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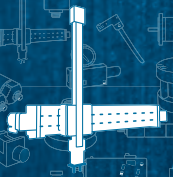
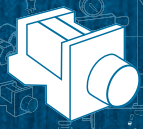


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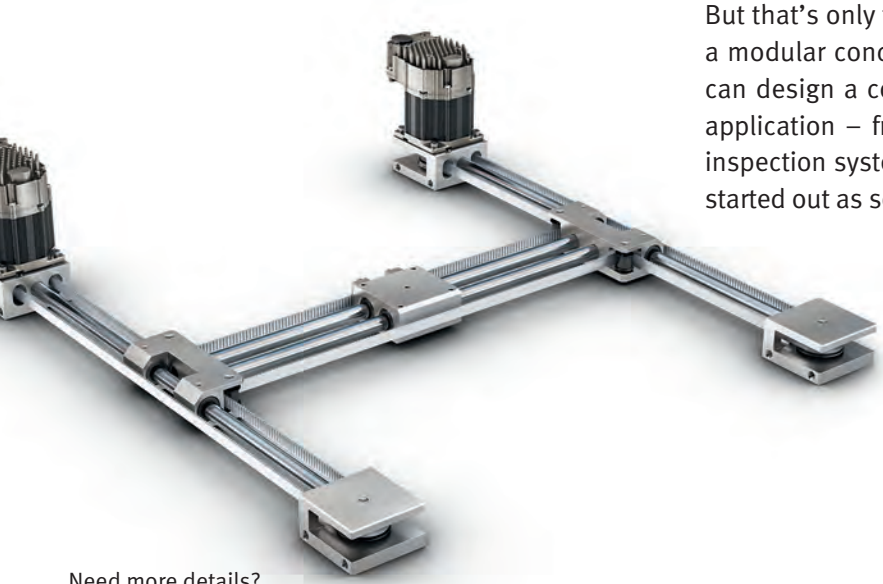

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Lessons Learned

In the 12 years I've been editor of *Design Engineering*, plus the years before as a business journalist, I've had the opportunity to interview more than a 100 innovative people who've turned a market insight, their creative/engineering talent and a desire to make their own way into a successful product.

While the inspiration for those ideas came from sources as unique as the products themselves, the process from ideation to profitable business tended to follow a somewhat predictable course. More specifically, the people who made that journey were more likely to hold to, consciously or not, a certain set of principles. The following are some of the habits, actions and mindsets I learned from them, and put into practice at *Design Engineering*, that skew the chance of success in one's favor.

Abhor convention: It goes without saying in a piece on innovation that convention is something to be avoided but that axiom also extends beyond product ideas. Business processes, marketing strategies and product development all need to be re-assessed to see if they rely on convention. One of my favorite profiles was about Canadian twin engineers whose racing bike wheels upturned the triathlete equipment market. Their product was innovative to be sure, but unlike their much larger competitors, they developed them in software simulation instead of spending millions on physical testing. They also sold online, rather than through distribution channels. As a result, they could sell at a fraction of traditional prices and quickly stole a sizable portion of the market from their conventional competition.

Never go it alone: As Malcolm Gladwell laid out in his book, *Outliers*, the self-made entrepreneur is largely mythical. So much depends on things outside their control: Family, culture, historical timing and chance. Successful innovators rely, instead, on things they can influence, like who they partner with. Finding and employing people with complimentary talents, particularly the ones you lack, is critical. A handful of domain-specific experts can cut through years of wheel spinning and lack-luster returns.

Emulate the peacock: Unless you've come up with something never seen before (unlikely), you'll be competing in a fairly crowded field, which makes peacocking highly effective. Many innovators, particularly engineers, focus on function while ignoring, or even mocking, form. However, even the most logically minded aren't immune to "cool factor" or a pretty package. A distinctive design, a streamlined enclosure or even a splash of sports car-like color draws the eye and cements brand identity. In short, clever industrial designers pay for themselves before they walk through the door.

Be audacious: The hard part of innovation isn't coming up with an idea or making it a reality, it's getting the market to believe in it. To get the message through, many of the successful innovators I've spoken with did something audacious or even obnoxious to get noticed. Also, there is no limit to the number of people who will try to pass off your ideas as their own. Patents have their place, but making sure the marketplace knows who is truly innovative rather than imitative is invaluable.

There's no end to it: Finally, innovation doesn't have a finish line. The tech industry is littered with companies that shook the world but then let innovation take a back seat to quarterly reports and market analysis. Innovation is a cultural value that can all too easily be lost or even punished in a company. Instead, innovation should be infectious. When everyone on the team is competing to come up with the next good idea, someone's bound to hit on something great.

Mike McLeod

@ I enjoy hearing from you so please contact me at MMcLeod@design-engineering.com and your letter could be published in an upcoming issue.

Design ENGINEERING

www.design-engineering.com

Publisher
Alan Macpherson (416) 510-6756
amacpherson@design-engineering.com

Editor
Michael McLeod (416) 442-5600 ext. 3231
mmcleod@design-engineering.com

Associate Editor
Lindsay Luminoso (416) 510-5233
lluminoso@design-engineering.com

Account Manager
Ron Salmon (416) 510-4362
rsalmon@design-engineering.com

Art Director
Elena Novinskiy (416) 510-6809

Account Coordinator
Cheryl Fisher (416) 510-5194
cfisher@annexbusinessmedia.com

Circulation Manager
Beata Olechnowicz (416) 442-5600 ext. 3543
bolechnowicz@annexbusinessmedia.com

Vice President
Tim Dimopoulos (416) 510-5100
tdimopoulos@canadianmanufacturing.com

COO
Ted Markle
tmarkle@annexbusinessmedia.com

President & CEO
Mike Fredericks

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Circulation
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Mail: 111 Gordon Baker Rd., Suite 400, Toronto ON M2H 3R1
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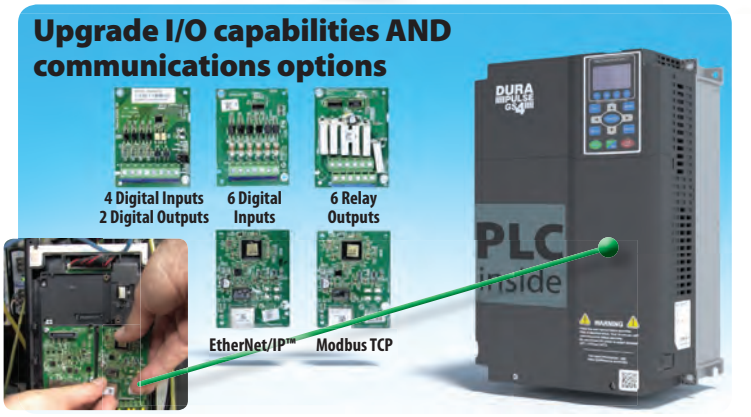

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Queens researchers unveil true holographic videoconferencing system

Queen's University researchers have perfected a system that enables two people, in different locations, to appear life-sized and in 3D. The holographic videoconferencing system, dubbed TeleHuman 2, allows people to meet virtually, as if they were in the same room.

"Face-to-face interaction transfers an immense amount of non-verbal information," says Roel Vertegaal, Professor of Human-Computer Interaction at the Queen's University School of Computing. "This information is lost in online tools. Users miss the proxemics, gestures, facial expressions and eye contact that bring nuance, emotional connotation and ultimately empathy to a conversation. TeleHuman 2 injects these missing elements into long-distance conversations with a realism that cannot be achieved with a Skype or Facetime video chat."

Dr. Vertegaal explains that what the majority of people think are holograms are actually 2D video projected on a flat piece of glass. Instead, Dr. Vertegaal's team has been able to project humans and objects as light fields.

To accomplish this, the TeleHuman 2 captures live, 3D images – one for every degree angle of the 'sender' – using an array of depth cameras. That data is then "teleported" to a retro-reflective, human-size cylindrical pod. A ring of intelligent projectors mounted above and around the pod project the 3D data. The result is a display that makes it look as if the sender is in the pod and can be viewed from all sides simultaneously by multiple users.

TeleHuman 2 is the next-gen version of Dr. Vertegaal's technology, debuted 2012, which only allowed a single viewer to see the 3D projection correctly using 3D glasses. Now, multiple participants are able to see their holographic colleague in full 3D, without glasses.

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Waterloo researchers strive to move quantum radar into the field

Researchers at the University of Waterloo have developed a quantum radar system that could potentially spot stealth aircraft even through heavy background noise. To date, the system has only been tested in the lab but the team hopes new funding will help them move the technology toward a successful field test.

Unlike traditional radar, which uses radio waves, quantum radar employs quantum entangled pairs of photons. Using a process called quantum illumination, the system casts one of the entangled photons toward a distant object while retaining the other photon. The photons reflected back are then checked for entanglement signatures, thereby allowing the system to ignore

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photons from background noise.

"In the Arctic, space weather such as geomagnetic storms and solar flares interfere with radar operation and make the effective identification of objects more challenging," said Jonathan Baugh, a faculty member at the Institute for Quantum Computing (IQC) and a professor in the Department of Chemistry who is leading the project with three other researchers at IQC and the Waterloo Institute for Nanotechnology. "By moving from traditional radar to quantum radar, we hope to not only cut through this noise, but also to identify objects that have been specifically designed to avoid detection."

Although the system has been explored in the lab, researchers haven't yet created an "at the push of a button" source of entangled photons. However, the Department of National Defence has awarded IQC a $2.7 million contract, under its All Domain Situational Awareness (ADSA) Science & Technology program, to help move quantum radar into the field.

The effort comes at an appropriate time since NORAD's 54 North Warning System (NWS) radar stations, based in the Arctic, are nearing the end of their life spans and could need replacing as early as 2025.

www.uwaterloo.ca

BMW awards LiDAR contract to Magna

Magna and its partner, Innoviz Technologies, announced they will supply the BMW Group with solid-state LiDAR for the German automaker's upcoming autonomous vehicle production platforms.

Prior to the contract, Magna collaborated with Innoviz to integrate solid-state LiDAR into the MAX 4, the Canadian company's autonomous driving platform. Capable of Level 4 autonomous driving, the MAX 4 includes RADAR, LiDAR, cameras and ultrasonic sensors, as well as an ADAS central computing module.

Unlike standard LiDAR, the Magna/Innoviz technology has no moving parts. Instead, the solid-state, high-resolution technology generates a 3D point cloud of the vehicle's surroundings in real time, even in direct sunlight and bad weather. In addition, the solution provides a complete computer vision software stack and algorithms to turn 3D vision into driving insights, the company says.

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GM Canada appoints new president

In April, General Motors announced the appointment of Travis Hester – formerly

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GM's vice president, Global Product Programs – as president and managing director of GM Canada.

Hester began his GM career in 1995 in Australia as a technical support engineer for GM Holden and, over his career, held various engineering positions in U.S. and China, including chief engineer for several global premium luxury vehicles. Since becoming VP of Global Product Programs in 2016, Hester has led the team responsible for balancing all aspects of vehicle development.

Hester replaces Steve Carlisle who has been appoint General Motors senior VP and Cadillac president, replacing Johan de Nysschen, who is leaving the company.

www.gm.com

UWindsor researchers 3D print "Robotoads"

UWindsor biological sciences master's student Lincoln Savi displays his 3D-printed "Robotoads". (Photo Credit: University of Windsor)

Biologists at the University of Windsor are leveraging additive manufacturing, plus a bit of basic robotics, to create life-like replicas of amphibians to better understanding what makes one toad more snoggable than another. Of special interest is the Neotropical Yellow Toad, a Central American species whose males are known for changing color from muddy brown to bright yellow during an annual mating ritual.

Research by UWindsor professors, Dr. Daniel Mennill and Dr. Stéphanie Doucet, had previously discovered that the toads' color transformation, in part, helps males discern between boys and girls. Now, the biologists want to see, with the help of UWindsor PhD student Katrina Switzer, if lady toads prefer a certain shade of yellow.

Previous studies had used hand-sculpted clay toads but the hope now, Switzer said, is that realistic robotoad models, animated by small motors to mimic amphibian behaviour, will lead to a more intense female response.

These lifelike replicas are the work of UWindsor master's student, Lincoln Savi, who produced the robotoads using a combination of photogrammetry, 3D modelling and additive manufacturing. Once printed, the toad models were then tinted to match the top and bottom 10 per cent of natural toad colour variation.

