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# Design World

September 2013

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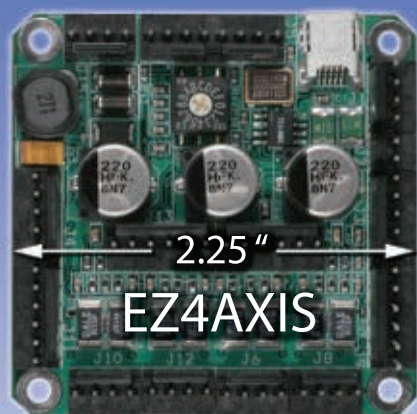
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## » Insights



### Good economic news for manufacturers

I had the opportunity to hear Alan Beaulieu speak at the National Fluid Power Association's annual International Economic Outlook Conference in Chicago last month. Beaulieu, one of the more personable economists you'll ever hear, works for the Institute for Trend Research. The feeling was decidedly upbeat after his presentation. And the crowd—a record 319 registered for this year's event at the Westin Chicago North Shore—was more than ready to hear it.

"The world is presenting you with more and more opportunities. The world is a good place right now in this industry," Beaulieu said.

Beaulieu told the audience that the next significant recession will be in 2019. He explained that it would not as bad as the 2008-2009 event, but worse than the small recession he predicts for 2014—overall, a similar recession to what was experienced in the U.S. in 2001.

#### Several reasons indicate a recovery for this year:

- Leading indicators pointing up for 2013
- Liquidity is not an issue
- The U.S. has become a major producer of energy
- There is a stimulative monetary policy for now
- Employment is rising (companies are finally right sized)
- Banks are lending
- Retail sales are good. Household net worth is up again; other countries will benefit from the fact that American consumers will be spending more over the next five years, and
- Construction spending is improving.

Manufacturing is on the ascent here in the U.S., Beaulieu said, because companies are leaving Europe, China and other parts of the world, and coming here because of our natural gas and energy availability. He said that the thing most hurting the U.S. is the corporate tax structure.

#### His areas of concern included:

- Europe's financial troubles
- China recession/housing bubble
- Massive legislative changes
- Israel and Iran
- Fiscal cliff
- Tax hikes, and
- Massive deficit and growing national debt

He had positive things to say about how Canada will balance its budget by 2015 and will begin to pay down its debt starting in 2016. And he was practically through the roof about Mexico, in spite of the dangerous conditions in parts of that country.

"Mexico has so much potential, it's incredible," Beaulieu said. "This is a place where you have to be deciding how you are going to do business [there]." 

**Where do you think the manufacturing economy is headed?** Comment on Paul's blog on Pneumatic Tips, [www.pneumatictips.com/blog](http://www.pneumatictips.com/blog)

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# The Truth About Compressed Air!

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

## Compare these Blowoffs

There are a variety of ways to blow the water from the bottles shown in the photo below, but which method is best? To decide, we ran a comparison test on the same application using four different blowoff methods: drilled pipe, flat air nozzles, Super Air Knife (each using compressed air as a power source), and a blower supplied air knife (using an electric motor as a power source). Each system consisted of two twelve inch long air knives. The following comparison proves that the EXAIR Super Air Knife is the best choice for your blowoff, cooling or drying application.

The goal for each of the blowoff choices was to use the least amount of air possible to get the job done (lowest energy and noise level). The compressed air pressure required was 60 PSIG which provided adequate velocity to blow the water off. The blower used had a ten horsepower motor and was a centrifugal type blower at 18,000 RPM. The table at the bottom of the page summarizes the overall performance. Since your actual part may have an odd configuration, holes or sharp edges, we took sound level measurements in free air (no impinging surface).



### Drilled Pipe

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



### Blower Air Knife

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



### Flat Air Nozzles

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



### EXAIR Super Air Knife

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

## Facts about Blowers

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

### Here are some important facts:

Filters must be replaced every one to three months.

Belts must be replaced every three to six months.

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

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

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

To discuss an application, contact:

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

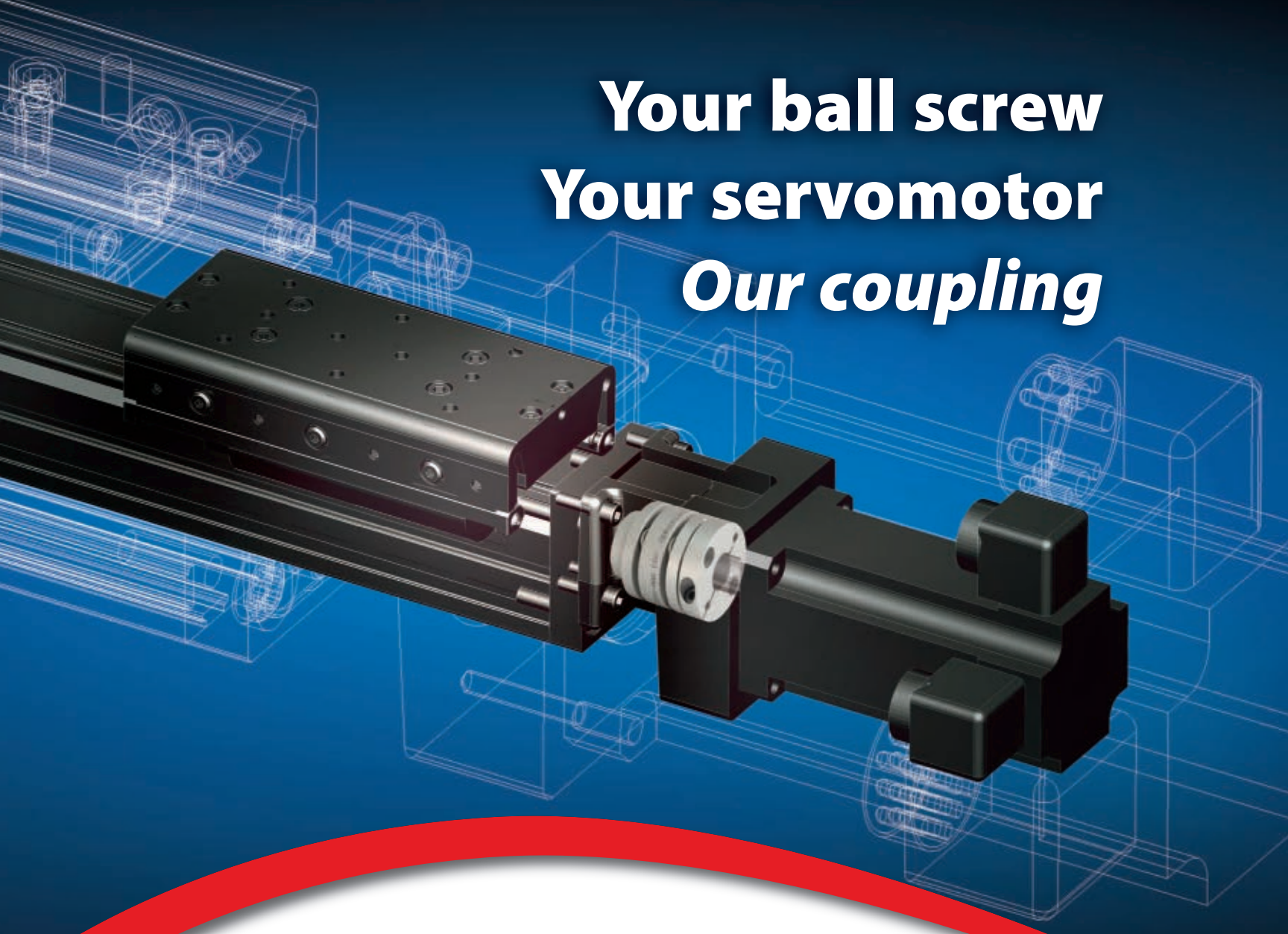
## Blowoff Comparison

| Type of blowoff  | PSIG | BAR | Comp. Air |       | Horsepower Required | Sound Level dBA | Purchase Price | Annual Electrical Cost* | Approx. Annual Maintenance Cost | First Year Cost |
|------------------|------|-----|-----------|-------|---------------------|-----------------|----------------|-------------------------|---------------------------------|-----------------|
|                  |      |     | SCFM      | SLPM  |                     |                 |                |                         |                                 |                 |
| Drilled Pipes    | 60   | 4.1 | 174       | 4,924 | 35                  | 91              | \$50           | \$4,508                 | \$920                           | \$5,478         |
| Flat Air Nozzles | 60   | 4.1 | 257       | 7,273 | 51                  | 102             | \$208          | \$6,569                 | \$1,450                         | \$8,227         |
| Blower Air Knife | 3    | 0.2 | N/A       | N/A   | 10                  | 90              | \$5,500        | \$1,288                 | \$1,500                         | \$8,288         |
| Super Air Knife  | 60   | 4.1 | 55        | 1,557 | 11                  | 69              | \$534          | \$1,417                 | \$300                           | \$2,251         |

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



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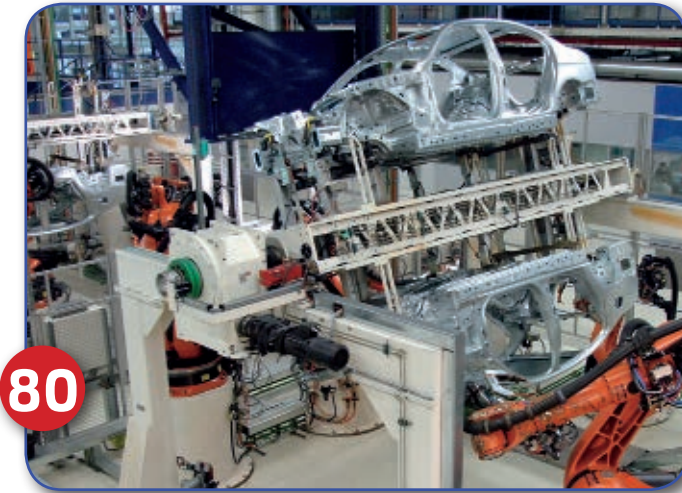




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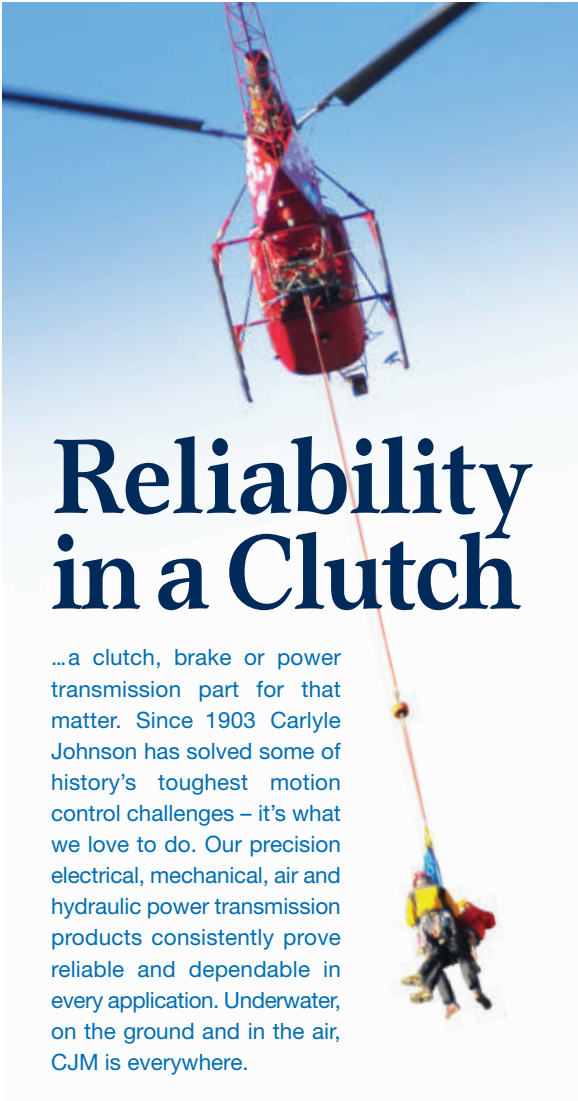


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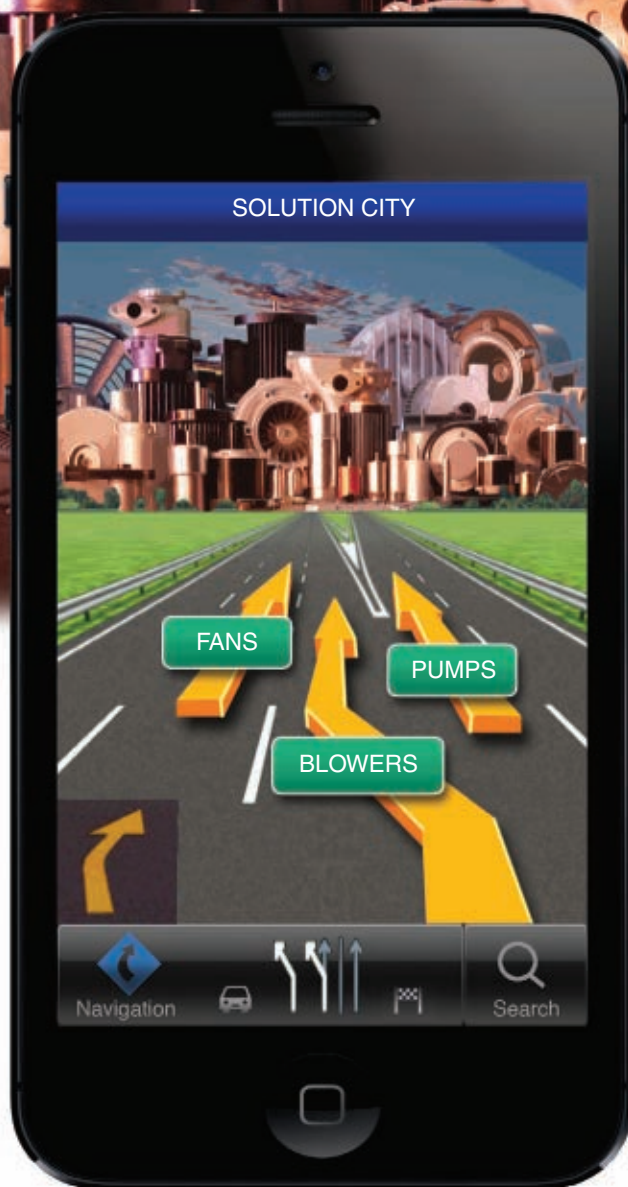
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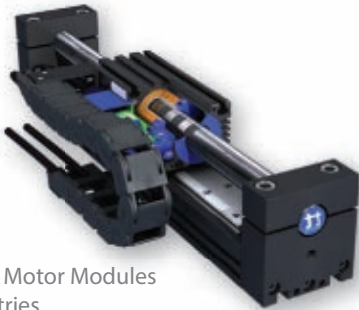
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## Yokogawa installs Blink EV charging stations

■ Paul J. Heney/Editorial Director

**Yokogawa Corp. of America** is offering electric vehicle charging stations to employees at its Newnan, Ga. facility. ECOtality Inc. has installed two Blink Electric Vehicle (EV) charging stations there as part of its Electric Vehicle Project. The EV Project is a public-private partnership with the Department of Energy that evaluates the effectiveness of EV charger infrastructure. Yokogawa Newnan is the first in the area to participate in the program and install EV charging stations.

"This is an advantage to me and future EV owners because it extends the

range of our cars," said Jimmy Newman, Engineering Manager for Yokogawa, who owns a Nissan Leaf electric vehicle.

The charging stations installed at Yokogawa are Level 2 stations (240-Vac input) and will charge any vehicle that uses a standard SAE J1772 connector. Some examples of vehicles using this standard are the Nissan Leaf, Chevy Volt, Ford Focus Electric, Toyota Prius Plug-in hybrid, Tesla, Mitsubishi i MiEV, and Fisker Karma. Level 2 stations can fully charge a vehicle like the Nissan Leaf, which has a range of about 75 miles, in about four to five hours.

The installation supports Yokogawa's "Go Green Initiative" and enhances the Newnan facility's ISO14001 requirements. One of the Group Green Promotion Committee's roles is to promote environmental conservation and monitor environment data related to CO2 emission and promote CO2 emission reduction. 

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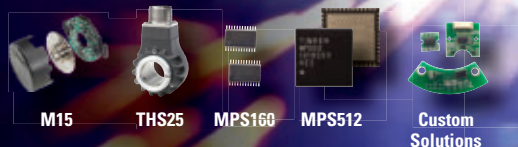
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## » Green Engineering

# Going green saves Empire State Building millions

■ Paul J. Heney/Editorial Director

The innovative energy efficiency program at the Empire State Building has exceeded guaranteed energy savings for two years in a row, saving \$2.3 million and providing a new model for building retrofits nationwide.

In 2009, the Empire State Building, President Bill Clinton and Mayor Michael Bloomberg launched a retrofit to reduce costs, increase real estate value and protect the environment. Led by an energy-efficiency and sustainability-focused coalition including the Empire State Building; Johnson Controls; Jones Lang LaSalle; and Rocky Mountain Institute, it beat its year-one energy-efficiency guarantee by 5% in 2011, saving \$2.4 million. In year two, it surpassed its guarantee by nearly 4%.

Over the past two years, the energy retrofit model has been replicated at 44 commercial buildings in the U.S., including One Worldwide Plaza in New York, The Port Authority of New York and New Jersey, and The Port of San Francisco's Pier 1, the corporate headquarters of Prologis Inc.

"The success from the Empire State Building retrofit project demonstrates that thoughtfully applied energy efficiency investments can deliver unparalleled returns through a combination of lower energy, lower operating costs, and increased building valuation," said Iain Campbell, vice president, Global Energy and WorkPlace Solutions, Johnson Controls Building Efficiency. "When implemented under a performance contract, the energy savings are guaranteed, ensuring a no-risk investment and a smart business decision."

Improvement measures performed by Johnson Controls and Jones Lang LaSalle included refurbishing all 6,514 windows, insulation installation behind radiators, a chiller plant retrofit, new building management systems controls, new revenue-grade meters serving the entire building, and a web-based tenant energy management system. **DW**

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## Here are a few plugs for the industry's first universal voltage blowers, from Windjammer.

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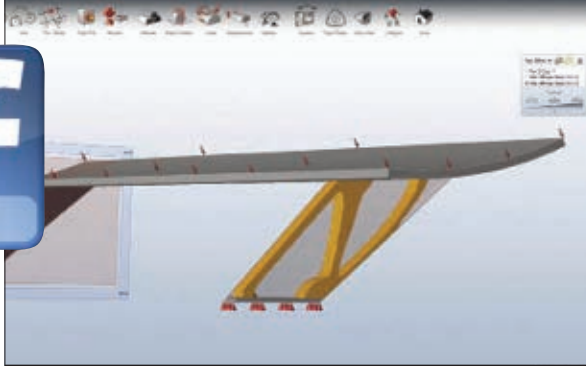
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## Structural Topology Optimization: The opposite of FEA

Most of the big CAE vendors are enthusiastic proponents for the democratization of simulation. In fact, Googling the term leads to a treasure trove of results—and shows that each of the CAE vendors seem to have entirely different ideas about what democratization involves.

<http://dwo.me/166Ek4p>

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3D printing is revolutionizing design and production. Scanners like the FARO Edge ScanArm play a vital role in this process with their ability to acquire super-accurate 3D data of physical objects and quickly export it to design software for production.

<http://dwo.me/12jkqn8>

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## Locking thread fastener improves hybrid battery life

As the federal government is set to nearly double car and light-duty truck fuel economy standards to the equivalent of 54.5 mpg by 2025, electric vehicle (EV) and hybrid electric vehicle technology will play a vital role—if lingering battery life and overheating issues can be resolved.

<http://dwo.me/160PEFq>



## 3D printing and thinking differently

You've heard it before—to take the best advantage of 3D printers, engineers need to think differently; to think in ways not associated with CNC machining or injection molding, to design knowing that with 3D printers, you have more freedom with form, fit, and function. As I watch artists develop amazing designs with 3D printers, I wonder whether artistic capability will become a new criteria for design engineers. And just how much artistry will change the parameters of form, fit, and function.



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## Engineering: More "Creative" Than We Previously Thought

Recently, Pamela Kan challenges us to understand what "creativity" really encompasses. She indicates that she has never considered herself a "creative" person, despite her many acts of innovation and creation throughout her personal and professional pursuits. Perhaps Kan, as she suggests, lacks artistic abilities, but who is to say that this indicates she has no true creative leanings?

<http://dwo.me/172bHdn>

You  
Tube



## What is an absolute encoder?

1:15/ 2:32

Encoders can be either absolute or incremental.

Absolute encoders have a unique code for each shaft position. Or in other words, every position of an absolute encoder is distinctive. The absolute encoder interprets a system of coded tracks to create position information where no two positions are identical. Another feature is that absolute encoders do not lose position whenever power is switched off. Since each position is distinctive, the verification of true position is available as soon as power is switched on. So it's not necessary to initialize the system by going back to a home base for a reference.

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# Sensor converts mechanical pressure to optical signals

**Researchers have developed** a sensor device that converts mechanical pressure – from a signature or a fingerprint – directly into light signals that can be captured and processed optically. Shown is Professor Zhong Lin Wang of the Georgia Institute of Technology. (Georgia Tech Photo: Gary Meek)

Using thousands of nanometer-scale wires, the researchers at the Georgia Institute of Technology have developed a sensor device that converts mechanical pressure – from a signature or a fingerprint – directly into light signals that can be captured and processed optically.

The sensor device could provide an artificial sense of touch, offering sensitivity comparable to that of the human skin. Beyond collecting signatures and fingerprints, the technique could also be used in biological imaging and micro-electromechanical (MEMS) systems. Ultimately, it could provide a new approach for human-machine interfaces.

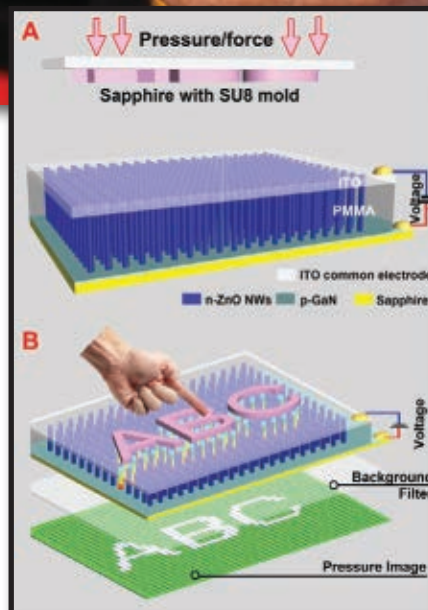
“You can write with your pen

and the sensor will optically detect what you write at high resolution and with a very fast response rate,” said Zhong Lin Wang, Regents’ professor and Hightower Chair in the School of Materials Science and Engineering at Georgia Tech. “This is a new principle for imaging force that uses parallel detection and avoids many of the complications of existing pressure sensors.”

Individual zinc oxide (ZnO) nanowires that are part of the device operate as tiny light emitting diodes (LEDs) when placed under strain from the mechanical pressure, allowing the device to provide detailed information about the amount of applied pressure. Known as piezo-phototronics, the

technology – first described by Wang in 2009 – provides a new way to capture information about pressure applied at very high resolution: up to 6,300 dots per inch.

Piezoelectric materials generate a charge polarization when placed under strain. The piezo-phototronic devices rely on that physical principle to tune and control the charge transport and recombination by the polarization charges present at the ends of individual nanowires. Grown atop a gallium nitride (GaN) film, the nanowires create pixelated light emitters whose output varies with the pressure, creating an electroluminescent signal that can be integrated with on-chip



**This schematic shows a device** for imaging pressure distribution by the piezo-phototronic effect. The illustration shows a nanowire-LED based pressure sensor array before (a) and after (b) applying a compressive strain. A convex character pattern, such as “ABC,” molded on a sapphire substrate, is used to apply the pressure pattern on the top of the indium-tin oxide (ITO) electrode.

