bonds between layers. This process is ideal for situations in which layering continuous fiber is geometrically impossible or otherwise doesn't make sense.

"It allows us to deposit the material exactly where it needs to be and only where it needs to be, achieving the highest possible strength and lowest weight," says Ryan Bischoff, senior composite engineer at Electroimpact.

This is a true 3D printing process where the layers are not simply a stack of planes. Complex geometries such as variable density core and other internal structures can be printed directly onto continuous fiber-reinforced layers with widely varying curvature. If desired, additional continuous fiber-reinforced layers can then be deposited on top of the chopped fiber-reinforced core structure, forming an upper skin.

### Factory in a Cell

"Electroimpact expanded from doing mostly drilling and fastening to additive manufacturing about 15 years ago," Bischoff says. "That move, and the advancements over the years, led to the development of a system that we call a 'factory in a cell.' Instead of needing a whole assembly line, with each dedicated machine only performing a single function, it is one system, which can be printing ducts for jet engines one day and a wing component the next. It can be quickly changed and adapted according to needs."

The SCRAM system enables the tool-less rapid fabrication of aerospace-grade integrated composite structures. This factory-in-a-cell gives builders the option to produce low-run parts that make all the difference in their designs. This might be a carbon fiber element for Formula One racing or a part made from an alloy destined for space.

"Here is where the factory-in-a-cell helps teams develop parts much more quickly than a traditional facility," Bischoff says. "You complete the whole process within the SCRAM system. It makes sense because these are not the kind of parts that are produced in the thousands."

"Our customers are doing extraordinary work, and we are right there alongside them," he adds. "Your Electroimpact engineer is with you though the lifespan of the system for all questions and requests. We are here to help builders push boundaries. We service our equipment till the day it dies. Support is one of the things Electroimpact does better than anyone else in the industry."

With the SCRAM system, 3D printing replaces the need for the traditional complex tooling development typically used for automated carbon-fiber layup. This eliminates the inflated cost and time investments needed in traditional tooling and development; therefore, the SCRAM system allows for faster corrections and modifications.

Once the complex tooling is printed, the SCRAM system changes to a multi-axis milling head that finishes the form to exacting specifications. It then changes once again to the 6-axis carbon-fiber placement head and applies the intricate pattern of carbon fiber tape to the support material. Bischoff explains that the tape is deposited quickly, establishing the form. Next, the

*The SCRAM system provides a true 3D printing process, where the layers are not simply stacked on top of each other. The 6-axis tool paths place continuous fiber filament as well as chopped fiber.*

***Brian McMinn, head of Siemens Machine Tool Systems business, Brian Cubie, account manager for Siemens, Kylie Martineau, controls engineer at Electroimpact, and Ryan Bischoff, senior composite engineer at Electroimpact with the SCRAM system.***

additive support material is then dissolved away, leaving behind a component in the exact shape needed.

"We are working to make an open system that will support the material choices and make the parts each customer needs. We are driven by customer demand," Bischoff explains.

To facilitate the quick change over between multiple 3D printing operations, plus the subtractive milling process, while enabling the complex and accurate motion paths of the printer, Electroimpact's SCRAM relies on the SINUMERIK ONE from Siemens. According to the company, the CNC control system is ideally suited to the SCRAM's ability to shift from 3D printing to finishing and continuous carbon-fiber placement, all from one control.

"The faster processor times for both motion control and PLC, combined with new functionalities of the SINUMERIK ONE, further enable the incredible work Electroimpact is doing with the SCRAM system," says Steve Czajkowski, engineering manager at Siemens.

Brian Cubie, account manager for Siemens, agrees. "Our system is the foundation on which they are building, and it is just incredible to experience," he says. "I have been in robotics for many years, and to see what the engineers at Electroimpact are doing in terms of digitalizing the factory floor is exciting. They are always at the forefront. Electroimpact does a phenomenal job of taking our new SINUMERIK ONE control and adding encoders for feedback and run it though their own kinematics."