Not satisfied with simply creating the Channing Tatum of toads, Savi has launched his own business, called Savi Made, based on positive response to his 3D printed amphibians.

"It's an interesting way of still being involved in research while focusing on a more creative aspect of it," he said.

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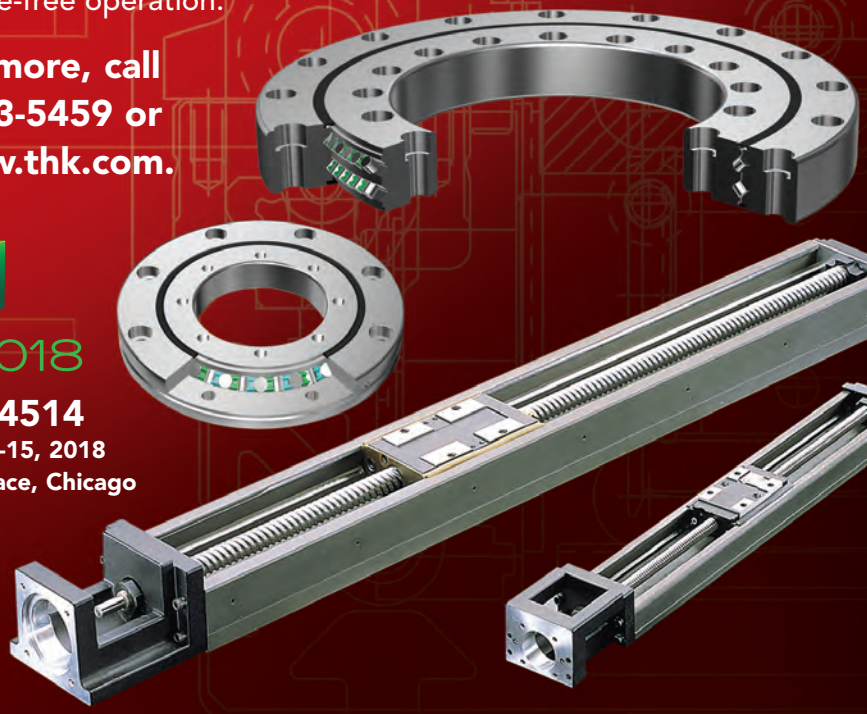

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MCAD SOFTWARE You've Never Heard Of

Young CAD companies may be unknown and untested but aren't bogged down by old code and technology.

By Ralph Grabowski

We know a lot about the Big Four MCAD vendors (Dassault, Siemens PLM, Autodesk, and PTC), and you probably use programs made by them. So it may pique your interest that smaller vendors have popped up in the last several years to fill in gaps left by the big boys. And by 'new' I don't mean headline-grabbing software like Onshape, Fusion and XDesign.

Being new means the software company can start fresh, without the burden of carrying a lot of baggage forward to maintain compatibility with functions and interface peculiarities of 30 years ago, even as programmers cobble new functions on top of the old.

Back in the old days, CAD programs developed slowly because the underlying technologies barely existed. I think back to the machinations Autodesk went through to get 3D solid modeling into AutoCAD. Their efforts began with the Pioneer Program, followed by Engineer Works, then the AutoCAD Modeling Extension add-on. Next, ACIS was built in, and finally the company's got its own ShapeManager kernel.

By contrast, being a new CAD software company also means it can start at a sprint. Everything needed to build a new CAD system is readily available under surprisingly favorable licensing terms. You can get pre-built SDKs with APIs for 3D solid and surface modeling, 2D and 3D constraints, display and rendering, foreign file import/export, non-platform-specific user interfaces. There is even code to run the same program in Web browsers, on mobile platforms and with desktop computers. Heck, there are companies that'll sell you the entire CAD system; all you need to do is rebrand the program with your logo.

Funding seems surprisingly easy to obtain these days, as well, with venture capital and angel investors desperate for the Next Big Facebook-like Return. That's unlike Solidworks, for example, which launched on the back of winnings from

Figure 1 (left to right): Structural ribs, a stochastic structure, and a conformal structure generated by nTopology's Element Pro.

Figure 2: Frustrum's Generate running in a Web browser, showing the original part in gray and the optimized part in blue.

card-counting at Las Vegas gambling tables.

One thing that hasn't changed, though, is the question: Which platform? Thirty years ago, CAD vendors had to choose between dialects of Unix, CP/M, VMS, OS/2, Windows, MS- and PC/DOS – plus two kinds of Apple operating systems – running on 8-, 16- or 32-bit little- and big-endian systems.

It was actually a bit of a relief when most of CAD coalesced onto a single platform, Intel-Windows, with a little bite of Apple on the side. But thanks to the Internet and Apple, the possibilities re-expanded to Web, mobile or desktop; Android or iOS; and Linux, MacOS or Windows. Nascent developers have to decide whether to develop on one, some or all of them.

Let's take a look at just four niche MCAD programs that came out in the last couple of years. All are new, yet polished. Crudely-written CAD need no longer exist.

nTopology

Due to its history, MCAD software is segmented by function: Pre-design, sketching and parts, assemblies, simulation, optimization and finally manufacturing through subtractive or additive operations. Some of these have merged in the last decade, but nTopology CEO Bradley Rothenberg feels all design ought to be generative. As a result, the company's Element Pro software combines all design functions – from concept through to 3D printing – in a single software package.

In nTopology's software, the generative design process optimizes object geometry by creating and testing dozens or hundreds of possible variations. The final result is often a latticework or an organic looking part that minimizes weight but maximizes strength.

Rothenberg believes 3D printing has the capability to create things so complex that we humans won't be able to design them with traditional MCAD software. Instead, he sees routines performing the design for us. This concept is already happening with the Grasshopper programming environment hooked into 3D MCAD like Rhinoceros. Element Pro's solution is its interactive Lattice Rule Builder, which generates a lattice work of gyroids (self-supporting 3D lattices) to fill empty volumes of parts with repeating patterns.

The structures don't need to be lattices. Element Pro can also generate ribs that aren't round and other optimizations (see Figure 1). The company plans to add a simulation tool that generates optimized structures, making them thicker where strength is needed, and thinner where it isn't.

Frustrum

Frustrum also offers a generative design package, and a lot of what I said about nTopology applies to Frustrum. But this firm's angle is that their software (named Generate) runs on its own solid modeling kernel, named TrueSolid. Whereas nTopology currently generates only 3D lattice structures, Frustrum adds what's missing: Integrated simulation, which they call Hexahedra-8.

You can't, after all, properly optimize parts until you apply stresses and determine

where and how the part will experience strain. And so, rather than ending up with a lattice structure that mimics the original part, Frustrum ends up with organic-looking shapes with voids where material is unnecessary for strength (see Figure 2).

Frustrum runs on the cloud and inside NX, probably because the company received funding from Siemens Venture Capital. The TrueSolid kernel is available for licensing.

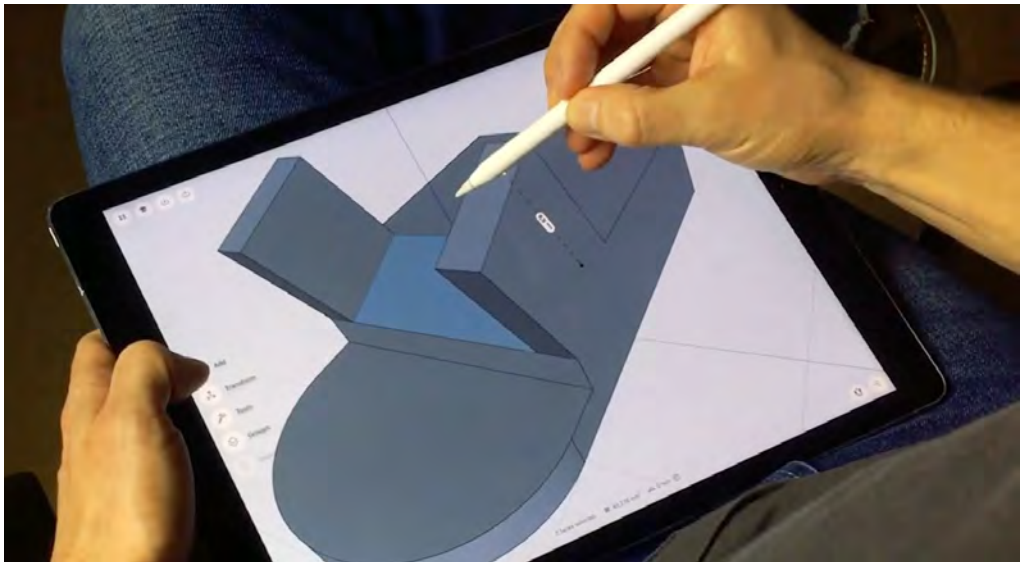

Figure 3: Shapr3D employing the Pencil to create 3D models on an iPad.

Shapr3D

The development of CAD for mobile devices has gone through three generations. The first generation was view-only while the second added drawing and editing functions. Now, the third generation consists of mobile apps that do feature-recognition and automatic constraints.

Feature recognition turns your finger-drawn loops and squiggles into round circles and arcs, straight lines, and smooth splines. It makes sense on smartphones and tablets (when the primary interface is your finger), more so than on desktop computers. Automatic constraints assist the drawing process by setting those lines horizontally and vertically, and connecting endpoints.

The first firm to do constraints and recognition on any mobile device was Arctuition with its ArcSite app, followed closely by Siemens PLM with its CatchBook app. But both do only 2D designs. To date, there is just one app that does 3D modeling, Shapr3D.

The catch to Shapr3D is that it works with exactly one hardware combination: iPads that support Apple's Pencil stylus. (On iPads without a stylus, the app is only a 3D viewer.) Developer Istvan Csanady says he picked the iPad Pro initially because it is four times more powerful than regular iPads, and because Android "hardware is crappy." He has no immediate plan to support Windows laptops that work with a touch screen and stylus.

The reason Csanady requires users to employ the stylus is for its precision; the area under your finger is too large, and in any case it covers up exactly what you are interested in editing and drawing. Fingers in Shapr3D are used only to zoom, pan and orbit in 3D space.

The user interface of Shapr3D is designed so that the left hand selects commands from buttons that line the left edge of the screen, while the right hand controls the stylus. (See Figure 3.) The Apple stylus lacks buttons but does sense pressure, so you can specify data like control points by pressing harder every so often.

Some functions are determined by the direction in which you move the stylus. For example, dragging an edge away from you creates a fillet, while dragging it towards you creates a chamfer. As with desktop MCAD systems, you can enter precise radii and distances with the onscreen keyboard.

