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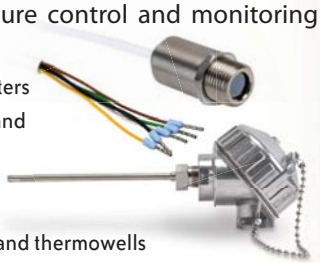

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"DfX is a guide for design, such that when the design blueprints are moved to manufacturing, you have few surprises, or fewer surprises."

COVER STORY

Cover Photo Credit: aleksandarvelasevic #165964237 | Getty Images

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From the Editor

By Rehana Begg, Editor-in-Chief

Modeling a **New Frontier**

The metaverse will disrupt and support well-being all at once.

FOR ALL THE APOCALYPTIC, digital utopian puffery, the metaverse harbors untapped opportunities.

What we know about the metaverse is that the term has hit mainstream and represents a range of technologies that coalesce hyper-realistic, sensory, parallel virtual experiences.

We also know that enables new revenue streams. By McKinsey estimates, advanced technologies that make up the metaverse will potentially raise productivity and GDP growth to $5 trillion in value by 2030.

In the early 2000s Big Tech coopted the idea of a metaverse envisioned in Neal Stephenson's 1992 novel *Snow Crash* and surged to flaunt rapid growth by leveraging interactive digital innovations on metaverse platforms.

Over the past two decades we've observed public perceptions of the use of frontier technologies—Internet of Things, advanced analytics and predictive models, automation and smart robotics—undergo regular pendulum swings from tech is good to tech is bad to tech is good...

Then the world faced a reckoning. Through the pandemic, collaboration and video-conferencing platforms helped to foster innovation by overturning historical notions of where we need to be to get the job done. Businesses are steadily realizing how and why tech adoption is an act of enlightened self-interest.

It remains to be seen how the industrial metaverse will fully unfold, but the important factor to keep in mind is its interoperable potential and the extent to which emergent technologies are likely to shift the way we interact.

On p. 22 we are introduced to Christopher Lafayette, a futurist and keynote presenter at MD&M West in Anaheim, Calif. (Feb. 7-9), who advocated that technology has caught up with the concept. He characterized the metaverse as having scaled to the brink of creating, buying, selling and trading in an emergent economy.

A natural extension of this development is the establishment of public and private sector, government laws, rules and ethics, Lafayette said, while making his case to a MedTech power network, who thrummed at the possibilities for health technology development.

He was equally mindful of the idea that an unchecked vision of the metaverse won't serve all people. His humanity first platform, Gatherverse, is built around bringing communities together to cross-examine approaches to the metaverse and emerging technologies.

Point taken. Beyond the economic impact, ample research focusing on measures of living standards suggest that technology adoption is poised to improve well-being more broadly. But it is foreseeable that not all players will respect guardrails. The architects of the future will need to ensure the highest ethical standards are upheld by factoring guidelines around such risks as data privacy, security, ethics, physical safety, sustainability and equity.

There's a lot of promise and potential in impending digital ecosystems, as long as risks are taken into account along the way. ■

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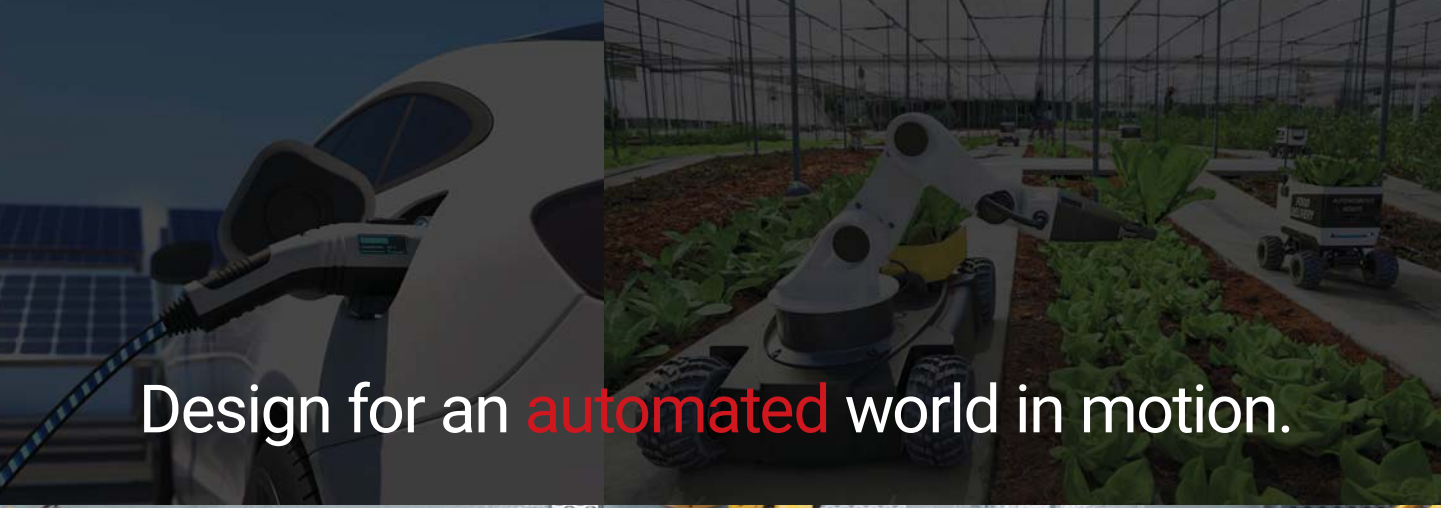

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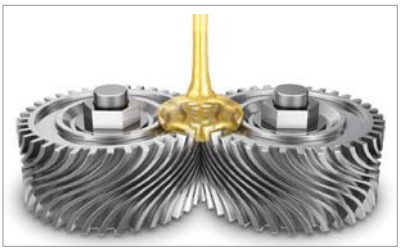

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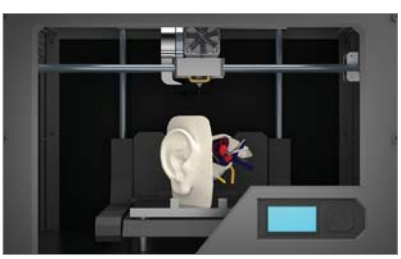

Additive Manufacturing Drives Resilience, Adaptability and Innovation in 2023

Making a case for using 3D printing for tackling pain points that accompany traditional manufacturing methods during a time of unprecedented global insecurities.

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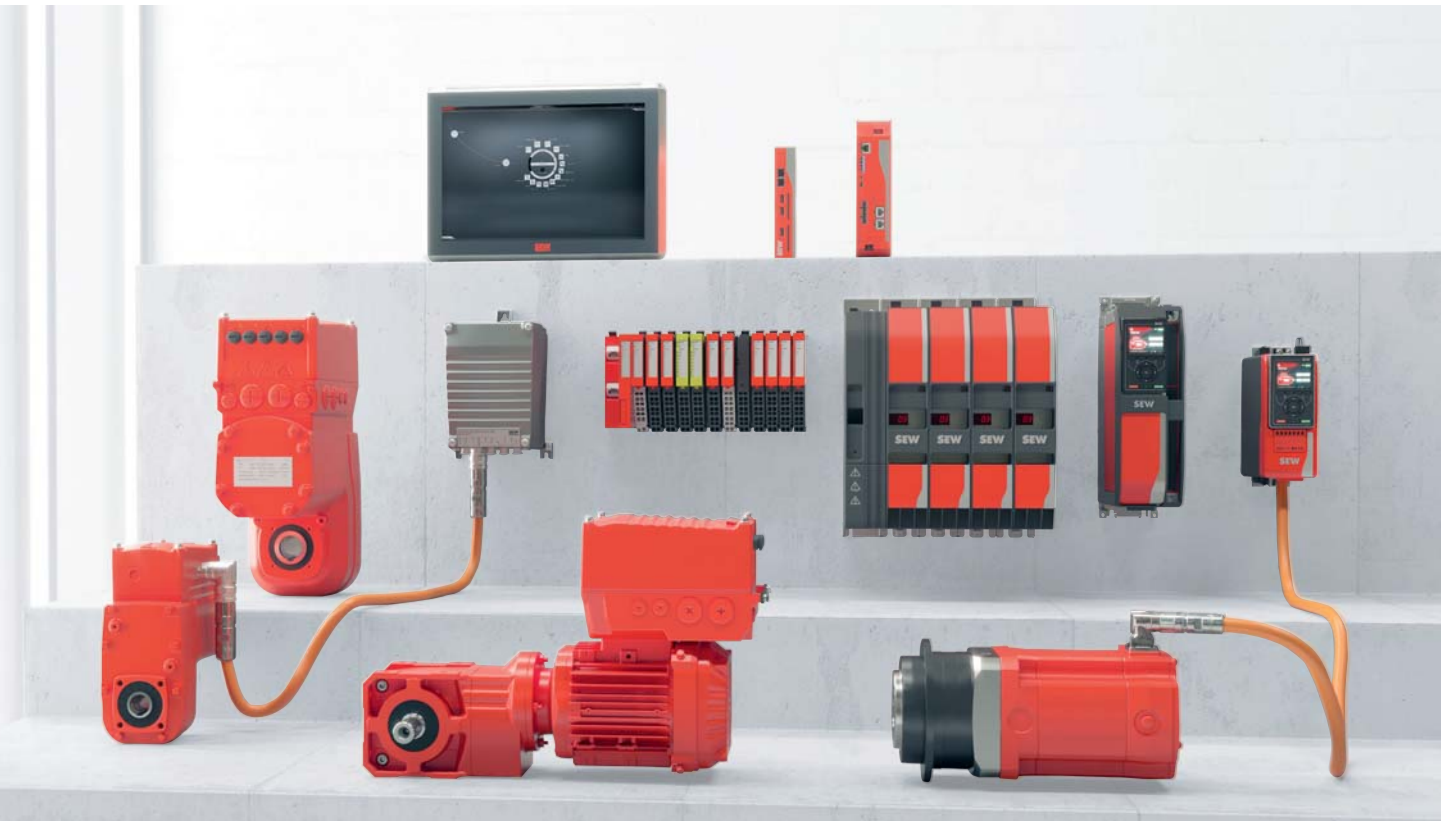

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Bosch Rexroth Completes HydraForce Acquisition

HydraForce will become a part of Bosch Rexroth's compact hydraulics business.

The combination of Bosch Rexroth and HydraForce will strengthen both companies' presence in the compact hydraulics space. *Images courtesy Bosch Rexroth*

ON FEB. 3, BOSCH REXROTH completed its acquisition of HydraForce upon receiving approval from antitrust authorities. HydraForce will join Bosch Rexroth's Compact Hydraulics portfolio, helping to further expand the business unit's product offering and customer support.

The companies initially signed the acquisition agreement on July 15, 2022.

Although both companies offer various compact hydraulic products, HydraForce will bring its expertise in development of mechanical and electrical cartridge valves and hydraulic integrated circuits (HIC) which will help complement Bosch Rexroth's current portfolio.

According to Bosch Rexroth, the merger of the two companies' products will enable a broader range of offerings to meet varied customer needs as well as aid with the regionalization of supply chains—a growing focus for many companies to more easily meet customer demand.

"With Bosch Rexroth, we found a great partner who values and shares similar views on innovation, customer focus, application expertise and culture. I believe the new ownership will create great opportunities for our customers, partners and employees and lead to sustained growth," said Mike Terzich, president and CEO of HydraForce.

Managers from Bosch Rexroth and HydraForce will comprise the leadership team for the Compact Hydraulics Business Unit which will be headed by Frank Hess, who currently leads the unit.