### *Digital Twin*

Looking to the future, Electroimpact says the SINUMERIK ONE control platform will allow the company to implement advanced digital twin technology into its SCRAM system. The company says this will help its teams engineer a fully functioning machine even before a real-life prototype exists and for teams to transfer tasks from the real world to the virtual environment. It will also keep projects moving consistently to the work preparation phase.

"There‘s a huge industry push to having a digital twin," Electroimpact controls engineer, Martineau, says. "I am extremely excited about supporting SCRAM in our customers' endeavors moving forward. Each customer is pushing what is possible. They are reaching for ideas that are slightly out of the ordinary. With this true digital twin, instead of needing to travel for an on-site visit or asking for photos or video footage of their challenges, the PLC will allow simulation right inside the control."

Just as customers can run the digital twin from their computer, Martineau says she will be able to operate the digital control of a customer's SCRAM right from hers.

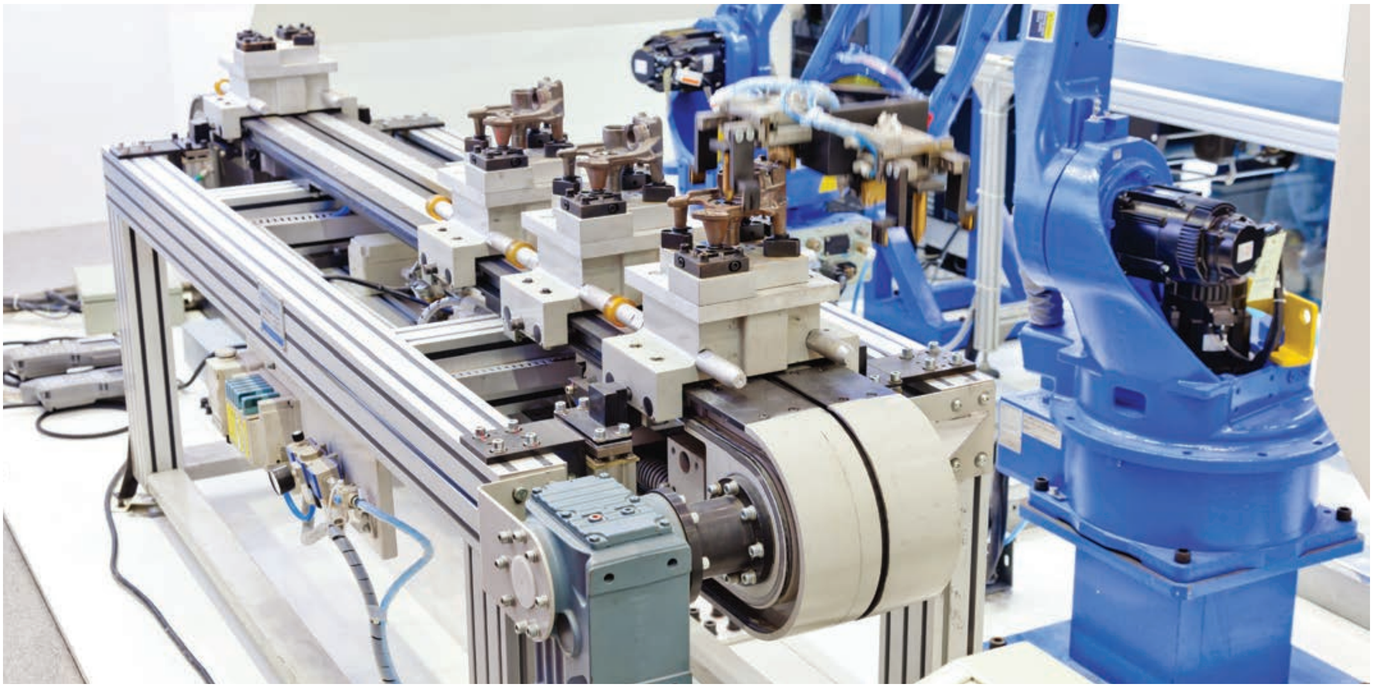
"We hear from customers when they're striving for the next level, pushing the system to the max. Being able to jump in and see what's happening is so valuable," she says. "The digital twin capabilities of SINUMERIK ONE will enable us to work extremely close to our customers in the future, supporting their desires to push the envelope of product development. With digital twin technology this accurate, customers will benefit from knowing we can jump in anytime to seamlessly help troubleshoot."