Csanady is proud that the entire system runs on the iPad with no assistance from the cloud. The kernel underlaying Shapr3D

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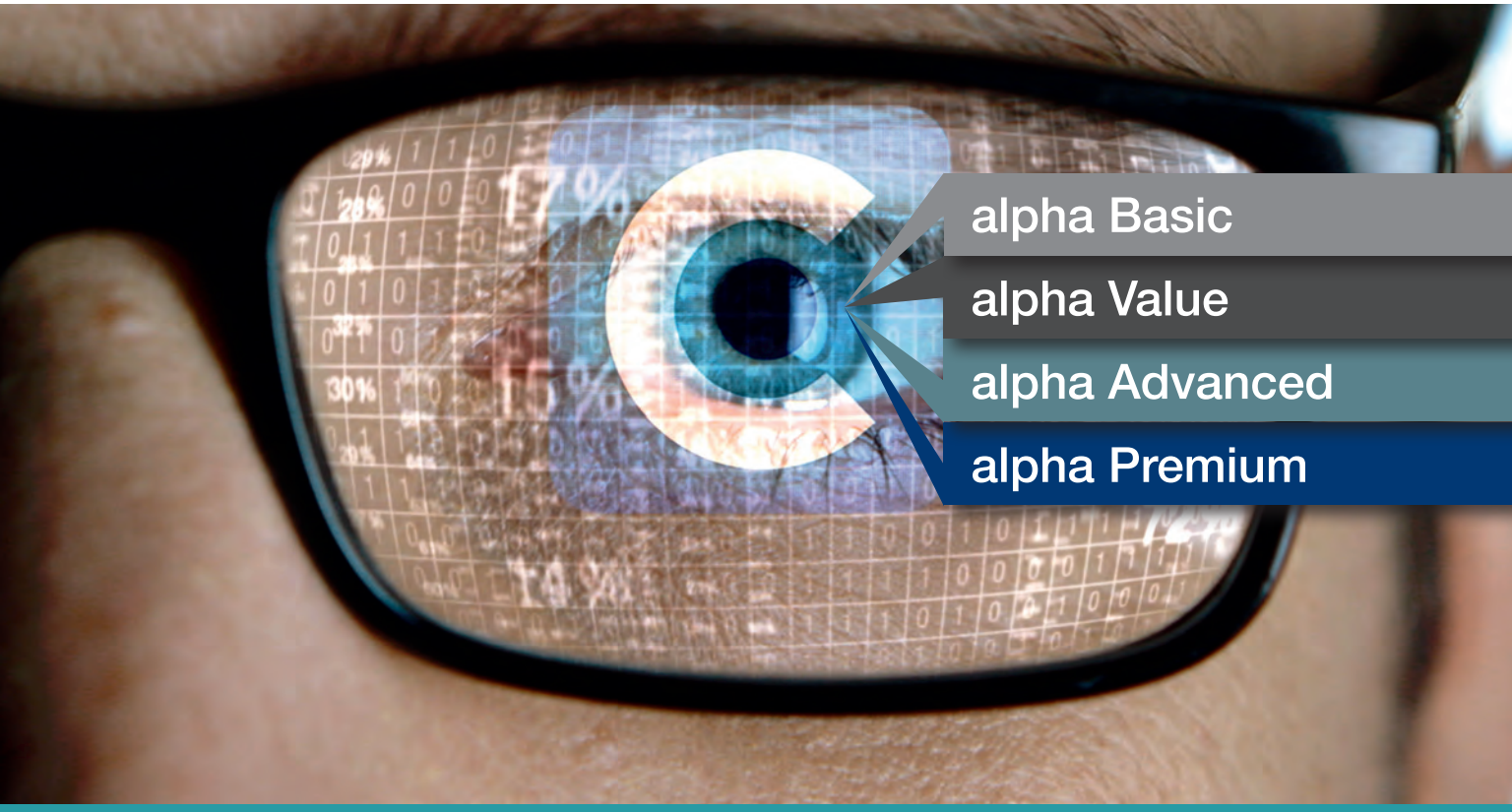

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Figure 4: Working with a pre-designed stand in Vention's Machine Builder.

is the open source Open Cascade kernel, but he is thinking of substituting ParaSolid when the iOS version becomes available.

Vention.io

Vention is a Canadian industrial parts distributor that specializes in the parts that support machines that work on parts, such as the stands that hold robotic arms and welders.

Last year the company added a Web-based program called Machine Builder for designing stands for industrial equipment. (See Figure 4.) It is a 3D modeling system that CEO Etienne Lacroix calls a powerful CAD configurator. It's not a CAD system, he insists: "We don't intent to compete in the CAD space."

Still, there are a number of similarities. In Machine Builder, you design stands by selecting parts from Vention's library, such as extrusions, plates and caster wheels. Extrusions can be dragged longer and shorter. All these parts snap into place, as they know their connection points through a constraint solver that Vention programmed on its own.

While you can import your own parts (from 20 file formats), you have to connect them manually to the rest of the design. In addition, Vention provides a library of finished designs made by its own staff and other users, which can be copied, modified and then exported in STEP format.

As you build the stand virtually, the BOM function reports the cost in real-time, as well as the estimated assembly time. Once the design is complete, you pay for the order and for shipping. Once the box of parts arrives, you get to assemble it.

Small, speedy software firms are doing exciting work, largely under the radar. There are many more – in MCAD, architecture and other disciplines – than the few described here. These firms have the advantage of working with modern APIs and choosing the best platform for their needs.

But, in many cases, they are also burdened by investor money that will need to be repaid, one day, plus a healthy return. Whether they can attract sufficient numbers of paying customers isn't certain. Certainly, one way out is for another, larger MCAD vendor to eventually buy the company, its intellectual property and/or the staff. For now, all have free versions that let designers see if they fit into the design workflow. DE

www.ntopology.com
www.vention.io
www.frustum.com
www.shapr3d.com
eui.eugiatet.nit

Ralph Grabowski writes on the business of CAD on his WorldCAD Access blog (www.worldcadaccess.com) and weekly upFront.eZine newsletter. He has authored many articles and books on AutoCAD, BricsCAD, Visio and other design software.

| AT11-15USA |

Ultra-compact footprint: the modular AX8000 multi-axis servo system.

EtherCAT®

Highly flexible:
- Free combination of modules as required:
  - Power supply module, 20 A, 40 A
  - 1-channel axis module, 1 x 8 A, 1 x 18 A
  - 2-channel axis module, 2 x 6 A

Safe:
17 drive-integrated TwinSAFE functions

High performance:
- Current controller response time of 1 µs
- Current controller cycle time of 62.5 µs (down to 16 µs)
- Position controller cycle time of 62.5 µs
- EtherCAT cycle time of 62.5 µs

Simple installation:
Fast, fail-safe and tool-free assembly; gap-free installation

Highly scalable:
AM8000 synchronous servomotors with One Cable Technology

www.beckhoff.ca/AX8000

The modular AX8000 servo system completes the highly scalable Beckhoff Drive Technology portfolio. In addition to the integrated motion control solutions in TwinCAT software and a scalable series of motors, there is a wide range of drive types available from compact drive technology, which is directly integrated into the I/O system, up to the AX5000 EtherCAT Servo Drives. With freely combinable modules, the AX8000 multi-axis servo system delivers high-performance EtherCAT drive technology in a modular format that can help dramatically reduce machine footprint.

New Automation Technology **BECKHOFF**

PASSING THE TORCH

After 30 years in business, Spark Innovations still finds new ways to shine.

Edited by Lindsay Luminoso

Chris Pearen (left) and Gary Vilinsky (right) in front of King City's Spark Innovations.

After a successful career as president of Northern Technologies, a division of Lanpar Technologies, Robert Dickie was looking for a new adventure. In 1988, he decided to strike out on his own and create a product design firm, Spark Innovations. From the start, Sparks' philosophy was to pursue opportunities "in little, high-volume things where we can innovate and patent."

Fast forward 30 years and Dickie is passing the torch to Chris Pearen, President and Design Director, and Gary Vilinsky, CFO and Director of Business Development.

What are your histories with the company?

Pearen: My background is in industrial design but I've spent the majority of my career focused more on the manufacturing side of product development. And that's [Spark's] niche: Product development for manufacturing. I've been with the company now going on four years, but Gary and I are now focused on getting our feet wet with running the business.

Vilinsky: I've been with the company for 14 years. With Robert [the owner] semi-retired, we are progressing to the full day-to-day operations. We have a five-year plan in place that we are looking at rolling out, which provides manageable growth year over year.

How would you sum up Spark Innovations?

Vilinsky: Our studio, located in King City, ON, currently employs six people – a mix of both industrial designers and mechanical engineers. As a company, we are pretty broad in terms of the industries we serve. We can work on anything from toys to medical, general consumer products to soft goods. It all depends on the product, client and where they want to go and what they want to do.

When individuals, start-ups or corporations bring us their idea, we turn around a plan to bring that idea to fruition. What makes us unique is that we offer a studio that includes both industrial design and mechanical engineers working together. On top of that, we have extensive experience in both manufacturing and patents.

Pearen: That's where Spark really shines. We have worked on over 250 issued patents, providing for a very strong understanding of patents and how to work towards a utility patent or work within the confines of existing patents to find the freedom to operate.

What's the "sweet spot" for Spark Innovation?

Pearen: One thing we are very good at is preparing the mechanical and enclosure components for a project. If you have a very mechanical project, something that you need to figure out a function or movement, we are very strong at those

kinds of projects – even so far as to develop testing equipment.

On the enclosure side, we have a lot of experience with injection molding and plastic/metal fabrication. For example, if clients have already developed the electronics or a mechanism and need an enclosure, they can come to us for industrial design and/or product development and we can take it to the next level of production.

We can consider things like seals and gaskets, snaps and minutia. It makes a huge difference between what you can do with a 3D printer to what a product looks like after production, to ensure you end up with a perfect finished product.

Vilinsky: We also have a number of individual start-ups and corporations that bring ideas to us and we take them all the way to commercialization. We recently developed the Indigo shopping cart, which was one big project for us.

What is your firm's design process?

Pearen: In general, we break our projects into three phases, starting with the creative phase.

We start with a very broad approach to the concepts, potentially starting with some hand illustrations, sketches and 3D illustrations. We work with the client to determine their likes and wants and then refine and tune the concept. At the end of phase one, the goal is to have an agreed upon direction for the concept to move forward.

In the engineering phase, things can be very broad depending on the materials and processes that are intended for the project. There could be more testing and research, depending on what the client is looking for and what the budget is. At the end of phase 2, we would end up with a production or prototype package with files ready for quoting by the manufacturer.

Phase 3 is building the prototype, setting up manufacturing and securing patents and intellectual property.

Last year, we did over 100 projects, which can be a little deceiving. Some projects can be quick, if we are just in the patent side of the project. For others, we take the concept right through to production.

Vilinsky: We've developed many products for many different corporations, start-ups and individuals, including products that were taken into Dragons' Den, sold on the internet and in retail stores.

Is there a project you are particularly proud of?

Pearen: Our real expertise came into play with a start-up called BrushPoint Innovations that designs electric toothbrushes. The company became the fourth largest toothbrush distributor in North America and was subsequently sold to it's biggest rival in store-brand oral care products.

Their team did the industrial design, patented every toothbrush and delivered the patent drawings. Our team 3D printed the prototypes to make sure the motors and all the mechanical parts fit perfectly. Beyond that, we also created functioning prototypes and renderings for marketing, presentations and pitches to retail stores and wholesalers. Packaging was another area we managed.

A line of Brushpoint toothbrushes.

What's next for Spark Innovation?

Pearen: The work we do on patents and the blending of skills is interesting and growing. We also work well with mid-sized companies that have existing product lines they are looking to add to, update or explore a different avenue with. We can look at the entire project or we can be one small part, a resource to get over a hurdle. At this point, Gary [Vilinsky] and I are looking to grow the company at a comfortable rate. **DE**

www.sparkinnovations.com

CANADA'S AUTOMOTIVE LANDSCAPE

This information is taken from the ***2018 Drive to Win: Automotive Advisor Report*** by Réal Tanguay, Automotive Advisor to the Government of Canada and the Government of Ontario.

MAIN AREAS OF CONCERN

Electricity Costs - Ontario has higher electricity costs than any other jurisdiction

Cap and Trade - Ontario's Cap and Trade program and regulations create restrictions for business

Workplace Environment - Ontario labour regulations are more restrictive

NAFTA - concerns expressed by U.S. are creating uncertainty

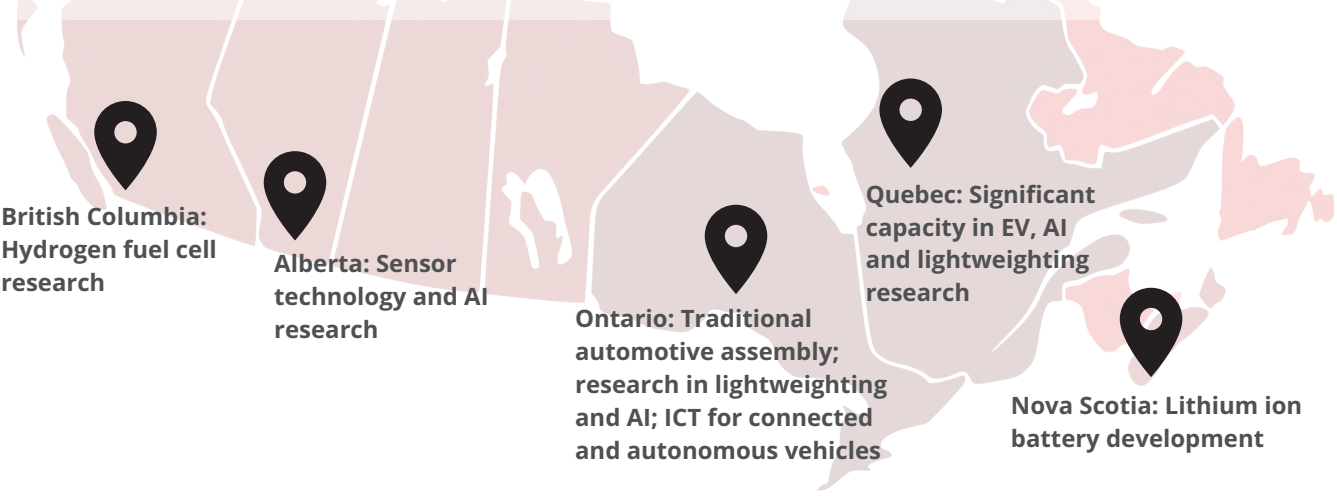
MAIN AREAS OF STRENGTH

Incentives - Incentive packages have improved and are competitive

Supplier Density - There are 700+ traditional parts suppliers, including most global suppliers

Educated Workforce - 64% of Canadians hold a post-secondary degree and 18.6% in STEM fields

Access to Markets - Highly integrated US/Ontario cluster



GENERAL MOTORS

GM will increase engineering base in Ontario to **1,000** and construct a **software engineering centre** in **Markham, ON**.