"As HydraForce and Bosch Rexroth join forces, we will combine our customer focus, application expertise and entrepreneurial know-how to achieve sustained growth above market. Together, we will continue to provide excellent support and innovations for our customers, further develop our strong relationships with partners and open great opportunities for our associates," said Hess.

Combined Expertise will aid Market Growth

The acquisition of HydraForce will enable Bosch Rexroth to expand its footprint in North America by growing its sales network and gaining access to more markets. "By acquiring HydraForce, we are expanding our presence in complementary geographies and developing a more balanced footprint in Europe and North America, while also enabling growth in Asia," said Rolf Najork, member of the board of management of Robert Bosch GmbH and CEO of Bosch Rexroth AG, in the company's press release announcing the acquisition.

HydraForce employs 2,100 people at six production sites located in the U.S., Brazil, Great Britain and China. Bosch Rexroth's Compact Hydraulics business includes approximately 1,800 employees at locations in China, the U.S., Germany and Italy.

The merger of these companies will expand the workforce and manufacturing capacity to help meet ongoing demand for hydraulic components, particularly in heavy-duty mobile equipment applications which is a strong market segment for both companies. This market is also expected to see continued growth in the coming years.

In addition, HydraForce noted in its press release announcing the acquisition the companies' regional sales structures are also complementary to one another. Bringing their sales activities together will create a well-balanced entity in North/South America and Europe, as well as support further growth in Asia Pacific stated HydraForce in its press release.

HydraForce will also help improve global market access for Bosch Rexroth to indirect sales channels such as dealers and system integrators which benefits the company's long-term goals.

"With its diversified portfolio and international setup, Bosch Rexroth has a strong foundation. The acquisition of HydraForce expands our global market access through indirect sales channels: Sales partners and system integrators will become important target groups. In these challenging times, we are also helping to stabilize regional supply chains so that we can support our customers even better," said Hess.

Integration of the two companies has begun; customers and suppliers will continue to be served by their respective sales and purchasing teams. For now, HydraForce will operate under its own branding. The newly formed Compact Hydraulics Business Unit will operate from the current locations of Lincolnshire, Ill. and Nonantola, Italy. ■

R&D Spotlight: Defect Detection in Metal 3D Printing, Multi-Metal Design, Plus a Novel Design Approach

A briefing of three novel additive manufacturing tech ideas in the pipeline.

THE PURPOSE OF EMERGENT TECHNOLOGIES is nothing more than to make new things that are better than what came before. Experiments in academia and R&D trials of today are the real-work 3D printing solutions of tomorrow. In this briefing, we narrow the scope to three ideas in the pipeline.

1. Real-Time Defect Detection in Metal 3D-Printed Parts

Structural defects that form during the additive manufacturing building process are commonly identified as a SNAFU that prevents metal additive manufacturing techniques from widespread adoption. Now a new method for detecting and predicting defects looks at using various imaging and machine learning techniques to detect and predict the formation of pores in 3D-printed metals in real time with near-perfect accuracy.

The method was recently published in the journal *Science* by a research team led by the U.S. Department of Energy's (DOE) Argonne National Laboratory and the University of Virginia (UVA). In this study, laser powder bed fusion (LPBF) was used to create metal samples. LPBF is a rapid prototyping technique that uses a source of heat to melt metal powder and generate a desired metal part.

LBPF can lead to the formation of pores that can compromise a part's performance. Even though additive manufacturing machines are equipped with thermal imaging sensors that monitor the build process, they miss the formation of pores. The research team chalked up this shortcoming to the fact that sensors only image the surface of the parts being constructed.

The way to directly detect pores inside dense, metal parts, they noted, is to use intense X-ray beams, such as those generated by the Advanced Photon Source (APS), a DOE Office of Science user facility at Argonne. "Our X-ray beams are so intense that we can image more than a million frames per second," reported Samuel Clark, an assistant physicist at Argonne.

The APS method of detection allowed the researchers to see pore generation in real time, as well as to observe distinct thermal signatures at the surface (detected with thermal cameras).

Additionally, the researchers used a machine learning model to predict the formation of pores within 3D metals using only thermal images. They validated the model against data from the X-ray images. Finally, they tested the model's ability to detect thermal signals and predict pore generation in unlabeled samples.

"The APS offered the 100% accurate ground truth that allowed us to achieve perfect prediction of pore generation with our model," said Tao Sun, an associate professor at UVA.

What's promising about the approach is that it can be readily implemented in commercial systems, noted Kamel Fezzaa, a physicist at Argonne. "With only a thermal camera, the machines should be

> *"Our X-ray beams are so intense that we can image more than a million frames per second."*
>
> *— Samuel Clark, Assistant Physicist, Argonne*

able to detect when and where pores are generated during the printing process and adjust their parameters accordingly," Fezzaa said.

That means not only that a major defect can be detected early in the manufacturing process, but also that the machine can automatically stop building a part. To boot, the approach saves inspection time. The ultimate goal, the researchers noted, is to create a system that not only detects defects, but repairs them during the manufacturing process.

2. Multi-Material Computer-Based Design will Take 3D Printing to the Next Level

Additive manufacturing methods provide countless opportunities for integrating customization and functionality into a single printing process. Yet, AM remains limited by the types of materials to be used in one component.

MADE-3D (Multi-Material Design using 3D Printing), a project backed by the European Union's Horizon Europe 2022 program, hopes to increase performance and reliability of muti-material components that will at once create opportunities for lightweighting.

One way to achieve their goals is to focus on the design phase of product development. Using systematic computer-based material design, the MADE-3D experts can calculate and predict the desired material properties for an application based on the chemical composition. This process-development method uses machine learning and enables users to optimize material combinations for multi-material candidate within two or three iterations.

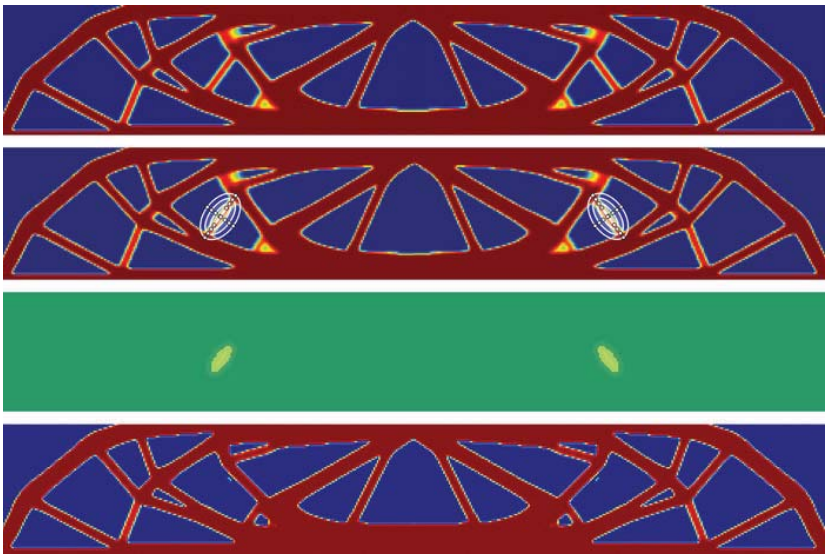
The use of ML is expected to reduce development cycles and promote the digitalization of the process chain. The project leans on both laser powder bed fusion (LPBF) and direct energy deposition (DED) to enable the atomized material combinations for 3D printing and produce high-quality components.

The consortium behind the MADE-3D project consists of an international team of research institutions, additive manufacturing market leaders, the aerospace industry, automotive engineering and start-ups. The project recently received funding of around €6.7 million ($7.2 million) for the next three-and-a-half years, and initial findings are expected in six months' time.

3. MIT Researchers Tinker with a New Design Approach

Researchers at MIT combined an automated design system with the skills of human engineers to develop a method that uses the best attributes of the two design approaches. The resulting methodology, they said, optimizes designs for both visual and mechanical properties.

In a paper published in *Structural and Multidisciplinary Optimization*, MIT doctoral student Dat Ha and Assistant Professor of Civil and Environmental Engineering



This sequence shows an example of the iterative design process in action. On top, you can see the AI-designed initial version of a support beam. In the second and third images, a human operator highlights two support segments as unnecessary. The bottom image shows how the AI system incorporates that input by eliminating those segments and strengthening others to compensate. *Courtesy of Dat Ha and Josephine Carstensen; edited by MIT News*

Josephine Carstensen describe how they set out to design a number of structural load-bearing beams that might be used in constructing a bridge or building.

The process, called Human-Informed Topology Optimization, begins with feeding the program specifications. As the structure evolves, the engineers interrupt the design and ask the user to evaluate the structure for potential weaknesses and to adjust the parameters according to their preferences. The algorithm takes the updated features and input into consideration and revises the design by strengthening and compensating struts.

The basic approach can be applied to a broad range of designs and industries—from biomedical devices and nanoscale materials to structural support members of a skyscraper, noted Carstensen. In the automotive and aerospace industries, where lightweighting and structural integrity are key considerations, the use of automated design systems is becoming ubiquitous.

In some cases, where internal components that aren't visible, appearance is irrelevant, but for other structures aesthetics may be important as well. The researchers said that the new system allows the user to optimize designs for visual as well as mechanical properties—and in such decisions the human touch is essential.

While the current results are not yet ideal, Carstensen maintained that "a fully rigorous yet significantly slower design algorithm that considers the underlying physics" would be better than a result generated by an automated design system alone. The system has demonstrated that the approach can be efficient at reducing design time and optimizing a design based on specific properties and additionally has the potential to change the way engineers tackle design tasks.

Development on a full 3D version is ongoing. Meanwhile, a basic two-dimensional version of the software, suitable for designing basic beams and structural parts, can be downloaded for free. ■

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DfX: How Design for Excellence Guides Product Development

Avoid issues and oversights by applying a coherent and systematic set of guidelines to the product development cycle.

by Rehana Begg, Editor-in-Chief

AT A GLANCE:

- Toronto-based NeuronicWorks Inc. is a design engineering and manufacturing company that casts a Design for Excellence (DfX) lens over product development.
- DfX is a set of best practices intended to analyze the way a product has been designed with the intention of optimizing the product development cycle.
- Fundamentally about risk reduction, DfX should be inherently present in new product design, according to Titu Botos, CEO, NeuronicWorks Inc.

In business for 14 years, NeuronicWorks Inc. started out as a design firm. But three years ago, the firm pivoted towards manufacturing in order to offer clients "level zero to market," particularly for those in industrial control and automation instrumentation industries, said Titu Botos, CEO of the Toronto-based design engineering and manufacturing company that specializes in the design, development and manufacturing of custom electronics and software products.

That shift demanded a greater focus on the scope of large production runs, as well as investing time and effort in thorough analysis of the product design and an ability to make adaptations before it moved to production.

The transition required Botos' design and engineering team to be flexible and to consider more closely a product's design in relation to its fabrication and manufacturability. The extra effort amounts to a small percentage of the overall cost, said Botos, whose team routinely filters product development through a Design for Excellence (DfX) lens.

What is DfX?

"These days, DfX is oftentimes used as a buzzword, as if it involves some rocket science and formulas," said Botos. "In fact, it is a down-to-earth, concrete set of practices and knowledge about the capabilities of the manufacturing process."

DfX is commonly defined as a set of practices that are intended to analyze the way a product has been designed with a view to optimizing production performance throughout the product development cycle. Stated simply, it means "knowing what machines are able to manufacture for you," Botos said. "DfX is a guide for design, such that when the design blueprints are moved to manufacturing, you have few surprises, or fewer surprises."