Siemens and Electroimpact have been partners for more than 10 years. The SCRAM previously included the SINUMERIK 840D sl, a precision CNC control favored by the aerospace industry. SINUMERIK ONE is faster and excels at more complex code.

"Electroimpact is always pushing the envelope," says Brian McMinn, head of the Siemens Machine Tool Systems business. "Their approach is to always be at the very leading edge of manufacturing technology. We are glad to be a part of their team as SINUMERIK ONE has the power and speed to make it all possible." **|DE**

**https://usa.siemens.com**

*This article was provided by Siemens USA*



# All About Motion

***Omron motion control specialist details the state of motion controllers and the trends shaping their future.***

The following is adapted from a Design Engineering podcast interview with Greg Dieck, product manager for motion control at Omron Automation – Americas. Over the two decades he's spent as an engineer in the automation industry, Dieck says the line between controllers (PLCs, machine automation controllers and IPCs) has increasingly blurred, especially in terms of their motion control capabilities. In this Q&A, he delves into what sets a pure play motion controller apart from other controllers and discusses the trends guiding the present and future of motion control technology.

***Q What sets a motion controller apart from other controllers, like PLCs, PACs and IPCs, that are capable of motion control?***

**Dieck:** Over the last 10 years, it's been fun to watch how PLCs. programmable automation controllers, or machine automation controllers, have advanced and become amazingly good. The connectivity of PLCs to things like vision systems, RFID, barcode readers, is just amazing now. We've even started to build in databasing, right from the PLC, so you don't need to have a third party PC for that. They've also accelerated in motion control as well, but there are still times where a dedicated motion controller really brings a lot to the table because of its flexibility.

***Q What are the advantages of a dedicated motion controller given the capabilities of other controllers?***

**Dieck:** A lot of times, it comes down to flexibility. When you're doing really complex motion control, off-the-shelf motors and drives often don't accomplish what you want them to do. So you might be looking at multiple different types of feedback devices, multiple different types of interfaces in different servos, drives, motors, or even steppers, but also custom-made kinematics. For customers in industries like semiconductor, where very high precision and very high throughput is extremely critical, the flexibility of a dedicated motion controller is important.

Also, a lot of controllers use programmable languages that are script-based and require a bit of overhead. Most PLCs run either IEC 61131 or functional blocks, which is easy to learn, easy to program, and it's easy to diagnose machines that are having issues. But it does have a little bit of overhead while you're trying to get down to very high speeds. For instance, some of our motion controllers can do five axes of coordinated motion at a 15 microsecond update rate. I don't think there's a PLC, or even IPC, out there that could hit that kind of speed. So if you're doing some very tight kinematics, the motion controllers have a distinct advantage.

***Q There's a move toward visual programming or low code programming for PLCs. Are there similar trends for more dedicated motion controllers?***

**Dieck:** We're seeing a move toward a graphical operator interface in motion

Photo: loonger/ iStock / Getty Images Plus/Getty Images.

controllers. PLCs have done a fabulous job with that but motion controllers are getting there. A lot of it is graphical set-up. But when we're getting into the very complex, high speed motion, when it's really going to run fast, we are still seeing, in a lot of cases, proprietary scripting languages. But we also do run C++ so that for new engineers coming out of school, there are some of the native languages they've learned.

So, in dedicated motion controllers, we're seeing more of the configuration and the setup done in more of a graphical interface. We are seeing some motion controllers do IO and things like that and some of that kind of devices in an IEC 61131 environment, but then still having the script language to run the motion control to get the best performance out of it.