(Courtesy of Zhong Lin Wang)

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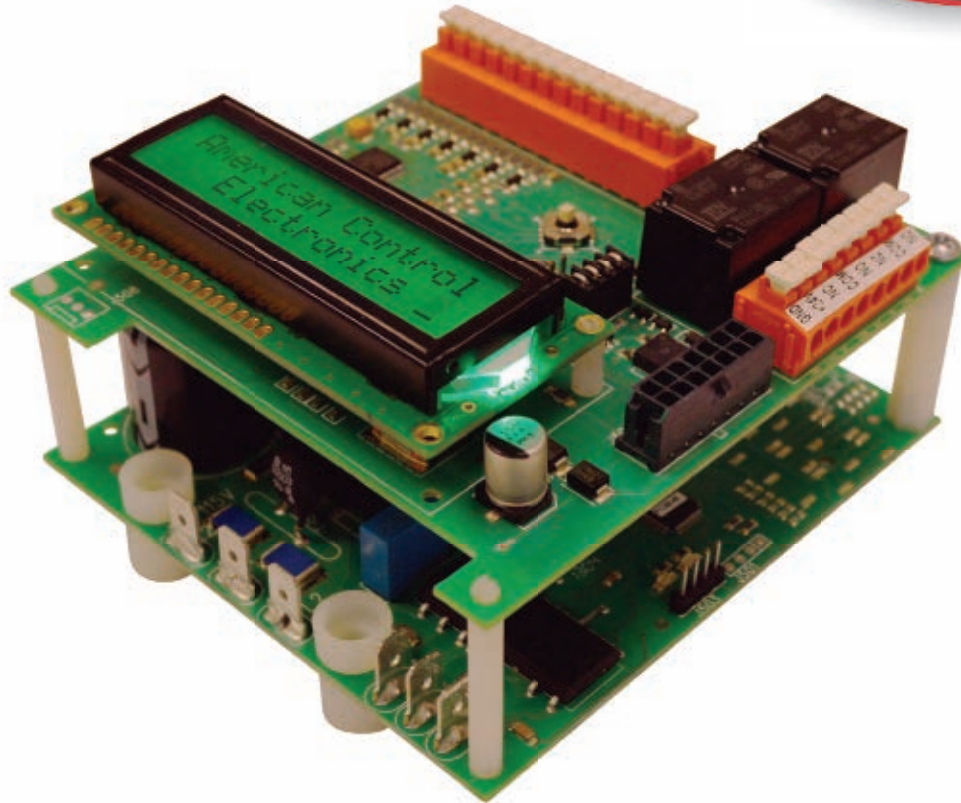


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"When you have a zinc oxide nanowire under strain, you create a piezoelectric charge at both ends which forms a piezoelectric potential," said Wang. "The presence of the potential distorts the band structure in the wire, causing electrons to remain in the p-n junction longer and enhancing the efficiency of the LED."

The efficiency increase in the LED is proportional to the strain created. Differences in the amount of strain applied translate to differences in light emitted from the root where the nanowires contact the gallium nitride film.

To fabricate the devices, a low-temperature chemical growth technique is used to create a patterned array of zinc oxide nanowires on a gallium nitride thin film substrate with the c-axis pointing upward. The interfaces between the nanowires and the gallium nitride film form the bottom surfaces of the nanowires. After infiltrating the space between nanowires with a PMMA thermoplastic, oxygen plasma is used to etch away the PMMA enough to expose the tops of the zinc oxide nanowires.

A nickel-gold electrode is then used to form ohmic contact with the bottom gallium-nitride film, and a transparent indium-tin oxide (ITO) film is deposited on the top of the array to serve as a common electrode.

When pressure is applied to the device through handwriting or other source of pressure, nanowires are compressed along their axial directions, creating a negative piezo-potential, while uncompressed nanowires have no potential.

The researchers have pressed letters into the top of the device, which produces a corresponding light output from the bottom of the device. This output – which can all be read at the same time – can be processed and transmitted.

The ability to see all of the emitters simultaneously allows the device to provide a quick response. "You can read a million pixels in a microsecond," said Wang. "When the light emission is created, it can be detected immediately with the optical fiber."

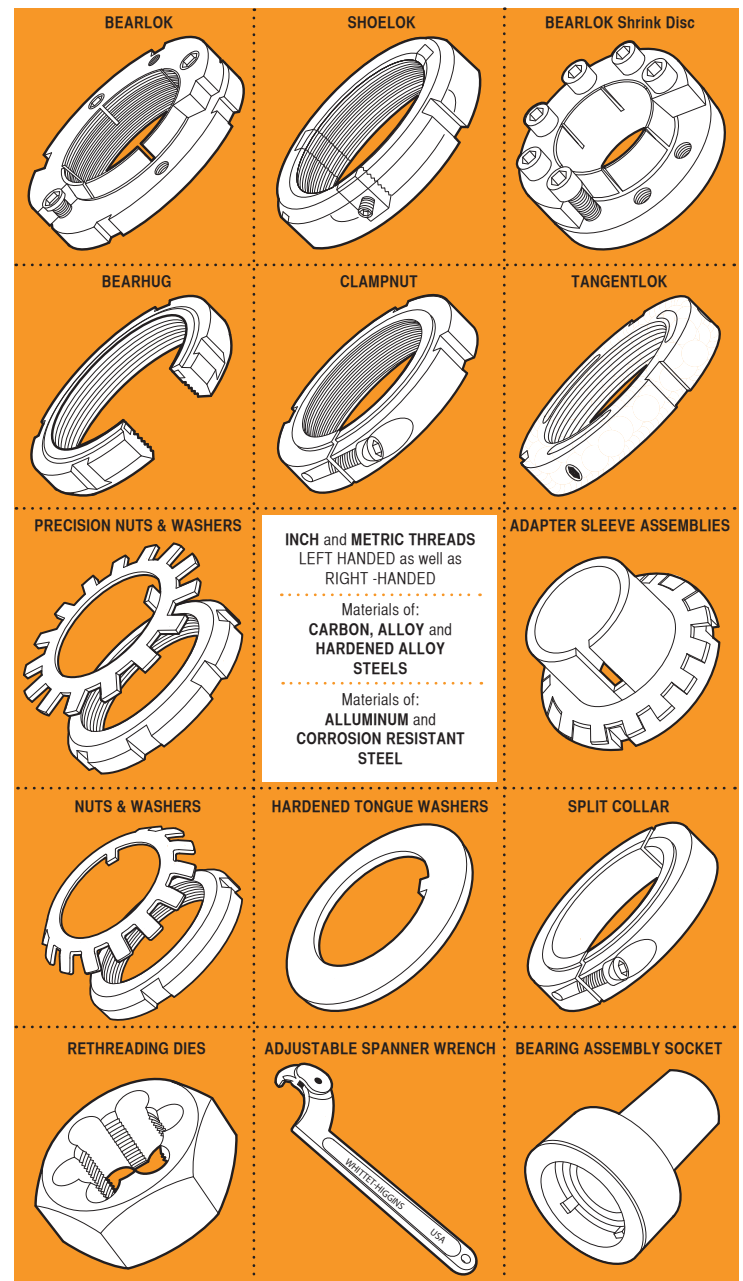
The nanowires stop emitting light when the pressure is relieved. Switching from one mode to the other takes 90 ms or less.

The researchers studied the stability and reproducibility of the sensor array by examining the light emitting intensity of more than 20,000 individual pixels under strain for 25 repetitive on-off cycles. They found that the output fluctuation was approximately 5%, much smaller than the overall level of the signal.

A spatial resolution of 2.7 microns was recorded from the device samples tested so far. Wang believes the resolution could be improved by reducing the diameter of the nanowires – allowing more nanowires to be grown in a given space – and by using a high-temperature fabrication process. 

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The fully integrated spacecraft and instrument for the IRIS mission sits inside a clean room at the Lockheed Martin Space Systems facility in Sunnyvale, CA. The solar arrays are deployed as they will be while in orbit.

*[Photo: Lockheed Martin]*

3D

## printer builds parts to test NASA's spectrograph, IRIS

**Final testing** is underway on NASA's next Small Explorer (SMEX) mission, which will fly into the lower levels of the sun's atmosphere to use high-resolution images, data collection, and advanced computer models to unravel how matter, light, and energy move from the sun's 6,000 K (10,240 degree F) surface to its million K (1.8 million degree F) outer atmosphere—the corona. The on-board instrumentation is called the Interface Region Imaging Spectrograph, or IRIS.

IRIS will gather information for solar and plasma physics, space weather, and astrophysics, helping researchers understand how internal convective flows power atmospheric activity. It will trace the flow of energy and plasma through the chromosphere and transition region into the corona using spectrometry and imaging technologies. The

combination of on-board instruments and 3D modeling, it is hoped, will complete the general knowledge of this dynamic region of the solar atmosphere. New insights are expected to help scientists better understand what drives space weather from the corona to the heliosphere.

The ability to complete form and function testing for IRIS was critical in the early stages of design. Engineers needed a physical model to incorporate into the testing process, so they used the latest Direct Digital Manufacturing (DDM) processes, supported by Solid Concepts Inc., Valencia, CA. DDM devices can produce key components in a matter of hours instead of waiting days for a model shop to machine the parts.

The most common DDM process for high accuracy component production is Fused

Deposition Modeling (FDM) technology. This technology heats a production-grade thermoplastic material to a semi-liquid state and then extrudes it layer-by-layer in accordance with computer-controlled motion paths until the part is complete. FDM technology incorporates two separate materials into the build, one is the modeling material used for the finished part, the other is a support material used as scaffolding while the part is being grown. Once the build is finished, the scaffolding material easily breaks away or dissolves in a mild detergent and water mixture, leaving an even surface. Thermoplastic parts can endure high heat, chemical exposure, high humidity, as well as extremely dry environments without showing mechanical stress. Materials are available in multiple colors when needed. Plus, complex

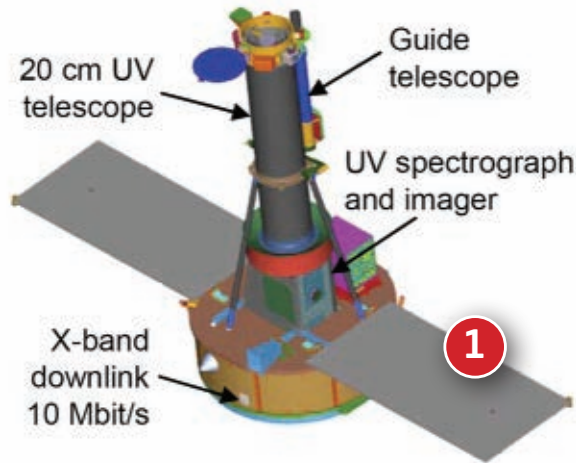


geometries from this technology can include internal cavities that would be nearly impossible to build using traditional manufacturing methods.

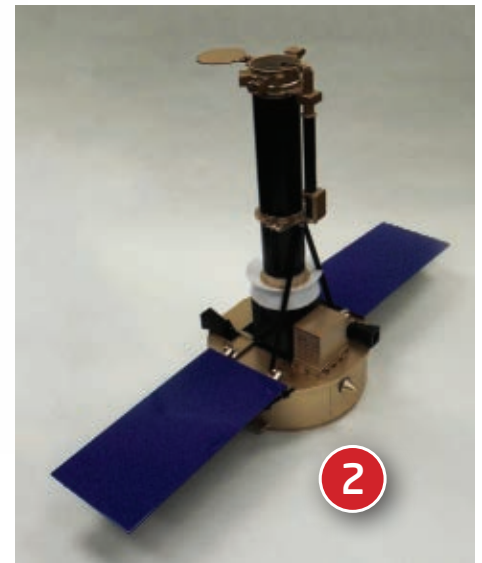
What's most important for projects like IRIS is the ability to produce highly accurate parts. Solid Concepts produces parts with layer thicknesses as precise as 0.007 in. in most materials, including PC materials known for superior mechanic properties and heat resistance. Tolerances are a function of the machine producing the part and the overall size of the part, and can reach an accuracy of  $\pm 0.0035$ -in. or  $\pm 0.0015$ -in./in., whichever is greater.

OW

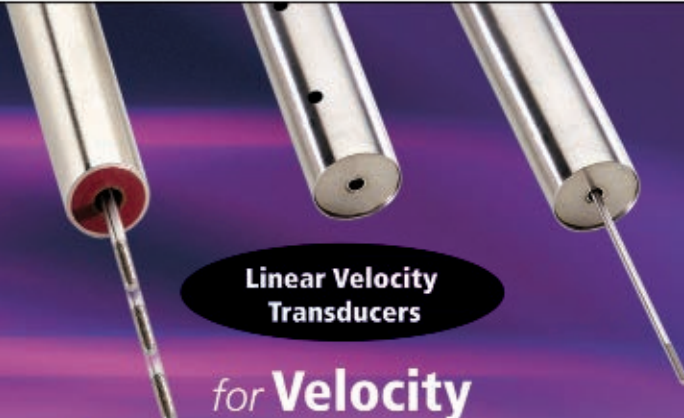
**Solid Concepts Inc.**  
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**1. The IRIS instrument**, as part of NASA's SMEX mission, is a multi-channel imaging spectrograph with a 20 cm UV telescope.



**2. Using** the latest FDM technology, Solid Concepts was able to build IRIS components that were highly accurate and durable for major testing. The FDM additive manufacturing process delivers highly smooth surfaces.



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## Modern mechanical carbon materials for aircraft seal applications

By Glenn H. Phelps / Technical Director / Metallized Carbon Corporation

### Oil-free, self-lubricating mechanical carbon materials

possess a combination of characteristics that make them suitable for use in both commercial and military aircraft seal applications.

The materials are self-lubricating, self-polishing, and dimensionally stable, which insures a good sealing mate. They are heat resistant and have a high thermal conductivity, which helps conduct frictional heat away from the sliding surface. In addition, these materials are readily machinable to exacting aerospace dimensional tolerances, and they can be supplied lapped and polished to a flatness specification of one helium light band. In aerospace applications, modern mechanical carbon materials are being used in aircraft gear boxes, air turbine motor starters, and main shaft seals for both aircraft turbine engines and aircraft auxiliary power units (APUs).

These self-lubricating materials are composed of fine-grained, electrographite substances that are impregnated with proprietary inorganic chemicals to improve their lubricating qualities and their oxidation resistance. They have a low coefficient of friction, low wear rate at high sliding speed, high thermal conductivity, and they resist oxidation in high temperature air. These properties also suit other high speed, rotating equipment, such as high-speed rotary gas compressors and steam turbines.

Aircraft gearboxes reduce the main engine shaft's rotational speed from as high as 26,000 rpm down to about 3,400 rpm, so the shaft can drive such system components as hydraulic pumps, generators, and air conditioning compressors. To seal the oil lubricant within the gearbox and protect it from leaking out at

the point where the shaft enters and exits the gearbox, most aircraft gearboxes use face seals. The face seals usually contain a carbon-graphite stationary ring and a silicon carbide or tungsten carbide rotating ring. The rings that make the dynamic face seal are both lapped flat and are held together with springs or magnets so that liquids cannot flow between the ring faces even though they are spinning against each other at high speed.

The two rings in relative motion that make the dynamic seal are sealed to the shaft or the gear box housing with static seal rings such as polymeric O-rings. Seal designers use spiral grooves, straight grooves, and wedges to channel or pump a thin film of air or oil between the two sliding sealing faces. This creates aerodynamic or hydrodynamic lift, which reduces the friction and wear of the seal faces.

For example, Metcar Grade M-45, manufactured by Metallized Carbon Corporation, is often used successfully as the stationary ring. This material is suited for these shaft seals because it is impermeable and thus able to support an aerodynamic film. It also has the ability to run at high speed with low friction and low wear.

Air turbine motor starters typically use the same carbon-graphite versus silicon carbide or tungsten carbide dynamic face seal materials used in gearbox seals, but the sliding speed is much higher. These air turbine motor starters are actually small turbines that use the exhaust gas from the auxiliary power unit to create the power necessary to start the main engines. The shaft speed on air motor starters can be as

high as 180,000 rpm, or a sliding speed of about 1000 feet/second, which is nearly the speed of sound. The seals are designed by aircraft seal manufacturers with wedges and gas flow passages to produce aerodynamic or hydrodynamic lift-off. Metcar Grade M-45 is used in air motor starter seals because of its outstanding self-lubricating qualities at the required operating conditions.

Face seal rings, with carbon-graphite primary rings, and carbon-graphite circumferential seal rings are used in aircraft engine main shaft seals to control the air flow and combustion gas flow inside the engine. They also seal the oil lubricant in the main engine bearings that allow the compressor shaft and the combustion gas turbine shaft to rotate freely. Both circumferential and face type seal rings are used.

For circumferential main shaft seal rings, carbon-graphite segments that fit with close end clearance in slots in the stationary housing are used. The carbon-graphite segments are tensioned against a ceramic or hard metal coating on the rotating shaft using a "garter" spring.

Lifting wedges and machined configurations are used to create lift so that these seals run on an aerodynamic or hydrodynamic film. Rotating speeds can be as high as 26,000 rpm, and temperatures in the seal rings can reach as high as 800 degrees Fahrenheit. 

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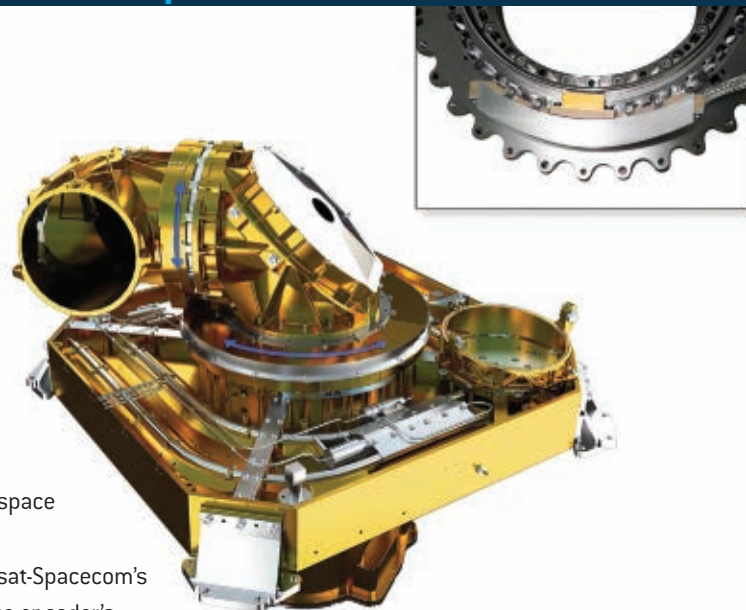




## Angle encoder for GEO space applications

**The ability to handle harsh environments** and deliver promised features and long life are critical attributes of all equipment designed for use in space. For encoders, Renishaw recently collaborated with Tesat-Spacecom GmbH to develop an angle encoder with high radiation hardness, very high accuracy, and qualification for 15 years life in a GEO space environment.

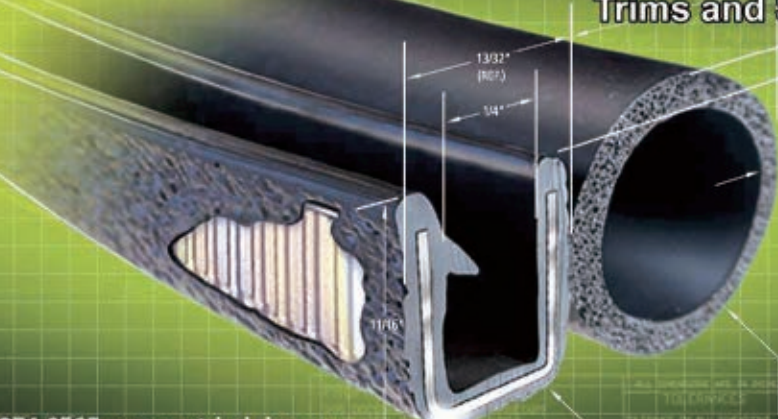
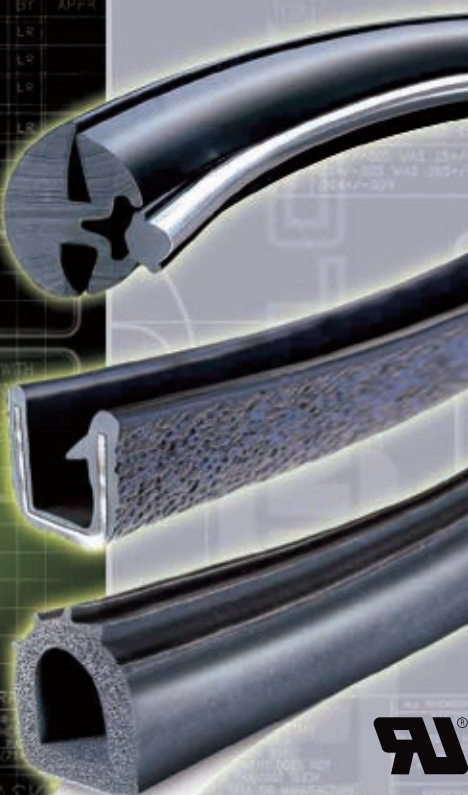
The device combines Renishaw's optical encoder technology with Tesat-Spacecom's knowledge and experience in ruggedized space electronics. The GEO space encoder's readhead is designed to survive harsh environments, with 150 g vibration resistance and wide operating temperature range, combined with an optical detection principle. The readhead has a mass of only 300 g and power consumption is typically less than 1 W. Special attention on radiation hardness imparts long life to the encoder—achieving qualification for 15 years of use in GEO space conditions.





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The scale consists of a stainless steel ring with graduations marked directly on the periphery, eliminating shock/vibration-induced breakages associated with traditional glass discs. The graduations include IN-TRAC™ reference marks that are directly embedded in the incremental channel, arranged in a distance-coded pattern so that the distance between any two adjacent reference marks is unique. This means that only a small rotation is required before absolute position is determined by the on-board field-programmable gate array (FPGA). The ring format enables easy integration into rotary axes, with a large through-hole for easy routing of utilities.

The ring is mounted directly to the rotor, with the head mounted to the stator. There is no contact between the two parts, so no need for separate bearings or flexible couplings. This arrangement improves reliability and eliminates backlash, shaft wind-up (torsion) and other irregular metrology effects that plague traditional enclosed encoders.

High accuracy is achieved with short-range error less than 0.5  $\mu$ rad RMS and long-range error less than 5  $\mu$ rad (without mechanical errors). Combined with resolution of less than 0.5  $\mu$ rad, the system is suited to applications demanding precision metrology. 

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DESIGN WORLD

29

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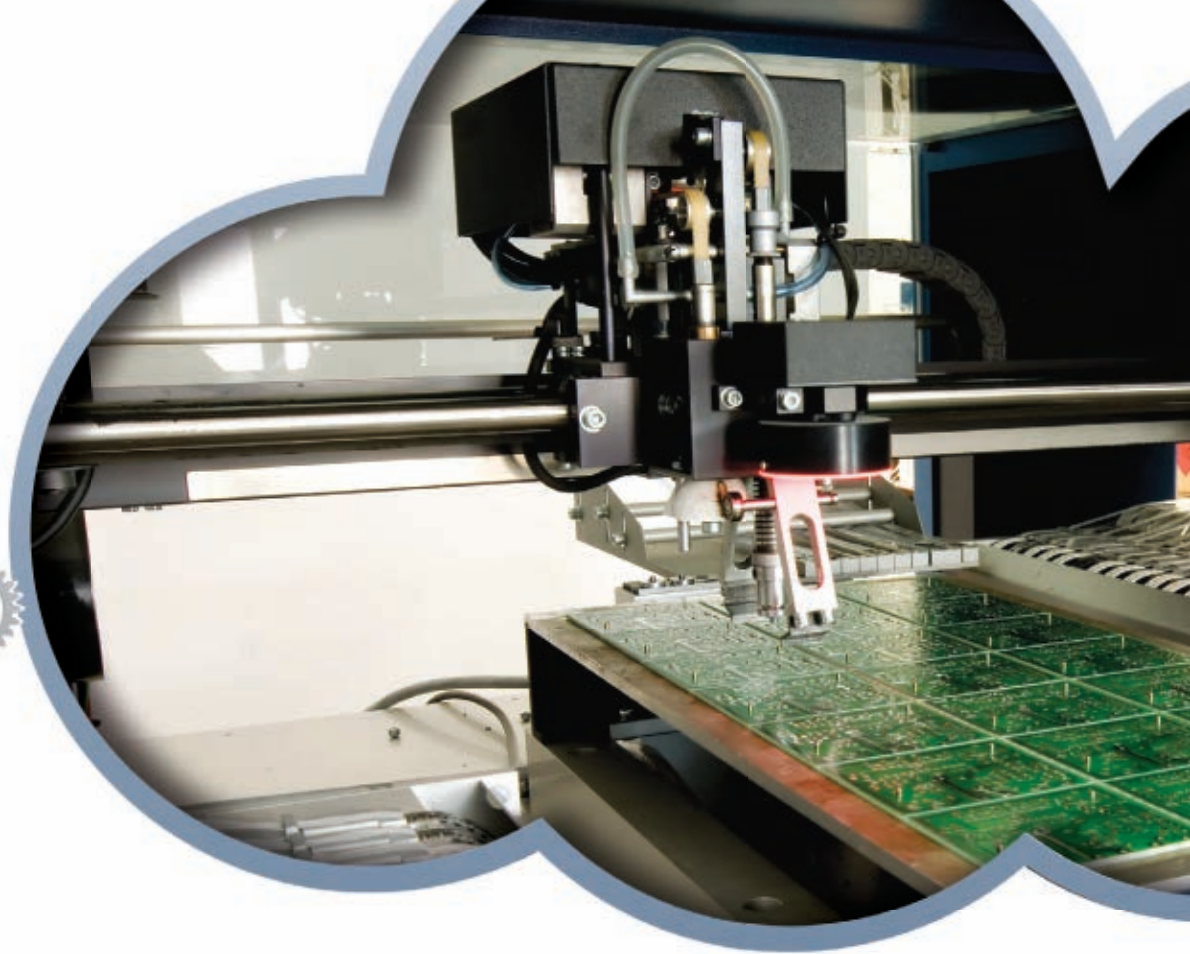
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## Twin belt turning device gently palletizes bags

**Palletizing** works better with dimensionally stable product. For bags, which can have an unpredictable flow behavior, this can be a challenge. This twin-belt turning device, though, helps palletize bags filled with bulk material in an even, gentle way. The twin-belt turning device works with two separately driven belt conveyors, which, by applying a differential speed between both belts, enables turning the bag to be palletized by 90°, and, in particular cases also by 180°. This procedure ensures a dimensionally stable bag.