According to Botos, NeuronicWorks aims to deliver consistent, good quality design by taking into consideration previous experience and boiling this down to a checklist. When manufacturing companies develop guidelines or checklists against the DfX dimensions, he explained, they are able to produce higher quality products, reduce product costs, take

Pictured on left: NeuronicWorks offers turnkey PCB Assembly services for prototype and high-mix, low-volume manufacturing. The company provides designs that incorporate best-in-class manufacturability and testability standards. *Images courtesy NeuronicWorks*

advantage of shorter product development cycles, reduce risk and bring order to chaos.

"Design, by nature, is chaotic in that you have to come up with ideas to solve problems," said Botos. "That's the fun part of design."

But in order to make sure that you produce good quality products and achieve the intended outcome that creative energy needs to be funneled through a filter. "The design phase starts everything and points the direction," he noted. "There are many approaches to product design, but there are few ways to produce a good quality design again and again."

Consider the "X"

DfX is both a framework and a practice to realize production. It is also an umbrella term, where "X" represents a set of criteria and can be substituted for reliability, assembly, serviceability, manufacturability, costs, supply chain, innovation, sustainability, reduced time to market…all dimensions that encompass better alternatives in an effort to achieve a competitive advantage and customer satisfaction.

Rather than take a hardline approach, Botos said DfX can be distilled into "simple, pragmatic down-to-earth set of rules and procedures that can be translated in a few checklists." DfX is fundamentally about risk reduction, which should be inherently present in new product design, he said.

It is crucial for a design team to consider the X dimension early in the development phase, as decisions made during this phase drive the future of the product's lifecycle. "An incorrect decision can cascade and multiply in the effort to correct it later on," he said. In other words, by applying DfX principles at the design phase, and by encouraging collaboration between the design team, suppliers and manufacturing team, one de-risks the new product.

Design for Manufacturability

As industries move to greater automation, design for manufacturability and assembly is gaining relevance. Design for Manufacturability (DfM), is a closely related subset of DfX, which has as its objective to ensure that the design stays within the capabilities of the targeted manufacturing process.

NeuronicWorks designed and developed a fully functional, assembled and tested system for controlling the concrete manufacturing process.

This requires design engineers to create a risk mitigation and avoidance plan in order to understand what can go wrong, explained Botos. They would mitigate risk by developing an efficient process and minimizing product iterations by taking into account, for example, the use of fabrication or level of automation in the production. By following these rules and guidelines, he said, one can reduce the number of tools required in production and achieve shorter time to market.

Design for Certification

Designing to certification is often passed over as part of the design phase, according to Botos. He recalled having customers request specific designs, only to discover during the process that they had neither received certification nor passed safety standards in order to sell the product. Certification is fundamental at the start of the design, as is knowledge of the safety standards the product needs to comply with and what geographical markets the product will be sold to. "When a system influences lives, it has to be certified—that goes without saying—but it is overlooked," said Botos.

Less Philosophy, More Pragmatism

The ultimate aim of DfX and its associated subsets—whether it is manufacturing (DfM), assembly (DfA), quality (DfQ) or supply chain (DfSC)—is to create a product that excels in each of these areas by making changes in the proposed design.

For Botos, building a checklist of what to look for "is not rocket science," but de-risking the process does require experience and the emphasis may differ for each manufacturer. NeuronicWorks aims to produce the blueprints that will at once minimize product iterations and fit the production capabilities of the chosen manufacturer.

"For instance, you cannot ask for a more precision than the manufacturer is able to provide," Botos said. "The point here is to understand clearly what your manufacturing partner is capable of doing, what machinery and automation they have. At the end of the day, somebody has to translate this information—the blueprints from the design phase—into the manufacturing phase. That is a process that is many times overlooked."

It all calls for greater communication, Botos added. "I cannot say enough how many times it is overlooked." ■

NeuronicWorks designed and developed a fully functional, assembled and tested system for controlling the concrete manufacturing process.

DfAM: How DfX Intersects with Design for Additive Manufacturing

ADDITIVE MANUFACTURING is gaining a reputation for its effective use of design technology to re-design a product or re-consider the manufacturing technology in record time. However, Design for Additive Manufacturing (DfAM) differs considerably from traditional manufacturing methods and has a unique angle on Design for Excellence (DfX).

Machine Design asked Protolabs Applications Engineer Eric Utley to consider how DfX principles might support DfAM. What follows is an abridged version of his interview. *(View the full interview at https://machinedesign.com/21262849.)*

***Machine Design*: If you were to apply the concept of Design for Excellence (DfX) to Design for Additive Manufacturing (DfAM), how would you relate it to improving the design, testing phase and reducing part counts?**

Eric Utley: If the part is truly being designed for additive manufacturing, then some thought has to be given on not just how well or efficiently the part prints but also the secondary processes that follow. At a minimum, virtually any additive process will require either scaffold supports to be removed or excess material to be blasted off. Particularly if the expectation is the part is to be printed in elevated volumes, then it can be very beneficial to start considering things like optimizing to avoid supports, adding holes to inaccessible areas to make cleaning easier, or adding fixture points to the part to hold it for secondary processes such as painting or electroplating.

***MD*: What are the defining characteristics and methods that ensure a sound DfX approach has been applied to the development of a product in a digital manufacturing process?**

EU: With digital manufacturing in mind, it can be important to realize that any manufactured product has a lifecycle, and it may make sense to transition between or even back and forth between different manufacturing methods as demand changes or as the product evolves to match the demands of the customer. A part may start as additive in early stages as volumes are low, and scale up to injection molding at higher quantities. You may have periods where the part is both printed and molded because you are trying a variation on the design with new customers.

Digital manufacturing gives additional flexibility in quickly iterating on the design and improving it and not having a stagnant product that competition can definitively respond to. We see a larger trend that product cycles are shortening and product lines can undergo design changes more frequently. A good DfX approach would be to ensure that there is both a well-designed additive version of the part, and a well-designed conventional version. Even better is if these two versions are the same geometry.

***MD:* How does DfAM support product developers and engineers to optimize designs and support their DfX goals? Can you provide an example?**

EU: The Downhole Emerging Tech project is a good example of DfAM getting a viable product up and running quickly. [Background: The U.S. Department of Energy (DOE) put out a call for engineers and scientists to address challenges associated with operating sensitive equipment in harsh geothermal environments. Houston-based startup Downhole Emerging Technologies (DET) responded to the challenge and turned to ProtoLabs for design assistance in developing a packer or plug system.]

In this case the customer uploaded an early concept that would not print cleanly. But after some quick advisement they were able to modify the design to require nearly no support structure and have as little labor as possible. The internal structure of the part made it non-conducive to being made more conventionally. For Protolabs, our automated tool on the website provided some initial, instant feedback and, in the case of this part, it came from discussions with our applications engineers on how to design the part to be self-supporting. We provide a lot of easily accessible content on how to design for DMLS (direct metal laser sintering), the process used in making DET's component. ■

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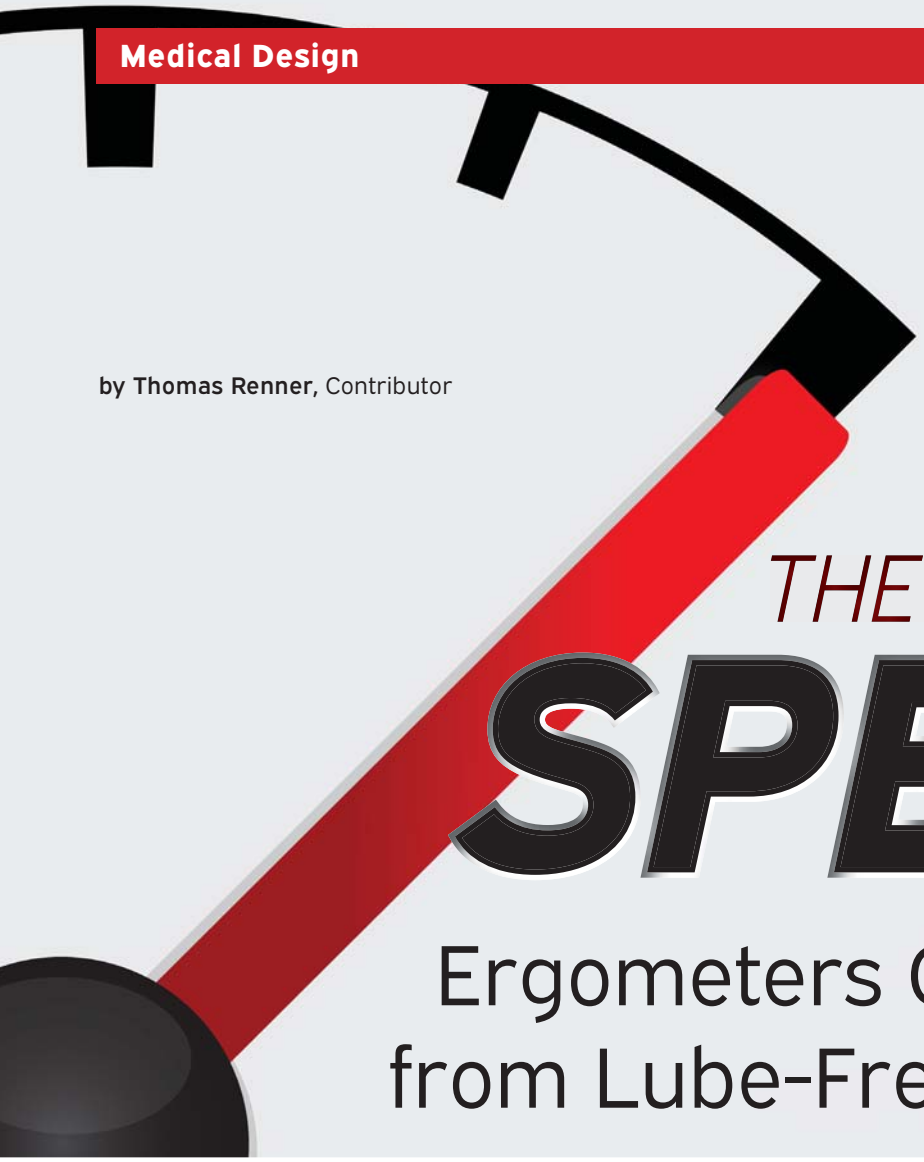

by **Thomas Renner**, Contributor

THE NEED FOR SPEED

Ergometers Can Benefit from Lube-Free Bearings

In the fast-moving manufacturing climate, materials providers are ramping up with innovative solutions to meet demand.

Sometimes in manufacturing, the tried-and-true principles of machine design simply don't work. Slow-moving supply chains are the antithesis of a climate that demands speed, innovation and adaptability. Time is money, and no one understands that phrase more than manufacturers who face high product demand. Quality still counts, but speed and efficiency are now tightly interwoven into the manufacturing process.

Solutions, however, are elusive. Producing quality components takes time. Workplaces are finding it hard to hire enough workers, and the supply chain seems as unreliable as the rust-covered links on the 43-year-old Schwinn stuffed in your grandfather's garage.

A German manufacturer of recumbent ergometers faced such a challenge. The units are used in exercise and for diagnosing heart diseases. The company, ergoline GmbH, needed wear-resistant and lubrication-free bearings in a custom dimension so that it could start production of its new series of ergometers. A swift solution was required.

Creating bearings from bar stock was too time consuming and expensive, and the company could not wait six weeks for a tool to make the bearings. igus, the German manufacturer of motion plastics, offered the customer its FastLine service, an innovative new resource which features modern computerized numerical control (CNC) technology. The time from order to delivery was four days.