### Q Is there a clear point at which a dedicated motion controller becomes the obvious choice over a PLC or PAC?

**Dieck:** That gray area is really growing; it's getting harder and harder to distinguish between the two. For example, we brought some G-code capability into our machine automation controller, but we couldn't bring our full G-code capability. So, when I'm talking to customers, what I look at is, what type of capabilities they need.

Take integrating a laser, for instance. Whether it's etching, cutting, or whatever you happen to be doing with a laser, those applications require very complex kinematics that a machine automation controller or programmable automation controller don't handle quite as well. So when I start looking at the application, it's really G-code, and what kind of accuracies and speeds they're trying to hit.

A lot of times, in PLCs, we either cut speed to try to gain accuracy or cut accuracy to gain speed. There's usually a point where you can only get so accurate and so fast. Motion controllers, because of what they do, can help. For example, integrating lasers is very critical now as the they are becoming more and more integrated in the industry. I've been able to do some of those with very high accuracy, while also overcoming mechanical systems, implementing compensation tables, and things like that. Those are some of the things we do more in motion controllers that we can't do in PLC-based motion.

***Omron Automation's Programmable Multi-Axis Controller (PMAC) line*** Photo credit: Omron

### Q If that gray area is growing, is there a push for motion controllers to get smarter to differentiate from other controllers?

**Dieck:** All the components are getting smarter. One of the things I've been working on lately has to do with the efficiency of the machines, and how long can we keep them running. Downtime is a big killer. We address that very well in PLCs, but we're starting to do more in motion controllers. So we're utilizing what some call machine learning or artificial intelligence now to watch the machine and spot an anomaly that could create a bad part.

When you start talking about the semiconductor, or the automotive industry, those end product are worth a lot of money. If you can say, 'Hey, we're about to make a bad part, stop and fix the issue before continuing', it's a tremendous cost saving for the customer. So we're just seeing everything down to the sensor level become more smart. And then, with IIoT, and IO link, we're starting to look at how to get that information out to the controller, and then how to use it in the controller. It's just amazing how everything, every aspect of the industry, seems to just be getting smarter, faster and better.

### Q What other trends do you see that are coming up in motion control?

**Dieck:** I've always told people that there are some things our motion controllers can do that I could write into the machine automation controller. With the motion controller, however, they're pre-done. Look ahead is a great capability within controllers nowadays and so is feed forward. That is, being able to really accurately do well with the tangential access, such as glass cutting, wood cutting, foam cutting, where you have to follow the tangent of the machine.

Are those things that could you write into a machine automation controller? Yes, you could. But it's all going to be functional blocks and it's going to cause overhead. Motion controller now have that built right into their framework.

We're also seeing a lot of very high-end tuning to get higher accuracies in motion controllers. You're able to take the PWM control, the tuning, out of the drive and let the motion controller fire directly. That gives you very tight accuracies. If we get really intense with it, we can get some encoder count accuracies down way beyond the micron, where we were years ago. Now, we can get down to single digit or double digit nanometer accuracies in some cases.

So, for example, if mechanical bearings have too much inaccuracy, we can do compensation tables and air bearings. And we can actually control the accuracy of the bearings with the coils of the motors. I've done motion for a lot of years, but when I go to our engineering center of excellence, it amazes me what the motion control guys are doing and what they're going to be doing in the future. |DE

**www.automation.omron.com**

## MOTION CONTROL

### ELECTRIC CYLINDER

Beckhoff has expanded its AA3000 series with the AA3100, an electric cylinder designed as a drop-in replacement for hydraulic or pneumatic actuators. To simplify replacement, the AA3100 leverage an ISO 15552 flange size with bolting points on both sides, as well as an external thread mount on the shaft end of the spindle. Each product in the series, the AA3123 and AA3133, have two variants; all feature a 24-bit multi-turn encoder, One Cable Technology (OCT) and an electronic identification plate. The first of the AA3123's two variants offers 5,300N peak force, 1,300N continuous force and 0.28 m/s maximum speed. The second offers 2,650N peak force, 650N continuous force and 0.56 m/s max speed. The AA3133 variants offer 12,500N peak force, 2,800N continuous force and 0.12 m/s max speed or 6,000N peak force, 1,400N continuous force and 0.24 m/s maximum speed.
**www.beckhoff.com**