MAGNA

$5 million investment in the **Vector Institute (AI)** in **Toronto.**

FORD

Part of **$1.2 billion** investment goes to opening a new **innovation centre** for connected and autonomous vehicles.

UBER

Invest **$5 million** in the **Vector Institute (AI)** in **Toronto.**

APPLE

Open a **22,000 square foot office** in **Kanata, ON** dedicated to operating systems for connected cars.

From February 2016 to March 2017, more than $3.2 billion of automotive investments in Canada has been announced. Many of these investments were crucial in securing Canada's automotive footprint. Here is a sample of automotive R&D (above) and manufacturing (below) initiatives.

GENERAL MOTORS

Invested **$554 million** to extend mandate for Cadillac XTS and Chevrolet Impala at its **Oshawa facility**, and increase flexibility for final assembly of the Chevrolet Silverado.

FCA

$325 million overhaul of its existing **Brampton paint shop** and **$6.4 million** for upgrades to its **Etobicoke facility**.

FORD

Investing **$1.2 billion** for a new engine mandate at **Windsor engine plant** and **$100 million** to update the Ford Edge and Lincoln MKT crossovers assembled at **Oakville**.

HONDA

$492 million to upgrade its **Alliston facilities** to build new models of the Civic and CR-V.

TOYOTA CANADA

Plans to bring new vehicle mandates to operations in **Woodstock** and **Cambridge, ON**.

To view full report, visit: http://capcinfo.ca/images/PDF/CAPC_Automotive%20Report-en.pdf

Equipped by SCHUNK

90%
faster gripper change
SWS Quick-change System

Up to 3°
maximum deflection
TCU Tolerance Compensation Unit

NEW: Up to 50%
higher gripping force
PGN-plus-P Universal Gripper

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SCHUNK®

Everything for your Articulating Arm Robot

More than 3,000 components for handling and assembly

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ROBO-VEST

Lightweight exoskeleton benefits health, productivity in manufacturing facilities.

By Tom Renner

Work-related musculoskeletal disorders (WMSD) are a huge problem for many businesses. More than 650,000 cases of WMSD cases are reported each year and represent 33 percent of every dollar spent on workers compensation. That translates to approximately $50 billion in lost productivity annually in the U.S., and nearly 70 million physician office visits each year, according to the Centers for Disease Control and Prevention.

In certain professions, nearly 45 percent of workers experience shoulder pain, resulting in missed days, decreased productivity and escalating healthcare costs for business. As a result, more businesses are using ergonomics researchers to closely examine personal lift assist devices.

One such device is the Airframe, a wearable, ergonomic exoskeleton manufactured by Levitate Technologies of San Diego. Originally designed for use by surgeons, the mechanical vest is now used extensively by professionals and skilled trade workers who are exposed to repetitive arm motions and/or stationary arm elevation. During use, the exoskeleton transfers the weight of the arms from the shoulders, neck and back to the core through pads that rest on the outside of the hips, thus relieving muscle and joint strain.

"The benefits of this device have been incredible," said Terry Butler, former Director of Environmental Health & Safety at the Vermeer Corporation, a manufacturer of industrial and agricultural equipment in Iowa. "The team members who have used this tool are more than happy to use it and have seen more prolonged work activities without feeling fatigued by the end of their shift."

Surgical Support

When engineer Mark Doyle designed the Airframe in 2013, there were no exoskeletons that allowed a surgeon to move freely while operating. Only stationary delivery systems were in use. Surgeons who used the wearable frame found it had a positive effect.

A study from an Internal Review Board at the hospital where surgeons used the device found fatigue in surgeons who wore the exoskeleton decreased by 50 percent in operations after 12 minutes, and the pain rate decreased by about 25 percent.

But when one major auto manufacturer discovered the benefits of the Airframe for its employees, Levitate switched its marketing focus and ramped up production.

"We became laser focused on manufacturing and our business plan switched," said Joseph Zawaideh, the Vice President of Marketing and Business Development for Levitate. "We changed our focus."

The Airframe is now being used in manufacturing plants in aerospace and airplane assembly, heavy machinery, shipbuilding, agriculture, paper and chemical industries. Even the U.S. Navy is using the Airframe for maintenance work. The exoskeleton has also been used extensively at one automobile manufacturing facility in the United States.

"They embraced the Airframe quickly and even mentioned that they do not want to go back to not using it," Zawaideh said. "Users said that they appreciated that the Airframe is very low profile, lightweight and did not restrict motion."

By transferring upper extremity load to the body's core, the device helps sustain high quality performance, protects health and improves overall work conditions. "The difference between the Airframe and other exoskeletons now on the market is that it's very lightweight, and extremely comfortable," Doyle said. "It makes motion very natural. We worked hard to make it feel smooth and natural when being worn and activated."

Reduced weight is key

Keeping the exoskeleton as light as possible was critical in its design. The weight of exoskeletons varies greatly – one cur-

rently being used by some military teams weighs staggering 68 kilograms (150 pounds). Lighter models weigh only 6.5 kg (14 pounds).

Providing an adequate power supply for exoskeletons is also one of the significant issues that has stymied many engineers. Doyle's Airframe doesn't require a power source, and while Levitate does not disclose the weight of the apparatus, its light weight enables users to wear the product for an average work day without effort.

"Asking human beings to wear a metallic frame and do their jobs is not an easy task," Zawaideh said. "We needed something that was lightweight, low profile and could adjust to all the different mechanisms and synchronization. It required attention to detail on every screw and every bolt. Our mindset was if you don't need it, don't add it."

As part of that lightweighting process, Doyle chose engineered plastic bushings manufactured by Germany-based igus. The company's iglide G300 bushing, for example, provided a PV value of 12,000 (psi x fpm) when dry, a density of 1.46 g/cm³ and a high modulus of elasticity, 1,131,000 psi.

The device also includes bushings from igus' T500, M250 and Z series. In testing, the Airframe exoskeleton generated heat which required that higher-heat rated bushings be used. The iglide bushings also offer the advantage of corrosion resistance and easy installation.

Improving Worker Health

Besides increased productivity and efficiency, the Airframe might also help workers stay healthy. A safety and ergonomic risk assessment at one auto manufacturer found that the Airframe reduced physical work stress by 20 percent.

Levitate also reported the findings of a study it conducted that measured the impact of wearing the Airframe during a series of physical activities that mimic common industrial tasks. During the study, objective measures of shoulder and neck muscle exertion and force were collected via electromyography (EMG) sensors placed on the muscles. Measures of dexterity were collected during tests, and subjective comfort and effectiveness data was collected.

The results indicated a statistically significant reduction in the muscle exertion required to perform the physical tasks, a slight increase in manual dexterity and an overwhelming preference regarding the comfort of the device. The device lessens muscle fatigue of the shoulder and, by supporting the upper arm and offloading weight to the hips, reduces spinal compression forces on the lower back. **DE**

www.levitatetech.com
www.igus.com

Tom Renner is an award-winning former journalist who writes extensively on issues in manufacturing, engineering and building trades industries.

FEATURE CREEP

Quebec innovator re-invents the auto mechanic's iconic creeper.

By Mike McLeod

For nearly as long as there have been cars, mechanics have relied on low-profile wheeled platforms, called creepers, to work on the underside of a vehicle. As pivotal as they are, though, their design and construction – typically a finished wood plank with a head rest supported by swivelling caster wheels – hasn't changed much in the century since their invention.

Enter Quebec City-based serial entrepreneur and inventor, Erik Sieb, whose company, Creepex, makes a line of modernized creepers that have caught the attention of Caterpillar, the U.S. military, prolific car collector Jay Leno and a high-profile aerospace company. According to Sieb, what sets his products apart is the fact that his designs aren't hampered by convention.

"None of us are car guys or mechanics by trade," Sieb says of himself and his three-man crew. "In fact, I'm not an engineer, a designer or a car person. I'm just a guy who has outside-the-box ideas and gets the best people I can find to do what I have to do."

The first of Sieb's unconventional ideas, and the inspiration for the company, came in 2006 from his then 17-year-old son, who had just bought his first car. Eager to keep it in working order, the teenager apprenticed with a car mechanic friend. However, a close call while under the car for the first time prompted Sieb's son to ask why there wasn't more protection for the mechanic beyond jack stands.

"He came home and asked me why there isn't a roll bar on the creeper to act as protection," Sieb recounts. "I thought it was a good idea, so I started searching to see if there was anything like that. What I found is that there were a number of creepers that were different here and there but all pretty much the same. So I filed for a patent and found a partner who was willing to manufacture it."

Sieb turned to André Wagner, owner of Quebec City-based metal fabrication job shop, Machinerie P&W Inc., to help create the Creepex Bodyguard. True to the original idea, the heavy-duty creeper includes roll bars along the user's torso and above the head. Together with its reinforced metal frame, Sieb says the Bodyguard withstands up to 30,000 pounds of crushing force.

"At that time, it was a novelty to put roll bars on a creeper," he says. "They have traditionally been very flat and very low to the ground, but those designs forget that the mechanic is the highest point so why not make the roll bar protector the highest point."

To promote his invention, Sieb took the standard trade show marketing route, but also approached both the U.S. military and Caterpillar with custom-made versions. While the U.S. construction equipment giant was intrigued, many of their mechanics weren't as receptive.

"The Bodyguard is very efficient at holding up 30,000 pounds, but it's a very bulky piece of equipment," he admits. "However, Caterpillar's rejection prompted me to create something else. Sometimes it's a negative point that pushes you forward."

That push forward became the company's best selling creepers to date, the FastBack. According to Sieb, direct sales to professional and prosumer mechanics constitute the bulk of sales to date followed by bulk orders from U.S. and Canadian military bases and automotive repair schools. Most recently, the company has entered retail agreements with Costco, Canadian Tire and Part Source. As with the Bodyguard, Sieb relied on Quebec-based freelance industrial designer, Luc Fortin, to modernize the century-old tool and bake in the user-friendly features the creeper line is known for.

"Luc is more than the designer," he says. "He does the CAD and the tooling afterwards, but he also thinks about every aspect. Not just the look and usability but he also makes sure the parts are replaceable and the overall product is maintenance-able."

Similar in profile and ergonomics to the Bodyguard, the FastBack features raised tool trays in place of roll bars and removable LED lights on either side of the head rest. More notable, Sieb says, are the lighter creeper's 7-inch straight wheels. Their positive camber and double bearing configuration allow users to spin in place while their dual tread works equally well on concrete or uneven surfaces. Most

importantly, Sieb says their positioning removes many of the annoyances of traditional creepers.

"Because we are running on 7-inch straight wheels positioned at waist level, you can 'pull a wheelie' on the small control wheel under the head rest," he says. "This allows the mechanic to easily pop over air hoses, floor grates and debris."

To promote his user-friendly product, Sieb reached out to former Tonight Show host and compulsive car fanatic, Jay Leno.

"I called his secretary and I offered him a FastBack as a birthday gift," Sieb recounts. "I think the secretary got a little annoyed when I called her every few days so she just handed the phone to him. When I said I was from Quebec City, he said he came to Montreal once a year for the *Just for Laughs* festival and he said I should swing by the garage."

"Swing by the garage" came to mean the comedian's influential prime-time television show "Jay Leno's Garage." Sieb's appearance on the show, along with his creeper, marked a turning point for Creepex and ultimately led to the company's latest venture, the Beast.