The rapid turnaround is a common theme in the current worldwide manufacturing climate, where customers seek speedy answers to their design challenges. igus is a materials provider that pushes the innovation envelope, and its new service focuses on delivering parts to customers quickly.

"Delivery time has been an issue since the early days of igus," said Tom Krause, the company's head of 3D printing. "Our founder, Günther Blasé, relied on a modular tool design in the first years. Over the years, however, the requirements became more and more time-critical and have become even clearer in the past 10 years."

Diagnosing Heart Disease

Worldwide statistics focused on heart disease are staggering. In 2020, approximately 19.1 million deaths were attributed to cardiovascular disease, according to the American Heart Association. The agency estimates that 244.1 million people globally were living with ischemic heart disease in 2020.

Eastern Europe has one of the highest prevalence rates of IHD in the world. The U.S. ranked 142nd in the world in coronary heart disease deaths in 2020, according to the World Health Rankings, and Germany ranked 155th. In both nations, the percentage of deaths attributed to heart issues topped 20%.

Diagnosing heart diseases makes the health risk even more complicated. One important examination for diagnosing heart health concerns and therapy is a stress ECG, in which a medical ergometer is used to ensure reproducible stress on patients. Ergoline is a leading producer of the medical devices and has specialized in producing a wide variety of high-quality medical ergometer designs for more than 30 years.

More than 60,000 ergometers from ergoline have been in use worldwide. The company also manufactures equipment used for cardiac diagnostics (for performing stress ECGs in clinics and after surgeries, for example) and develops equipment and software for training and monitoring patients in cardiac rehabilitation.

"These systems are especially common in rehabilitation clinics and sports medicine centers," says Dominik Huber, head of design at ergoline GmbH. "All components—such as plain bearings—must be durable and able to withstand a wide range of loads, such as acceleration and high weight."

Getting Smart on the Heart

One of ergoline's products, the ergoselect 1200 model, is a reclining ergometer developed for the purpose of dynamic stress echocardiography. In simpler terms, the procedure evaluates cardiac structure and function during physical exercise (or the pharmacologic simulation of exercise) by measuring increased heart rate, cardiac output and myocardial oxygen demand. The procedure allows for echocardiographic images to be obtained anywhere along the continuum from rest to peak physiologic stress.

The ergometer can be electrically adjusted horizontally or laterally between 0° and 45°, allowing special ultrasound heart examinations during an ergometric stress test.

Huber sought a plain bearing to support the adjustment mechanism for height and tilt. The company selected igus'

iglide P210 bearing, which works well in pivoting movements on various shaft materials.

The bearing requires no external lubrication and thus meets the stringent demands for the medical field. It is also extremely durable. While the bearing solved one problem, however, others arose.

Faster Turnaround Time

Shaft modifications in the product resulted in too much clearance from items that had been selected from the igus catalog. "Since production was about to begin, we initially decided to turn a small number of the parts from bar stock," Huber said. Volume production, however, required an even faster solution.

"Six weeks for a regular tool was too slow for us and continuing to turn bearings from bar stock was too time-consuming and expensive," Huber said.

igus offered its FastLine service to hasten the turnaround time. "By investing in our tool shop with its own production line for round parts that features modern CNC technology, we were able to produce specially shaped plain bearings for ergoline within a very short time," said Benjamin Haupt, technical sales consultant at igus.

> *"By investing in our tool shop with its own production line for round parts that features modern CNC technology, we were able to produce specially shaped plain bearings for ergoline within a very short time."*

In CNC, computer instructions guide mills and lathes that control the precision of the instruments. The process enables the development of parts and components that would usually be impossible to create manually. The time from order to delivery was four days, and at a price that surprised Huber. "We had expected to pay three times as much," he said. "Of course, we were very pleased. It gives us the possibility to work flexibly in design."

More Customization

More and more customers are requiring custom parts and quick service, according to Krause.

"There are different reasons," he said. "A common one is that part of a machine is broken down and it needs to be replaced, so it's imperative to get the machine running again. Other reasons are sourcing methods failed or an expectation of getting individual parts in a few days."

igus' focus on speedy delivery did not begin with FastLine. It previously manufactured molds from aluminum for time-critical developments and later added in print2mold (3D printing).

The ergoselect 1200 recumbent ergometer has been developed for cardiac diagnostics. *Images courtesy ergoline GmbH*

The tilting function of the ergometer also allows the heart to be examined with ultrasound.

The iglidur P210 plain bearings from igus ensure a safe lubrication-free height and tilt adjustment.

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"By investing in our toolmaking department with its own production line for round parts with modern CNC technology, we are now able to respond even faster to our customers' needs. In addition to our large catalog range of polymer plain bearings, which are available from stock, we can produce customized parts cost-effectively in just a few days using the appropriate injection molding tool."

"The advantage of FastLine is that we have a mold that is 100% suitable for series production and is not limited in the number of shots in injection molding," Krause said.

In 2014, igus introduced its first 3D-printing filaments, which are made especially for moving applications because of the solid lubricants, Krause said. In 2016, it introduced its first SLS material, iglide i3, and started with its SLS 3D print service. "Since then, our customer interest was constantly growing, so that we now have 10 SLS machines worldwide," he said. "We are able to produce special wear parts very quickly in Boston, Shanghai and Cologne. Last year, we made more than 200,000 special wear parts by 3D printing."

Life in the Fast Lane

igus' FastLine service was created to meet the needs of manufacturers with high product demand. Customized parts, such as plain bearings in unique shapes, have to be delivered without complications. Injection molding can require several weeks. With its expanded in-house toolmaking department, igus can deliver plain bearings in special dimensions in a few days and at cost-effective prices.

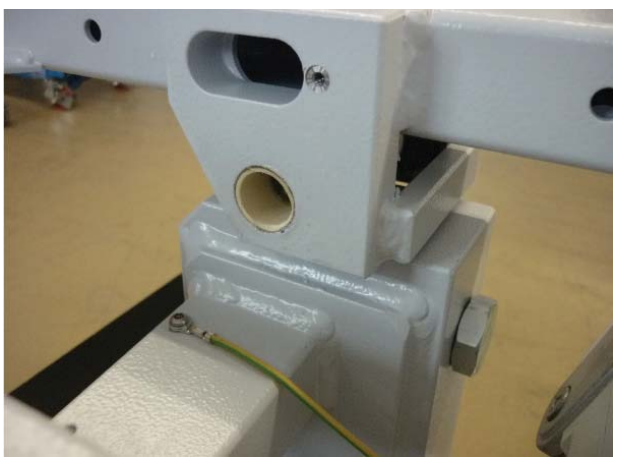
"By investing in our toolmaking department with its own production line for round parts with modern CNC technology, we are now able to respond even faster to our customers' needs," said Stefan Loockmann-Rittich, business unit manager of iglide at igus. "In addition to our large catalog range of polymer plain bearings, which are available from stock, we can produce customized parts cost-effectively in just a few days using the appropriate injection molding tool."

Customers can determine if injection molding or another production is more cost-effective with the iglide Designer. The online tool allows the customer to enter the dimensions of the plain bearing, select the desired material and define the quantity. The program will show an overview of the manufacturing processes with the appropriate costs.

Ergometers and More

In the ergometer, specially sized plain bearings are pressed into the bearing point where they ensure reliable, safe adjustment even with dynamic forces of 1.3 tons. The bearings are ideal for ergometers in that they are lightweight, corrosion-free and resistant to dust and dirt.

The example with the ergoline is one example of the depth to which igus can use its 3D and FastLine innovations to speed up industrial processes. 3D printing has even been used in energy chain applications, for instance. In one case, mounting brackets and moving ends for the energy chains were developed in a large-scale 3D printer.



The plain bearings in special sizes are pressed into the bearing location, and enable a reliable and secure adjustment of the ergometer.

In another application, iglide i6 material was used to develop glide pad adapter clips for energy chains. The clips serve as a ramp to relieve the glide pads, extending their service life. The material improves the lifetime of bearings by six times compared to its predecessors, even for temperatures over 212°F.

"Mostly we produce parts for our customers with their own design," Krause said. "Bearings, gears, sliders and other friction parts are the most printed parts. For energy chains, 3D printing is already used in the prototyping phase and in the start of the series. For the bigger quantities, injection molding is still more cost-effective. When a special design is needed and quantities are not big enough for molding, 3D printing is used as a bridge technology to move things along faster."

With the genie now escaped from the bottle, there is no turning back. Production cycles, Krause said, are going to continue to accelerate. "Shorter product cycles for consumer goods and more leaps in innovation in a short time are driving this accelerated schedule," he said. "In order to be competitive on the market, our customers must be willing to adapt to meet this new demand." ■

Thomas Renner writes on building, construction, engineering and other trade industry topics for publications throughout the United States.

The TRUTH About COMPRESSED AIR!

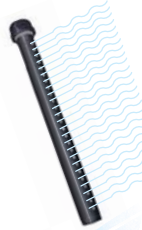
If you think compressed air is too expensive and noisy - read this. The facts will surprise you!

Compare These Blowoffs

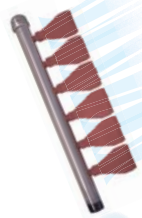
There are a variety of ways to dry, clean or cool products and surfaces, but which method is best? To decide, we ran a comparison test on the same application using four different blowoff methods: drilled pipe, flat air nozzles, Super Air Knife (each using compressed air as a power source), and a blower supplied air knife (using an electric motor as a power source). Each system consisted of two twelve inch long air knives.

The following comparison proves that the EXAIR Super Air Knife is the best choice for your blowoff, cooling or drying application.

The goal for each of the blowoff choices was to use the least amount of air possible to get the job done (lowest energy and noise level). The compressed air pressure required was 60 PSIG. The blower used had a ten horsepower motor and was a centrifugal type blower at 18,000 RPM. The table below summarizes the overall performance.



Drilled Pipe This common blowoff is very inexpensive and easy to make. For this test, we used (2) drilled pipes, each with (25) 1/16" diameter holes on 1/2" centers. The drilled pipe performed poorly. The initial cost of the drilled pipe is overshadowed by its high energy use. The holes are easily blocked and the noise level is excessive. Velocity across the entire length was very inconsistent with spikes of air and numerous dead spots.



Flat Air Nozzles This inexpensive air nozzle was the worst performer. It is available in plastic, aluminum and stainless steel from several manufacturers. The flat air nozzle provides some entrainment, but suffers from many of the same problems as the drilled pipe. Operating cost and noise level are high. For some flat air nozzles the holes can be blocked - an OSHA violation. Velocity was inconsistent with spikes of air.

Blower Air Knife The blower proved to be an expensive, noisy option. As noted below, the purchase price is high. Operating cost was considerably lower than the drilled pipe and flat air nozzle, but was comparable to EXAIR's Super Air Knife. The large blower with its two 3" (8cm) diameter hoses requires significant mounting space. Noise level was high at 90 dBA. There was no option for cycling it on and off to conserve energy. Costly bearing and filter maintenance along with downtime were also negative factors.

EXAIR Super Air Knife The Super Air Knife did an exceptional job of removing moisture on one pass due to the uniformity of the laminar airflow. The sound level was very low. For this application, energy use was slightly higher than the blower but can be less than the blower if cycling on and off is possible. Safe operation is not an issue since the Super Air Knife can not be dead-ended. Maintenance costs are low with no moving parts to wear out.

The Super Air Knife is the low cost way to blowoff, dry, clean and cool.