### COMPACT PLC

AutomationDirect has added LS Electric's XGB PLCs that feature IEC programming. The stackable PLCs come with integrated 2- or 6-axis pulse/direction motion inputs/outputs (up to 200kHz) and includes Ethernet and serial and USB ports. Any of the four PLC units in the series can be used as a stand-alone controller with 32 built-in I/O or add up to 7 expansion modules for up to 244 additional I/O points. Expansion modules also add extra discrete, communication, analog or motion control capability. The company's XG5000 programming software features four of the five languages included in the IEC 61131 standard. It also features more than 700 function blocks, including 70 motion control specific blocks. The included XG-PM software provides table-based position configurations of up to 400 moves per axis.
**www.automationdirect.com**

### COMPACT CONTROLLER

WAGO announced that its small-scale PLC, the Compact Controller 100, now includes BACnet, OPC/UA and DNP3 protocols, as well as MODBUS TCP/UDP, EtherNet/IP or EtherCAT using the two on board EtherNet ports. The controller also supports programming via Codesys 3.5, which allows coding in IEC 61131-3 compatible languages and building HTML 5 visualization for its built-in web server. The controller's two Ethernet ports can be assigned two unique IP addresses, with one port for field devices and the other for SCADA or cloud services. The model also provides a variety of built-in digital and analog I/O plus RTD inputs, that can be used with WAGO's 750-362 MODBUS Coupler for I/O expansion.
**www.wago.com**

### THREE-AXIS POSITIONING STAGES

OES introduced its YPR-10-15-60 Series of three-axis yaw, pitch, and roll stages that feature four motor options. The series is the integration of a 60mm diameter rotary stage (upper axis) capable of 360 degrees of continuous operation, and two goniometers (middle and lower axes). The middle stage has a range of +/- 15 degrees and the lower stage has a +/- 10 degrees range. The four motor options include the -01, a stepper motor-driven option that has knobs for manual adjustments. The stepper motors, with a 10 micro-steps per step motor driver, have a repeatability of +/- 0.01 degree and travel speeds of 30 degrees-per-second (roll stage) and 14 degrees-per-second (pitch and yaw stages). Option -02 is driven by three phase-servo motors, and option -03 is DC servo motor driven. The -04 option is stepper motor driven with quadrature optical encoders for position verification.
**www.oesincorp.com**

### IO-LINK MASTER

Emerson unveiled its G3 IO-Link Master designed with the AVENTICS Series G3 Fieldbus platform. The component's IO-Link capabilities allow for multiple IO-Link masters to be added on one G3 Fieldbus platform. The G3 offers eight Class A ports per module to support multiple IO-Link smart and standard analog sensors. The IO-Link master can be distributed up to 30 meters away from G3. Together with the 20-meter IO-Link cable length maximum, the sensors can be located up to 50 meters in total from the G3 Fieldbus platform. The models can also be configurable with the G3 web server.
**www.emerson.com**

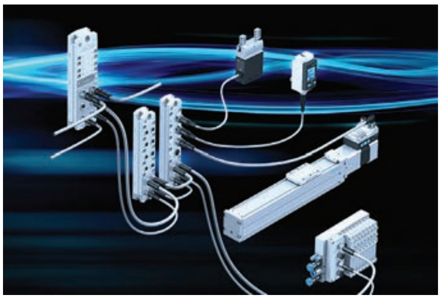
## MOTORS AND DRIVES

### STEPPER DRIVE


Kollmorgen has introduced its P80360 stepper drive, which

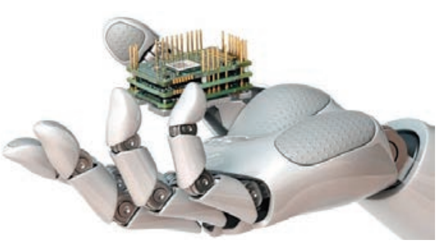
incorporates stepless control technology and offers closed-loop position control and full programmability, the company says. In addition to open-loop stall detection, the drive offers the ability to track load position via encoder feedback and automatically correct for any overshoot or undershoot errors. Using Kollmorgen Space software, the drive can be programmed for simple point-to-point movements as well as linked motion sequences. The P80360 stepper drive can be used with all stepper motors with phase current up to 3.0A rms. All P8000 series drives feature CE, RoHS and REACH certifications.
**www.kollmorgen.com**