The twin-belt turning device is used with the BEUMER paletpac high-capacity palletizer. With a stack height of up to 2,400 mm, the unit palletizes bags on any commonly used pallet size and in all technically feasible packing patterns. The variable bag and pallet sizes are adapted by rapid parametric setting with multi-programming. This system puts the bags into the desired packing pattern in a quick and gentle way.

Once the user has set the desired packing pattern, the device turns the bags with the help of two separately driven belts arranged parallel to one another. The rotation of the bag is initiated by the net weight of the bag and by the different speeds of the belts. The speeds and also the rotation of the bag are adapted to the different bag sizes by a self-optimizing highly dynamic active control loop. Each belt conveyor is provided with a synchronous servo drive, which accelerates and decelerates during the turning

process. The device has fewer parts subject to wear and tear. The new module operates at extremely low noise and existing palletizers

can be easily retrofitted. 

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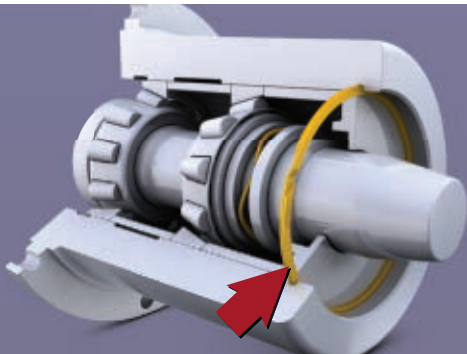
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## » Design Notes

Mary Gannon/ Senior Editor



**Tight tension control and repeatability is critical** in flexo printing press machines. That's why Mark Andy used a complete system of hardware and software from Mitsubishi Electric to increase tension control and accuracy and decrease errors.

## You can't cut this tension with a knife

**Maintaining tight tension control** in printing presses is critical for quality. So when Mark Andy, a major manufacturer of flexo printing press machines, decided to upgrade the controls on its servo-driven inline flexographic printing presses, it looked to standardize its product line on a single architecture to improve the ability to support customers with the best hardware and software available.

Two years ago, when faced with next-generation products that would force it to abandon its software platform, Mark Andy began pursuing an upgrade path with its motion control supplier. A considerable amount of program development was required to upgrade, so Kevin Wilken, Vice President of Engineering, led the search for a new controls platform to help maintain the company's reputation for cutting edge servo printing equipment.

The search started with a field of more than 15 potential suppliers, but after reviewing cost, overall system performance, commonality of development tools, training,

service, and local and worldwide support, Wilken's controls platform choices were whittled down to five.

Two of the companies presented polished software packages, but the hardware lacked backward and forward compatibility and future upgrades would be costly. Two other companies demonstrated industry-tailored products, but there were doubts about support and product obsolescence. Only one, Mitsubishi Electric, offered the best combination of reliable hardware and intuitive software with a clear long-term strategy for upgrades and product end-

***"The iQ Automation Platform and MR-J3-B Safety Servo System from Mitsubishi Electric improved our tension control by 500%," Kevin Wilken, VP of Engineering, Mark Andy.***

of-life. Ultimately, Mitsubishi Electric was chosen to demonstrate the iQ Automation Platform with MR-J3-B Safety servos, the GT16 Series HMI, and iQ Works Software. Working with HTE Technologies, the local distributor, a pilot project was started to evaluate the performance with emphasis on registration accuracy, servo following error, and tension control because these factors directly affect final print quality.

After six weeks of development and testing, Mitsubishi Electric and HTE Technologies were able to demonstrate significant performance advantages.

According to Wilken, "The iQ Automation Platform and MR-J3-B Safety Servo System from Mitsubishi Electric improved our tension control by 500%, with more accurate registration and less servo following error than other systems we have tested."

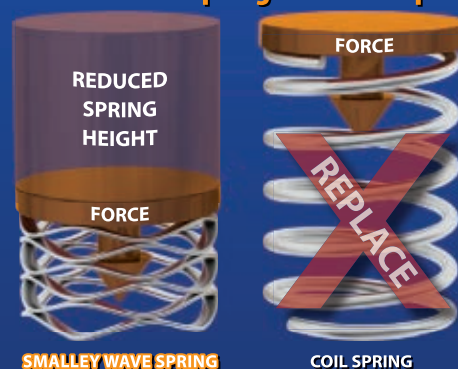
Beyond the performance advantage, Mitsubishi's software and hardware has maintained backward compatibility over the years. This stability provides a level of confidence that as performance-enhancing and ease-of-use features become available, Mark Andy will be able to take full advantage without the expense and learning curve of major architecture changes. 

**Mitsubishi Electric Automation Inc.**  
**[www.meau.com](http://www.meau.com)**

**Screen shots of iQ Works Integrated Engineering Software Suite from Mitsubishi Electric.**



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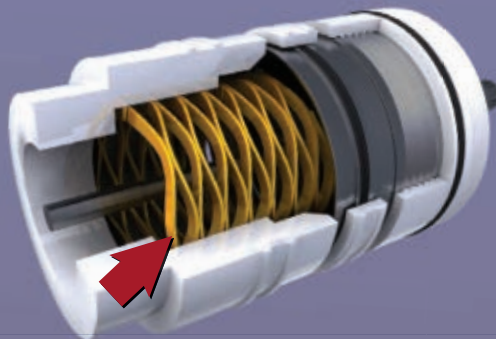
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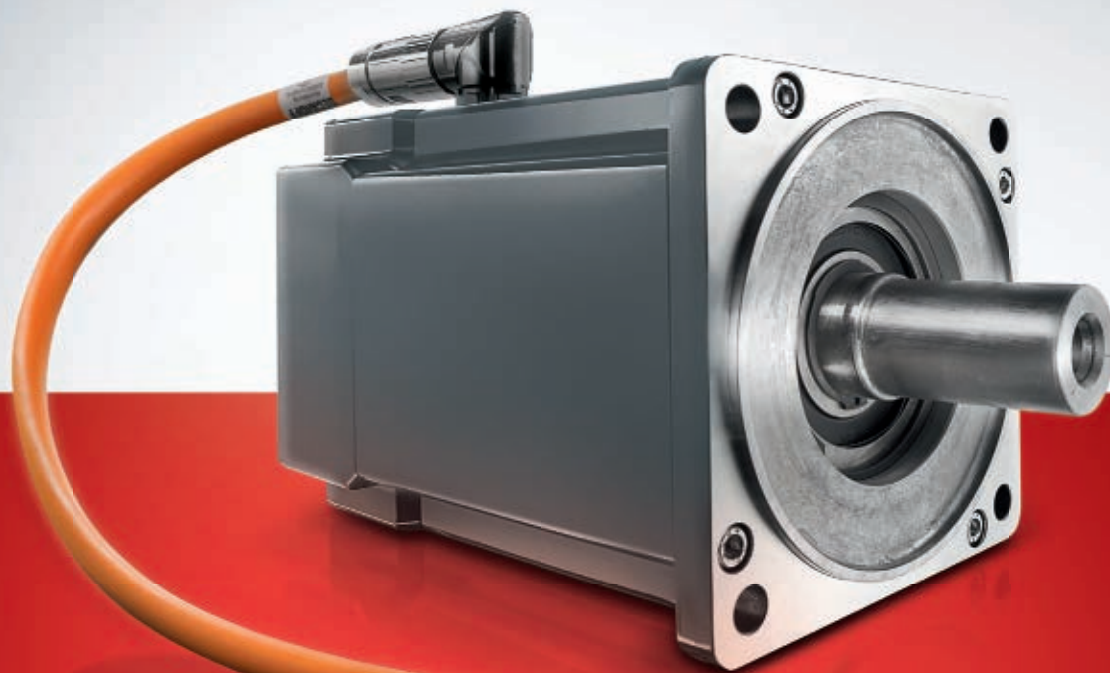
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## Peening adds strength and durability

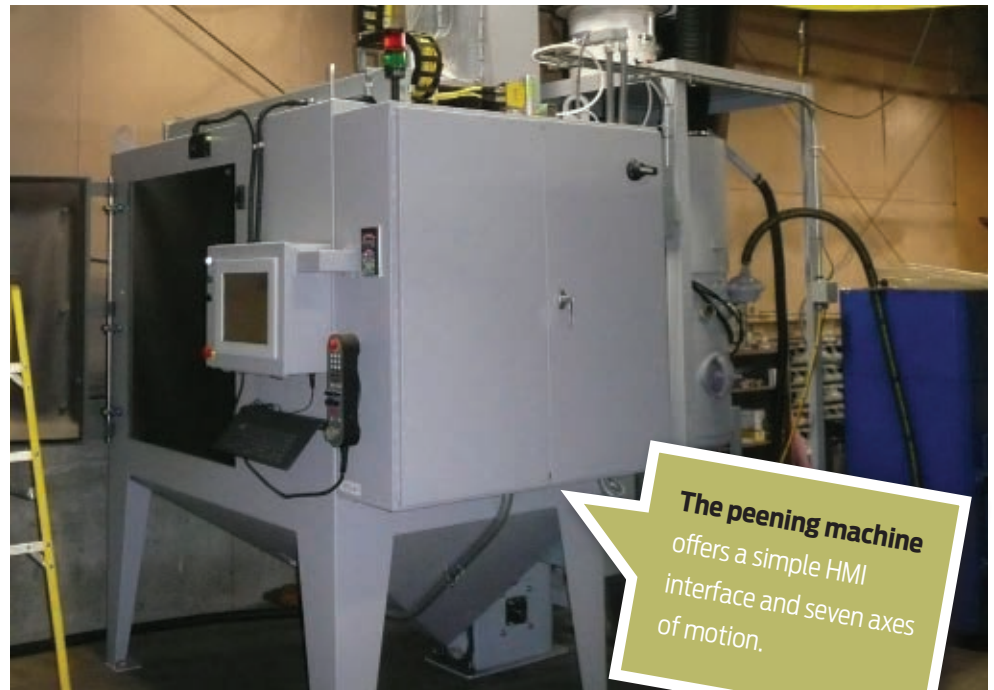
**Those who work with metal** have known for millennia that hammering the material strengthens it. Even Bronze Age blacksmiths bolstered armor, swords, and tools by forging and pre-stressing the metal with blows from a hammer.

Thousands of years later, technology has advanced to shot peening, a technique in which metal is bombarded with millions of tiny steel balls from a small nozzle at high velocity, creating microscopic dents, or dimples, in the surfaces of metal parts.

While it sounds counterintuitive, shot peening actually makes the material more durable because the dimples convert tensile stresses, which may compromise metal integrity, into compressive stresses that hold the material together. Nearly all fatigue and stress corrosion failures start at the surface of a part, but cracks will not begin or spread in a compressively stressed zone. Because the overlapping dents from shot peening produce a uniform layer of compressive stress at metal surfaces, shot peening imparts substantial increases in the life of a part.

This increased life is especially important when it comes to mission-critical aerospace components like engine blades. “Virtually every piece of a jet engine that moves is shot peened,” said Tom Beach, president of Connecticut-based Peening Technologies Equipment, whose computer-controlled equipment helps transform metal into reliable airplane parts. Beach says that compared with the cost of aerospace parts, shot peening is a fairly inexpensive process.

Peening Technologies was able to reduce costs when developing its systems with the assistance of Axis New England, their local Parker distributor. “We wanted to create a multi-axis and scalable shot peening machine that had a simple HMI interface but still offered sophisticated motion control,” said



**The peening machine** offers a simple HMI interface and seven axes of motion.

Beach. The machine they created includes BE servo motors, MPP/MPJ servo motors, PX gearboxes, Aries servo drives, ACR controllers, 6K controllers, and associated accessories, which provide up to seven axes of motion. (For now, the HMI is a custom unit Beach designed, though they have plans to upgrade to Parker's InteractX.) Older style, single axis, multi-nozzle machines required users to spend time setting up each individual part, but robotic automation allows a user to set up multiple parts by loading a single program into the machine.

The final result has been a machine that allows for a shortened development

cycle—and happy end-users. “The best feedback is there's not a lot of feedback,” says Beach. “There's nothing to complain about. Our customers have been very happy with this very reliable machine.” 

**Parker Hannifin Corp.**  
[www.parker.com](http://www.parker.com)

**Shot peening** creates microscopic dents, converting tensile stresses into compressive stresses.







Items in the rear of the photo are covered with blooming or frosting from regular instant adhesives, while items in the front are clean and bloom-free using Low Odor/Low Bloom Instant Adhesives.

## Nine simple steps to control blooming of adhesives

**Cyanoacrylates (CAs)** are one-part instant adhesives that fix rapidly and cure at room temperature. They bond to a range of components, including metals, plastics, elastomers, and porous substrates. When exposed to a weak base such as water, CAs polymerize. The water neutralizes acidic stabilizers in the adhesive, initiating rapid cure—obtaining fixture strength in just seconds and full strength within 24 hours.

These dry, colorless adhesives are easy to use and automate. Their cure speed increases throughput and reduces per piece processing costs. But CAs are prone to blooming or frosting, a cosmetically unappealing phenomenon that manifests itself as a rainbow or whitish haze surrounding the bond line. Blooming occurs when unreacted cyanoacrylate monomers evaporate and become airborne. Because they are heavier than air, these molecules tend to fall

back onto the surface of the part outside of the bond line in the form of white flakes. In great numbers, these flakes create a hazy or frosted appearance on the part.

The rainbow haze is due to a small concentration of cyanoacrylate particles on the surface. Light hitting the surface is diffracted causing the rainbow effect. The whitish haze surrounding the rainbow is due to a relatively higher concentration of cyanoacrylate monomer.

Blooming has no negative effects on the strength and durability of the bond. While blooming is desired in some CA applications like fingerprint detection, this purely aesthetic problem is viewed as a detriment in applications where a clean bond line is critical, for example on cosmetic cases, medical equipment, electronic devices, pharmaceutical packages, appliances, automotive parts, and speakers.

The following tips can help reduce or eliminate the potential for blooming or frosting of instant adhesives.

- ❶ Use low-odor, low-bloom instant adhesives – These adhesives use cyanoacrylate monomers with higher molecular weights than those of traditional CAs, which make them less likely to become airborne than standard cyanoacrylate monomers, reducing blooming and chemical odors.
- ❷ Use flashcure or light cure CAs – These adhesives combine cyanoacrylate and light cure technology to cure tack-free in less than 5 seconds rather than the 30 seconds required by regular instant adhesives. This extremely rapid cure eliminates the possibility of blooming because the adhesive never has a chance to become airborne.
- ❸ Avoid large fillets – Fillets are areas along the bond line where adhesive squeezes out or reaches just beyond the edge of the

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## » Design Notes

substrate. This provides an ideal opportunity for blooming to occur, as the adhesive is completely exposed to the open air. By keeping the adhesive within the bond line and minimizing substrate-level exposure, less adhesive will be available to become airborne and migrate beyond the bond line.

**4** Increase air flow – Avoid assembling parts and immediately placing them in an airtight environment such as a bag or shipping container. Cross ventilation helps carry airborne CA molecules away from the bond area, minimizing the number of molecules available to fall back to the bond line area.

**5** Use accelerators – The faster the adhesive cures, the lower the chance there will be unreacted cyanoacrylate monomers that

become airborne. Adding an accelerator to speed the rate of cure reduces the chances of frosting. But cure speed must be carefully managed—the heat generated by too fast a cure may result in a phenomenon similar to frosting where the rapid exothermic reaction drives off unreacted monomer.

**6** Avoid acidic surfaces – Acidic surfaces slow down the cyanoacrylate cure mechanism and keep the adhesive uncured longer. When bonding acidic surfaces, rinse to reduce acidity or choose an adhesive or accelerator designed to work under these conditions such as a surface insensitive instant adhesive.

**7** Avoid extremes in relative humidity – If relative humidity is too low, the adhesive will take longer to cure. If it's too high, the curing reaction may occur too quickly

and exothermic reaction may allow blooming to occur. Relative humidity of 40 to 80% is recommended for cyanoacrylate cure.

**8** Avoid extremes in temperature – Elevated temperatures promote the vapor pressure or volatility of the CA monomer, leading to higher blooming vulnerability. Conversely, lower temperatures slow the reaction mechanism, causing prolonged cure time and opportunity for the CA monomer to become airborne. A temperature controlled environment as close to 70°F is ideal.

**9** Avoid the use of old material – Old product does not cure as quickly as fresh material. And when cure is slowed, there is more opportunity for adhesive particles to become airborne and for blooming to occur. **DW**

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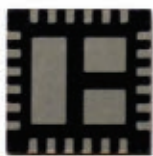
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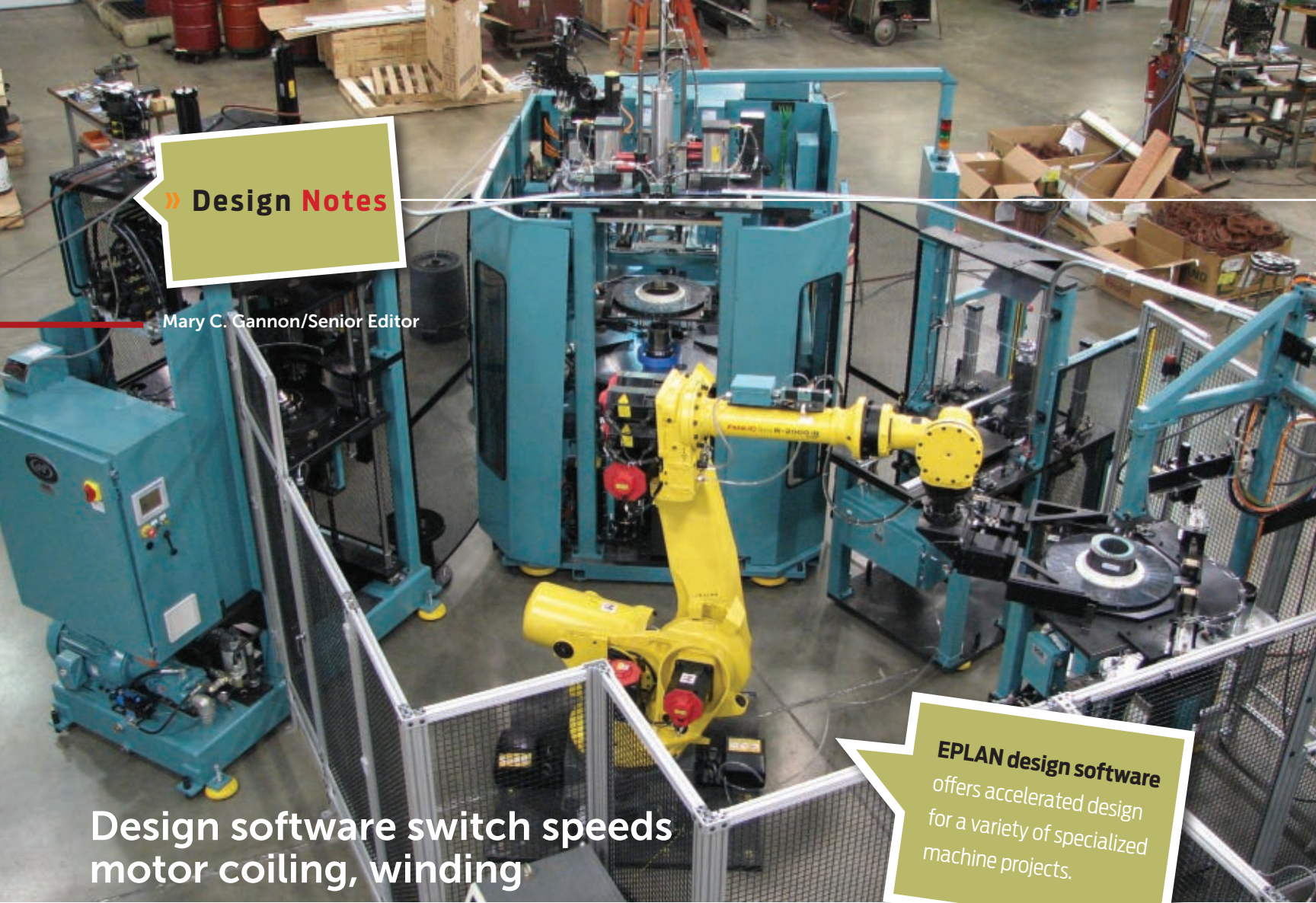


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## » Design Notes

Mary C. Gannon/Senior Editor

# Design software switch speeds motor coiling, winding

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### When a customer asked

Advanced Machine & Tool Corp. (AMT), of Fort Wayne, Ind., to start using EPLAN Software & Service electrical drawings for the machines it ordered, AMT quickly found that using EPLAN for all its software development projects offered a number of productivity improvements.

AMT switched from AutoCAD Electrical to EPLAN because time-consuming product development steps—such as device tagging, wire numbering, and machine design standardization, including archiving and re-using recurrent content—have been simplified and accelerated.

Engineers at AMT made the switch after a major auto industry customer made a point of stipulating it wanted EPLAN electrical drawings for the machines it orders to expedite the

production of documentation and improve their accuracy.

Finding it was a better option, the engineers at AMT began a gradual process of switching all electrical and fluid power assignments to the EPLAN Platform. “I thought we were comfortable with our old CAD system, but I sure wouldn’t go back to it now,” said electrical engineer Mark Lohrman.

AMT specializes in the building of coiling and winding equipment and other machines used in the production of electric motors, generators, alternators, and other devices. The engineering phase of fulfilling an order can take as little as three days, or as much as 60 weeks for elaborate projects, but a typical order involves

a customer wanting a single machine to produce a new motor or for augmenting or streamlining current production.

“It might be as simple as adding a machine similar to one they have now, or showing us a product they want to produce and asking, ‘How do we manufacture it,’” said Lohrman.

AMT took a conservative approach to implementing EPLAN. Projects were benchmarked to verify productivity gains and over time, more and more projects were done in EPLAN. “Now we are at a point where regardless of what is being released, we do it in EPLAN,” said Lohrman.

Switching to EPLAN has made it possible to generate accurate and well-structured

documentation faster than previously possible.

For an assignment that might have taken two weeks working in AutoCAD, the biggest savings using EPLAN—about 23-28 work hours—were achieved in four areas:

- Previously, device tagging and wire numbering were manual tasks. Now they have been automated along with the generation of the actual device tags, wire numbers and terminal tags. AMT engineers use the internal functionality of EPLAN to set up the printers by transmitting an Excel spreadsheet with all the data. This has resulted in 4-5 hours saved.
- Error-free terminal



diagrams and BOMs are automatically generated, resulting in five hours saved.

- Standard circuitry is archived and re-used from project to project, saving 8-12 hours.
- Fluid schematics have been integrated into the overall project, eliminating errors with device naming and missed components. This has saved six hours.

For larger projects, the savings are proportionately greater. In addition, the ability to archive macros is key, as the company continues to expand this function. "Automatic numbering is a big thing for us," said Lohrman. "I can go to the parts list and pick out a part. If there is a macro associated with it, I am set."

The benefits of archiving and re-using standard content are growing with the amount of content items stored as EPLAN macros: now more than 300 processes and more than 500 components.

"Drawings are archived and can be easily found. I can bring up a complete set of drawings in just a few minutes—I don't have to go back into paper files. While the vast majority of our machines are custom, there are a few we repeat with minor adjustments. With EPLAN, we can pull up the drawings, make minor adjustments quickly and easily, and spit out a set of plans for it."

AMT engineers also use another source of parts data, EPLAN Data Portal, to download component data sets including Allen Bradley, WAGO and other information.

"Data Portal is easy to use," said Lohrman. "It's a major time saver not having to go through all the pages of documentation to find out measurements. If I want a new part, I always go to Data Portal first."

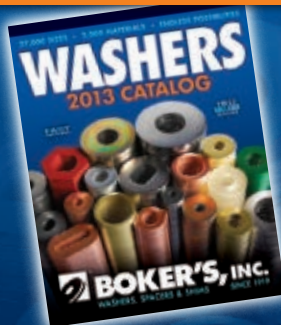
Finally, EPLAN helps integrate engineering and has made for a smooth transition. "We get a quick turnaround when we make a request—usually within the day. (An EPLAN support technician) can go online and see my screen, he can see the problem, which makes trouble-shooting so much easier," said Lohrman.