Blowoff Comparison

Type of blowoff	PSIG	BAR	Comp. Air SCFM	Comp. Air SLPM	Horsepower Required	Sound Level dBA	Purchase Price	Annual Electrical Cost*	Approx. Annual Maintenance Cost	First Year Cost
Drilled Pipes	60	4.1	174	4,924	35	91	$50	$4,508	$920	$5,478
Flat Air Nozzles	60	4.1	257	7,273	51	102	$300	$6,569	$1,450	$8,227
Blower Air Knife	3	0.2	N/A	N/A	10	90	$7,000	$1,288	$1,500	$8,288
Super Air Knife	60	4.1	55	1,557	11	69	$802	$1,417	$300	$2,519

*Based on national average electricity cost of 8.3 cents per kWh. Annual cost reflects 40 hours per week, 52 weeks per year.

Facts about Blowers

Energy conscious plants might think a blower to be a better choice due to its slightly lower electrical consumption compared to a compressor. In reality, a blower is an expensive capital expenditure that requires frequent downtime and costly maintenance of filters, belts and bearings.

Here are some important facts:

Filters must be replaced every one to three months.

Belts must be replaced every three to six months.

Typical bearing replacement is at least once a year at a cost near $1000.

- Blower bearings wear out quickly due to the high speeds (17-20,000 RPM) required to generate effective airflows.
- Poorly designed seals that allow dirt and moisture infiltration and environments above 125°F decrease the one year bearing life.
- Many bearings can not be replaced in the field, resulting in downtime to send the assembly back to the manufacturer.

Blowers take up a lot of space and often produce sound levels that exceed OSHA noise level exposure requirements. Air volume and velocity are often difficult to control since mechanical adjustments are required.

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Building a MedTech Metaverse

By reviewing immersive medical technologies that build the metaverse, Christopher Lafayette, founder of Gatherverse, highlighted opportunities to create new MedTech products and services.

by Rehana Begg, Editor-in-Chief

In the minds of many, the metaverse remains an abstract and idealistic concept. Yet, the convergence of technologies is enabling the next level of interaction in the virtual and physical worlds and providing strategic business opportunities.

By 2026, 25% of people will spend at least one hour a day in a metaverse for work, shopping, education, social media and/or entertainment, estimate Gartner analysts. They also expect the industrial metaverse to thrive as a result of maturing immersive technologies.

For the sake of simplicity, think of the metaverse as a supercharged internet, where multiple technologies converge to enable virtual interaction and digital economy. Within this ecosystem, one finds artificial intelligence, machine learning, deep learning, neural networks and digital twins, as well as extended reality (a catch-all for augmented reality, virtual reality and mixed reality), robotics and automation. Add FinTech (including crypto assets such as DeFi and dApps) to the mix, and a collective virtual space emerges.

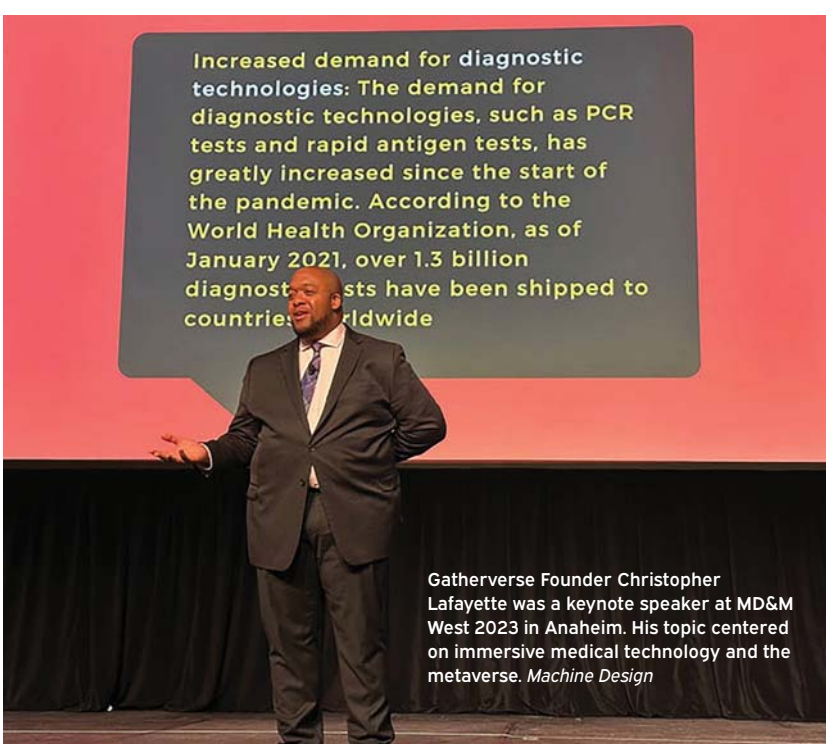
None of these technologies are new. It's what happens when these technologies become interoperable in a unified virtual ecosystem that one can appreciate the formation and potential of a metaverse, said Gatherverse Founder Christopher Lafayette, whose keynote at MD&M West 2023 in Anaheim (Feb. 7-9) centered on how immersive medical technology is developing through the metaverse.

Such ecosystems are "growing and scaling at a rapid clip, unlike anything we've ever seen before," Lafayette said. What's mystifying, he noted, is that no one—not even your best so-called futurist—knows what this will turn into.

Industrial IoT Leads the Charge

Once designed for highly niche applications, IIoT technologies such as digital twins, AI and edge computing have tipped the scales, evolving to become game-changing enablers for testing and monitoring in industrial applications. So much so, that ABI Research views the industrial segment—where operational results, automation and monetization potential shows early traction—to be the "surer bet" relative to consumer or enterprise segments.

Investments in digital transformation are skyrocketing, with revenues for industrial digital twin and simulation and industrial extended reality expected to hit $22.73 billion by 2025 as organizations use Industry 4.0 tools.



Gatherverse Founder Christopher Lafayette was a keynote speaker at MD&M West 2023 in Anaheim. His topic centered on immersive medical technology and the metaverse. *Machine Design*

Game-Changing Enablers

Since the pandemic, the world has observed a leap in disruptive technology that would not have been possible without cloud enablement. "I subscribe to you that if the pandemic happened just seven years ago, we would have grossly failed without the power of the global cloud… We have become more virtual in the past 36 months than we had the past 36 years," Lafayette argued.

One of the effects of becoming virtual is that people realize that there's more that they can do beyond sending files to one another and exchanging information. "We can buy, sell and trade within these virtual ecosystems," he said. "We've never been more virtual than we are in this new hybrid world, and we're not going back."

Knock-on Effects

Lafayette, an emergent technologist and humanitarian in virtual and augmented reality, warned that manufacturers should expect to see the establishment of public and private sector government laws, rules, foundations and ethics as business models mature alongside technologies. Gatherverse, which launched in 2021, has a specific focus on humanity-first standards of accessibility, education, equality, community development, safety, privacy and wellness, and ethics. The platform was established to bring together multi-disciplinary professionals to consider stakeholder impacts.

Concerns about having ethical standards and guardrails are especially relevant for the MedTech sector—a rapidly advancing industry worth $521.9 billion by 2026 at a CAGR of 6.1%, according to Lafayette. To this end, he underscored the impact of disruptive technologies in the hospital ecosystem: There are more than 5,534 hospitals in the United States, with 7.9 million beds, an average of 200 to 300 rooms per hospital, and a minimum of 200 to 1,000 employees at each.

"There are up to 1,000 vendors that contribute ceiling to floor, floor to ceiling, wall to wall and everything in between," not including the teams it took to build the hospitals, he said.

Advancing Telemedicine

The knock-on effects were never clearer than when the pandemic was declared in March 2020. That's when the general public was coopted into "a giant case study and everyone had to participate," Lafayette reminded the audience. Since then, hospitals have recognized how much more sensible it could be to operate with distributed and remote workforces. From a practical standpoint, telemedicine has become convenient for both the practitioner and patient.

The MedTech industry is actively turning to artificial intelligence and the study of deep medicine for ways to operate virtually, in hyper-realistic, immersive and simulated environments. The industry is

looking at ways to interweave technologies that will enable doctors to treat more patients and to improve "deal flow and dollars" that deliver healthcare more efficiently and remotely, Lafayette explained. These enablers drive interest in remote diagnostic technologies, monitoring devices and wearables.

Prepare for Obsolescence

In addition, the disruptive nature of emergent technologies—such as Meta and ChatGPT—have carved a path for a litany of other artificial intelligence platforms coming online. This development will affect career paths and companies, from those at the C-suite level and management to those who have to make decisions on product development.

"My consideration for you is to be diligent and to get ready to understand that your world is getting ready to change," Lafayette advised. "I do encourage every platform to make sure that they hire someone that understands the emerging nature of these technologies."

But while advanced technologies mean definitive changes for the industry, Lafayette advised manufacturers to be cautious with budgets, as the tools available to create a digital twin today will likely be outdated within the next 12 to 24 months.

Instead, he said, manufacturers would be wise to have "an appreciation for the cadence and how we develop and design within platforms, especially when it comes to building for MedTech development."

What is the Metaverse Good for Today?

For Lafayette, the metaverse is good for showcasing product and for surgical theater training and testing, including digital cadaver development. "Surgeons can afford to make mistakes within digital training construct environments," he said. "What we don't want to happen is for them to make mistakes in the real theater."

The metaverse also shows promise for telepresence. As an example, Lafayette described a scenario where a specialist who operates from Costa Rica may be one of the only practitioners in the world who can perform a particular operation. If Lucile Packard Children's Hospital Stanford needed her expertise, but a flight would be too long for what was needed in an emergency situation, the doctor would be able to teleport and translate her capability through the metaverse, he said.

In other words, the doctor could be teleported into the operating room, control a DaVinci machine and perform precision, gestural interface operations on the patient through point cloud, including where to make the incisions and cuts. "That is something that is capable today and will happen more abundantly," said Lafayette. ■

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Finger to the Wind:
MD&M West 2023 Exhibitors Call the Trends

Medical device trade show exhibitors steer industry toward the path of least resistance.

by Rehana Begg, Editor-in-Chief

The first rule of attending an industry trade show: One should arrive with a plan for navigating the show floor.

Attendees to Medical Design & Manufacturing West 2023, however, could add the caveat that pre-planning and best intentions to visit every hall likely would be overrun by unexpected opportunities and chance meetings.

The annual medical design and technology event (which took place Feb. 7-9) is co-located with four other advanced manufacturing events that bring together 1,600 suppliers and about 14,000 attendees. (The other four events are Design & Manufacturing West, Automation Technology West, Plastec West and WestPack.)

Unlike general attendees, exhibitors don't have the luxury of holding a finger to the wind. Since they linger at their booths, they tend to have a unique vantage point from which to assess the overall event experience. They also arrive at the show with a unique set of goals.