## SERVO DRIVES



Festo has debuted its CMMT MP multi-protocol servo drive family that supports multiple protocols including EtherNet/IP, EtherCAT, PROFINET and Modbus TCP. End-users can choose the appropriate protocol directly on the unit or by logging in using Festo's Automation Suite commissioning software. The CMMT family includes the CMMT-ST-MP compact DC servo drives, rated up to 300W, and the CMMT-AS-MP compact AC servo drives, rated up to 6 KW. The company's 9- and 12-KW CMMT-AS-MP units are slated for sale later this year. CMMT MP drives are backwards compatible with Festo's single-protocol CMMT drives, including identical cabling and mounting.
**www.festo.com**

## SERVO DRIVES



Advanced Motion Controls (AMC) has added six CANopen servo drives with extended environment capabilities to its EtherCAT FlexPro line. AMC's standard line of extended environment servo drives can operate in temperatures from -40°C to +95°C and at altitudes from 25,000 meters above sea level to 400 meters below. The drive line carries an IP65 rating for ingress protection, and shock protection up to 25gms for 5 minutes. The drive line is compatible with EtherCAT and CANopen network protocols.
**www.advancedmotion.com**

## DISTRIBUTED SERVO DRIVE

Rockwell Automation has launched its ArmorKinetix distributed servo drives, an extension of the company's Kinetix 5700 platform. The line features an architecture that mounts the drive outside an electrical cabinet. It also includes vibration and thermal sensors that can detect potential machine issues. Available as a distributed servo drive or as an integrated servo/motor, the drive offers power output up to 5.5KW. With IP66 certification, the line also features CIP Security capability and integrated safety technology capable of achieving the SIL 3 standard.
**www.rockwellautomation.com**

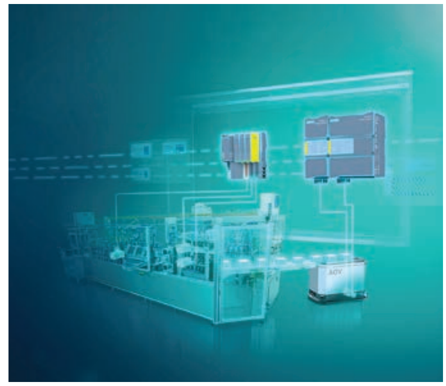
## SERVO MOTORS

Mitsubishi Electric Automation has expanded its MELESRVO-J5 product family with two servo motors: The HK-RT/ST and the HK-KT/ST motors with 3000 rpm-rated speed. The models include a Simple Motion Mode for the RD78G Motion Module,

Advanced Synchronous Control, and positioning mode or "point table" for MR-J5G servo amplifiers. Networking and communication feature master "follower" operation to transmit commands to master and following axis in a synchronized servo system, auto-detection of IP address on the CC-Link IE TSN network and support of Line Star and Ring topologies with CC-Link IE TSN.
**https://us.mitsubishielectric.com**

### SERVO-DRIVE

Siemens introduced its SIMATIC Micro-Drive, designed for extra-low-voltage (24–48V) applications. The 20mm-wide, UL- and CE-marked components consist of the PDC (PROFIdrive Control) servo drive with a range of motors, along with the TM (technology module) format. Communication takes place over PROFINET using PROFIsafe and PROFIdrive profiles. Torque is limited by the Safety Integrated function, SLT (Safely



Limited Torque). The drives are available in 280W-rating and come standard with hardwired Safe Torque Off (STO) safety functions. The Siemens Totally Integrated Automation (TIA) Portal is used to configure drives and motors. Machine operating data can be transmitted directly to the controller from the drive and transferred to Cloud-based platforms such as MindSphere over MindConnect.
**https://usa.siemens.com**