AMT's way forward with EPLAN is likely to include closer integration of electrical and fluid design as more engineers are trained in EPLAN Fluid. That way, two disciplines could work side by side to accelerate projects and optimize outcomes. Other future steps might include adopting EEC One—the new EPLAN Engineering Center One, to begin designing machines mechatronically in functional units. **DW**

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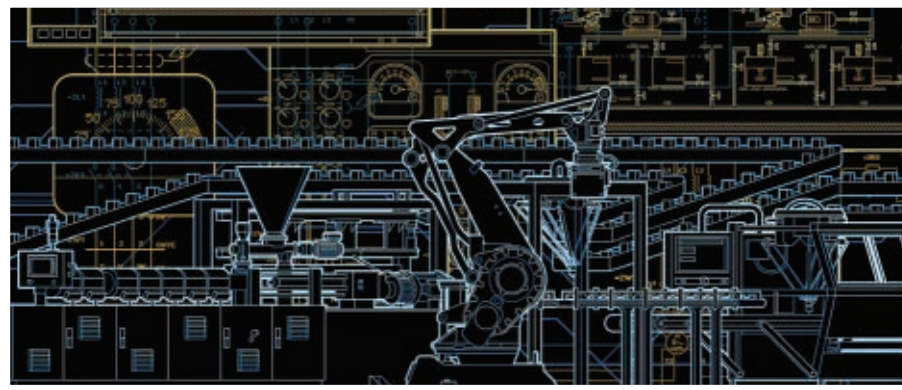
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# Tool-suite combats cost of software

■ By Leslie Langnau/Managing Editor



**Automation Builder** is an engineering development tool-suite to help you integrate the build of control and motion systems based on PLCs, safety PLCs, robots, motion control, and related automation components.

Combining all of the tools required for configuring, programming, debugging and maintaining automation projects from a common intuitive interface, it addresses the largest single cost element of most of today's industrial automation projects: software.

"Industrial automation projects are

becoming more complex, and it's leading to spiraling software development costs and project timescales," said Soenke Kock of ABB. "Automation Builder delivers a means to simplify the control engineering task and standardize on a single development platform for all projects—regardless of scale."

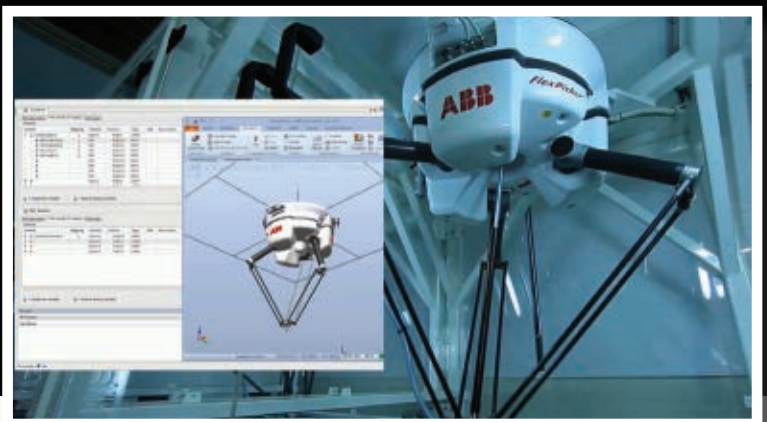
The tool-suite builds on the Control Builder Plus tool for programming PLCs, which delivers PLC development resources in the form of the CoDeSys IEC 61131-3 development environment and the Panel Builder tool for

creating HMIs. These are complemented by tools for configuring and programming safety PLCs, the RobotStudio tool for simulating and programming industrial robot applications, and the Mint WorkBench tool and pre-built and tested libraries for controlling drives and other devices connected through fieldbuses, networks, or the web.

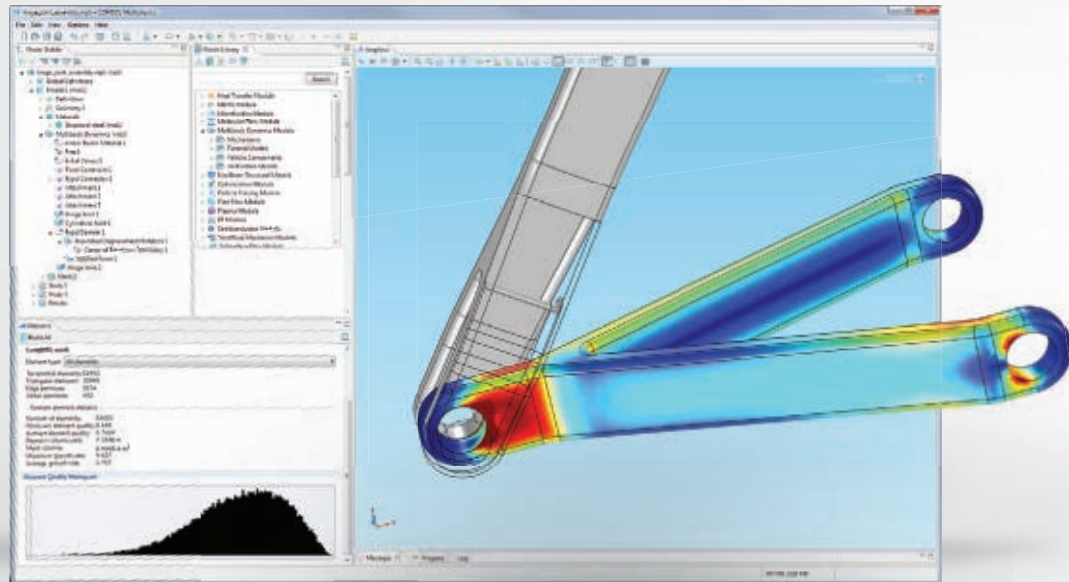
The tool-suite integrates all these capabilities into a single environment served by common data and an intuitive user interface. The data consistency eliminates the need to enter data multiple times, and avoids the programming effort and potential problems associated with exchanging data between the controller and all of the various devices in the automation system such as servomotor drives, robot arms, operator panels, and I/O. Third party devices can also be interfaced into the environment.

ABB estimates that the Automation Builder environment can shorten development times by up to a third for complex systems. 

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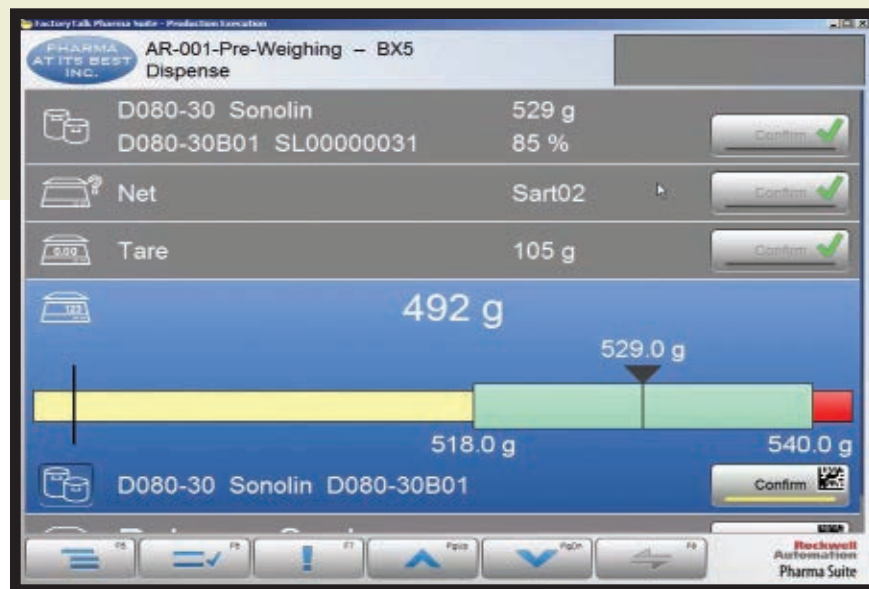
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## Easy programming for pharma and life science applications

**Rockwell Software PharmaSuite v5.0 system**, for pharmaceutical and biotech production, delivers a single MES system with the agility to integrate and streamline production across multiple production areas and product lines, as well as from line to site level.

This suite delivers automation-layer integration, equipment modeling and non-order work-flow management:

- **Automation-layer integration** – The software system includes improved integration with production equipment—including to the Logix control platform—and automated batch processing using the PharmaSuite Recipe Designer. The system automatically collects data directly from production equipment, provides automation set points, monitors automation events, and integrates process information into the electronic batch record to reduce the risk for human error that can result from manual data collection.

The PharmaSuite Recipe Designer supports a greater number of production processes. Its information-flow design enables access to definition and run-time information across the entire recipe to give users added insight into real-time production information.

The new data types within the expression editor help you deploy more sophisticated conditions, rules and calculations to customize function to your needs.

- **Equipment modeling** – The system uses an equipment modeler to define the underlying model and optimize integration across the range of manufacturing types, including biological, secondary, active, discrete assembly, weigh and dispense, and packaging. This allows you to define the automation interface, maintain equipment descriptions and specifications, and use the equipment modeler as the foundation for GMP-compliance tracking and automation-integration scenarios.

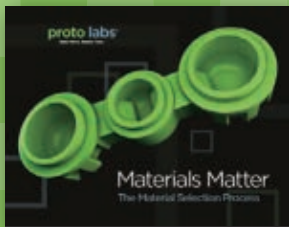
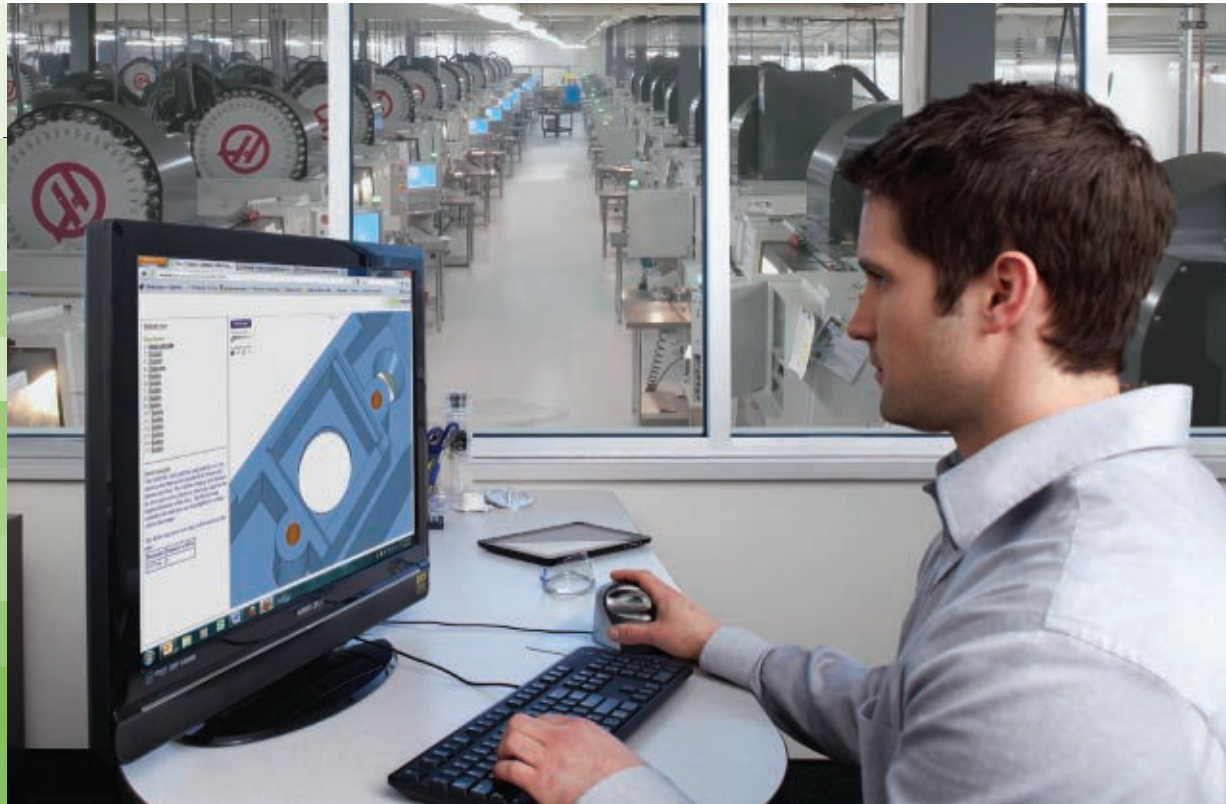
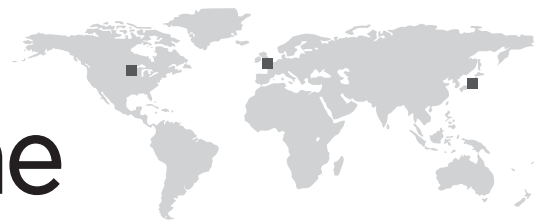
- **Nonorder work-flow management** – The system redefines assembling and supporting nonorder-related work flows that traditionally require custom programming by a systems integrator. Using S88-recipe design principles, the system enables the on-site end user or recipe author to create new work flows on their own, in minutes, by re-using existing building blocks. 

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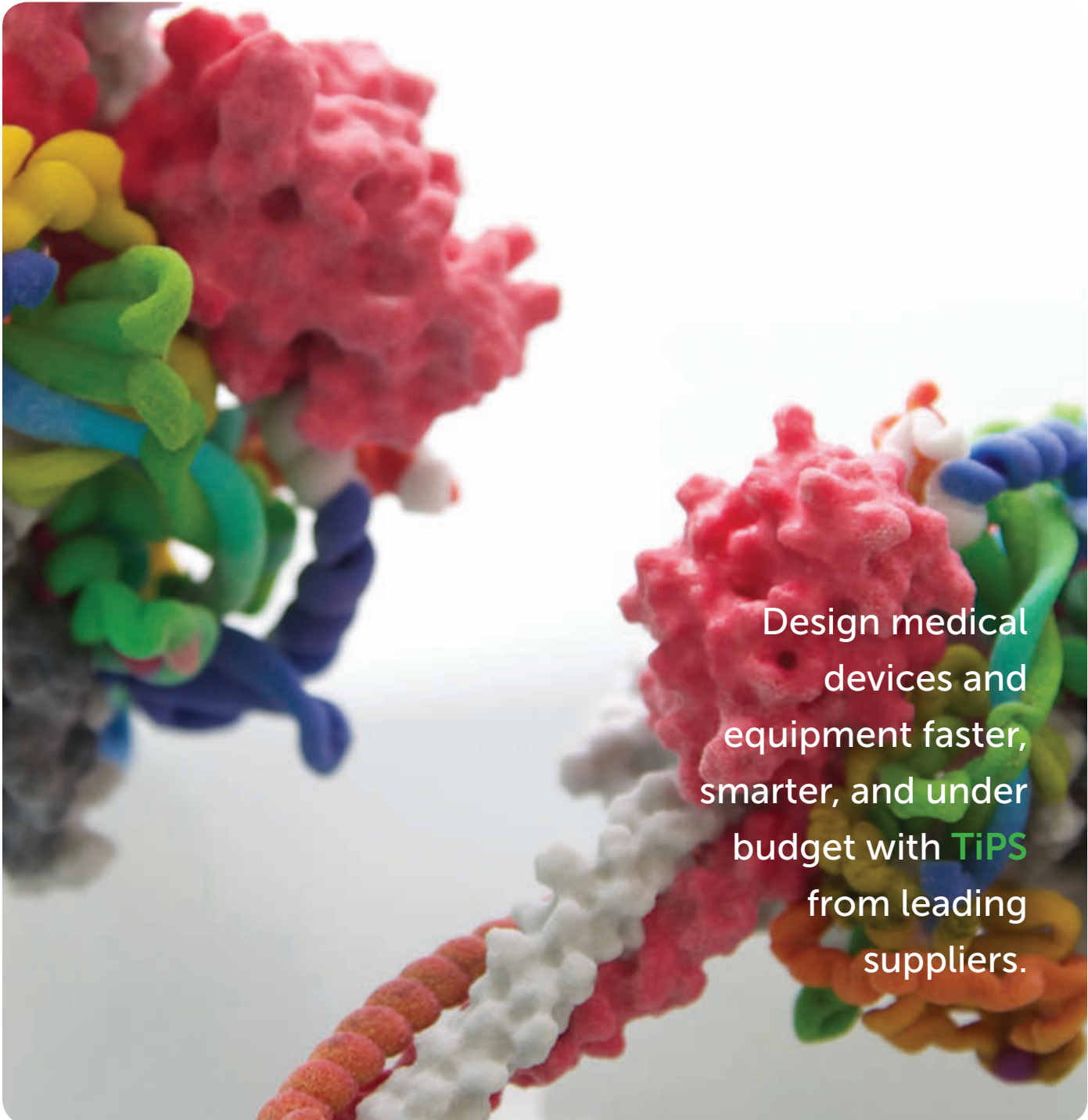
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# Two-part production simplifies medical designs



Mary C. Gannon / Senior Editor

## Two years ago, Trelleborg Sealing Solutions

purchased a liquid silicone company headquartered in Switzerland, which provided silicone extrusion and silicone molding, all in a clean room facility. The facility in Stein am Rhein, Switzerland and another in Northborough, Mass., allows the company to manufacture and design two-part Liquid Silicone Rubber (LSR) devices and components for the medical, biotech, pharmaceutical, and food and beverage industries.

The facilities specialize in finishing, washing and packing products and processes, manufacturing high-precision, miniature silicone parts.

Silicone is best suited to life sciences applications because it features matchless inertness and biocompatibility, which should be considered when factoring in potential bacteria growth and alleviating contamination. It is also the most widely tested and proven material related to human compatibility. In addition, silicone's mechanical properties prove to be excellent in dynamic applications where accuracy, consistency and longevity are

important performance determining factors.

The key to LSR injection molding, said Jerry Zawada, Life Sciences Segment Manager, is a two-shot, two-component technology, which allows Trelleborg to mold plastic and silicone into one piece, such as a pushbutton on an IV machine.

"The advantage of this is usually when you injection mold something, you then have to transfer it and hand assemble it into the new mold and do the rubber mold that way," Zawada said. "With the finished part, there is no plastic trimming needed and no waste."

In addition to meeting the needs of high-precision applications, the wasteless and flashless design of LSR injection molding is ideal for complicated geometrical features, especially in situations where thin wall thicknesses (as low as 0.10 mm / 0.004 in.) are needed.



Finally, unlike most compression molded components, LSR technology allows for undercutting. “Because it’s fully cured, there is no need to cure it, so you can undercut it,” Zawada added.

The technology is much faster and can be accomplished with much less labor, Zawada said.

The facilities operate from low to high volume production, ranging from 100 to 100 million pieces. Fully closed-loop, automated production ensures high product purity and cleanliness. In addition, sophisticated robot technology, and high-precision tool design and manufacture eliminate secondary parts handling operations. 

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» **When medical devices** require two types of material—silicone and rubber—to be manufactured into one piece, Trelleborg’s Liquid Silicone Rubber manufacturing allows for seamless, one-piece designs that eliminate waste and simplify production.



# ColorJet 3D

## printing helps vaccine research

**By their nature,** two-dimensional images offer incomplete views, leaving that third dimension to speculation. In non-technical applications, it's not critical to know what's on the other side. But in medical research, when doctors are trying to find big answers that lie hidden in small organisms, the failure of two-dimensional images can multiply the difficulty of finding cures. To combat the problem, Dr. William C. Ray, principal investigator and faculty member of The Battelle Center for Mathematical Medicine, is using 3D printing for visualization in his study of the Respiratory Syncytial Virus (RSV). By 3D printing large physical representations of proteins and organisms, his team is able to break away from flat microscope images and see these structures in full view.

» 3D printed models of the Respiratory Syncytial Virus (RSV) F protein. Researchers could hold it in their hands and gain visual access to the third dimensional aspect of its molecular machinery. This has helped them see RSV in enough detail to formulate new intuitions about how it works and how it does not.

Dr. Ray is conducting his work at the Research Institute of Nationwide Children's Hospital, located in Columbus, Ohio.

RSV is the leading viral cause of lower respiratory tract infection in infants and children worldwide. RSV has an estimated annual global disease burden of 64 million cases and 160,000 deaths. It is the most common cause of bronchiolitis and pneumonia in the United States for children under one year of age, and each year 75,000 to 125,000 children are hospitalized due to RSV infection, most under six months. It is estimated that more than 8.5 million adults (including those over age 65) are also infected

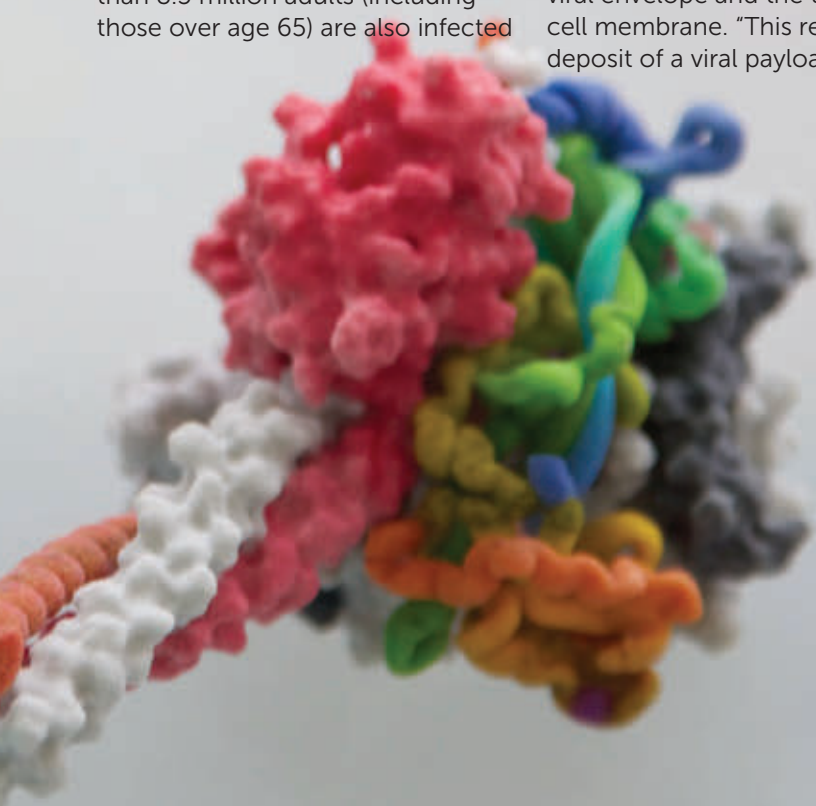
annually. In the United States and Europe, approximately 900,000 hospitalizations result from RSV each year. Taking hospitalizations, lost workdays and mortality into account, this virus costs billions of dollars annually, yet there is currently no approved vaccine for its prevention.

One problem facing Dr. Ray and his fellow researchers is that no one is sure how RSV actually works. What has become evident about the virus, however, is that a critical part of its lifecycle involves a molecular machine (the "F protein") that is used to stir together the viral envelope and the targeted cell membrane. "This results in the deposit of a viral payload into the

cell," he said. "Putting a wrench in the gears of this machine would stop the infection process, but because the gears of this metaphor have not yet been located (we still do not know how it works), past attempts to find a vaccine have failed."

To determine the true colors of this machinery, Dr. Ray set out to study the F protein using 3D printing. With a background in computational graphics, Dr. Ray knew relying on two-dimensional pictures would not yield the degree of insight required to solve the challenge of RSV, but he believed color 3D printed representations of the virus would benefit his research. Thus, when his center was awarded funding to invest in new technology to support its research, Dr. Ray jumped at the chance to obtain full color ProJet 3D printers from 3D Systems.

Dr. Ray and his team, including noted virologist Mark Peebles, as well as William's wife and longtime collaborator, Joan Ray, modeled RSV using computer graphics and computational physics tools. They then 3D printed models of the F protein, so they could hold it in their hands and gain visual access to the elusive third dimension of its molecular machinery. This has helped them see RSV in enough detail to formulate new intuitions about how it works and how it does not. According to Dr. Ray, this third dimension provides researchers with critical information. Even with prior access to stereo-3D monitors and professional graphics cards, nothing compares to a full color, physical 3D model.







» By using 3D printing for visualization, researchers can break away from flat microscope images and see proteins, organisms, and other biological structures in a three dimensional full view.

Though Dr. Ray is quick to emphasize that a cure for RSV is still a ways off, he says ready access to color 3D models has moved research substantially forward and inspired new ideas about how it functions. 3D visualizations have also been instrumental in debunking former disruptive myths about the virus that had been leading researchers down unproductive paths.

Dr. Ray continued, "Yet even for sophisticated users with extensive experience in photoreal graphics, 3D visualizations can do a poor job of conveying uncertainty. Though portions of models containing calculation error may be colored differently to indicate this distinction, uncertain parts are still just as real on the screen as the parts that are certain. This disconnect is exacerbated with solid 3D prints, as speculative parts of the model are just as solid in your hand as high-confidence portions. Therefore, at least until new technology allows us to print models with variable flexibility to tactilely represent uncertainty, the knowledge-transfer benefits of 3D printing are paired with the responsibility to remain ever cognizant of the reliability limitations of our current models."

This realization notwithstanding, the research community now has another tool in its arsenal to assist it in its quest to isolate, understand and resolve harmful pathogens and threats to our health. Full color 3D printers can cost between \$25,000 and \$70,000, but for the advance of our physical wellbeing and the knowledge of modern medicine, the investment is well worth it. After all, if a picture is worth a thousand words, a full color 3D model is all but priceless. 