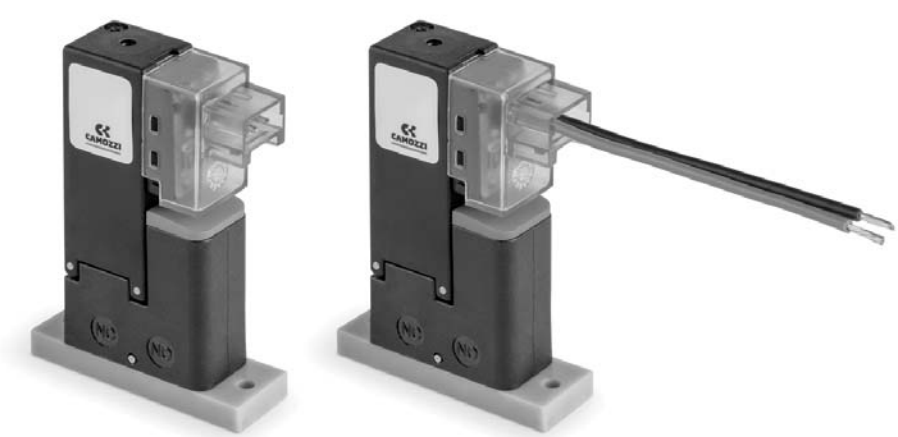
An unscheduled stop at the Camozzi booth validated this idea. "Our goal is to get a feel for the industry, explore new opportunities where our products fit, and to continue building brand awareness around our product lines and our ability to provide custom solutions," said Jo Solano, head of marketing for Camozzi's USA office, who is tasked with looking for new marketing angles for the three Camozzi business channels of Life Science, Industrial Automation and Transportation.

Camozzi was a returning exhibitor and Solano said he had observed multiple companies returning for the 2023 show. "It was confirmation, in a way, that the medical trade show industry was returning to a sense of normalcy," said Solano. "Attendees were very eager to mingle with suppliers and had very specific and sometimes super-technical questions regarding key components that they were needing to source for either new projects or projects currently in development."

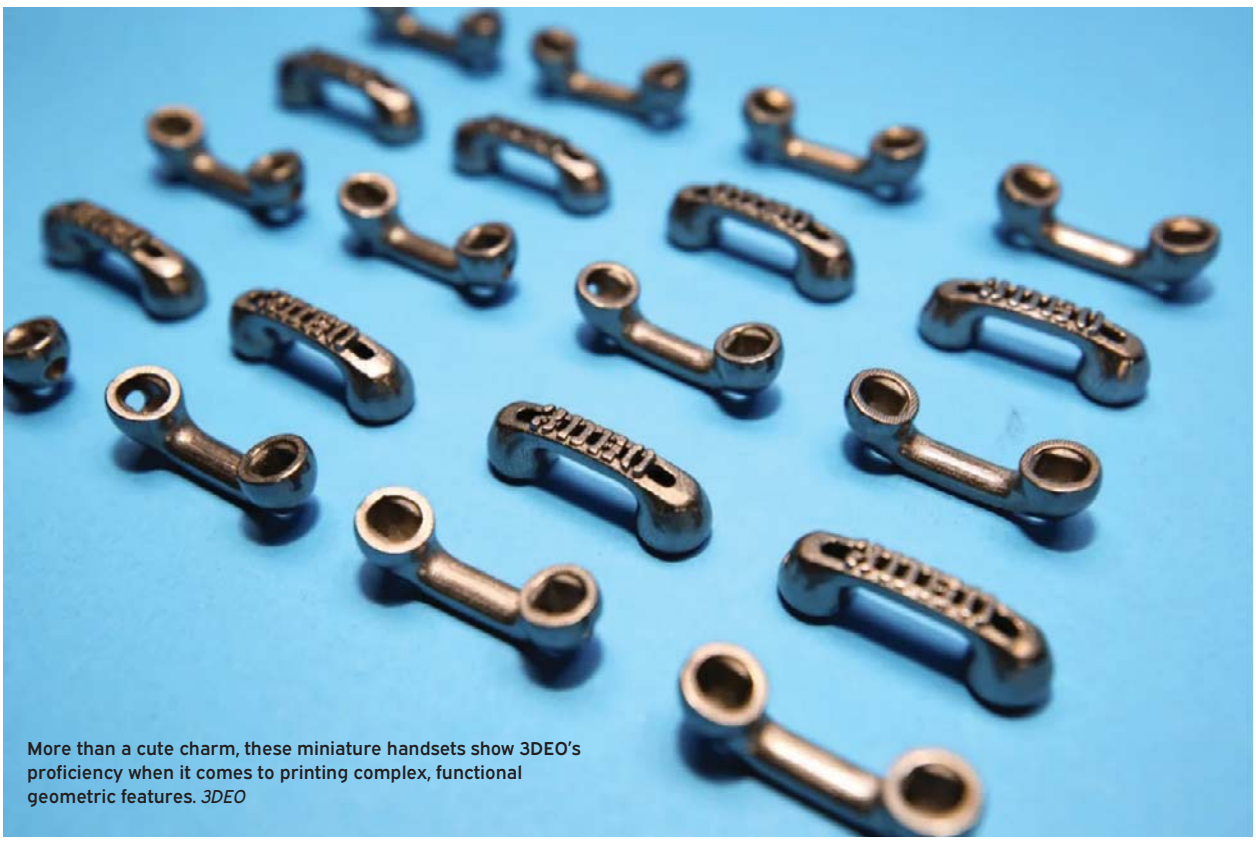
From where he stood, there are three trends stemming from this year's event: getting back to a sense of normalcy; eagerness to resume in-person, meaningful conversations and catching up with colleagues; and growing 2023 business.

Attending and showcasing new product releases at tradeshows continues to be a critical part of the gameplan for the medical devices market. The tactic is especially true when companies want to expand their reach and strengthen their presence in a growing market. The global medical devices market is expected to be valued at $964.9 billion by 2030, according to one report.

Gauging this year's show, collaboration with business partners is another strategy—whether it is for specific expertise, agility, time to market or to scale. Add to this the fact that brands can maintain an established identity while leveraging the technical developments of their partners (see for example the Apera.AI and Universal Robots collaboration).



Camozzi media-separated solenoid Series KDV valves are designed to control fluids, such as high-purity or temperature-sensitive fluids, from interacting with the internal mechanical parts. *Camozzi*



More than a cute charm, these miniature handsets show 3DEO's proficiency when it comes to printing complex, functional geometric features. *3DEO*

Solano pointed out that event organizers were already hosting registrations for the 2024 show, and the general feeling was that companies were looking to expand their booth space for 2024. "It will be interesting to see if the show hosts need to add more floorspace to accommodate all of the exhibitors," he said.

What follows below is a mere sampling of products. Be sure to read our expanded coverage on MachineDesign.com and watch the videos associated with this year's show.

Solenoid Valves Control Critical Fluids

Camozzi released its KDV series of valves, which features a compact, lightweight design with low power consumption and is an ideal solution for Life Science applications, such as mass spectrometry, liquid and gas chromatography and molecular analysis. Designed to protect controlled fluid from contamination, excessive temperature fluctuations and from interacting with the internal mechanical part of the valve, Series KDV can easily be integrated with manifold or subbase systems within small equipment and portable devices.

3D-Printed Charms Demonstrate Complex Geometries

Los Angeles-based 3DEO, one of the highest volume metal 3D printing companies with customers in the medical, industrial and aerospace industries, prioritizes Design for Additive anufacturing (DfAM). Recently, 3DEO added design and engineering services to offset its offerings, hoping to close the loop on end-to-end design and manufacturing services, with an ultimate goal of production at scale. 3DEO lured attendees to its booth in the MD&M West exhibit hall with "Call Me!" charms.

The miniatures are a tribute to Henry Dreyfuss's Western Electric Model 500, an iconic classic of industrial design in mass production. According to 3DEO's press materials, these tiny handsets demonstrate an ability to print highly complex, functional geometric features. The smooth inner channel of a constant cross-section is a nod to an ability to work "on ball-nut ball return tubes in aerospace linear actuators and also trocar y-connectors for laparoscopic medical devices."

Bringing Nitinol to the Table

Endosmart is a German manufacturer of medical devices and components made of nitinol, a metal alloy consisting of nickel titanium. The alloy's unique properties—including superelasticity and "shape memory"—is undoubtedly a significant part of the motivation behind Alleima's strategic acquisition of Endosmart in 2022. Formerly known as Sandvik Materials Technology, Alleima is known for advanced materials development and has more than 200 medical materials on offer. The acquisition of Endosmart would bolster its presence in the medical wire market. Fortunately, both companies have

Nitinol retrieval basket from Endosmart, now an Alleima company. *Alleima*

the shared goal to enable medical device users to live their day-to-day lives with minimal interruption.

During a lunch & learn presentation, colleagues from both sides shared why miniaturization of medical devices requires ultra-fine wire components. Using a material like nitinol helps them achieve precision cutting and wire grinding capabilities for such devices as pacemakers and hearing implants, but also wire-based components used for stimulation, sensing and transmitting signals.

Automation for Plastics Welding and Joining

At Emerson's booth, the focus was on assembly, cleaning and fluid-control solutions. The automation solutions company showcased technologies that demonstrate its compliance with Medical Device Regulations (MDR). Emerson's Branson range of welding equipment and automated solutions for plastics joining and mold cleaning boasts two laser plastic welding offerings, said Emerson's Tom Hoover, senior key medical accounts manager, Americas, Branson Welding and Assembly.

One branch focuses on product designers for product development and the other focuses on high-speed automation. "In automation, we take a laser diode energy and put it discretely around the part perimeter and match the part's design...It's a fast and efficient joining technology for plastics and has a cycle time of less than three seconds on most parts." The GPX PulseStaking series is touted for giving OEMs greater design freedom by making it possible to join complex, delicate and sensitive components with embedded electronics to plastic moldings.

> *"In automation, we take a laser diode energy and put it discretely around the part perimeter and match the part's design... It's a fast and efficient joining technology for plastics and has a cycle time of less than three seconds on most parts."*

Ultra-Miniature, Programmable DC-DC Converters and Capacitor Chargers

For show and tell, Denver-based Advanced Energy Industries, Inc. could share its newly released Advanced Energy UltraVolt AEQ series, a series of ultra-miniature isolated single and dual-output high voltage DC-DC converters, as well as the Excelsys FC1500, a fully integrated capacitor charger and multiple output power supply. With a supply up to 600 VDC at 0.5 W output power from an input voltage of +5 VDC, the AEQ series optimizes power conversion in a wide range of applications, from handheld and portable devices, ranging from silicon detectors and avalanche photo diodes to MEMS devices and ultrasonic transducers.

The GPX series gives manufacturers greater design freedom by making it possible to join more complex, delicate and sensitive components to plastic moldings. *Branson*

The Excelsys FC1500A from Advanced Energy is an integrated capacitor charging and AC-DC power supply that addresses multiple power demands in system electronics such as touch panels, pumps, cooling elements and other treatments. *Advanced Energy Industries*

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The FC1500 capacitor charger delivers 1,500 W of constant power over all charge voltages from 200 V to 1,000 V and enables faster charging of capacitors when used at lower voltages in mixed technology systems. This helps reduce treatment times, according to the company. Field-configurable outputs provide a "plug-and-play" approach to address specific application requirements. "By combining a capacitor charger, AC-DC power and intelligent control, the FC1500 offers new ways for medical OEMs to design their laser and IPL systems," noted Conor Duffy, vice president of marketing, medical power products at Advanced Energy.

"What is important to know about AI in the robotics space is that it's changing the project model, especially when it comes to robotic vision."

Apera AI offers vision software that allows a UR5 robot to pick and place shiny metal parts, as well as clear and transparent parts. *Universal and Apera.ai*

4D Vision for Robotics

At the Universal Robots booth, one cobot picked shiny sockets out of randomized, mixed bins. The task is a complex challenge for traditional robotic systems. "What is important to know about AI in the robotics space is that it's changing the project model, especially when it comes to robotic vision," touted Eric Petz, head of marketing at Apera AI. The company is a UR+ partner, which means it is part of the Universal Robots' ecosystem of third-party solutions for UR's collaborative robot (cobot) arms. Apera AI makes it possible to achieve a total vision cycle time of just 0.3 sec. (3 Hz). The cobot can pick clear and translucent objects—a former gap in vision system abilities.