Initially designed for rocket engineers, the Beast isn't a creeper by traditional standards but what Sieb calls an industrial chair. With input from Machinerie P&W engineer, Gaétan Roseberry, the Creepex team designed the chair to gently recline from a 45 degree back angle to fully flat using two motors powered by a rechargeable battery pack.

Sieb says the Beast's ability to progressively recline the back rest and flatten the seat via a switch on the left hand arm rest makes it perfect for mechanics working around the curved underbelly of a plane fuselage or jet engine. Not yet available for retail, the Beast is currently being tested by Canadian Air Force mechanics working on CF-18 fighter jets.

"There are other industrial reclining chairs but not one as fully mobile," he says. "We use the same idea as our other creepers, with two sets of frictionless caster wheels, which gives you a lot of stability and control when moving. We've also adapted the handles or arms of the chair so they are low enough that you can drive it precisely with your knees."

As far as Creepex has come, Sieb says the company will continue to improve it's existing line and add as many as eight new creepers to the line-up in the future. DE

www.creepex.com

Automation

Compact Industrial PC

Beckhoff has extended it C60xx series of compact Industrial PCs with the addition of its C6017, which includes an increased variety of interfaces and an integrated UPS. In addition to the existing C6015's configuration with DisplayPort connection, dual Ethernet adapters and USB 3.0 and USB 2.0 ports, the C6017 adds two RJ45 and two USB 2.0 interfaces. Moreover, the IPC features an optional capacitive 1-second UPS. Measuring 82 x 82 x 66mm, the passively cooled C6017 is equipped with an Intel Atom CPU, with up to four processor cores, in an aluminum and die-cast zinc housing.

www.beckhoffautomation.com

Industrial Gripper

SCHUNK introduced its EGP-C Co-act, a 2-finger parallel gripper that is German Social Accident Insurance (DGUV) certified for collaborative operations. Controlled via digital I/O, the gripper satisfies the requirements of ISO/TS 15066. It includes a protective cover as well as safe current limiting. To make the collaboration with the operator as intuitive as possible, the 24V gripper is fitted with LED lighting in traffic light colors. The user can use this to signal the status for each module. It is delivered as a pre-assembled unit that includes the right interface for co-bots from KUKA, FANUC or Universal Robots.

www.schunk.com

Web Terminal

B&R has added two sizes to its T50 power panel series for a total of five different sizes with diagonals ranging from 5 to 15.6 inches. The series features a projected capacitive multi-touch screen, for creating HMI applications. All models have a glass touch screen and are capable of handling multi-touch gestures. With hardware that meets the demands of web-based HMI, the panel can be used to implement either web-based or VNC-based applications. The Power Panel T50 is equipped with a Gigabit Ethernet interface and is available with an optional integrated switch that allows simple daisy-chain cabling.

www.br-automation.com

Motors & Drives

High performance drives

Festo unveiled its ELGC/EGSC drive series for high precision in large-volume, lightweight applications. This series includes ELGC spindle and toothed belt axes and EGSC mini-slides, as well as axial and parallel kits of paired servo and stepper motors. The drives can be utilized as single axis or joined as multi-axis systems. Two ELGC drives or an ELGC and EGSC mini-slide can be combined. The ELGC axes feature a protected recirculating ball bearing guide designed for XY-movements and vertical Z-movements. The EGSC mini-slides feature quiet spindle operation for vertical Z-movements or guided linear individual motion. The drive and guide elements deliver load carrying ability and repetition accuracy up to ±0.003mm for spindle axes, ±0.015mm for mini-slides and ±0.08mm for tooth belt axes.

www.festo.ca

Control Cabinet-Free Drive System

Bosch Rexroth announced its control cabinet-free IndraDrive Mi drive systems are now equipped with convection and forced air cooling options, in addition to thermal interface for cold plate or insulated mounting. These two types of cooling do not require any process water for cooling. All mains connection components are now IP65 rated in the IndraDrive Mi and can be directly installed in the machine. The mains filter, mains choke and mains contactor are integrated in the KNK03 mains module to supply direct power from the grid. According to the company, its regenerative KMV03 power supply module with control electronics, braking resistor and brake transistor can replace the power supply and the control electronics in the control cabinet.

www.boschrexroth.ca

Brake Motors

Oriental Motor has added reversible and electromagnetic brake type motors to its KII Series global standard AC motor line. The reversible motors are designed for bi-directional operation. A friction brake is equipped at the back of the motor for applications that require rotational direction changes. The electromagnetic brake motors are designed for applications where holding the load is required. An AC power-off activated type electromagnetic brake is equipped to allow the motor to stop instantly. The KII Series motors are available in imperial or metric output shafts with output power ranging from 6W (1/125 HP) to 90W (1/8 HP). They are also available with lead wires or an optional IP66-compliant slim body terminal box (25W and higher).

www.orientalmotor.com

Metrology

3D Scanning CMM

Creaform introduced the CUBE-R, which extends the 3D digitizing and inspection capabilities of the company's MetraSCAN 3D for dimensional measurement of parts ranging from 1 to 3 meters with metrology-grade volumetric accuracy. The CUBE-R offers a realistic and comprehensive alternative to coordinate measuring machines (CMM) and other robot-mounted, structured-light 3D scanners. According to the company, the system performs effective inspections on several hundred parts a day, even on dark or reflective parts with complex geometry. It can maximize production cycle and throughput by offering a simultaneous operation of data acquisition and analysis in a continuous and uninterrupted measurement flow.

www.creaform3d.com

CMM

Hexagon Manufacturing Intelligence introduced its GLOBAL S coordinate measuring machine (CMM) series, customizable for specific inspection work and changing manufacturing objectives. The CMM platform features four capability packages (Throughput, Precision, Multi-Purpose and Shop-Floor) and uses Hexagon's smart technologies and sensor configurations to streamline the creation, execution and analysis of measurement routines. The EPS concept presents users with software and probe choices, as well as the Compass vibration-reduction system, and the PULSE environmental monitoring tool and machine messaging lights.

HexagonMI.com

Optical 3D Measuring System

FocalSpec released its UULA Line Confocal Scanner, a general-purpose 3D metrology tool for offline and at-line users. The UULA is an automated optical 3D imaging and metrology system for submicron resolution measurements on any material. The stand-alone system is used in state-of-the-art R&D laboratories, smart manufacturing and quality control. The scanner is based on FocalSpec's patented Line Confocal Imaging technology that enables high-speed 3D imaging of surfaces that are otherwise difficult or impossible to measure. With UULA, parts and assemblies having highly reflective, mirror-like, transparent, curved and sloping surfaces can be scanned in seconds at sub-micron resolution.

www.focalspec.com

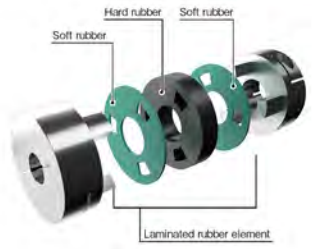
Power Transmission

Plastic pillow block bearing

igus has developed the xirodur B180 pillow block bearing, a self-lubricating solution with FDA-compliant and high-performance plastic components. Due to its material and built-in stainless-steel balls, the bearing is smooth-running and corrosion-resistant. The self-lubricating and wear-resistant properties also eliminate potential contamination, the company says. Due to the identical hole spacing dimensions, metal bearings can be easily replaced. When metal solutions are replaced, 83 percent weight is reduced. The ball-mounted xiros pillow block bearing is flushable and suitable for application environments of up to 176°F.

The bearing can also withstand with up to 110 pounds and 850 revolutions per minute. The bearing is currently being used for shafts with a diameter of 2.5 centimeters, but other sizes are available upon request.
www.igus.com

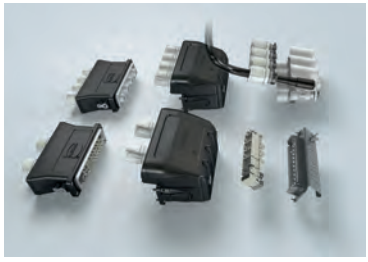
Shaft Couplings



Miki Pulley introduced its Step-Flex class of shaft coupling with a two-part elastomer element combination. With this design, a hard (black) element is separated from the aluminum alloy hubs by a softer (green) elastomer disc. This combination maintains adequate torsional stiffness for precise positional accuracy while still allowing for minimal angular and parallel misalignment and absorbing vibration. The coupling's elastomer element also provides the electric and temperature isolation. The bearing offers torque up to 531 in-lbs. (60 Nm) and comes in 9 sizes with bore sizes ranging from 1/8 to 1.125 inches (3mm-30mm).
www.mikipulley-us.com

Electrical

Connectors



HARTING Slim, EasyCon connectors provide greater flexibility.

HARTING has expanded its Han HPR connector series with its Han HPR 22 Slim connector that can accommodate up to four 250A contacts. The company also has added sizes 16 and 34 to the Han HPR EasyCon line that was launched originally with size 24. EasyCon connectors feature more high current carrying capacity and configuration possibilities than standard Han HPR interfaces. The size 16 can house 2-4 high current contacts, up to 2 x 650A. It also can be configured as a hybrid with power, signal or data modules from HARTING's Han-Modular lineup, with more than 100 inserts to choose from. The size 34 can accommodate up to four 650A contacts each and, as a hybrid, can house up to 12 Han-Modular inserts.
www.harting.com

Power Supply

Omron unveiled its S8VK-X switch mode power supply, which incorporates the company's Push-In Plus technology. The S8VK-X has EtherNet/IP and Modbus TCP compatible communication capability to enhance automation facility's preventative maintenance programs. Information from the S8VK-X can be monitored in a centralized location for years until replacement and percent-

age life to plan replacements according and increase uptime. Product status can be checked on-site using the indication monitor. The power supply has an operation temperature range from -40 to 70°C. It comes with a Power Boost function at 150% (240W and 480W).
www.industrial.omron.ca

Sensors

Signal Conditioner

Alliance Sensors Group released its S2A, a LVDT signal conditioner with cyber security tamper prevention and notification features. The conditioner has been engineered to work with the widest range of LVDTs, RVDTs and inductive half-bridge sensors including 3-wire GE LVRTs and GE gas turbine buck-boost style LVDTs. The S2A's diagnostics can detect at least 11 fault conditions, including common hook-up errors and cybersecurity tampering attempts. The signal conditioner's internal microprocessor calculates jumper connections for gain, range, etc. The new S2A DIN-rail-mounted module can be hot swapped into an existing installation, with original calibration data saved and then reloaded into a new module via its RS-485 port.
www.alliancesensors.com

Safety Limit Switches

AutomationDirect has added a line of limit switches from IDEM that provide positively operated switching contacts to verify the position of machine elements or other moving parts for safety related purposes. The company offers a range of housing types, each of which offers a variety of actuation mechanisms. HLM series limit switches with heavy duty zinc aluminum die-cast bodies and LSPS series limit switches with standard duty plastic bodies have IP67 ratings and 1/2-inch NPT conduit fittings. The HLM-SS series of heavy duty stainless steel limit switches has an IP69K rating and 1/2-inch NPT fittings. LSMM series (die-cast zinc aluminum body) and LSPM series (plastic body) are compact size switches with 2m pigtails and IP67 ratings.
www.automationdirect.com

Incremental Encoder

POSITAL through-hollow incremental encoders are designed to be installed with the machine shaft passing through the sensor. For motors, they can be installed between the body of the motor and other components mounted on the shaft. POSITAL's through hollow encoders are available for shaft diameters ranging from 3/8 inch (9.5mm) to 1-3/4 inch (44.5mm). The

smaller units (up to 14mm shaft opening) have an external diameter of 2-1/4 inch (58mm). The larger units (5/8 inch to 1-3/4 inch shaft size) have external diameters of 3 or 4 inches (77 or 100mm). Available resolutions extend from 360 PPR to 4096 PPR (pulses per revolution). All encoders have aluminum housings and an IP65 protection rated. Communications interfaces include RS422 (TTL) 5V or 11-30V and Push-Pull (HTL, 5-30V).
www.posital.com

IO-Link Programming Tool

Novotechnik introduced its IO-Link programming tool designed for its RFC-4800 Series of touchless angle sensors. The device connects a sensor to a mini USB port of a PC running Windows or newer operating system. IO-Link enables users to program, test and adjust custom offset values to null point. It also allows setting direction of rotation as clockwise or counter clockwise, average the output across, smooth the signal for noise filtering and other reasons. It also reads an error signal if the magnet is absent or outside the sensor's operating range. It also reports functional status of the sensor. Once a sensor has been programmed, it can be software-locked through IO-Link. A unique device identifier is also readable over the IO-Link interface.
www.novotechnik.com