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## ACCUMOLD

### 5 Things Everyone Should Know About Micro Molding

One of the greatest challenges facing many of today's design engineers, especially when designing for medical applications, are the limiting factors of today's technology. The goals of designing devices or tools for doctors and patients that can do more in less space present huge challenges for engineers. Medical devices that are less invasive, more effective in diagnosis or treatment, or that can simplify complex procedures are in high demand. But how is this accomplished?

One of the enabling technologies of late to the medical industry is micro molding. Capable of extremely small part sizes, tight tolerances, thin-wall sections or micro features, micro molding can often allow designers to achieve what was once thought impossible. But what exactly is micro molding? How can a designer take full advantage of its capabilities? And, how can it help push the limits of other technologies?

These questions and more are examined in Accumold's latest discussion, 5 Things Everyone Should Know About Micro Molding. This conversation highlights the main areas where one might get stuck in the process when designing for micro sized parts or components. Topics in the article include: General Guidelines and Design Considerations, Material Selection, Prototyping, Manufacturing and more.

Go to: [http://www.accu-mold.com/Accumold\\_Resources.html](http://www.accu-mold.com/Accumold_Resources.html) or follow the Corporate Resources link on the Accumold home page to download 5 Things Everyone Should Know About Micro Molding.



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## MICROMO

### New Best in Class Additions to the Micro Brushless Motor Series

MICROMO introduces the new 8 and 10 mm diameter Brushless Motors from the FAULHABER Group. The 0824 and 1028 motors offer high precision speed control and optimal power in the smallest size. The new motors are ideal for a variety of applications in the medical device, robotics and optics and photonics markets. MICROMO provides a complete, flexible systems solution. The motors can be used with a wide variety of FAULHABER Group encoders, gearheads and speed and motion controllers.

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- Very low weight (0824 = 5.2 g) and (1028 = 9.1 g), with high stall torque 3.3 and 8.4 mNm, respectively.
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- Encoder resolution incremental, up to 1,024ppr, or 12 Bit (4,096 steps), single turn absolute version is available.
- A wide range of planetary, spur and low backlash spur gearheads are available.



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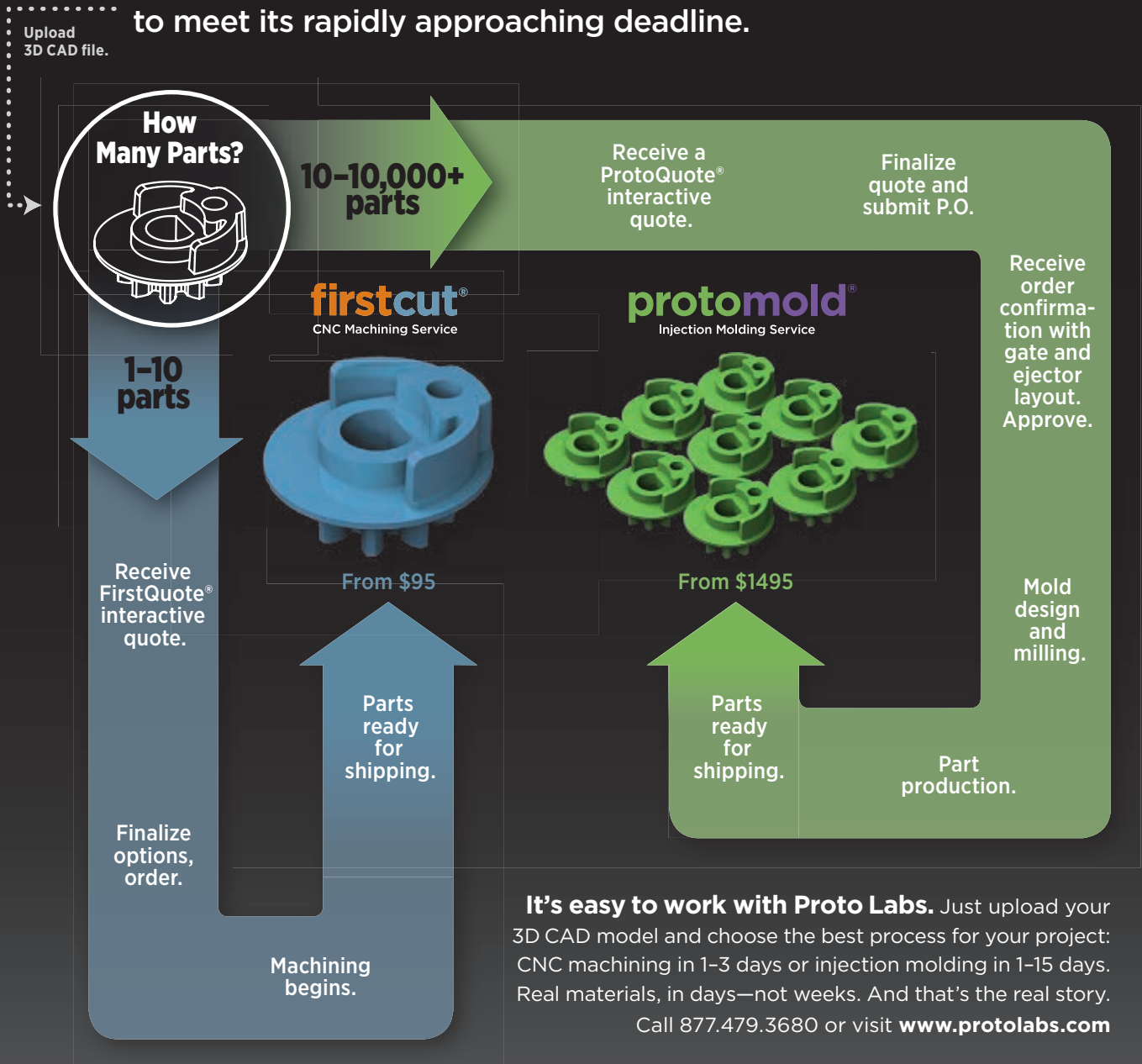
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## Bison Gear & Engineering Corp.

The new 34 frame AUTONOmotor® gearmotors are powered by totally enclosed, non-ventilated (TENV) brushless motors. The motors are sensor-less to reduce cost, size, and wiring complexity while offering improved reliability and noise immunity compared to brushless motors with shaft mounted rotor position sensors. Offered with 1/6 (124 watts) and 1/10 (74 watts) input Hp. BLDC motor & drive sold as a package.



### Drive Features & Functions

Used only with sensorless BLDC Gearmotor. The drive detects rotor position at motor stand still, based on motor phase-inductance measurement. Used to start the motor reliably, uni-directionally and without any start-up delay.

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- Digital on-off enable
- Digital direction control
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- ROHS compliant

Check with your local Bison distribution partner to get the brushless AUTONOmotor system from Bison, or see more of our motor and gearmotor solutions at [www.bisongear.com](http://www.bisongear.com).

You can also contact us directly at 1-800-AT-BISON.



## BIMBA

### Bimba Announces New "Blue and Improved" Original Line® Cylinders

Bimba Manufacturing Company, a provider of pneumatic, hydraulic, and electric solutions, announced a series of product enhancements to its industry-leading round line, non-repairable Original Line® product series.



These changes include design modifications to further extend the catalog life rating of the cylinders from 1,400 miles to 3,000+ miles, as well as new product labeling and packaging.

"These design enhancements are the culmination of more than three years of product testing and communications with our customers. It will more than double the life of our Original Line®, enhancing the value to our customers of the industry's hardest working, longest lasting cylinder," said Jerry Scherzinger, Bimba's OL Product Marketing Manager. "Additionally, we are updating the look of the cylinder by replacing our pre-existing red logo with an updated blue logo, as well as introducing new packaging that will be easier for customers to remove prior to installing our cylinders.

Scott Meldeau, Bimba's Vice President of Sales and Marketing said, "These changes reflect the aggressive corporate approach Bimba is taking to strengthen our existing products, in addition to developing new products to position us for future growth."

To learn more, visit [www.bimba.com](http://www.bimba.com).



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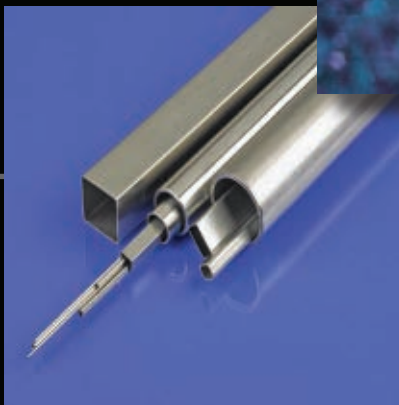
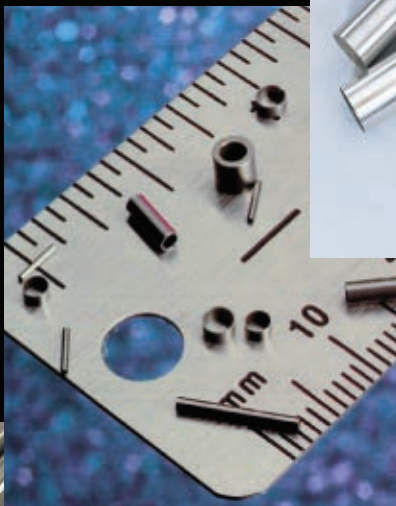
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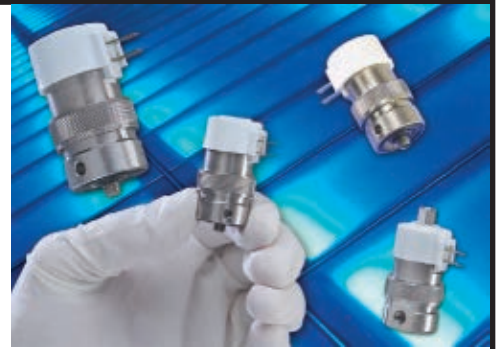
## Clippard Oxygen Series Electronic Valves

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For complete details on the "O-E" series of electronic valves that provide safety of operation in oxygen applications with quick response, low power consumption and long life, visit [www.clippard.com/oxygen](http://www.clippard.com/oxygen).



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For over 25 years, Dunkermotor has partnered with medical device, diagnostic equipment, hospital and home healthcare OEMs to provide safe, long-life motor and motion control solutions. In 2012, Dunkermotor produced over 500,000 motors for the global medical market.

Dunkermotor's medical application experience is vast. It ranges from simple permanent magnet DC and brushless motors used in peristaltic pumps and vacuum systems to brushless servo motors with gearing and embedded intelligence deployed in today's most sophisticated multi-axis diagnostic systems. Other applications well-served by Dunkermotor's Medical Duty Motors™ are CT/MRI scanners, mobile X-Ray scanners, Immunoassay systems, surgical tools, operating tables, dialysis systems, patient lifts and automated pharmacies, to name a few.

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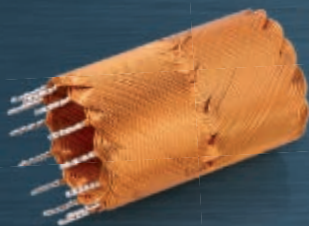
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Maxon's EC4 is a 4 mm diameter brushless DC motor and gearhead. The typical issue found with micro drives of this size is the output power is too low for the application requirements because of the physical limitations. maxon increased the performance of this tiny motor using the latest winding technology along with the most powerful magnets available. This motor is available in two lengths; short version with 0.5 W nominal power or long version with 1.0 W nominal power.

maxon also incorporated a high quality gearhead to ensure optimum continuous running. High performance ceramics are used for the gearhead carrier to make the motor capable of high input speeds and drive torques. The speed/torque gradient of the EC 4 is an impressive 50,000 rpm mNm<sup>-1</sup> with a continuous torque of 0.4 mNm. There are options on the windings and encoders as well as different reduction ratios on the new 4 mm planetary gearhead.

This 4 mm brushless DC servo motor is becoming the benchmark solution in miniature pumps, surgical robots, diagnostic devices, endoscopes and anywhere miniaturization is critical. maxon motor has explored the limits of technical boundaries with this EC4 motor development. For more information and product specifications, visit [www.maxonmotorusa.com](http://www.maxonmotorusa.com)



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For an insider's look at the technology behind at Proto Labs' quick-turn manufacturing operation and our Protomold Injection Molding service and Firstcut CNC Machining service visit us at [www.protolabs.com/tour](http://www.protolabs.com/tour).

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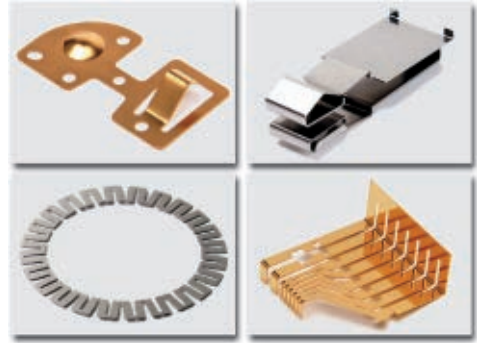


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## Products

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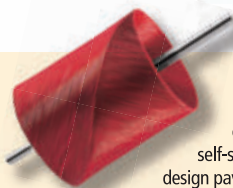
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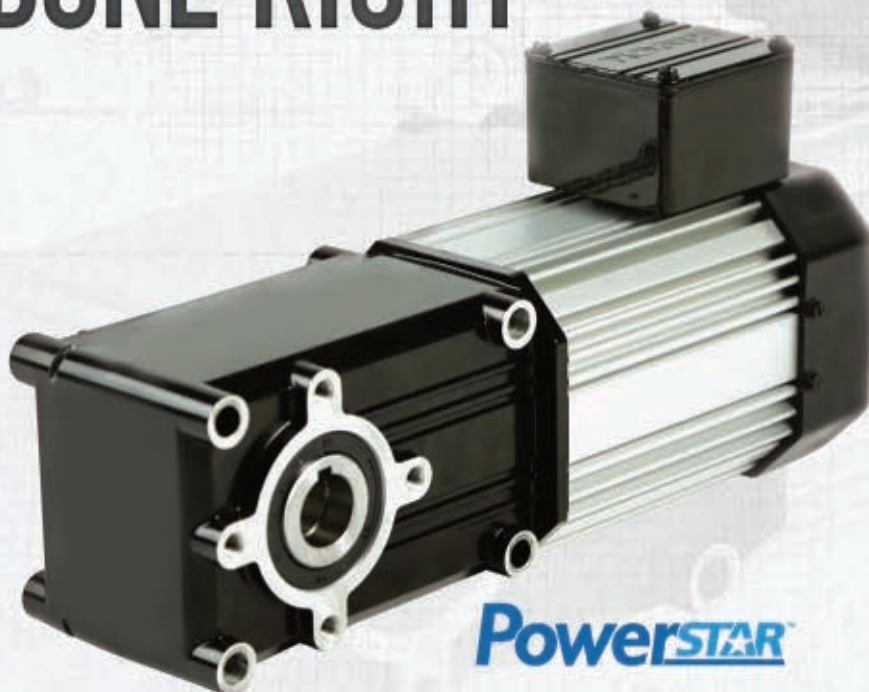


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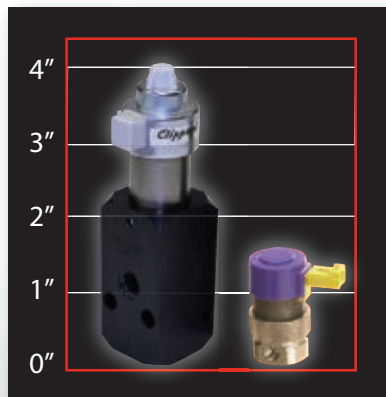


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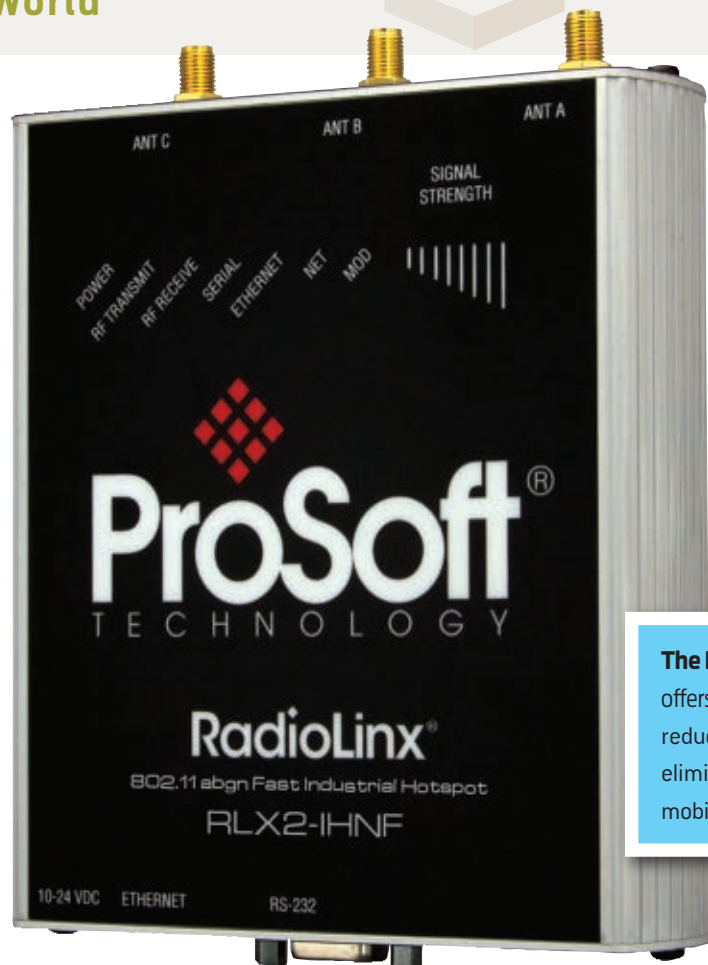
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The radio's Fast Roaming technology uses less than 50 ms time between access points and provides full device bridging. The module provides secure 802.11i and 128-bit AES Encryption and operates securely in the 2.4 GHz or 5 GHz bands. The microSD card

will automatically store/load configurations, reducing down time.

The Hotspot is designed for extreme environments and hazardous locations, including oil and gas systems. It is a suitable wireless system for Producer/Consumer PLC/PAC networking, remote I/O, safety I/O, plant backhaul networking, remote video and mobile worker connectivity. It works over operating temperatures of -40 to +75°C (-40°F to +167°F) and has agency approvals and certifications with Class 1, Division 2 and ATEX Zone 2. The module is high shock/vibration tested.

**ProSoft Technology, Inc.**  
[info@prosoft-technology.com](mailto:info@prosoft-technology.com)

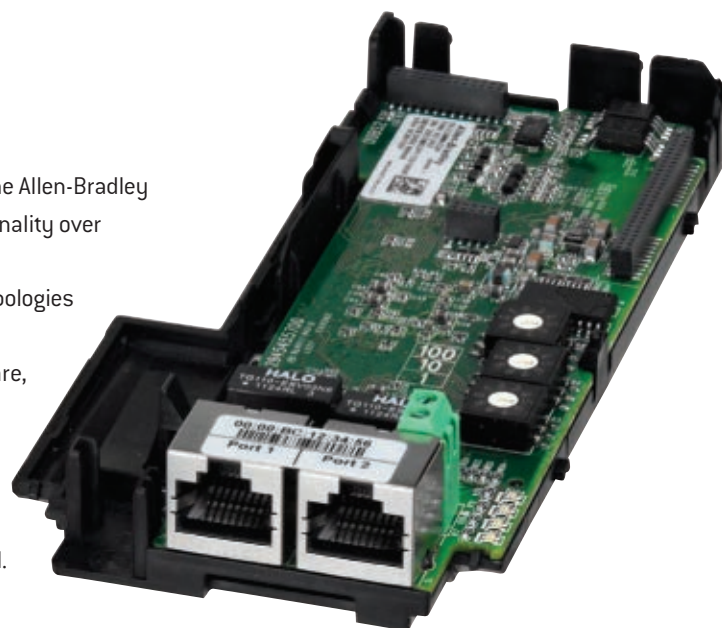


## Ethernet adapter for ac drive

**A** dual port EtherNet/IP communication adapter is available for the Allen-Bradley PowerFlex 525 AC drive, offering device level ring (DLR) functionality over EtherNet/IP networks.

The dual port EtherNet/IP card lets users select from a range of topologies including ring, linear and star while lowering the total cost of machine design, development and ownership with less wiring, reduced hardware, ease of use and reduced downtime.

DLR technology, which is an ODVA standard, helps reduce configuration time and costs by minimizing the number of managed switches and reducing cabling needs while allowing users to create a single network ring that connects all components at the device level.



Rockwell Automation, Inc.

[ab.rockwellautomation.com/Drives/Low-Voltage-AC-Drives](http://ab.rockwellautomation.com/Drives/Low-Voltage-AC-Drives)

## EtherNet Starter Kits

**ETHERNET 2.0** (IP20) and **SPEEDWAY** (IP67) Ethernet Starter Kits offer a low-cost approach to training. Developed to provide the Wago-I/O-SYSTEM fundamentals, the kits consist of comprehensive I/O nodes complete with software site licenses and hardware. The kits also include free, downloadable sample applications including: visualization, controlling process digital inputs and outputs, controlling rotating machinery and processing the fieldbus controller's real-time clock.

The IP20 Ethernet Starter Kit contains: 750-880 Ethernet 2.0 PLC with SD Card, a 2-channel DI and DO modules, power supply, 2-way digital input simulator and end module. The 750-880 blends IT-style flexibility and PLC functions, demonstrating large-scale programming, data logging, backup/restore and more via SD Card.

The IP67 Starter Kit introduces cabinet-free automation through prominent protocols such as Modbus/TCP and EtherNet I/P. It features a SPEEDWAY programmable controller with Ethernet ports, 8-channel DO and spacer modules, power supply rocker switch and RJ-45 to cable breakout module.

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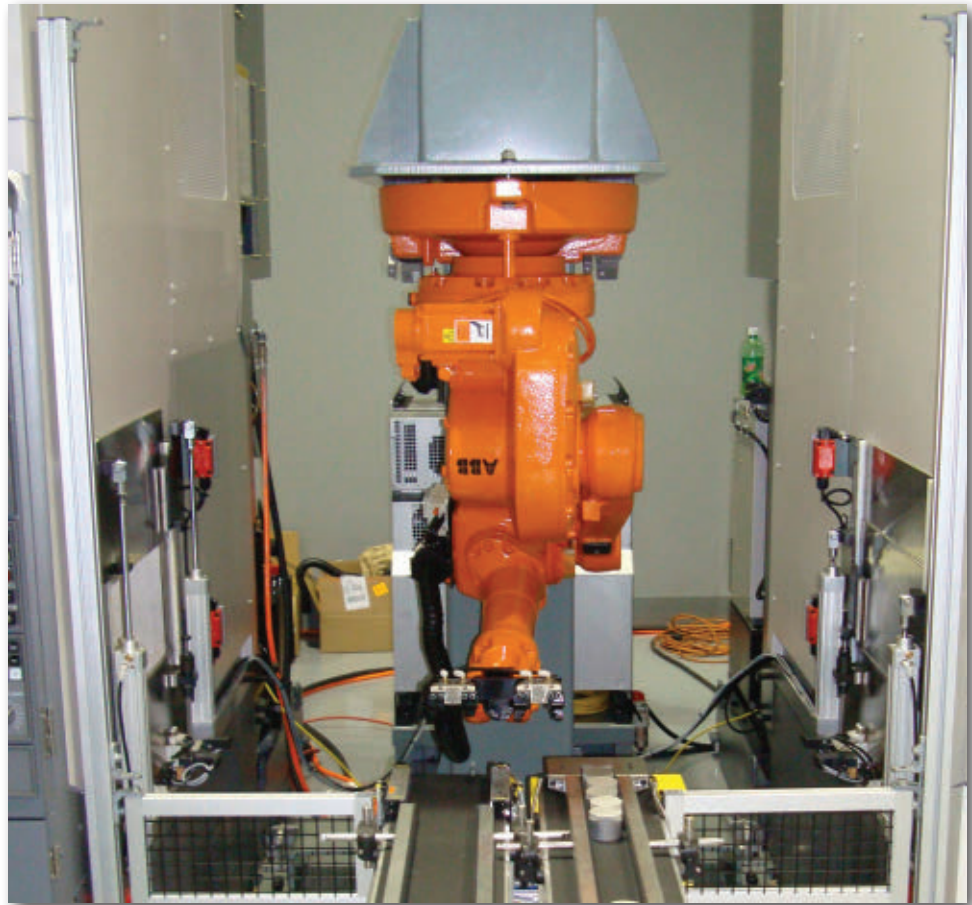
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# ABB's IRB 1600 increases payload

Paul J. Heney Editorial Director

**ABB Robotics** has increased the top payload of its IRB 1600 from 8 to 10 kg, expanding the performance of this versatile robot to heavier part applications. The IRB 1600 is used in a variety of applications including machine tending, material handling, arc welding and cutting. The increased payload is available in both the 1.2-m and 1.45-m reach variants, and will allow the robot to handle larger parts and end-of-arm-tools with no sacrifice in accuracy and speed. ABB says this will achieve up to 50% better cycle times than competitor robots of the same class.