## AUTOMATION

### AUTOMATION OS


Weidmuller USA has launched its u-OS, an open operating system engineered for Industrial IoT and automation applications. In addition to supporting Weidmuller's u-remote and u-control lines, the OS embraces open standards including Linux, OPC-UA and Docker, the company says. Using containerization, users can combine proprietary, third-party and custom-built applications with increased stability and security. The OS also integrates open-source tools such as CODESYS, the manufacturer-independent IEC 61131-3 automation software for engineering control systems, and Node-RED, the low-code programming tool for wiring together hardware devices, APIs and online services.
**www.weidmuller.com**

## EDGE GATEWAY SOFTWARE

Hilscher North America released its EtherCAT Tap software application for netFIELD OnPremise edge gateway. The netFIELD App EtherCAT Tap enables the extraction of process data from existing machines on EtherCAT networks. The containerized software includes a built-in configuration app that is accessible via web browser. By implementing a physical data switch, directly after the PLC, users have access to all messaging and data traffic. This is made possible by Hilscher's netX system-on-chip (SoC) hardware. After configuration, data can be sent via MQTT to monitoring or analytics applications. Additionally, the listen-only functionality ensures that netFIELD App EtherCAT Tap is secure by design.
**www.hilscher.com**

## SECURE CELLULAR ROUTER

Moxa has introduced its OnCell G4302-LTE4, a secure cellular router that complies with IEC 62443-4-2 standards. It also integrates MXsecurity software and security features such as Secure Boot, Virtual Private Network (VPN) and Network Address Translations (NAT). With built-in WAN redundancy and GuaranaLink technology, the router model recovers connection quickly, the company says. Suited for hazardous locations, the model carries CCCEx, IECEx, ATEX, and Class 1 Division 2 certifications. It also operates in temperature range from -30°C to 70°C and also has the EN50121-4, NEMA TS2 and E-mark E1 certifications to meet the needs of vertical applications.
**https://moxa.com**

## INDUSTRIAL WI-FI BRIDGE

Moxa introduced its AWK-4252A Series 3-in-1 industrial wireless Access Point/Bridge/Client that offers aggregated data rates of up to 1.267 Gbps. Featuring IEEE 802.11ac technology, the unit can operate concurrently on both the 2.4 and 5 GHz dual-band Turbo Roaming with an average handover time under 150 ms. Its IP68-rated weatherproof metal housing withstands outdoor environments from -40° to 75°C, while its enhanced antenna port isolation protects against up to 30kV ESD and 6kV surges. The AWK-4252A is certified for IEC 62443-4-2 that ensures device-level security and verifies that devices are suitable for building an IEC 62443-3-3 compliant security environment. It also supports the latest WPA3 encryption.
**www.moxa.com**

# ELECTRICAL

## CIRCUIT PROTECTORS

AutomationDirect has added the Gladiator GECP series of modular 12/24 VDC circuit protectors. The series offers both fixed trip current versions and a version with an adjustable trip current range and adjustable trip characteristics. LED

signaling with output alarms allows real-time status monitoring. In ratings up to 10A, the modules can be used as standalone devices or integrated into a modular system using optional supply and ground modules, busbars and comb jumpers (total system load up to 40A). The modules offer a remote set/reset function useful in applications where physical access to the unit is difficult or dangerous. The protectors are UL Listed, CE marked and RoHS compliant.
**www.automationdirect.com**

## DC ENERGY METER

Carlo Gavazzi announced its DCT Series DC Energy Meter, designed for electric vehicle fast chargers. The DCT1 Series enables a metering system that can be certified according to the requirements of the U.S. Electric Vehicle Service Equipment (EVSE), European and German calibration and cybersecurity laws. The series features integrated voltage measurement, power supply and RS485 port (with signature). It also

supports multi-protocols, including RS485 Modbus RTU or SML, and measurement ranges of 150 to 1000 VDC, 300A or 600A max current. It also offers energy resolution of 0.0001 kWh to meet EVSE certification requirements. Approvals and certifications include cULus; NMi evaluation certificate for Eichrecht approval according to IEC 62052-11, IEC 62052-31, IEC 62053-41, VDE-AR-E 2418-3-100 Annex A, WELMEC 7.2. V2G compliance.
**www.GavazziOnline.com**