True Color Sensor with IO-Link

Balluff introduced its BFS 33M true color sensor with IO-Link that detects fine shade differences while ignoring surface textures. The sensor checks small spots of color at a rate of up to 1.5 kHz with a range of 400mm. The sensor uses white LEDs combined with the CIELAB Lab color space which includes all possible colors, exceeding the range of the RGB color model. The sensor can be configured and parameterized with IO-Link to store up to 256 true color programs.
www.balluff.com

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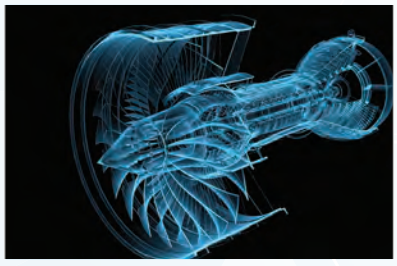

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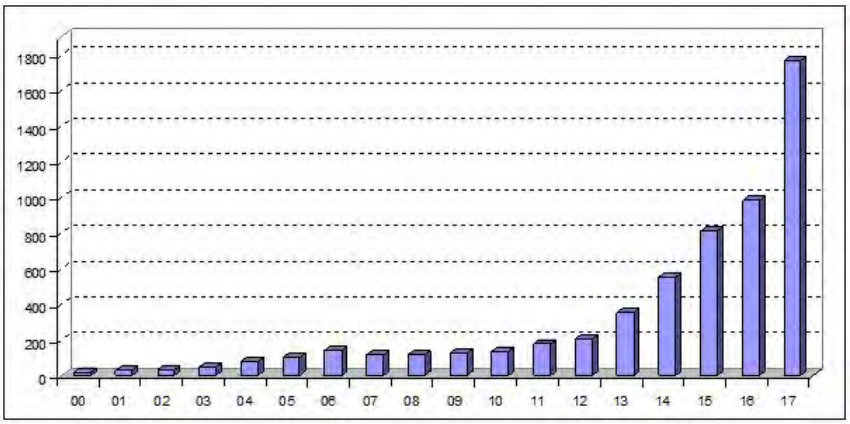
ANNEX BUSINESS MEDIA

2018 CANADIAN ADDITIVE MANUFACTURING GUIDE

Wohlers Report: AM industry expanded by $1B+ in 2017



Dramatic rise in metal AM system sales — Source: Wohlers Report 2018

In April, Wohlers Associates officially released its 2018 industry-leading global report on the state of the additive manufacturing industry. According to the report, the global industry expanded by more than US$1.25 billion last year.

Part of the expansion is due to new system manufacturers entering the market at a rapid pace, offering machines with open material platforms, faster print speeds and lower pricing. In 2017, the report says, there were more than 135 companies around the world producing and selling industrial AM systems (machines costing $5,000+). That number is up from 97 companies in 2016.

Another source of growth, the Wohlers Report 2018 states, came from an estimated 1,768 metal AM systems sold in 2017, compared to 983 systems in 2016, an increase of nearly 80%.

This stat supports the finding that global manufacturers are becoming increasingly aware of the benefits of using metal additive manufacturing tech to produce parts. The report also suggests that manufacturers have more confidence in metal AM systems due to improved process monitoring and quality assurance measures – although more work is ahead.

The 344-page Wohlers Report 2018 was developed with the support of 92 service providers, 64 AM system manufacturers and 19 producers of third-party materials and desktop 3D printers. It also includes the shared data and expertise from 76 co-authors and contributors from 32 countries.

wohlersassociates.com/2018report.htm

Javelin and Cimetrix join forces

(From left) Senior management team for the integrated company: Kirsten Janeteas, John Carlan, Ted Lee, James Janeteas.

Javelin Technologies and Cimetrix Solutions announced they will combine into a unified team to enable a greater level of service and support. The integrated company covers Canada coast to coast, with offices in Vancouver, Calgary, Edmonton, Winnipeg, Kitchener, Oakville, Oshawa, Montreal and Dartmouth. All current employees, the company says, continue to play a key role in the unified enterprise.

The senior management team for the integrated company will consist of Javelin's leaders – John Carlan and Ted Lee – with James Janeteas of Cimetrix. Javelin will

continue to be known as Javelin Technologies and Cimetrix will be referred to as "Cimetrix Solutions, a division of Javelin Technologies."
www.javelin-cimetrix.com

Concordia researcher develops composites with 4D printing

Suong Van Hoa/Advanced Manufacturing: Polymer & Composites Science.

A professor at Concordia University has discovered a way to create curved composite objects using 4D printing. Similar to 3D printing, the 4D variant creates objects that change shape when exposed to heat, light, a magnetic field, moisture or some other environmental input. What's more, the engineering researchers says his new method removes the high costs associated with creating such structures.

"4D printing allows us to make curved composite structures without the need to make curved moulds," says Suong Van Hoa, professor in the Department of Mechanical, Industrial and Aerospace Engineering in Concordia's Faculty of Engineering and Computer Science (ENCS).

Hoa says his process relies on exploiting the anisotropic properties of composite layers – how a material acts while bearing loads along different axes. Resin shrinkage, for example, can cause materials to deform, while temperature changes can cause fibres to expand or contract. Hoa argues that understanding and controlling these changes is key to making curved laminates without curved moulds.

"4D printing of composites utilizes the shrinkage of the matrix resin, and the difference in coefficients of thermal contraction of layers with different fibre orientations, to activate the change in shape upon curing and cooling," he says.

Hoa cautions that the degree of shape-changing depends on the material properties, the fibre orientation, the lay-up sequence and the manufacturing process. Still, he believes his research is well suited for the aerospace industry, where composites are widely used. He also thinks this will be useful for space applications where there is significant temperature fluctuation.

"The structure can open up during the day (when the temperature is high) to collect the solar energy, and close up at night to provide protection for its interiors," he adds. He announced his latest discovery in the journal *Advanced Manufacturing: Polymer & Composites Science*.
www.concordia.ca

SLM Solutions expands Canadian footprint

Metal-based additive manufacturing company, SLM Solutions, announced it will partner with Spark & Co., a Canadian machine tool distributor, to sell SLM Solutions' machines in Quebec and Ontario.

"As a supplier of CNC controlled EDM, waterjet and machining solutions since 2002, Spark & Co. has developed a reputation as a true one-stop shop for customers establishing or growing their manufacturing capabilities" stated Mark Hoefing, President of SLM Solutions NA.

"The addition of SLM Solutions machines to their equipment portfolio enhances their ability to support their customer's manufacturing strategies and gives SLM Solutions a strong commercial partner in this technology-focused area of Canada."

SLM Solutions offers three unique metal AM machines using a selective laser melting (SLM) process and a variety of metal powders.
slm-solutions.us
www.spark-co.com

AM SERVICE BUREAU CAPABILITY GUIDE

Service Bureau	Contact Info	Additional Services
3DPhacktory	5 Dickens St., Toronto, ON, M4M 1T8 416-462-0994 I www.3dphacktory.com	Also serves Vancouver, Calgary and Montreal; In-house design; Post-production
3D Print Western	15825 118 Ave. NW, Edmonton, AB, T5V 1B7 780-447-1578 I www.3dprintwestern.com	3D Modelling Service; Product testing; 2D to 3D; 3D scanning
3DX Production	12 Bram Ct. - Unit 12, Brampton, ON, L6W 3V1 855-208-8659 I www.3dxproduction.com	Surface finishing; Packaging services; Specializes in large quantity runs of custom parts
Additive Metal Manufacturing	131 Citation Dr. - Unit 17&18, Concord, ON, L4K 2R3 905-738-0410 I www.additivemet.com	Serves Montreal, Quebec City, Toronto, Windsor, Ottawa, Vancouver, Edmonton; Engineering & design consultation; Rapid prototyping
Agile Manufacturing	141 Reach St. - Unit 9, Uxbridge, ON, L9P 1L3 905-852-0794 I www.agile-manufacturing.com	3D Scanning for reverse engineering; Casting of urethanes for low volume production of metals
Anubis 3D	4100 A Sladeview Cres. - Unit 4, Mississauga, ON, L5L 5Z3 800-905-6073 I www.anubis3d.com	Specializes in SLS technology; Design/build end-of-arm tooling and end of use mechanical components
Axis Prototype	6956, rue Jarry Est, Saint-Léonard, QC, H1P 3C1 888-320-8851 I www.axisproto.com	High-end finishing; Design & scanning services; Foundry pattern processing
Burloak Technologies	354 MacNab St., Dundas, ON, L9H 2L2 905-592-0244 I www.burloaktech.com	R&D production; Machine shop/CNC services; Metrology lab
Cimetrix, a division of Javelin Technologies	1143 Wentworth St. W - Suite 100, Oshawa, ON, L1J 8P7 905-728-6962 I www.javelin-cimetrix.com	Serves Oakville, Edmonton, Calgary, Winnipeg, Dartmouth and Vancouver; Specializes in jigs, fixtures, tooling; Design for AM; Reverse engineering; Laser cutting & engraving
Custom Prototypes	214 Evans Ave., Toronto, ON, M8Z 1J8 416-955-0857 I www.customprototypes.ca	3D scanning; Post-process finishing; CAD design
Envirolaser	199 Colonnade Rd., Nepean, ON, K2E 7K3 613-225-4726 I www.envirolaser.com	2D and 3D Printing
Forge Labs	480 Smithe St. - #103, Vancouver, BC, V6B 5E4 604-259-1399 I www.forgelabs.ca	3D CAD modeling & design; Proprietary online quoting & order system direct to website
FusiA	2485 rue Guenette, Saint-Laurent, QC, H4R 2E9 514-377-9961 I www.fusia.fr	Design support services; Machining and post-processing services
Hot Pop Factory	215 Spadina Ave. - b05, Toronto, ON, M5T 2C7 416-306-6468 I www.hotpopfactory.com	Design; Laser cutting and engraving; CNC machining
Industrial Technology Centre	78 Innovation Dr. - #200, Winnipeg MB, R3T 6C2 204-480-0344 I www.itc.mb.ca	Shape capture services; Accredited material testing/metrology services
Kuzma Industrial	Suite 396, 100-111 5th Ave. SW, Calgary, AB, T2P 3Y6 403-774-7384 I www.kuzmaindustrial.com	Design and rapid prototyping; CNC machining; Casting services
Lae Technologies	145 Welham Rd., Unit 11, Barrie, ON, L4N 8Y3 705-728-7000 I www.laetechnologies.com	CNC machining; Quality/inspection; Design and prototyping services
Lezar3D	851 Rue Ontario Est., Montréal, QC, H2L 1P3 438-990-5333 I lezar3d.com	Self-serve and full service options
MedPrint	1 Kings College Cir. - Room 1208, Toronto, ON M5S 1A8 416-946-3235 I uoftmedprint.com	Specialty 3D printing service through Faculty of Medicine at the University of Toronto; Reverse engineering and design services
NOVACAD 3D	20-250 Brownlow Ave., Dartmouth, NS, B3B 1W9 902-292-7443 I www.novacad3d.com	Scan-to-CAD; Post-processing
Nova Product Development Services	7 Labatt Ave., Toronto, ON M5A 1Z1 416-368-0896 I www.novaproduct.com	Model finishing; Urethane casting; Relationships with other service bureaus to provide SLA, SLS and DMLS models
Objex Unlimited	36 Fieldway Rd., Etobicoke, ON, M8Z 3L2 416-233-7165 I www.objexunlimited.com	Design for AM; Concept development; Model making and finishing; Digital sculpting; Rapid prototyping; 3D scanning; Sales and services; Reverse engineering
Openforge AM	148 rue de la Barque, Gatineau, QC, J8P 0A7 819-208-5721 I www.openforge.ca	Rapid prototyping; Reverse engineering; Low-volume manufacturing
Precision ADM	1595 Buffalo Pl. - Unit A, Winnipeg, MB, R3T 1M1 204-289-4491 I www.precisionadm.com	CAD design & engineering; 3D scanning & metrology; CNC machining; Inspection
Proto3000	6260 Highway 7 - Unit 8, Vaughn, ON, L4H 4G3 905-738-1779 I www.proto3000.com	Jigs and fixtures development; Tooling and on-demand low volume production
ProtoLabs	5540 Pioneer Creek Dr., Maple Plain, MN, 55359 877-479-3680 I www.protolabs.com	CNC machining; Injection molding; Sheet metal fabrication
Solaxis	11A Du Pacifique St. E., Bromont, QC, J2L 1J4 450-919-1515 I www.solaxis.ca	Mechanical Design (CAD); Dimensional metrology; Painting and finishing
Troadey	1020 Rue Bouvier - #400, Québec City, QC, G2K 0K9 418-476-8252 I www.troadey.com	3D printing technologies; Automation and robotisation; Binder jetting mass-production; Production service for 3D printed food
Westech Labs	7106 42 St. - Unit 104, Leduc, AB, T9E 0R8 780-436-5200 I www.westechlabs.com	Calibration; Inspection; Laser engraving