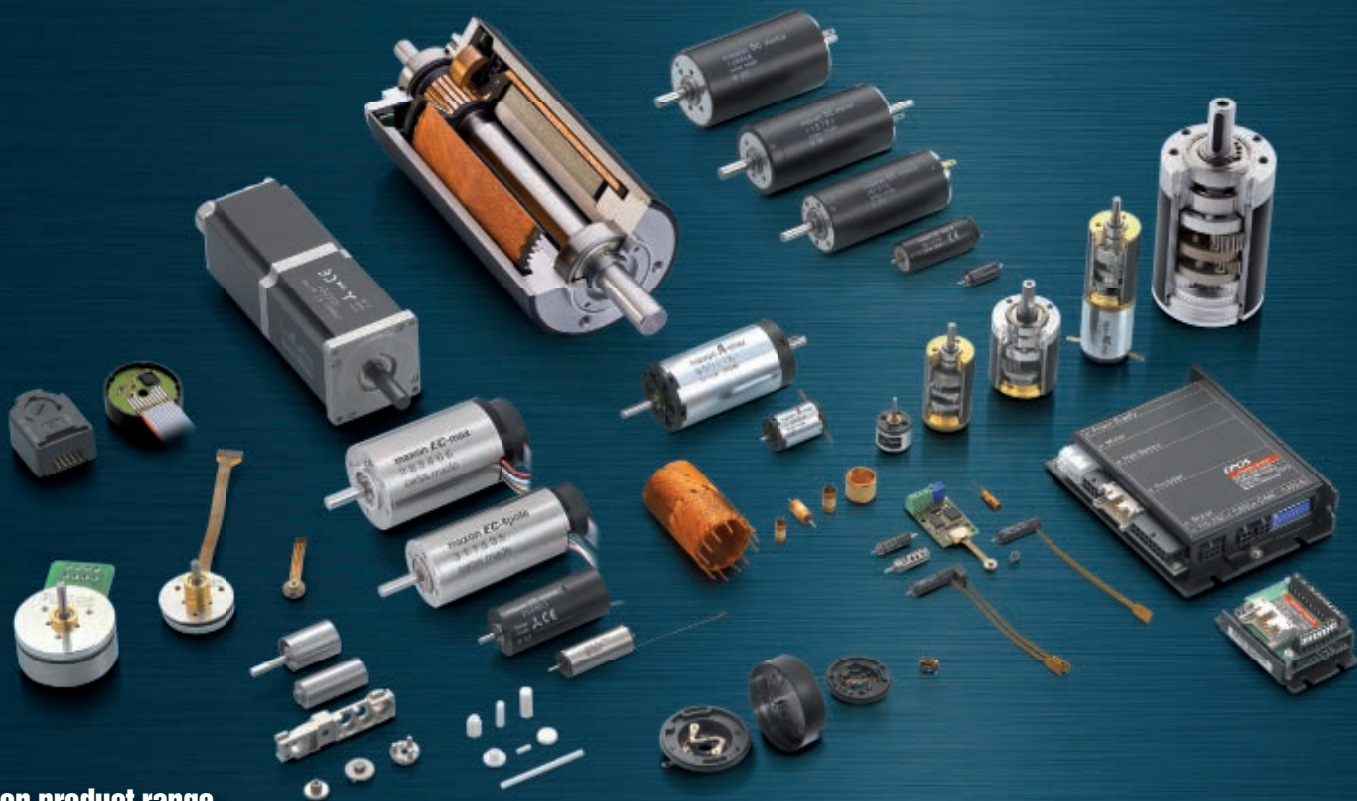
The IRB 1600 provides a combination of acceleration and accuracy, eliminating the common trade-off between these two primary performance metrics. The company's second generation QuickMove motion control technology and low friction spur gears allow the IRB 1600 to speed up and slow down faster than other robots, saving time while moving between tasks and improving cycle time. And the second generation TrueMove technology ensures that the robot will maintain the same path at all speeds, eliminating the corner-cut paths that most robots default to at high speeds.

"Whether it's a small job shop or a huge tier one manufacturer, the challenges for these industries are the same. Produce quality parts at a low cost," said Terry Crunk, machine tending specialist, ABB Robotics. "This upgrade, though seemingly insignificant, will be just enough to give the end-user a valuable competitive advantage for a number of different robotic applications, particularly for machine tending applications."

The upgrade enhances the IRB 1600's other advantages such as solid protection for use in harsh environments (IP 67 and Foundry Plus 2), and the ability to be invert or side mounted, on a shelf, a wall or other existing structures. The compact 1.2-m reach variant makes the robot more dexterous in confined spaces for improved reach and flexibility. The IRB 1600 is also more energy efficient and provides lower noise levels than comparable models.



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## New website for DENSO

**DENSO Robotics** has launched a new website at [www.densorobotics.com](http://www.densorobotics.com). The redesigned site showcases the company's range of compact, high-speed industrial robot arms, including four-axis SCARA and five- and six-axis articulated robots.

"Our website has always offered users a wealth of information about our robots," said Peter Cavallo, robotics sales manager, DENSO Sales California. "Now with the new site, there is even more information available, and it's easier to find."

Each product page on the new website includes tabs that allow quick access to complete information for a particular robot model. The tabs include features, specifications, dimensions, standard

components, accessories and application videos. Users can also download product data sheets and CAD drawings.

The site's support section features a new troubleshooting FAQ, as well as downloadable robot information sheets and maintenance guides. A training section details course descriptions, schedules, costs and locations. An applications section offers case studies, downloadable white papers, and videos. 

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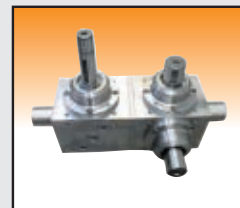
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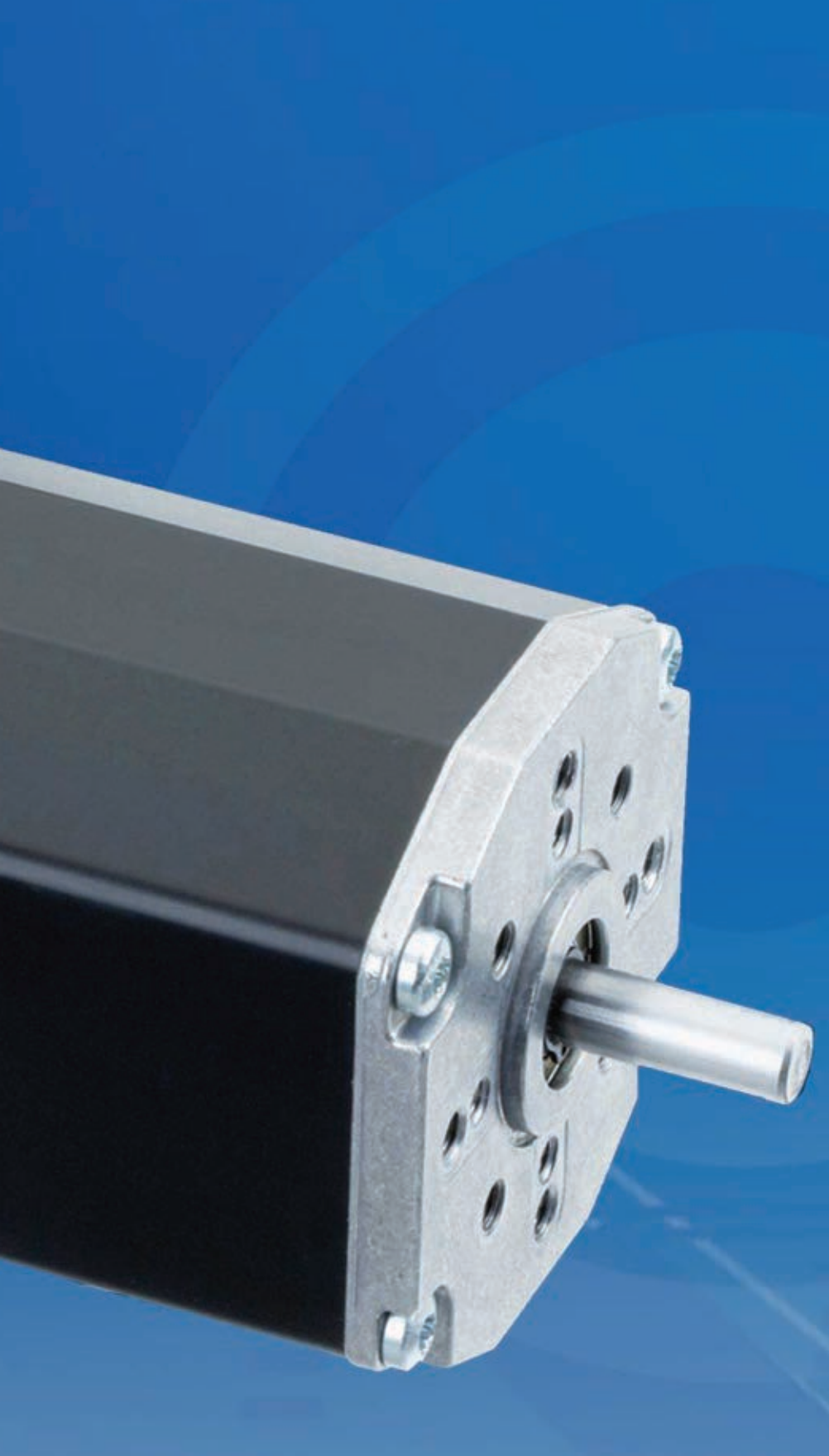


Motion Control ||||

# Developments in Integrated Motors

By: Miles Budimir / Senior Editor

New integrated motors offer expanded networking options, more control flexibility, and greater capacity for handling harsh environments.



**I**negrated motors are not a new concept, having been around for at least a few decades. In that time, the individual components that make up an integrated motor have gotten smaller. So by extension, when putting all these components together the overall integrated motor units are smaller and more compact.

As a result, more and more motor manufacturers are releasing integrated motors, realizing the benefits and advantages for their customers and their applications, especially the simplification of machine building.

One reason for the growth in the integrated motor space has been the fact that heat management techniques have gotten better over the years. This, combined with shrinking component size means that integrating drives and motors and other components has gotten easier and more practical than in the past when components were bigger and heat dissipation was more of an issue.

Integrated motors offer a number of advantages. For instance, machine builders don't have to buy separate components and hook them up together but only buy one integrated motor unit, typically with a connection point for a network cable, and link as many motors together as the application calls for. This also simplifies purchasing because instead of having to order many different components engineers can order one unit or as many as are needed for the project.

---

◀◀ **Dunkermotor's BG series** of integrated motors now feature EtherCAT connectivity.



## Motion Control ||||

**The Lexium MDrive from Schneider Electric Motion** comes in two sizes and features different modes such as pulse/direction and motion control.

These systems are said to offer greater reliability mainly because there are fewer parts to connect together. Also, fewer external connections mean less cabling and wiring. Less cabling and wiring reduces costs as does the fact that the components that one would usually purchase separately such as the motion controller and the drive are integrated into one package.

These integrated motors are also designed to be programmed easily and quickly, which can help reduce development times. Communication options can range from simple serial communication links to more advanced network topologies suited to complex motion control tasks.



Integrated servomotors are classified by their design. The motor itself is combined with the other essential components of a complete motion control system including the feedback device (generally an encoder), the amplifier or motor drive, a communication port and the motion controller itself. So technically, an integrated motor is any motor that has another component combined with it, such as a drive or amplifier, controller or encoder. Consequently, integrated motors come in many different types and sizes from servo motors to stepper motors and even large ac motors.

Manufacturers can offer a range of combinations and also differing definitions for what constitutes an “integrated” motor.

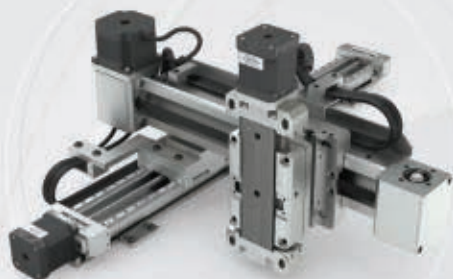


**IP65 rated integrated drive+motors** from Applied Motion Products can easily interface with 3rd party controllers such as the Allen Bradley ControlLogix series.

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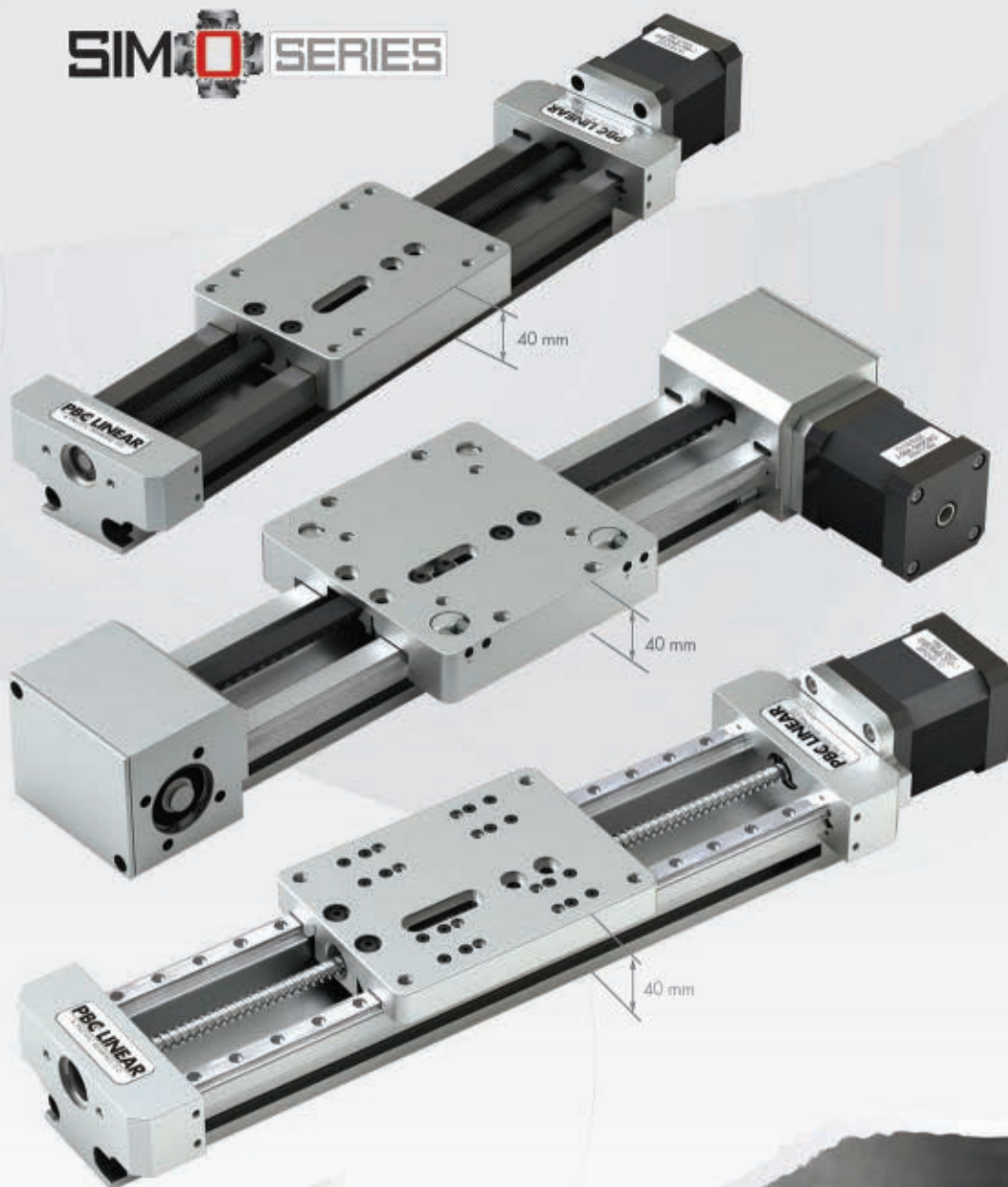
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For instance, Lin Engineering offers a number of combinations from a simple stepper motor and driver to a stepper motor with driver, controller, and encoder. So you can get different combinations depending on your application needs.

A survey of what manufacturers are

offerings with heavy-duty ratings for use in harsh environments.

### Greater control flexibility

The latest offering from Schneider Electric Motion is the Lexium MDrive. The Lexium MDrive products can benefit a range

four control modes (torque, speed, velocity, and step clock direction), and a Motion Control version which includes a motor, drive, and controller for direct programming with 11,120 bytes of flash memory.

Both offerings have a serial RS-422/485 communication interface, with an operating power range from 12 to 70 Vdc. An intuitive user software suite is provided for product configuration and programming. These products with an internal encoder also operate in closed-loop mode using the company's hMT technology, which blends stepper and servo motor benefits, while eliminating negatives such as loss of synchronization or stalling. And a variable current control feature may also reduce heat, save energy and lower operating costs.

### Handling harsh environments

Another trend with companies that have existing integrated motor product lines is to

**“Technically, an integrated motor is any motor that has another component combined with it, such as a drive or amplifier, controller or encoder.”**

offering in the integrated motor space reveals the addition of greater control flexibility, increased network offerings and capabilities including seemingly minor hardware and connectivity changes that make the motors more flexible in that they're suitable for a greater range of applications, as well as more

of motion applications by saving space, reducing wiring and improving machine reliability.

The initial Lexium MDrive product release includes two motor sizes, NEMA 23 & 34, and two product versions; a Pulse/Direction line with a motor and drive with

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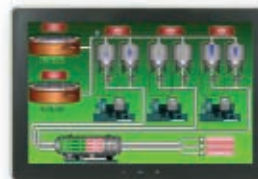
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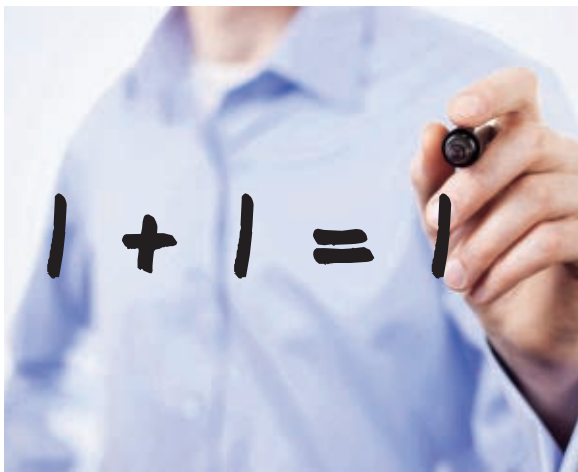
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## Motion Control ||||

add features. One such feature is to make the motors more suitable for harsh environments by making them IP65 rated.

This is what Applied Motion Products has done with the addition of five IP65 rated integrated drive+motors to their line of motion control products.

The new SWM24 fuses a motion controller to a high torque NEMA 24 step motor. The NEMA 24 frame size mounts like the NEMA 23 motor, but has a 15% larger cross section, allowing it to deliver more torque in the same length. The entire package is engineered to resist the ingress of water and dust to IP65 standards with all the connectors sealed, M12 style.

The SWM24 models provide 340 oz-in. of holding torque and are available with Ethernet or RS-232 communication. All models include a 4,000 count/rev optical encoder to provide features including stall detection, position verification, position maintenance and a proprietary stall prevention algorithm. The auto tuned digital current control and high-resolution microstepping engine provides smooth, quiet motion, while an advanced anti-resonance algorithm with electronic damping ensures maximum torque utilization, rapid acceleration, and fast settling times.

The S and SF models can be used in step direction or velocity control applications while the Q and QF models include stored programming capability using the company's Q programming language. All models can be configured and programmed using the company's free ST Configurator software.

Software applications can communicate with the SWM24 in real time, streaming SCL and Q commands over standard 100 megabit Ethernet cabling, addressing and protocols. The RS-232 versions also support streaming commands at bit rates from 9600 to 115,200. EtherNet/IP is also available for connecting to an Allen-Bradley ControlLogix, CompactLogix or MicroLogix PLC.

### Networking focus

In line with other trends in automation and motion control, integrated motor manufacturers are expanding their networking and connectivity options. For

instance, Moog Animatics, one of the early originators of the integrated motor concept, recently added a CAN communication option to its SmartMotor line of integrated motors. It gives users the option of connecting to CAN through the D-sub connector on top of the motor instead of at the rear of the motor, simplifying connections as well as saving space.

Other motor manufacturers are adding EtherCAT connectivity. Dunkermotor, now a unit of AMETEK Precision Motion Control, extended its range of brushless dc servo motors with integrated intelligence and fieldbus connectivity with ten new models. The extended family now offers EtherCAT interface on all of its BG45, BG65, BG65S and BG75 base models. Available motors range from 50 to 500 W of power in 45 to 75 mm square frame sizes and feature CANopen over EtherCAT (CoE) compatibility. This feature combines the benefits of CANopen's standardized DS402 motion profile with EtherCAT's real-time fieldbus. 

### Schneider Electric Motion

[motion.schneider-electric.com](http://motion.schneider-electric.com)

### Applied Motion Products

[www.applied-motion.com](http://www.applied-motion.com)

### Dunkermotor (AMETEK)

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

### Moog Animatics

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

### Lin Engineering

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

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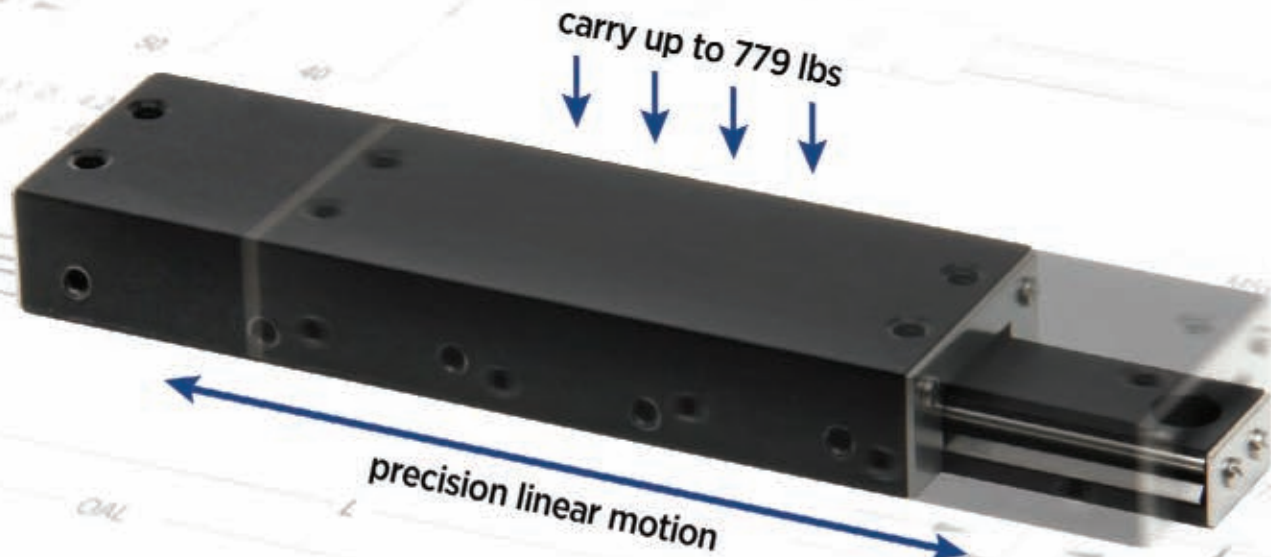


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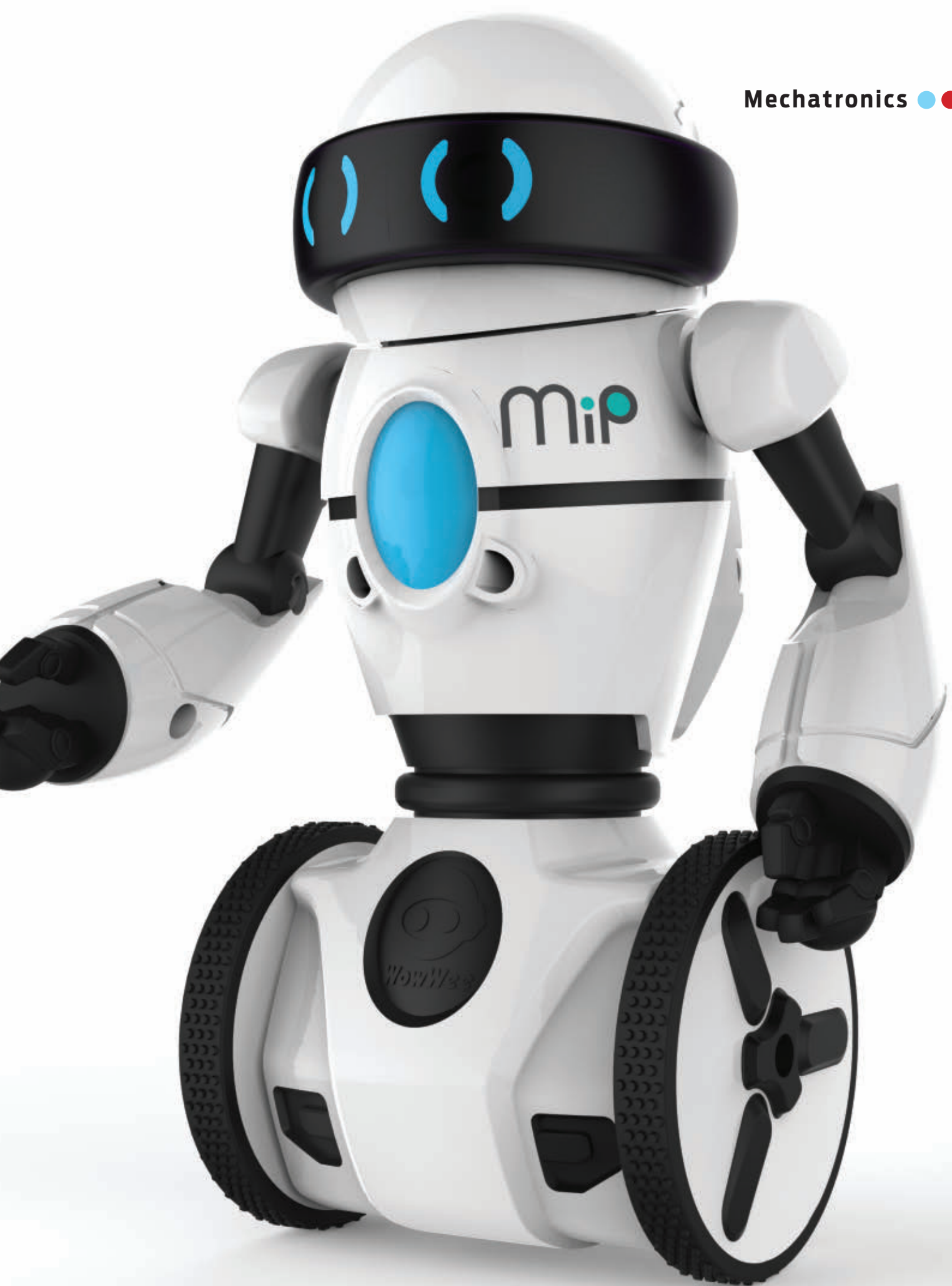
# Toys: **big** mechatronic challenges in small packages

Will your **kids** be begging you for this amazing robot in 2014?