## AC ENERGY METER


Carlo Gavazzi launched its EM511 Series 1 Phase Energy Meters, designed for load balancing for Level 1 and 2 EV charging applications. The series is bi-directional, thus enabling the separate measurement of imported and generated energy, including vehicle-to-grid (V2G) technology. In addition to monitoring power, real-time energy consumption, electrical variables, and total harmonic distortion, the EM511 provides maintenance data, such as a built-in run-hour meter that records total operating time. The meters support direct connection input up to 45A and voltage inputs of 120 to 240V with self-power supply. cULus approved, the series also carries MID certification (PF version), and Swiss MID certification (SF version).
**www.GavazziOnline.com**


# POWER TRANSMISSION

## SWIVEL JOINT BEARING

igus has expanded its iglide PRT series with the addition of the PRT-05-15-PC, a swivel joint bearing made from 97% regranulated iglide M260 and iglide P4 high-performance plastics. The bearing consists of an inner ring and an outer ring, which execute a sliding movement on each other without balls. According to the company, it is produced by injection molding from high-performance plastics. With a diameter of 100 millimeters (3.93 inches), the bearing is 10 millimeters (0.39 inches) high and weighs 72 grams. The bearing's plastic incorporates solid lubricants that are released during operation and enable low-friction dry running without grease.
**www.igus.com**

# VISION SENSORS

## THERMOGRAPHY CAMERA

Teledyne FLIR unveiled its focus-free FLIR E5 Pro and FLIR E6 Pro cameras, which feature a 3.5-inch touchscreen display and access to FLIR Ignite Cloud connectivity. Both allow users to share captured images over Wi-Fi. The E5 Pro and E6 Pro Ex feature a 180 × 120 thermal resolution and 240 × 180

thermal resolution, respectively. The Ex Pro-Series cameras also feature built-in 5MP digital cameras and LED lamps. The cameras are drop-tested up to two meters (6.6 ft) and feature an IP54 rating, 25G-shock, and 2G vibration test ratings. Ex Pro-Series cameras also offer four hours of continuous operation on one charge.
**www.teledyneflir.com**

## HIGH-SPEED CAMERA


Vision Research announced it has updated its published product specifications to incorporate European Machine Vision Association (EMVA) 1288 testing standards to measure sensor characteristics. EMVA 1288 measures performance in machine vision cameras; Vision Research is the first to apply it to RAM-based high-speed cameras. The inclusion means the company won't be including ISO 12232 measurements for their products. Quantum efficiency, temporal dark noise, dynamic range and absolute sensitivity threshold are among the parameters specified in an EMVA 1288 report. Referencing these in addition to pixel size, resolution and throughput provides the information necessary to compare cameras in terms of image response.
**www.phantomhighspeed.com**

## RADIOMETRIC THERMAL CAMERA

Teledyne FLIR released its Lepton 3.1R, a radiometric thermal camera module with a 95-degree field of view (FOV), 160 x 120 resolution, and a scene dynamic range of up to 400°C. The 3.1R is a drop-in enhancement for existing Lepton-based products. It incorporates the same visual object and space perception interface (VoSPI), inter-integrated circuit (I2C), and electrical and mechanical form and fit as predecessor Leptons. All Lepton modules include thermal sensitivity of <50 mK and feature wafer-level detector packaging, wafer-scale micro-optics and a custom application-specific integrated circuit (ASIC).
**www.flir.com**

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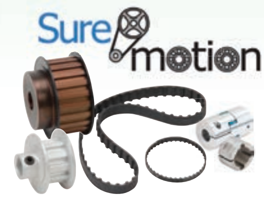


### Helical Bevel Gearboxes

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