SLA	DLP	FDM	MJ	DOD	BJ	MJF	SLS	DMLS/SLM	EMB	ADAM	CFF/FFF	Specifications
●		●	●				●					SLA (max. build vol. 600 x 900 x 1200mm); FDM (max build vol. 203 x 203 x 152mm); MJ (max, build vol. 490 × 390 × 200mm); SLS (max. build vol. 200 x 250 x 330mm)
●	●	●	●				●	●				Fortus 900mc; Ember DLP printer; Formlabs Form 2; Additional capabilities not in-house
							●					SLS 3DSystems ProX 500 (max. build vol. 381 x 330 x 457mm)
								●				2 EOS 290 machines (max. build vol. 250 x 250 x 325mm)
●	●	●	●		●		●			●	●	30 production machines (max. build vol. 1500 x 750 x 550mm); New Metal X, Figure 4, FabPro 1000 3D printers
●		●	●		●		●	●				Machines include EOS P395 & EOS P100
●	●	●	●				●	●				7 SLA (max build vol. 20 x 20 x 13 inches); 1 DLP (13 x 15.7 x 15.7 inches); 1 FDM (17.8 x 17.8 x 25.1 inches); 1 MJ (15 x 19 x 7.9 inches); 3 SLS (11 x 13 x 11 inches); 1 DMLS: 9.8 x 9.8 x 7.2 inches
		●					●	●				9 Machines: 1 FDM; 1 SLS; 7 DMLS
		●	●	●								29 machines: 21 FDM (max build vol. 914 x 610 x 914mm; 7 MJ (max. build vol. 490 x 390 x 200mm); 1 DOD (max build vol. 152 x 151 x 101mm)
●	●	●					●	●				7 machines: (max. build vol. 600 x 600 x 400mm) including a Renishaw 250 Metal 3D printer
		●	●		●						●	8 machine: 3D Systems HD3500Max (max. build vol. 11.75 x 7.3 x 8 inches); 3D Systems Spectrum Binder Jetting (10 x 14 x 8 inches); Markforged FFF (320 x 132 x 154mm); FDM (500 x 500 x 500mm)
●		●				●	●					13 machines in-house (max. build vol. 406 x 406 x 355mm)
								●				EOS M280 and M290
		●					●					Max. build vol. 140 x 220 x 140mm
		●										1 Stratasys Fortus 400mc (max. build vol. 406 x 355 x 406mm)
●		●					●	●				SLA/FDM/SLS (max build vol. 590 x 600 x 600mm); Renishaw AM250 (max. build vol. 250 x 250 x 365mm)
●		●	●				●					Stratasys Fortus FMD machine; Stratasys Objet 3D Polyjet printer
		●										7 machines: MakerBot and Markforged
		●										2 machines: Stratasys FDM F170 and 450MC
			●								●	ProJet 3500 HD Max; ProJet 860 PRO; BigRep ONE; Mark Two
		●					●					3 FDM machines with new SLS machine to be added mid-2018
●		●	●		●						●	14 machines in-house (max. build vol. 1000 x 500 x 500mm)
●		●					●					6 machines in-house: SLA (max. build vol. 145 x 145 x 175mm); FDM (max. build vol. 300 x 300 x 300mm); SLS (max. build vol. 110 x 110 x 110mm)
		●						●				2 DMLS (EOS M290) machines (max. build vol. 250 x 250 x 290mm)
●		●	●			●	●	●	●			30 machines (max. build vol. 914.4 x 609.6 x 914.4mm)
●			●			●	●	●				80 machines (max. build vol. 737 x 635 x 533mm)
●		●										1 SLA 3D Systems Viper SI2 (max. build vol. 254 x 254 x 254mm); 5 FDM Stratasys Fortus (max. build vol. 914 x 609 x 914mm)
●		●	●		●		●					3 SLA and 4 FDM machines; 1 MJ machine; 11 BJ machines; 1 SLS machine. Overall max. build vol. 508 x 610 x 406mm
●		●					●					SLA experts

AM DISTRIBUTOR & RESELLER LISTING

Company	Brands Sold	Address	Phone Number	Email	Website
3D Printers Canada	Stratasys	6260 Highway 7 Woodbridge, ON, L4H 0K9	905-738-1779	info@3dprinterscanada.com	www.3dprinterscanada.com
		43 Boul. Samson - Suite 396 Laval, QC, H7X 3R8	514-664-2016		
Agile Manufacturing	3D Systems; Markforged	141 Reach St. - #9 Uxbridge, ON, L9P 1L3	905-852-0794	agile@agile-manufacturing.com	www.agile-manufacturing.com
AON3D	AON3D Direct Sales	9494 Boul. St. Laurent, Suite 600 Montreal QC, H2N 1P4	438-807-0872	sales@aon3d.com	www.aon3d.com
Arcam CAD to Metal Inc.	Arcam Direct Sales	6 Gill St. - #6B Woburn, MA, 01801	781-281-1718	N/A	www.arcam.com
CAD MicroSolutions	BigRep; HP; Markforged; Nano Dimensions	225 Pinebush Rd. - Unit 102 Cambridge, ON, N1T 1B9	519-642-8222	info@cadmicro.com	www.cadmicro.com
		65 International Blvd. - Suite 103 Toronto, ON, M9W 6L9	416-213-0533		
		6500 Trans Canada Hwy. - Suite 400 Pointe Claire, QC H9R 0A5	888-401-5885		
Canadian Additive Manufacturing Solutions	3D Systems	5605 Timberlea Blvd. Mississauga ON, L4W 2S4	416-479-0009	sales@canadianadditive.ca	www.canadianadditive.ca
Carbon	Carbon Direct Sales	1089 Mills Way Redwood City, CA, 94063	650-285-6307	info@carbon3d.com	www.carbon3d.com
Cimetrix, a division of Javelin Technologies	Desktop Metal; Stratasys	1143 Wentworth St. West - Suite 100 Oshawa, ON L1J 8P7	905-728-6962	sales@javelin-tech.com sales@cimetrixsolutions.com	www.javelin-cimetrix.com
		3457 Superior Crt. - Unit #1 Oakville, ON, L6L 0C4	905-815-1906		
		10060 Jasper Ave., Tower 1 - Suite 2020 Edmonton, AB, T5J 3R8	780-822-4700		
		10 Morris Dr. - Unit 9 Dartmouth, NS, B3B 1K8	902-332-3210		
		675 Berry St. - Unit G Winnipeg, MB, R3H 1A7	204-474-0982		
		480 Smithe St. - Unit 103 Vancouver, BC, V6B 5E4	604-343-1890		
		3030 Sunridge Way NE - Unit 9 Calgary, AB, T1Y 7K4	403-517 5800		
Concept Laser	Concept Laser Direct Sales	1000 Texan Trl. - Suite 150 Grapevine, TX, 76051	817-328-6500	info@conceptlaserinc.com	www.conceptlaserinc.com
Creative CADworks	MiiCraft B9 Creations	27 Queen St. East - Suite 1401 Toronto, ON, M5C 2M6	416-368-7266	sales@creativecadworks.ca	www.creativecad.works
designfusion	HP	305 Milner Ave. - Suite 308 Toronto, ON MIB 3V4	416-267-5542	info@designfusion.com	www.designfusion.com
		2734, rue Étienne-Lenoir Laval, QC, H7R 0A3	514-761-5682		
		871 rue Shefford - Suite 201 Bromont, QC, J2L 1C4	450-534-5682		
		5490 MacLeod Trl. South Calgary, AB, T2H 2G4	888-567-3933		
		2828 Boulevard Laurier - Suite 782 Québec, QC, G1V 0B9	418-834-5225		
DWS Systems	DWS Systems Direct Sales	Viale della Meccanica, 21 36016 Thiene, VI, Italy	+39 0445 810 810	info@dwssystems.com	www.dwssystems.com
EOS of North America	EOS Direct Sales	28970 Cabot Dr. - #700 Novi, MI, 48377	248-306-0143	info@eos-na.com	www.eos.info
Evolv3D	3D Systems	225 Industrial Pkwy. South - Suite 29 Aurora, ON, L4G 3V5	905-727-5019	info@evolv3dlabs.com	www.evolv3dlabs.com
Genistar	Prodways	6956, rue Jarry Est Saint-Léonard, QC, H1P 3C1	438-738-4133	info@genistar.com	www.genistar.com
Hawkridge Systems	HP; Markforged; UnionTech	1450 Meyerside Dr. - Suite 502 Mississauga, ON L5T 2N5	866-587-6803	info@hawkridgesys.com	www.hawkridgesys.com
		1661 Portage Ave. - Suite 307 Winnipeg, MB, R3J 3T7			
		4208 97th St. NW - Suite 110 Edmonton, AB, T6E 5Z9			
		7101 5th St. SE - Suite 100 Calgary, AB, T2H 2G2			
		10451 Shellbridge Way - Suite 204 Richmond, BC, V6X 2W8			

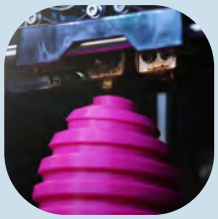
Company	Brands Sold	Address	Phone Number	Email	Website
Hewlett Packard	Hewlett Packard Direct Sales	5150 Spectrum Way - #600 Mississauga, ON, L4W 5G1	404-774-7828	canadastore@hp.com	www.hp.com
Machine Tool Systems	EOS	4025 Sladeview Cres. - Unit 3 Mississauga, ON, L5L 5Y1	416-254-6298	JohnManley@ MachineToolSystems.com	www.machinetoolsystems.com
Objex Unlimited	Formlabs; MakerBot; MarkForged	36 Fieldway Rd. Toronto, ON, M8Z 3L2	416-233-7165	sales@objexunlimited.com	shop.objexunlimited.com
Optomec	Optomec Direct Sales	3911 Singer Blvd. NE Albuquerque, NM, 87109	505-761-8250	sales@optomec.com	www.optomec.com
PrintYourMind3D	LULZBOT Ultimaker	Calgary, AB	587-226-2645	support@printyourmind3d.ca	www.printyourmind3d.ca
Proto3000	MakerBot; Stratasys	6260 Highway 7 - Unit 8 Vaughan, ON, L4H 4G3	905-738-1779	info@proto3000.com	www.proto3000.com
		43 Boul. Samson - Suite 369 Laval, QC, H7X 3R8	514-370-5548		
Renishaw	Renishaw Direct Sales	41 Ardelt Pl. Kitchener, ON, N2C 2C8	905-828-0104	canada@renishaw.com	www.renishaw.com
Sciaky	Sciaky Direct Sales	4915 W 67th St. Chicago, IL, 60638	734-277-8084	rbrown.sciaky@psi-corp.com	www.sciaky.com
Shop3D	FormLabs; MarkBot; Ultimaker	2005 Clark Blvd. - Unit #4, Brampton, ON, I6T 5P8	905-799-1133	sales@shop3d.ca	www.shop3d.ca
SLM Solutions	SLM Solutions Direct Sales	48561 Alpha Dr. - Suite 300 Wixom, MI, 48393	248-243-5400	info@slm-solutions.us	www.slm-solutions.us
Spark & CO	SLM Solutions	30 Émilien-Marcoux - Unit 102 Blainville, QC, J7C 0B5	450-433-2160	sales@spark-co.com	www.spark-co.com
		PO Box 397, Station A Brampton, ON, L6V 2L3	905-670-4333		
Thor3D	MakerBot	109 Saskatchewan Ave. E - Box 268 Outlook, SK, S0L 2N0	306-867-9888	Greg@Thorstad.ca Steven@Thorstad.ca	www.thor3d.ca
XJET	XJET Direct Sales	Science Park, 10 Oppenheimer Street Rehovot 7670110, Israel	+972 8 9314620	info@xjet3d.com	www.xjet3d.com