**Sometimes,** a designer's main mechatronic challenge is to make something that is normally big and complex into something small and inexpensive. Such is the case with MIP robots. MIP stands for Mobile Inverted Pendulum. It is one solution to the problem of mobility platforms that are expected to radically change our idea of what robots are and what they can do. Like the radio controlled car or R/C plane of the past, the addition of high-performance embedded controllers is transforming what mobile platforms can do.

In the community of robotic development, the University of California at San Diego (UCSD) is home to an outstanding group of innovators. Prof. Thomas Bewley has been teaching in the Department of Mechanical and Aerospace Engineering at UCSD for 15 years. In a 2003 final exam, Prof. Bewley challenged his students to work out the dynamics and control of a novel "robotic pogo stick" concept. The exam had a completely unanticipated side effect: several of the students approached Prof. Bewley after the course ended and went on to perfect the proposed system of locomotion, and the

By Steve Meyer    Contributing Editor





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#### AGRITECHNICA

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UCSD Coordinated Robots Lab was born. The Lab has been creating breakthrough mobile robot solutions ever since.

Among the many platforms that have come out of the lab in the last few years are Switchblade and IFling. Switchblade takes the classic treaded tank concept and adds a pivot at one end of each tread. These additional axes of articulation—and the associated control algorithms—create a mobility platform that can use its own body as a counterweight. This combination allows the unit to climb stairs and navigate obstacles much larger than is possible with other treaded platforms.

IFling is a simple two-wheel mobility platform that leverages a clever 3D-printed body shape to pick up and store ping pong balls simply by rolling over them, and then throw them on command with a jai-alai style arm. It is lightweight and nimble and practically breakdances on command. To see it in action, please visit the Engineering Exchange, [www.engineeringexchange.com](http://www.engineeringexchange.com) and search for iFling.

By mathematically modeling the mechanics of each type of platform and using model-based feedback control in a high-performance, low-cost ARM processor, the robot is able to both move and resist disturbances while executing complex maneuvers. In

the case of MIP, the stabilization software combines the readings of a gyro, a two-axis accelerometer, and optical encoders on each motor to estimate the orientation of the robot at each instant. A control algorithm operating at 100 Hz then calculates the necessary voltages to send to two inexpensive brushed dc motors, which are connected to the wheels through a small 50:1 gearbox. The inexpensive ARM microcontroller used is quite fast, so there's plenty of room for the other software, which shapes the vehicle's unique personality.

## Enter the **toymaker**

A few years ago, the management group at WowWee Toys, which has its U.S. offices near UCSD, was introduced to the UCSD Coordinated Robotics Lab by UCSD's Technology Transfer Office. While the Lab's proof-of-concept platforms were engaging, they were far too expensive to be the basis of a marketable toy.

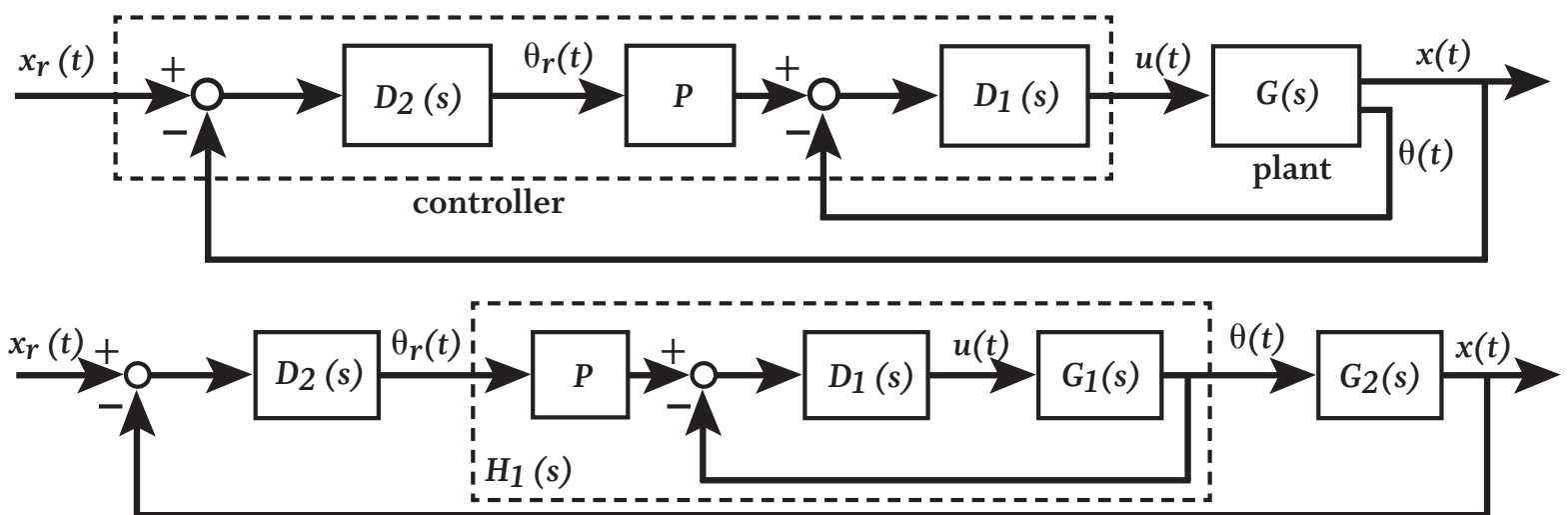
Sensing the potential that might result from collaboration, UCSD and WowWee teamed up and began exploring new platforms with low-cost and design for manufacturability in mind. Timing was fortunate, as the semiconductor industry's continually improving performance and cost brought a new ARM Cortex M0 processor at less than

\$1 at high volume. The cost of Micro-Electro-Mechanical-Systems (MEMS) sensors like accelerometers and gyros, which used to be prohibitively expensive, are now less than \$1 each given the high-volume production of these sensors for smart phones. Add in toy-grade motors and gearboxes and low-energy Bluetooth modules, high performance, sophisticated vehicles become possible at the low price points demanded by the toy industry.

## MIP

MIP is roughly 10% the height, 2% the mass, and 2% the price of a Segway, with similar dynamic behavior. MIP as an interactive two-wheeled mobility platform expected to come to market at under \$100, with dynamic behavior comparable to a \$5,700 Segway. Granted he's just a little guy, but consider the transformation of technology the enables such a toy to run circles around his much bigger and more expensive cousin. Such a development could not be foreseen in 2002 when the Segway was first released and suggests the emergence of a range of new platforms enabled by this new cost/performance level.

MIP is fully interactive with its surroundings and is controllable by gesture or through Bluetooth link to any intelligent device. MIP





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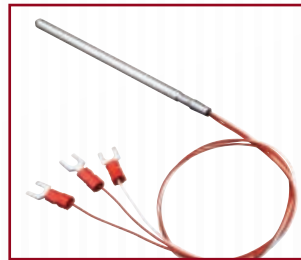
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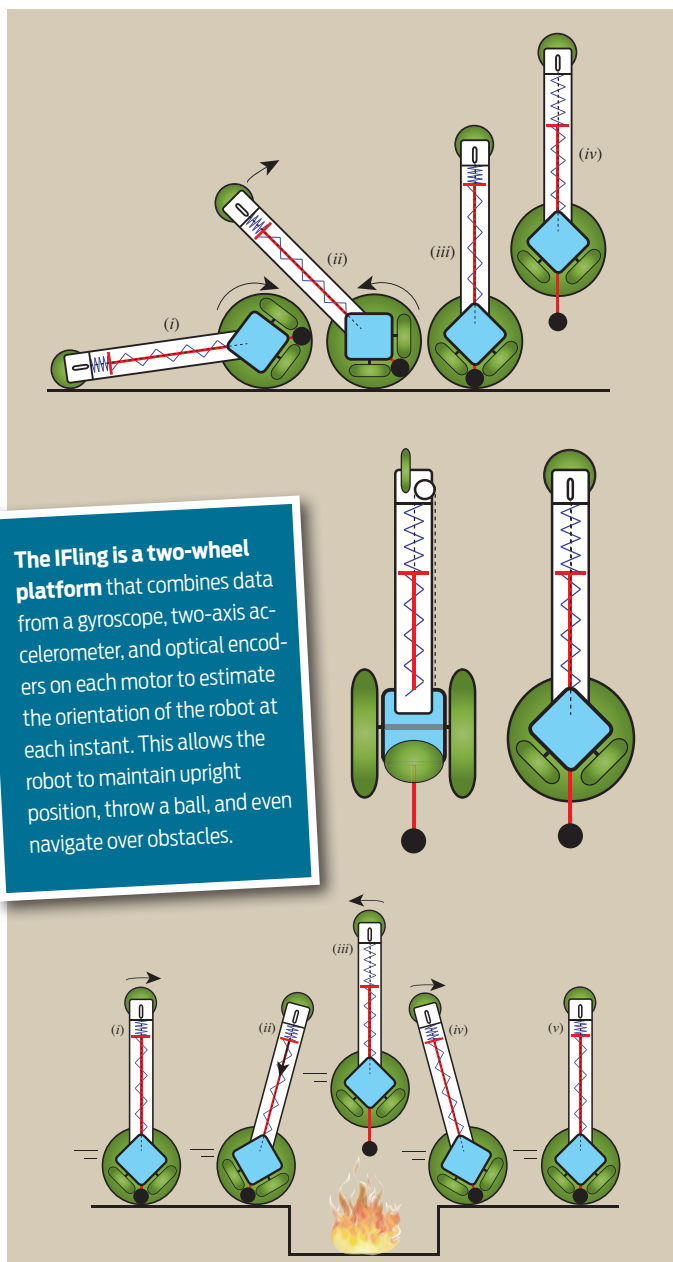


## Mechatronics ●●●

has personality features, has a limited “voice” like R2D2, can dance to your iTunes and will be able to play games with humans. Given the capability of its computing platform, features for MIP are still evolving.

As part of the extreme manufacturability solutions needed to bring MIP to market, WowWee/UCSD figured out how to mount the motors, gearboxes, and custom encoders to one side of a printed circuit board (PCB), and the sensors and processor on the other side, maximizing the automated assembly and optimizing the cost of an otherwise mechanically complex system.

MIP's first public showing will be at the Dallas Toy Fair (October 1-3, 2013), with broad availability planned for the first half of 2014.



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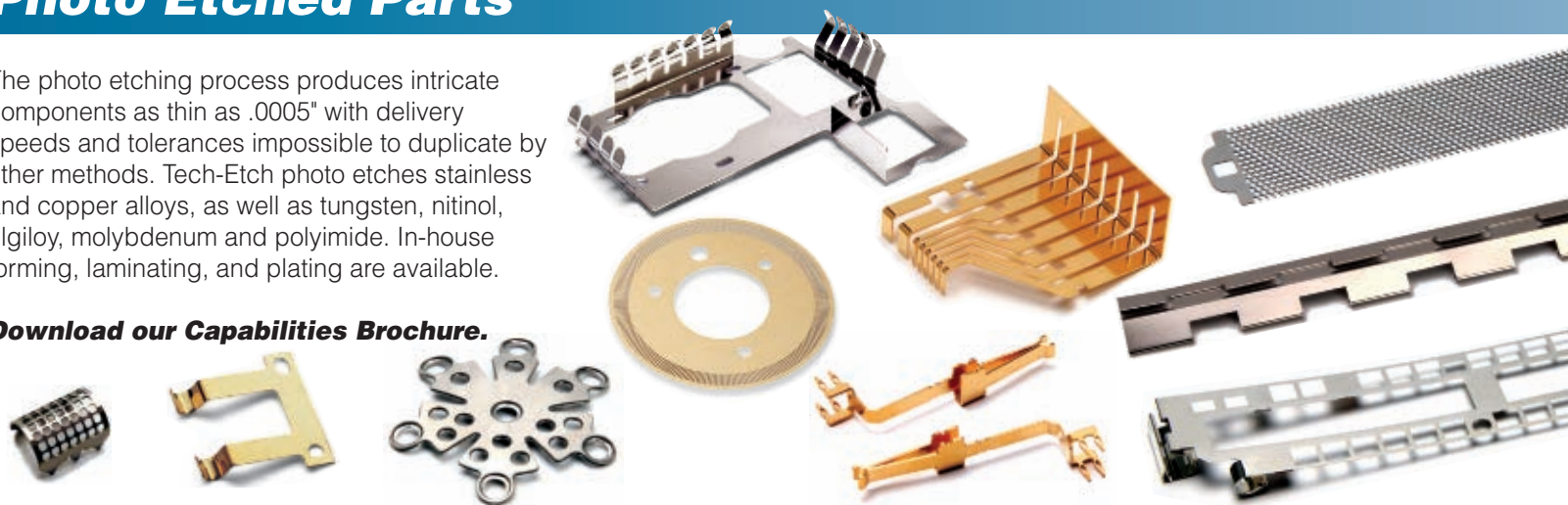


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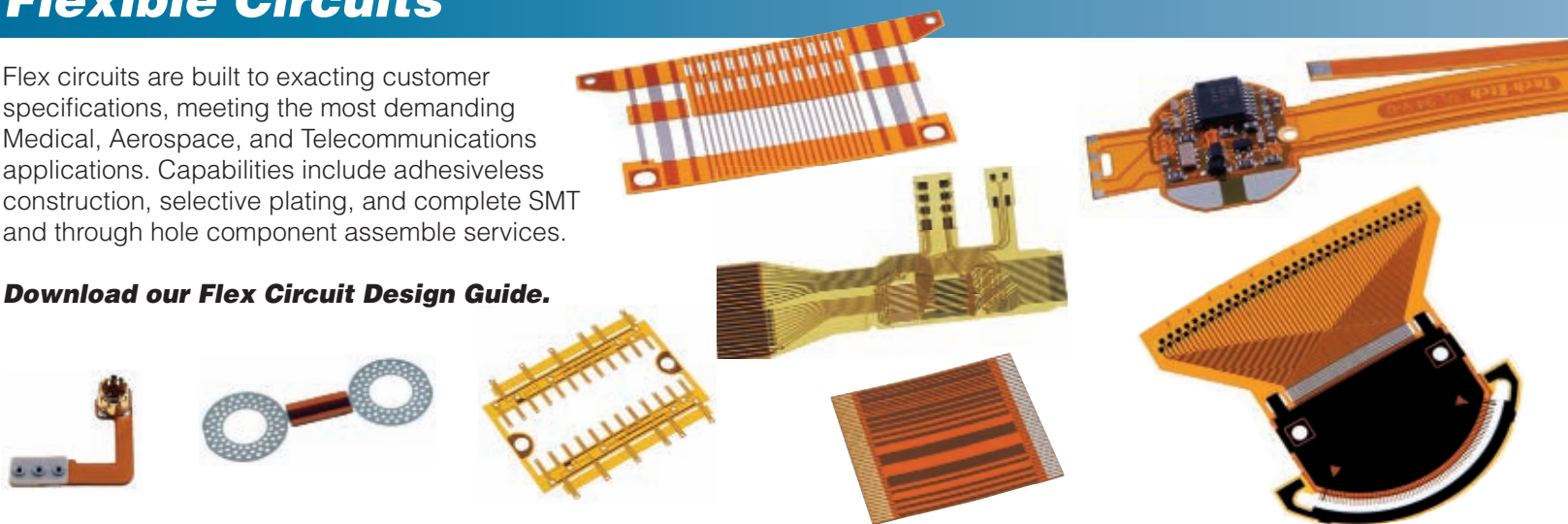
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## Mechatronics ●●●

### The economics of robotics

The energy going into the development of MIP and related designs at UCSD is not simply for fun or profit. The field of robotics is evolving almost as quickly as the advanced smart phone technology that it leverages, and there is an acute awareness of the revolutionary new applications that are soon to be enabled by these advances. Unmanned mobile vehicles today are relatively big and expensive, and have been limited to applications in manufacturing, security and defense. Where there is a transformational change in cost and function, new applications in fire fighting, medical care and personal service will produce great change in our society.

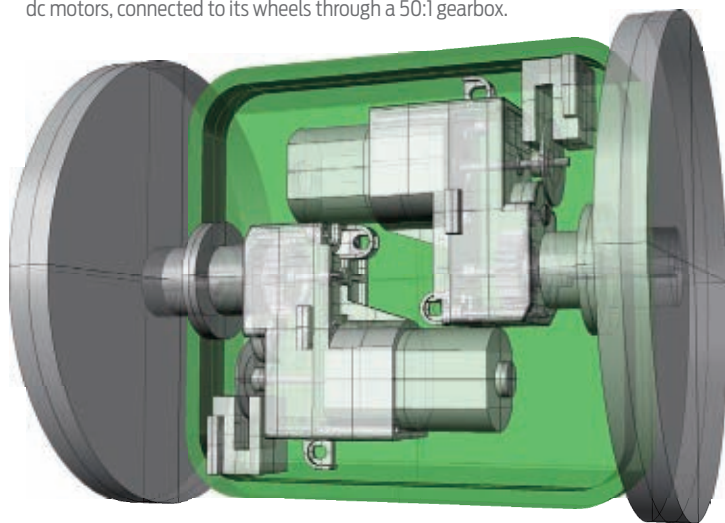
### Understanding stability

There are two approaches to stabilizing MIP. Using Successive Loop Closure (see figure on page 67), classical (single input, single output) techniques may be applied via two nested control loops—the inner loop regulating the body angle  $q(t)$  relatively quickly, and the outer loop regulating the horizontal vehicle position  $x(t)$  relatively slowly. Alternatively, state-space (multiple input, multiple output) techniques can be applied directly, thereby regulating both the body angle  $q(t)$  and the horizontal vehicle position  $x(t)$  simultaneously.

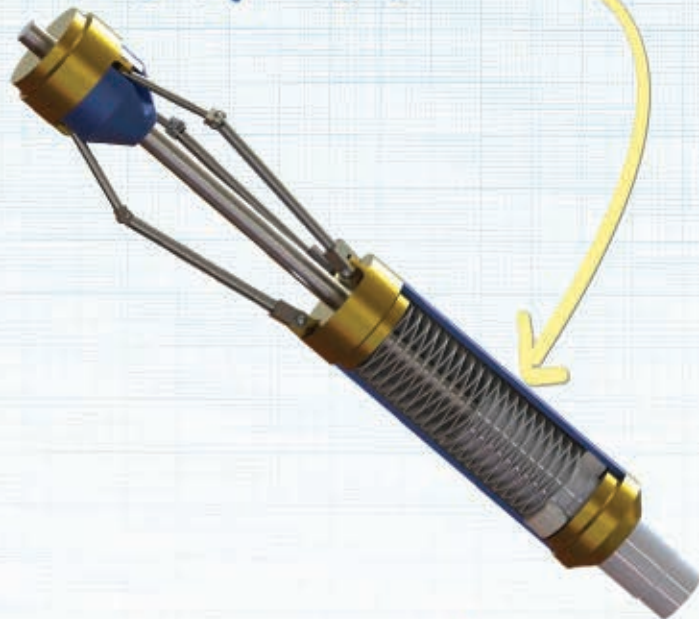
### Education and MyMIP

To the people at Wowwee, “It’s not just about bringing technology to the toy industry, it’s about bringing technology to a broader audience.” Today’s children grow up with computers, the Internet, and smart phones as an integral part of their daily lives. This generation has technology as an integrated part of its perspective and they are bringing new ideas into the mainstream. A generation that grows up with embedded controllers and dynamic control systems as a part of their everyday experience will invent things we haven’t even

**MIP, the Mobile Inverted Pendulum robot,** contains two brushed dc motors, connected to its wheels through a 50:1 gearbox.



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## Mechatronics ●●●

imagined yet. Recognizing this the UCSD Coordinated Robotics Lab is developing a new undergraduate controls curriculum around home-built MIPs called MyMIPs.

MIP and many robotic toys that will follow are the direct result of the educational process. These platforms are not just compelling toys to inspire imagination and creativity, they also serve as a practical platform to teach science, mathematics, mechanical engineering, and embedded processing. Given the educational legacy it is fitting that the products of the UCSD/WowWee collaboration are being designed specifically with “hackability” in mind: A standard 3-pin UART connection to the onboard ARM microcontroller is being built into these toys. An open standard will be published for communicating with the ARM processor, allowing higher level functions to be generated by new platforms like the MyRIO board from National Instruments. It is easy to imagine more complex applications through a high level graphical language like LabVIEW, so that students can explore complex behaviors like visual recognition or collaborative play, like a nice game of robot soccer.

Teaching and research based on these platforms will move all the associated technologies forward, because the platforms are inexpensive but feature high performance. Potential applications are broad, ranging from control theory, embedded processing, adaptive communication networks, the study of swarming behavior, non-cooperative games, and collaborative Simultaneous Localization and Mapping (SLAM) algorithms using multiple vehicles to explore unknown and potentially hazardous environments. 

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## » Fastening & Joining

# Critical steps in selecting fluid connectors for medical applications

**Jim Brown**

*Medical Business Unit Manager  
Colder Products Co.*

Choosing the right fluid connectors can improve patient safety and user convenience while maximizing sealing and flow performance.

**W**ith so many risks and options for connecting tubing in medical applications, it is important to have a simple and repeatable strategy for selecting the best connector solution. The process requires a thorough analysis of the application to ensure connectors will be compatible with the physical, chemical, and biological environment, and be easy to use as well as help prevent misconnections—whether the application involves connecting air lines for a blood pressure cuff, connecting reagent supplies to a blood analyzer, or making critical connections between a patient and heart-lung machine. The connector selection process can be broken down into the following decision-making steps.

### **Step 1** Consider safety needs

Begin by considering the safety of the patients and health care professionals who will be using the connectors. Connectors need to be easy and intuitive to use so there is no danger of leaks, spills, or in particular, misconnections.

In the past, the luer was a simple, universal design that provided an acceptable connection for many applications. However, today's escalation in the number of tubes and

connections in medical laboratories, hospital rooms, and operating rooms has increased the danger of misconnections. Regulatory and reporting groups such as the Food and Drug Administration (FDA), the Institute for Safe Medication Practices (ISMP) and The Joint Commission (TJC) have all reported patient injuries or deaths arising from misconnections.

» Connections to medical equipment need to be secure and convenient while also preventing misconnections.



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## » Fastening & Joining

» The variety of connection types and designs enhance the safety, functionality and usability of medical equipment.



Due to concerns over the proliferation of luer connectors, a series of new small-bore medical connector standards is being developed by a work group of the International Standards Organization (ISO) and the International Electrotechnical Commission (IEC). The ISO 80369 series of standards will define non-interchangeable connectors that will affect connector selections for a range of medical device applications. In the meantime, work with a company that understands these standards and has developed products to answer these concerns.