The system can operate under ambient light so that no specialized cameras, lighting or lasers are needed. The vision technology is also equipped for high-mix manufacturing, as it can flexibly change between parts. "It's all off-the-shelf gear," pointed out Petz. "We make the software that makes the whole system really smart…The AI ensures nothing collides in the environment. So, it's path planning, it's grasp intelligence. It's the move in and out, and then verifying that the parts have been put together correctly."

Software and Design Aids

In the CAD/CAM/CAE and software department, Design for Manufacturing & Assembly solutions loomed large. Featured among exhibitors were Source Graphics, which represents such brands as Formlabs, Ultimaker, Hewlett Packard, Canon and Artec 3D; Theorem Solutions, which provides specialist tools for CAD Translation and full-scale immersive XR visualization and collaboration; and HCL America, Inc., whose DFMPro suite facilitates upstream manufacturability and supports areas of design that are difficult and expensive to produce.

Between 30-50% of product development time is spent on rework, according

to HCL America, Inc.'s press notes. This adds costly engineering changes to later stages of the product lifecycle and unnecessary delays and cost overruns. DFMPro from HCL provides built-in checks for manufacturing processes like machining, sheet metal, casting, molding, assembly, additive manufacturing and tubing. The software integrates fully within Creo Parametric, NX and SOLIDWORKS, and supports other leading CAD platforms.

CAD/CAM Consulting Services Inc. sells Mastercam, a computer-aided manufacturing (CAM) software that's compatible with most CNC machines. "You can design on it, build tools on it, or run simulations so that you don't have a failure on your machine when you go to print your part," explained Axel Fernandes, additive manufacturing solutions lead with CAD/CAM Consulting Services. The Southern Calif.-based consultancy is able match the right solution with customers' portfolios, Fernandes said during a booth demo of a Desktop Metal Studio 3D printer. ■

Axel Fernandes, additive manufacturing solutions lead with CAD/CAM Consulting Services, demonstrates the relationship between software, a Desktop Metal Studio 3D printer and the part he holds in his hand. *Machine Design*

3M Unveils Longwearing Medical Tape at MD&M West 2023

One of the company's noted scientists demonstrated the new innovation at Anaheim's MedTech extravaganza.

by Rehana Begg, Editor-in-Chief

Among a host of smart technologies on display at MD&M West 2023, one medical device stands out as emblematic of the innovative medical science one expects to see at the largest medical design and manufacturing event.

A new adhesive unveiled at the show, 3M Medical Tape 4578, can stick to the skin for up to 28 days. It is intended for use with an array of sensors, long-term medical wearables and health monitors such as glucose and heart monitors.

Granted, adhesive tape might seem like a modest pick for a standout product among cutting-edge technologies. But behind this innovation is more than 55 years of skin adhesion science and it is the creation of a team of scientists led by Audrey Sherman, a division scientist at 3M Company, in the Medical Solutions Division.

To the uninitiated, Sherman is an innovation powerhouse when it comes to adhesives. She also happens to hold the record for the most patents by a female scientist at 3M (168).

"I'm really excited about this product because it hits home with me," said Sherman. "My husband uses blood glucose monitors and I see him struggle with devices that don't last very long, that fall off. And I really wanted to change that for the diabetic patients of the world."

Sherman said she was asked to develop a solution within a short period of time. With teams set up in Japan and the U.S., the solution was designed in record time (12 months) and underwent rigorous testing.

Prior to 2022, the standard wear time for extended medical adhesives was up to 14 days.

The medical tape is made of non-woven fabric, consisting of a white spunlace polyester nonwoven backing and coated with a pressure sensitive acrylic adhesive. The primary application of the tape is adhesion to the skin, particularly for healthcare medical devices.

"3M does not produce the sensors, but we make the critical part which is what holds the sensor on to the body," said Sherman. "Even if the sensor works, if it falls off, it's a failure. Even if the sensor works [if] it moves in position, and you lose contact with the center that's inside the body, it's a failure. So, we had to come up with an adhesive that would go on in an instant, and stay put."

Audrey Sherman, division scientist, Medical Solutions Division at 3M Company. *Machine Design*

3M Medical Tape 4578 can stick to the skin for up to 28 days.

The team developed new test methods and tested rigorously to mitigate different skin and surface energies. The result was a quick stick adhesive that was long lasting and added the feature of liner free stability. The medical tape can be stored for up to one year, giving device makers more flexibility in the design process.

"We tested triathletes, weightlifters, swimmers," said Sherman. "At the end of 28 days, the sensors were in place, and I was so happy for all of the team because we've worked fast. We work hard and we work for the goal of our patients."

Attendees to the 3M booth were able to sample the medical tape, along with other 3M product demonstrations.

MD&M West 2023 ran from Feb. 7-9, 2023 at the Anaheim Convention Center, Anaheim, Calif. ■

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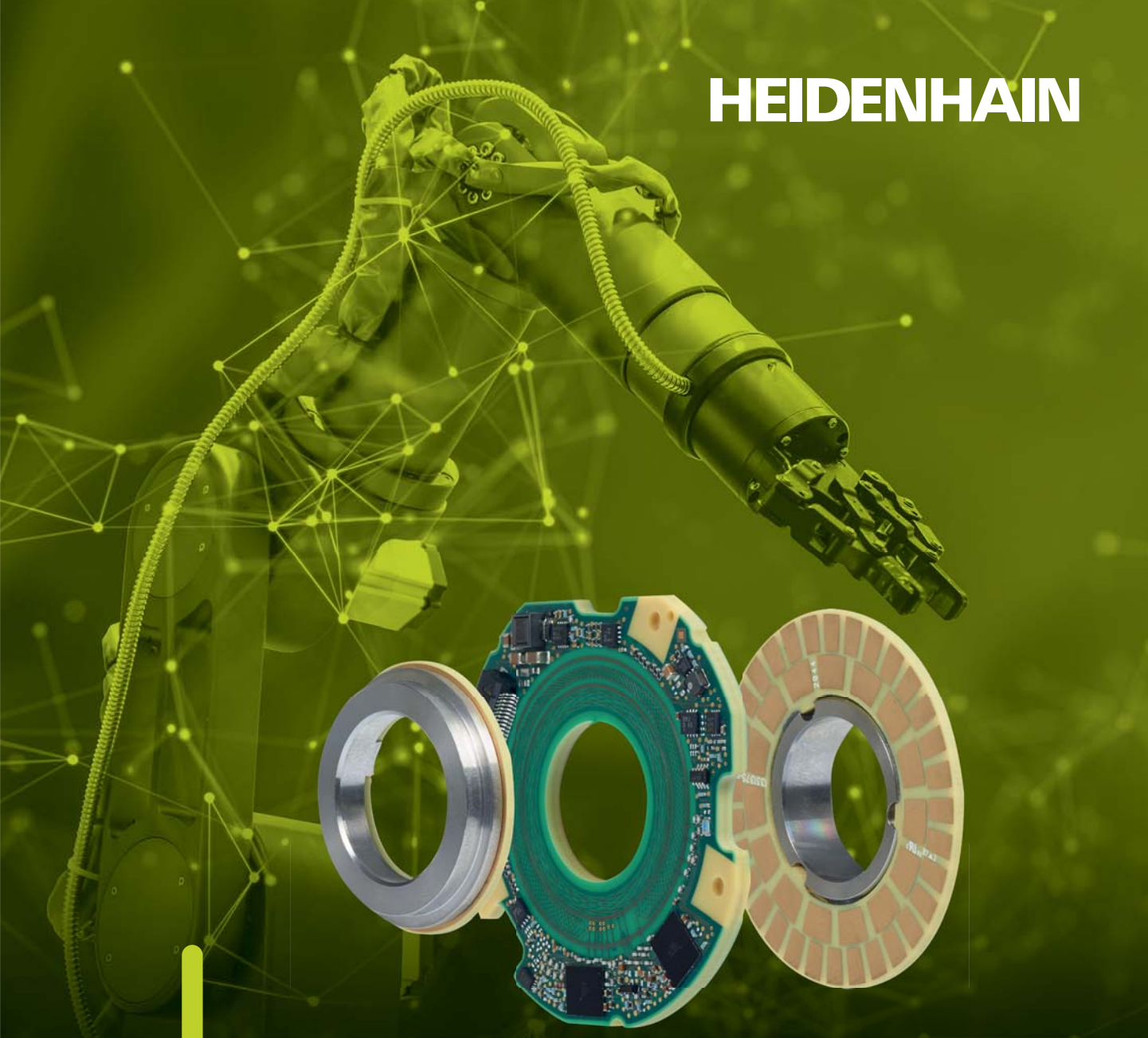

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Erik Schluntz Calls Out Four Tech Trends Transforming Robotics and AI in 2023

The CTO of Cobalt Robotics proselytizes on using artificial intelligence to smarten up autonomous security guard robots.

by Rehana Begg, Editor-in-Chief

By the time Erik Schluntz co-founded Cobalt Robotics in 2016, he had already carved a few notches in his belt.

The engineer-cum-tech-entrepreneur worked on SpaceX's Flight Software Team, testing a fuel system on the Falcon 9 rocket in 2015; prototyped new uses for low power electronics on Google X's Smart Contact Lens project; and temporarily set aside his studies in electrical engineering at Harvard to start Posmetrics, a data collection tool that would help businesses collect customer feedback.

Is it any wonder that in 2018, at the ripe old age of 24, Schluntz was named to Forbes 30 Under 30 for his work on a security robot?

Today, Schluntz's role as chief technology officer (CTO) at Cobalt Robotics in San Mateo, Calif. allows him to combine his interests in both software and hardware. "Robotics is so interdisciplinary that you need to understand the software, the mechanical hardware, the electrical design, as well as the human factors and economic factors in order to create a solution that works and solves across all these domains," he said.

Cobalt Robotics builds and operates autonomous security guard robots that will patrol an office building or a warehouse and look for anything out of the ordinary. If something strange is detected—such as an unauthorized person after business hours, or a door that's propped open—the robot sends an alert to human operators who can respond and intervene.

Pictured on left: Erik Schluntz, CTO and co-founder of Cobalt Robotics discussed the needs and opportunities for security robots. *Cobalt Robotics*

Cobalt's robots currently work as security guards by night and recharge on their off hours. But Schluntz and his team are working on expanding their fleet of robots to become multi-purpose. "We're looking at having them become virtual receptionists during the day, especially at remote offices, where a lot of places now have smaller satellite offices and don't have a full-time receptionist," he said. "The robot could be the receptionist and have a sign-in screen where you can tap to talk to a human operator if needed. And then, at night it becomes a security guard robot."

In the following edited version of an interview with *Machine Design*, Schluntz calls out four technology strides that are transforming the fields of robotics and AI in the near term. These technologies are stoking wider adoption, he said, but are merely precursors to what lies ahead.

Machine Design: **Cobalt's work to make the user experience easy or seamless is a big factor in your success. Part of your work involves Large Language Models. [In lay terms, this means using AI tools to read, analyze and translate speech to text and predict future words.] Why will LLM build on its importance in the field of AI in the coming years?**

Erik Schluntz: Large Language Models are really exciting to me, simply because language is the interface that humans use to communicate with each other. Almost anything can be expressed in language. Whether it's a problem of security—you would tell the security guard what to look for through language, or when designing something, tell the engineer what needs to be built—language is the universal interface between everything.

Language models are not just good for completing text, but they're good for everything when you think about text as this universal interface. As an example, a language model can help control a robot. Someone could instruct the robot to, "Make me a peanut butter and jelly sandwich." And then the language model will understand what a peanut butter and jelly sandwich is, and could even break that down into steps.