BENEFITS AND LIMITATIONS OF

Stereolithography (SLA)

SLA is ideal for highly detailed and intricately designed parts with superior accuracy and strength

Benefits	Limitations
• Great value • High accuracy • Large capacity • Virtually limitless part size • Smooth surface finish • Fast • Strong enough to be machined if required • Best for rapid prototyping of concept and designer models	• Brittle • Smaller material selection • Requires printed supports • Products are UV sensitive • Not for functional part or production line



Fused Deposition Modeling (FDM)

FDM is the most widely available 3D printing process, mainly used to produce affordable models with moderate amounts of detail and strength

Benefits	Limitations
• Fast turnaround times (short lead times) • Affordable • Wide range of materials and colours • Most common printer type • Best for hobbyists and some small prototypes	• Low dimensional accuracy and resolution • Limited design compatibility • Print layers are likely to be visible, requiring post-processing • Generally requires printed supports • Slow build rate • Not for high impact parts

Material Jetting (MJ)

MJ produces parts with high dimensional accuracy with a smooth surface finish, making it ideal for realistic visual and haptic prototypes

Benefits	Limitations
• Smooth parts with surfaces comparable to injection molding • Very high dimensional accuracy, resolution • Fast • Homogeneous mechanical and thermal properties • Accurate visual and haptic prototypes • Many materials, texture and colours (option for multi-material 3D Printing)	• Poor mechanical properties • Weak material • Photosensitive and mechanical properties degrade over time • Expensive • Requires supports

A look at other 3D Printing processes

Digital Light Processing (DLP)

+ Highly-accurate layers in just seconds

- Requires support structures for integrity

Continuous Digital Light Processing (CDLP)

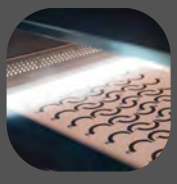
+ High-speed, accurate 3D printing

- Potential for distorted build surface

NanoParticle Jetting (NPJ)

+ high resolution and density

- Tech is expensive; low material selection



Multi Jet Fusion (MJF)

+ improved detailed output, fast

- Limited material selection

OF POPULAR AM TECHNOLOGIES

Information taken from 3D Hubs: www.3dhubs.com

Binder Jetting (BJ)

Binder Jetting is ideal for 3D printing full-color, metal components and large gypsum, sand casting molds

Benefits	Limitations
• Produces metal parts and full-color prototypes	• Low mechanical properties
• Fraction of the cost of other AM technologies	• Higher porosity
• Very large parts and complex metal geometries	• Brittle
• Fast	• Requires post processing
• Not limited by any thermal effects	• Limited material selection
• Low to medium batch production	

Selective Laser Sintering (SLS)

SLS is suited for fully functional prototypes and series of small components, as well as complex, highly durable plastic parts

Benefits	Limitations
• Good, isotropic mechanical properties	• Generally longer lead times
• Requires no support	• Grainy surface finish, internal porosity
• Design freedom for complex components	• Requires post-processing
• Ideal for functional parts and prototypes	• Large, flat surfaces and holes are not printed accurately
• Small to medium batch production	• More expensive, less accessible

Direct Metal Laser Sintering (DMLS)

DMLS/SLM prints high performance, end-use metal parts with complex structures for industrial applications

Benefits	Limitations
• Stronger than cast parts	• Rough finish
• Complex geometries	• Limited part size
• Part weight reduction	• Slow build speed
• No tooling, reducing cost	• Lower tolerance than machining
• High accuracy in fine details	• Generally more expensive than machining and most other AM technologies
• Exotic and expensive to machine metals	• Parts should be designed for additive manufacturing
• Produces parts that are otherwise not manufacturable	

A look at other 3D Printing processes

Electron Beam Melting (EBM)

+ Design flexibility and cost effective

- Requires post-processing

Laser Engineered Net Shape (LENS)

+ Completely dense and can be used to repair parts

- Severe overhangs; post processing required

Electron Beam Additive Manufacturing (EBAM)

+ Fast and cost-effective for large metal parts

- Requires more post-processing; sacrifices accuracy for speed

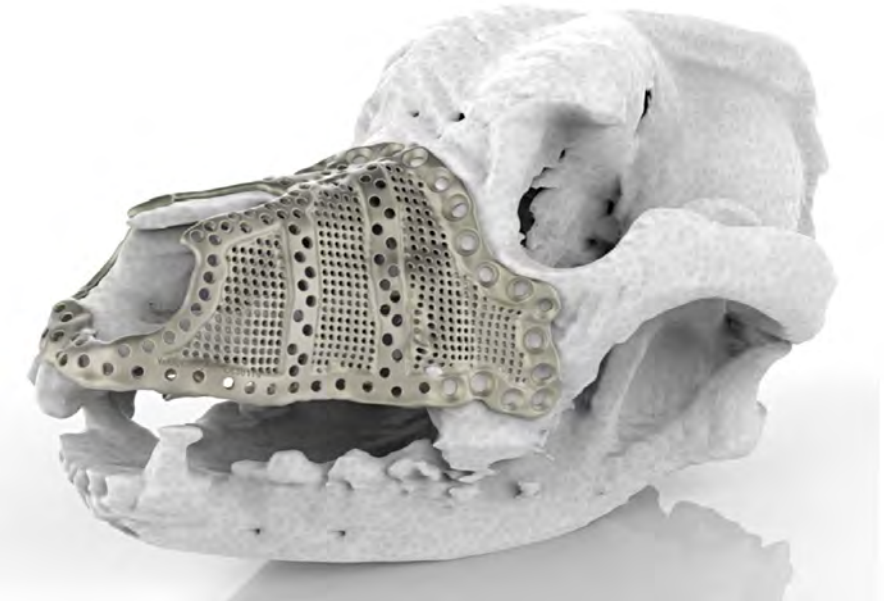
Laminated Object Manufacturing (LOM)

+ improved detailed output, fast

- Limited material selection

CLOSE TO the BONE

Canadian family looks to metal additive manufacturing to save beloved dog.



This medical implant, created by German veterinary designers and 3D printed by Renishaw Canada, saved an Ottawa family's beloved Bernese Mountain Dog stricken with cancer.

More than 50 per cent of dogs over ten years of age are likely to develop a tumour. Often, tumours can be shrunk with chemotherapy and removed with surgery without excessive long-lasting trauma. In some cases, however, the placement of the tumour is too difficult to operate on without severely impacting the quality of life for the dog.

In the human world there has been a significant shift towards surgeons using customized implants to help improve

the results of surgery and reduce patient recovery times.

In the past, hospitals would only use patient specific implants (PSIs) for complex cases, but now – thanks to advances in technology – they are becoming part of standard practice. One of the most effective ways of producing a custom PSI is by using additive manufacturing (AM) with medical-specific CAD tools for the custom design.

That was certainly the case for one beloved Canadian pet. In a truly international effort, UK-based Renishaw banded together with 3D medical designers in Germany and additive manufacturing experts in Canada to help save an Ottawa family's dog with the help of 3D printing.

The seven-year-old Bernese Mountain Dog had a tumour on the left side of his maxilla (upper jaw) and had few options other than total excision of the growth followed by reconstruction. A customised 3D printed titanium implant supporting the dog's bone structure was the most appropriate treatment due to the complexity of the region, requiring significant design and manufacturing freedom.

The procedure, which was carried out by Julius Liptak, veterinary surgeon at Alta Vista Animal Hospital in Ottawa, used an additively manufactured titanium maxillofacial implant designed by Voxelmed, based in Germany. Using Digital Imaging and Communications in Medicine (DICOM), a standard that enables the integration of medical imaging devices, a digital 3D model of the dog's affected area was generated. The model was used to design a custom implant with input from Dr. Liptak.

During the design of the implant, Dr. Liptak reviewed the design repeatedly to compare it to 3D scans and models of the dog's skull. This made the process of manufacturing and placement much more straightforward, as it met the surgeon's specifications for how the implant would fit. Dr. Liptak was able to plan the procedure in advance, streamlining the process and reducing the time that the dog was under anaesthetic.

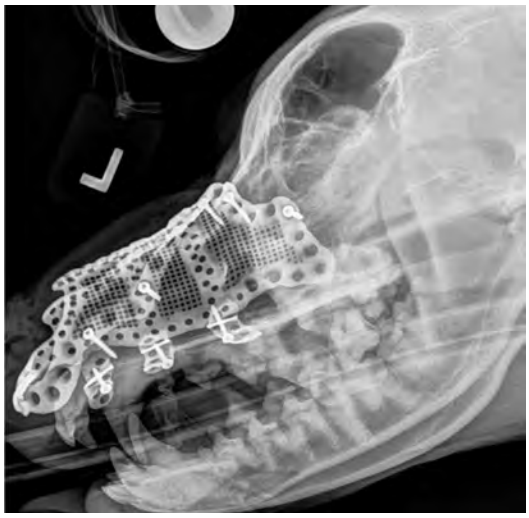
The implant was manufactured at the Additive Design in Surgical Solutions (ADEISS) centre in London, Ontario. ADEISS is the result of a partnership between Western University, the London Medical Network and Renishaw. The centre will focus on the research, development and commercialisation of additively manufactured medical devices and surgical instruments. It will also aid in the development of additively manufactured medical technology to address healthcare issues across the globe.

"During surgery, the affected areas, along with clean tumour margins, were removed," explained Jan Klasen, veterinary surgeon, 3D designer and CEO of Voxelmed. "Because the tumour occurred in the skin, rather than the maxillary bone, resection involved a revision maxillectomy with excision of the 45mm by 50mm mass, with 30mm lateral margins. The implant was then put into place and

fixed with surgical screws. A facial axial pattern skin flap was prepared and used to cover the affected area and the implant. This left the dog with a particularly impressive physical outcome as the nose structure did not have to be altered to account for the missing tissue."

The design and manufacture of the implant took just two weeks to complete. In this particular case, the dog was suffering with on-going tumour growth. So, if the implant had taken too long to be produced, it would have no longer been fit for purpose, as the affected area would have grown.

"Without additive manufacturing technology, it would have been almost impossible to reconstruct the dog's maxilla after tumour removal, because the area was extremely complex in geometry," Klasen commented. "The implant had to have a similar shape and functionality as the dog's existing bone structure. Using additive manufacturing to maintain the original shape and function of the oral and nasal cavity ensures a high quality of life for the dog, just as a naturally shaped skull and maxilla helps the dog to breathe and eat easily.



A side view xray image of the implant following the successful surgery that restored the dog's ability to breath and eat normally.

"To my knowledge, this is the first implant of its kind," Klasen added. "Prior to this case, the majority of veterinary surgeons were unaware that the technology was even available. Similar reconstructions are now being planned in Germany and there is on-going research into how animals can benefit from this procedure."

The seven-year-old Bernese Mountain Dog was able to leave the hospital just one day after surgery. While he spent a little time taking pain medication and antibiotics he was able to breathe normally through his nose and has since made a full recovery. Without the advancements in additive manufacturing, this dog would not have such a long and happy future ahead of him. **DE**

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CONTACT

Alan Macpherson, *Publisher*
416-510-6756
amacpherson@design-engineering.com

Ron Salmon, *Account Manager*
416-510-5249
rsalmon@design-engineering.com

Mike McLeod, *Editor*
416-442-5600 x3231
mmcleod@design-engineering.com

Lindsay Luminoso, *Associate Editor*
416-510-5233
lluminoso@design-engineering.com

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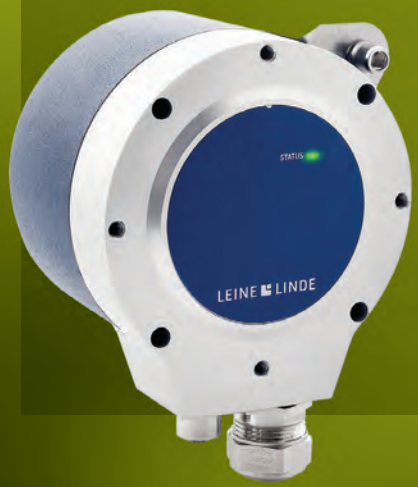

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