Whereas before, a person designing a robot, such as a home helper robot, would have to manually program in any possible thing that the robot can do. Language models encode all of this common sense, or contextual knowledge that humans have. The interesting way that that happens is that they were basically trained by reading the entire internet, given sentences from the internet and instructed to predict the next word. It's really fascinating that in order to do this well, these large language models basically had to form an understanding of how everything connects together. And so, it really does give this common sense that feels very human, and that robots and AI have really been missing before this.

MD: **That brings us to the second trend your work calls out, which is combining LLM with robotics. You mentioned common sense. The idea of**

Cobalt Robotics builds and operates autonomous security guard robots that integrate with facilities. *Cobalt Robotics*

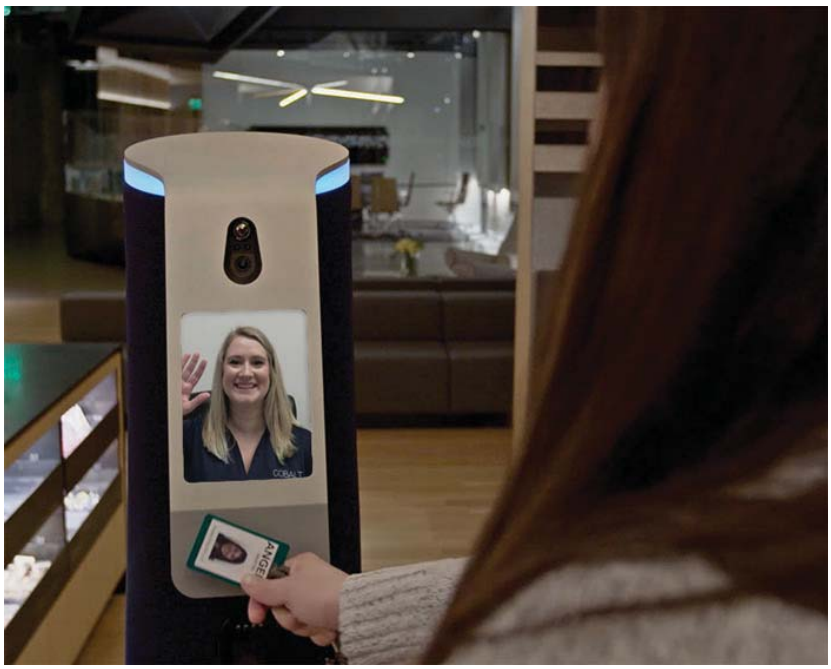
training large amounts of data can be concerning. I think about how you train these models and how they respond. And I think about good data versus bad data. And I think about biased data. Help me understand and contextualize why this is an important area of growth?

ES: Those are really good concerns. And there are a lot of people worried that, on the entire internet, there's a lot of language that you don't want your language model repeating. Just like raising a kid, you wouldn't want them reading certain parts of the internet. Reddit comes to mind, as it's a place where I'm sure there's all sorts of nasty language. I think there's a lot of researchers that are working on how to do that and how to filter out this content, and make sure that these language models can understand the difference between real news and fake news or offensive content, or [obscene] content.

Within robotics, those concerns are a little bit less pressing, because this common sense of the physical world, of knowing that if the robot is instructed to make a sandwich, that means taking two pieces of bread and putting things between it, without someone needing to explicitly program that into the computer.

I'm sure I could be surprised, but I don't think there's a lot of room for offensive or bad content to sneak into these physical world understandings. I don't think there's a lot of people trolling the internet, and writing fake instructions on how to make sandwiches to mess up future robots. But that's one of the reasons I'm most excited by this physical world common sense; it seems to be pretty accurate on the internet.

And the biggest research has gone into this has been from Google so far. They worked on combining a language model with a robot, and it was able to do very general tasks using the language model to convert the high-level instruction into step-by-step steps that the robot could do. And that way the creators of the robot can just focus on making individual, small tasks that a robot can do. For instance, to pick something up, bring it somewhere, combining something. And then the language model can figure out how to convert a high-level instruction from one thing to another.



Cobalt security robots use AI and machine learning to monitor and detect anomalies in the work environment. *Cobalt Robotics*

So back to the sandwich example. If someone gave the instruction of, "Make a peanut butter and jelly sandwich," it could convert the language into the step-by-step instructions of "find bread, find peanut butter, find jelly, put them together." In the past, that could also be programmed by hand.

But the really cool thing about the language model now is that once you've done this, it knows how to make any kind of sandwich that the internet knows how to make. You could also ask it to make a Reuben, and it would know how to make a Reuben, whereas, previously someone would have to go and program in the instructions for any possible kind of sandwich. So, it creates this very general-purpose ability to scale to many different instructions.

And, as a roboticist, one of the interesting things that I heard in the past was that "if it's just as hard to describe a task as it is to actually do it, it will never be automated." I think the language models could be a solution to that. You can just say, "Do it," and it will have the common sense to do it. And you don't need to tediously program, which would probably make the funny example of sandwich making a prohibitively expensive thing to build.

MD: **So that brings us to the question, "Will the robot take my job?"**

ES: I think this is a really fascinating topic. Five years ago, everyone thought that by now truck drivers and taxi drivers would all be out of a job, replaced by self-driving cars. That clearly hasn't materialized. People think of blue collar work as something that can be automated because a lot of it has been automated in the past. But the interesting thing about AI is that it is best at things that humans are bad at. They are these very complementary skill sets.

One of the earliest things that AI was amazing at was chess. And before this happened, people thought chess is the pinnacle of human intelligence. AI actually was really good at that even 50 years ago,

but couldn't do very basic things that the humans take for granted. So, AI progress is actually happening from the opposite end of the spectrum than we all expected.

And if you look at things like generative models and images that have come out this year, with things like GPT-3, Dall-E and Stable Diffusion, you see AI able to do things like generating artwork really effectively. One would think creativity might be the last thing that ever gets automated. And it seems like it's happening in the other direction. However, I'm optimistic that these things are not going to replace jobs, but augment them.

MD: **The idea of a humanoid robot and general-purpose robots, I think, go hand-in-hand. Talk a little bit about where we're at with the humanoid robot.**

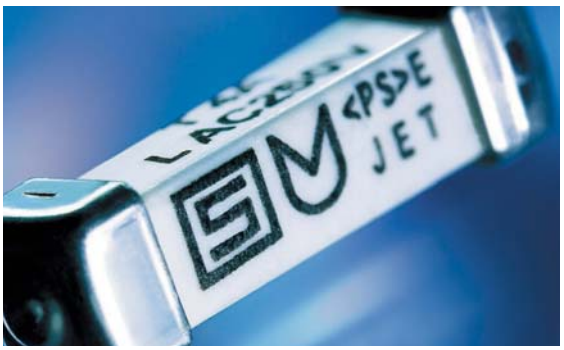
ES: Humanoid robots and general-purpose humanoids have fascinating history. There is a large graveyard of companies that tried to make general-purpose robots. In the past, general purpose kind of meant "no purpose." And they would say it's general purpose because they couldn't come up with a use case for it. People doing that failed and went out of business, and those that made much more specific robots for warehouses or for security have done quite well.

The really interesting thing in the last year is Tesla coming out with the Tesla Bot and launching this project to try to leapfrog all the way to the end. The idea there is that ultimately, in a world where tons of different things are done by robots, everything at the end of the day is built for a human interface.

A humanoid robot is this universal interface to the physical world, where, if a human can use it, a human-like robot will do it. Tesla made a lot of interesting progress over the last year, and basically went from just an idea to a walking robot, which they demoed at AI Day in Palo Alto, Calif. recently.

What to note, though, is that Tesla caught up to the state of the art incredibly quickly—in about a year. But they've just reached the edge of it. I'm very curious to see whether they will actually be able to push beyond the current state of the art and do new things that others have not been able to do. There's a big jump between catching up and extending beyond that. So, I'm really looking forward to seeing that in this next year.

For humanoid robots getting out into the wild, that will be a much longer term thing. Legs are much, much more expensive to build than a simple wheel. And luckily for Cobalt, and a lot of other robotics companies, human spaces are also built for people. Wheelchairs and robots with wheels are able to get around really well in most of our environments. Jumping to full humanoid adds a lot of complexity and a lot of cost that right now I don't think is worth it, or even if 10 years from now, when it is more fully featured and can get to those last-edge cases that robots with wheels can't get to today. ■



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Ad Index

Case Study: Proper Seal Choice and Press Programming Mitigate Yield Issues and Scrap Waste

Collaboration between The Lee Company and Promess enabled a transmission manufacturer to eliminate hydraulic fluid leaks and manufacturing issues.

by Sara Jensen, Technical Editor, *Power & Motion*

PROPER SEALING OF cross drilled holes in the outer shell of automatic transmission cases is necessary to prevent fluid loss. Cross drilling of the casing is often required during the manufacturing process to create and precisely connect the many channels and passages common to the transmission's valve body which enable control functions to be performed.

When a transmission manufacturer found its previous sealing method would not work for its new thin-walled case design, it turned to The Lee Company to provide an alternative solution.

The Challenge

The manufacturer is a long-time customer of Promess, a provider of monitoring and motion systems for various assembly and test applications. When manufacturing transmission cases, it had typically used Promess' Electro-Mechanical Assembly Press (EMAP) to press a steel ball bearing and seal the cross-drilled hole to prevent any fluid losses.

However, the manufacturer found this method did not work well for its thin-walled transmission case. It caused the housing to crack as well as unacceptable leakage rates and warranty issues.

The EMAP is designed to monitor and precisely control peak force and final position. But an evaluation of its use for the thin-walled case established only distance was controlled because the ball pressing application was programmed by a user to stop at a specific distance. Therefore, the tight tolerances normally used for the dimensions of the ball bearing and the diameter and surface finish of the cross-drilled hole were not followed, leading to cracks and leakage issues.

New Sealing Method Offers Potential Solution

To overcome these issues, the manufacturer chose to use a Betaplug expansion plug from The Lee Company in place of the steel ball bearing. The company describes its Betaplug as a pre-assembled, two-piece tapered expansion plug. It features an inner pin and an outer plug body with lands and grooves which bite into the transmission housing during installation to create a leak-tight seal.

When installed in a matching tapered bore, the Betaplug provides proper sealing. According to The Lee Company, the plug reduces unnecessary expansion and has a predictable boss stress suitable for brittle materials or thin-wall conditions like those of the transmission manufacturer. This is due to the size of the tapered pin on the Betaplug precisely controlling its expansion and making the resulting boss stress predictable, easing installation as well as making it repeatable.

The Betaplug works without threads or sealants, and features a single-piece design which helps to reduce costs for manufacturers. Its tapered design removes the need to use tight tolerances during the manufacturing process, helping to ensure proper sealing in even high-volume production applications.

Once the transmission manufacturer began using the Betaplug expansion plug, cracks in the housing and production yield issues were eliminated.

However, it was discovered an improper installation specification was carried over to production of the thin-walled transmission which lead to new issues:

- an unacceptable scrap rate
- yield issues
- damages in the fixturing.

The Promess Electro-Mechanical Assembly Press (EMAP) is a fully electric, programmable motion controlled ball screw press designed to provide accurate and efficient assembly. *The Lee Company*

The manufacturer contacted Promess and The Lee Company to have both companies examine the installation and assembly process to help find a solution to these new manufacturing issues. ■

To read the full article, detailing the outcome of the two companies' collaboration, visit https://machinedesign.com/21260202. This article is based on information provided by The Lee Company and originally published on its website.

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