### **Step 2: Define the functional needs of the application**

The functional needs of a medical equipment application determine the parameters for tubing and connectors. The application also dictates whether the tubing and connectors are disposable or reusable and whether valves are required. For example, many hospitals use disposable blood pressure cuffs as one means of

infection control. For the manufacturer of the blood pressure unit and cuffs, it means selecting a connector style without a valve that is simple, low cost, and easy to secure and remove.

A blood analyzer is a more complex application. This application uses multiple lengths of tubing and connectors to supply the machine with various reagents or cleaning chemicals. Typically, lab technicians connect bottles of reagents to the machine through tubing with connectors on both ends. Connectors with valves are designed to eliminate spills and limit air from entering the system upon disconnect, creating a closed system and a cleaner, safer work environment. Finally, the connector and tubing materials selected need to be compatible with the reagents, solvents and cleaners used.

Consider the following factors as part of your decision-making process:

**Flow requirements** – The inner diameter (ID) size of the tubing generally establishes the first consideration for the size of the connector. Pressure drops across connectors and valves vary greatly by manufacturer, and some designs exhibit less turbulence and resistance to flow than others. By comparing published CV factors for various connectors (often listed in manufacturers' catalogs), you can determine the pressure drop across the connector and match the correct size to their application requirements.

**Media effects** – Connectors and O-rings should be compatible with the media being transferred. Start with a



review of published data in chemical compatibility charts to understand what materials will work acceptably with the range of chemicals, media or reagents in the application. Remember to consider cleaning solutions and other environmental exposure. Testing of potential product material is always a good idea to evaluate the material's performance in the actual application. Also take into consideration the effects of gamma ray, electron beam, ETO or autoclave sterilization on connector materials if the device will be sterilized.

**Temperature and pressure** – Consider the range of temperatures and pressures in the application and also consider the range of temperatures that the connectors might encounter in storage or shipping.

**Connector quality** – The level of manufacturing quality of a connector dramatically affects its performance and can also play a role in aesthetics. On molded plastic couplings, parting lines and mold defects (where two halves of the mold came together) should be minimal on the connector body and absent from the first hose barb. Imperfections on barbs or threads can lead to leaks. The molded connector's gate (the point where the

plastic was injected into the mold) should be free of jagged edges—poke-points that can catch or tear surgical gloves or tubing.

**Fitting type** – The most popular styles of hose connection are the single and multiple hose barb. Single hose barbs work well with softer tubing such as silicone rubber. However, connectors with multiple, sharp, well-made barbs, free of parting lines, provide a more secure connection over a range of tubing types.

**Valve options** – There are many styles of valves, and their flow rates and pressure drops vary. Connectors with integral valves prevent spills upon disconnection and prevent air from entering the system. Connectors with integral precision flush-face valves are considered true “dry-break” connectors and should be selected when there is a critical need to avoid any spills, contamination, or the introduction of air upon connection.

**Mounting options** – In some applications, a connector is mounted to the back, side, or front panel of a machine. Metal may be preferred for strength and a higher-end appearance; however, in most applications, plastic provides a robust, cost-effective solution.

### Step 3: Match materials to the application

The type of media flowing through a connector can influence the selection of a connector. Following is a list of generally available connector and O-ring materials, plus guidelines for using these materials.

#### Plastics

- **ABS** – Economical medical-grade thermoplastic that withstands gamma and E-beam sterilization.
- **Acetal** – Strong, lightweight and economical material that has good rigidity over a broad temperature range, with toughness and durability.
- **Polyamide (nylon)** – Very resistant to wear and abrasion, with good mechanical properties at elevated temperatures.
- **PEEK (polyetheretherketone)** – An engineered thermoplastic with high-temperature, chemical and fatigue resistance.
- **Polycarbonate** – Resistant to some chemicals, transparent and withstands sterilization for medical applications.
- **Polyethylene** – Low-cost, chemically resistant, opaque thermoplastic.
- **Polypropylene** – Excellent general-purpose resin that is highly resistant to attack from solvents and other chemicals.



#### » Connectors for medical applications

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### Fluoropolymers

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### Alloys

- **Aluminum** – Lightweight metal with a high strength-to-weight ratio that is available with a durable anodized finish.
- **Chrome-plated brass** – Rugged and attractive, this metal is excellent for high-pressure and high-temperature applications.
- **Die-cast zinc** – Weighing about 20% less than brass, this durable and lightweight material withstands high pressure and high temperature.

### O-Ring selection

- **Buna-N** – This is the most common O-ring material due to its solvent, oil and water resistance.
- **EPDM (ethylene-propylene-diene-monomer rubber)** – Also known as EPR, this material offers excellent chemical resistance.
- **FKM (fluorocarbon)** – Known for its outstanding resistance to heat, oxidation, weathering and ozone.
- **Silicone** – Has good temperature resistance. Medical-grade silicones also meet FDA Class VI requirements for biocompatibility in life-science applications.

Although connectors are sometimes thought to be a minor component of medical equipment, they should not be relegated to an afterthought in the design process. Connectors need to be considered early in the process to fulfill aesthetic goals as well as product performance and patient safety objectives. Because the connector is usually the user's primary interface with the device, it plays a key role in overall perception of the design. A well-designed connector makes the medical device easy to use and enhances the overall satisfaction with the device. 

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## Networking ||||

By: Leslie Langnau/Managing Editor

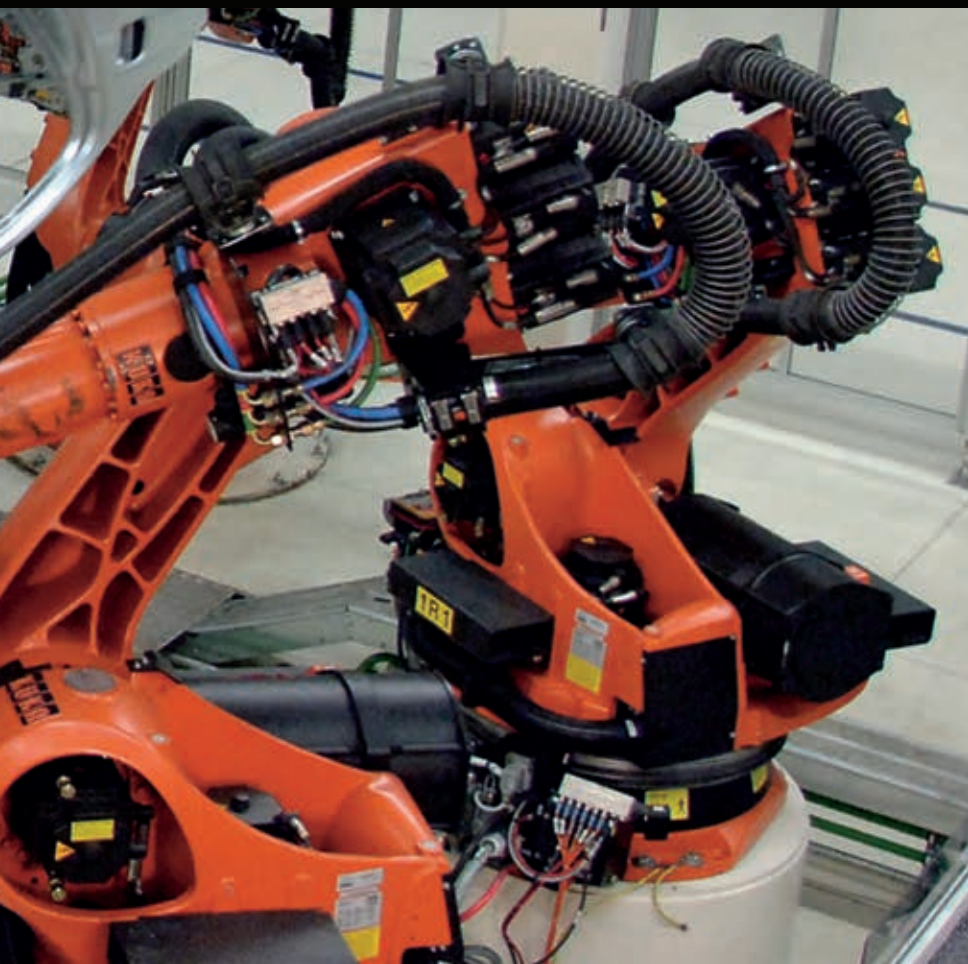




### **The MTConnect communication**

*protocol is one way to deliver shop floor data to the software applications used to run a business. Initially, this protocol establishes connectivity among machine devices. When fully implemented though, it will interconnect any equipment or device on the shop floor.*

## **Tips on working with the MTConnect industrial network**



**D**espite the fact that there are a number of communication protocols available for use in the manufacturing world, (Devicenet, Ethernet, Modbus, Ethernet/IP, and so on), none are optimized to work well with the Internet. In any manufacturing facility, especially the shop floor, hundreds of machines and devices operate, needing to share data to ensure efficient and cost effective production of product. Each device tracks information on its operation. But transmitting that data efficiently to other devices is still a challenge.

The IT world has solved this issue with its model for efficient communication. The USB standard, for example, is just one available standard that allows a range of disparate devices to easily exchange data.

At the 2006 annual meeting of The Association for Manufacturing Technology (AMT), presentations from David Edstrom of Sun Microsystems and Dr. David Patterson, Professor of Computer Science at the



## Networking ||||

University of California, Berkeley described the need for an open communication standard that would allow manufacturing equipment to connect to the Internet and use it as a means of data exchange. The question asked was, how could manufacturing replicate the IT model of interconnectability? By 2008, joint efforts among academia and industry machine developers resulted in the MTConnect protocol, an open, royalty-free communication standard that uses Internet communications technology to link machines and systems together. The protocol is based on HTTP and XML.

### Eliminate the communication “Tower of Babel”

According to AMT calculations, there are more than 1.2 million machine tools installed in the U.S, most of which have limited communication capability. Through MTConnect, this equipment could transmit such shop floor data as alerts, equipment availability, equipment usage, equipment effectiveness, energy use, security information, and other data for quality and statistical process control to various business optimization software to improve

**Table 1:**  
Here is a sample of data items defined in the MTConnect data dictionary.

|                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------|
| Acceleration; rate of change of velocity                                                                                |
| Accumulated time; the measurement of accumulated time associated with a component                                       |
| Clock time; reading of a timing device at a specific point in time. Clock time must be reported in W3C ISO 8601 format. |
| Displacement; the change in position of an object                                                                       |

operations, track production, and analyze plant operations.

The goal of MTConnect is to enable a range of devices to speak in the same language. It differs from other manufacturing communication protocols in that it lets you develop a dictionary for manufacturing data, and it is a read-only protocol. MTConnect is set up to only extract data from devices, not write data to them.

The dictionary enables machine developers and users to label and categorize data through common definitions, names, units, values, and context. Thus, data need only be defined once, rather than anew for each application. Then, the data can be transmitted over networks using the Internet

Protocol through HTTP and XML languages.

MTConnect compliant devices process information locally and then deliver it to any application, such as ERP, MES, and production management systems, spreadsheets, and other business management software. In addition, this protocol makes it easy for OEMs and users to add new data types that can be exchanged between machines and applications.

### MTConnect basics

The MTConnect protocol is divided into three sections; one for information on the protocol itself and how to use XML, one for specifying the equipment, components, and data that will work with this protocol, and

**The goal of MTConnect** is to enable a range of shop floor devices, not just machine tools, to communicate.



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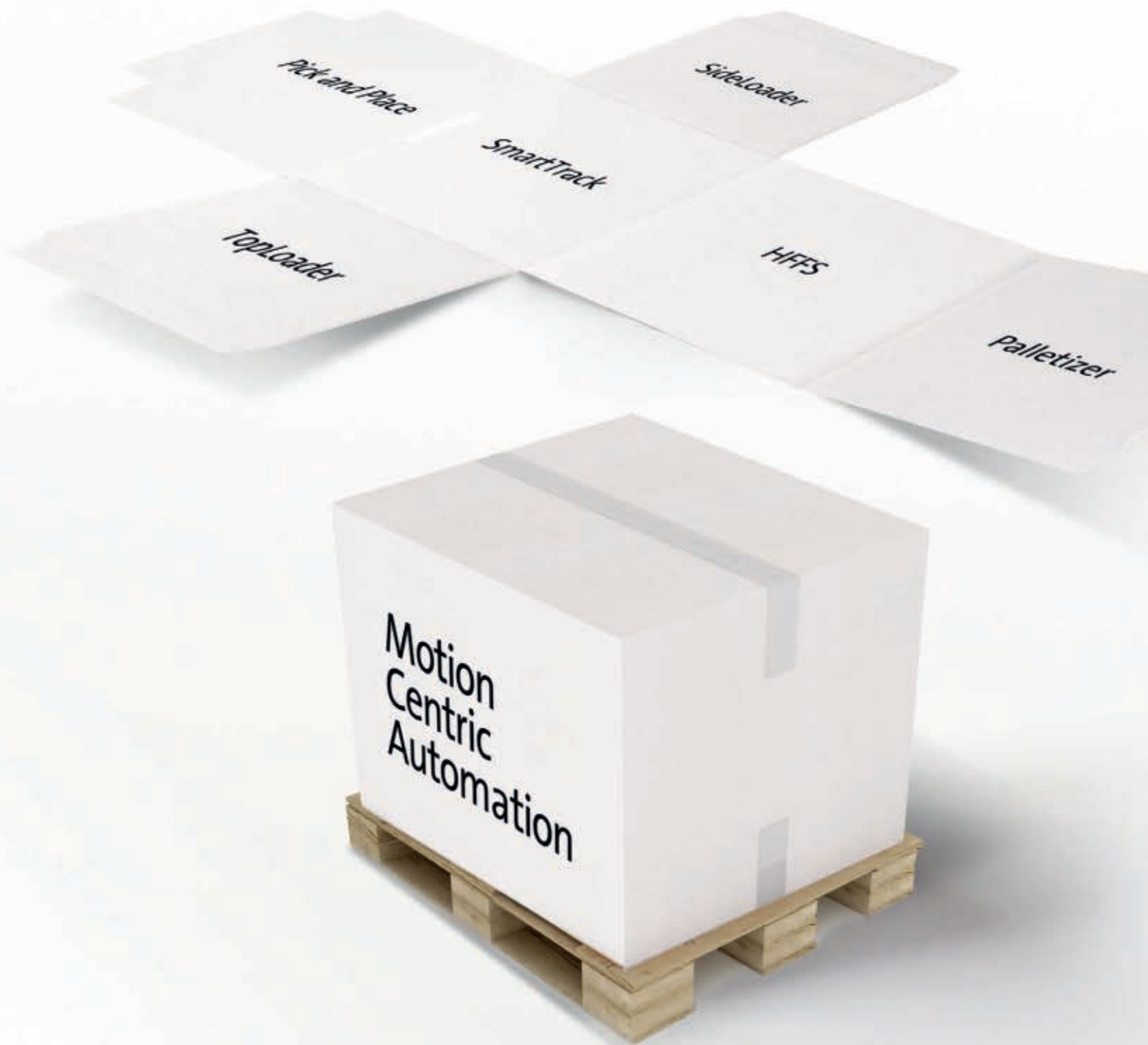
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a section that specifies how the data will be organized from each connected device. A fourth section may be added later that will support mobile devices.

You implement MTConnect through these components:

**The Device**—a machine tool or other piece of equipment or data source.

**An Adapter**—an optional piece of software or hardware that translates data from its source to the data definition used in the MTConnect dictionary. Devices already compliant with MTConnect do not need this component.

**An Agent**—software that collects, arranges, and stores the data gathered from a device or the adapter.

**A Network**—the physical wiring between two or more shop floor devices. Usually, this is an Ethernet network; MTConnect is network neutral so it is compatible with other protocols, such as EtherCAT and Modbus. It can even be used with wireless technologies.

**The Application**—is the device or software requesting data from a machine, controller, or other shop floor device. A software

function known as the Client initiates the request for data, and then translates them into a format compatible with the application.

Even though MTConnect works with HTTP formats, it is important to use other network security methods, such as a firewall or whatever else you or your customer uses.

The software for the Adapter and Agent functions can be located anywhere in the network architecture. Often, they are placed near the machine or device, but they do not need to be placed near each other. They can affect the amount of data flowing to different parts of your network.

### Tips on connecting devices to an MTConnect network

The first step is to determine which existing devices can connect to this protocol. Some will have the communication capability built in; others will need it added. Machines are defined as either MTConnect Native, MTConnect Translation Dependant, or MTConnect Data Connection Dependant.

**MTConnect Native Devices**—are machines with the data dictionary and protocol functions. No other devices or MTConnect components are needed for communication. Data collection can begin immediately through a MTConnect compliant software application once you have an IP address for the machine or shop floor component.

### MTConnect Translation Dependent Devices

—are devices that require a component known as a Translation Unit to convert data from the device into a format compatible with this protocol. (Sometimes, the Adapter performs these needed functions.)

The Translation Unit is usually software and/or hardware. It can be installed within a machine controller, such as a PC, and can be placed in the machine or located external to it. The Translation Unit can isolate an application from any proprietary requirements of the devices; but it will need to know where data are stored within the controller.

### MTConnect Data Connection

**Dependent Devices**—are devices that do not normally publish or send data to other devices, or the amount of data they have is limited. Thus, a separate connection unit is needed to collect the data. For these circumstances, the Connection unit can function as a Translation Unit.

Once you've established what MTConnect connection equipment or software you need, the next steps are:

- 1 Clearly define your problem. Are you looking to improve production capacity? Is there an issue with excessive or unpredictable downtime? If you could see information more clearly, how would that benefit your bottom line?

| Table 2:<br>Here is a sample of event items defined in the MTConnect data dictionary.                                                                                                    |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| Availability; Represents the ability of a component to communicate. This information must be provided for a Device and may be provided for any other component. Available or Unavailable |  |
| Controller_Mode; The current mode of the Controller. Automatic, Manual, Manual_Data_Input, or Semi_Automatic                                                                             |  |
| Execution; The execution status of the Controller. Ready, Active, Interrupted, Feed_Hold or Stopped                                                                                      |  |
| Pallet_ID; The identifier for the pallet currently in use for a given Path                                                                                                               |  |



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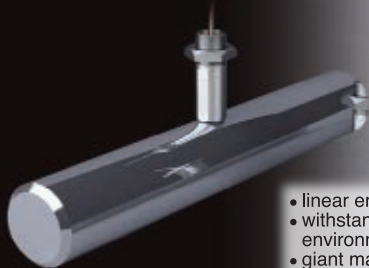
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## Networking ||||

### Table 3:

Here is a sample of the **third type of data, Condition**, which communicates information on a device's health and ability to function.

Actuator; An actuator related condition

Amperage; A high or low condition for the electrical current

Angular-acceleration; Rate of change of angular velocity

Frequency; The number of occurrences of a repeating event per unit time

**2** Determine how you will measure success. Will a successful MTConnect implementation be evaluated by improvements in production capacity; by what percentage, for example? What measurements and parameters will be used to evaluate the benefit of using this protocol?

**3** Determine the equipment that will need to be connected. What controls, sensors, measurement devices, and so on will need to be involved? It is important to know the details of all controllers involved.

**4** Define the limitations or constraints you may encounter, such as budget, accessibility, security issues, must-have functions, legacy network systems, and so on?

**5** Determine who will be in charge of the implementation process. Also assess which departments will benefit from more and better data. Who or what could restrain or even derail the project?

**6** Define the resources you will need to implement the project. What equipment will be sending data, what software will be needed, and what legacy network systems will you be working with?

The MTConnect group also offers third party resources that can help with any parts of this process or with the installation. The website has a directory of these resources.

Currently this protocol supports a variety of controllers, linear and rotary axes, various tooling, actuators, sensors, and hydraulic, pneumatic, and electric machine tool components. **DW**

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[www.mtconnect.org](http://www.mtconnect.org)
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# It's a small world: sensing in tight spaces

*Incredible shrinking sensors satisfy system requirements.*



Randy Frank — Contributing Editor

**M**any of the newest sensing technologies are based on microelectromechanical systems (MEMS) technology and have an unpackaged footprint of a few millimeters or less. However, it takes more than a small sensing element to have a sensor that works in tight spaces. The sensor must satisfy other system requirements. Sensors designed using MEMS technology readily demonstrate both size and systems aspects.

Designed for smart phones and other portable electronic products, InvenSense MPU-9150 is the world's first 9-axis MotionTracking device. It uses a System in Package (SiP) design that combines two chips within a  $4 \times 4 \times 1$ -mm land grid array (LGA) surface mount package. The MEMS-based MPU-6050 contains a 3-axis gyroscope, 3-axis accelerometer, and an onboard Digital Motion Processor (DMP) capable of processing the company's complex 9-axis

MotionFusion algorithms. The second chip, the AK8975, is a 3-axis digital compass that uses the Hall Effect to detect magnetic fields. Even with three integrated 3-axis sensors, the processor and software are required to provide the motion tracking capability.

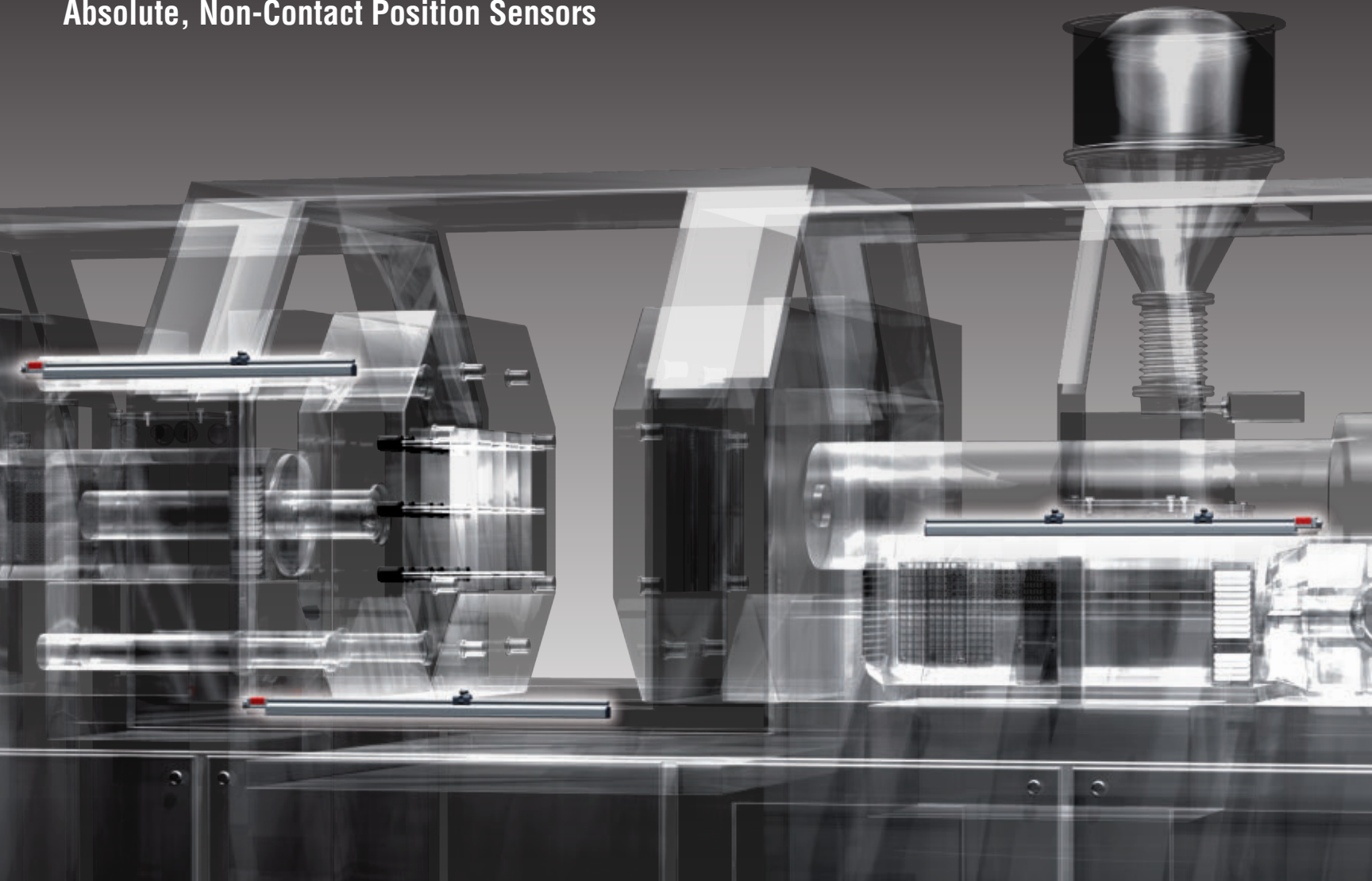
However, other sensing technologies are being pushed into smaller and smaller form factors and for far more applications than smart phones. In fact, the sensing requirement and the target applications establish the sensors technology and form factor. A pressure sensor, magnetic encoder, optical encoder, torque sensor, linear position sensor and 2D code reader provide examples of other shrinking sensors

**With a size** 50% to 80% less than the competition, SR-750 Series from Keyence has several integrated features.



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## Sensors ||||



and the added value they provide target products.

### ***The package defines small***

No matter how small the sensing element, the end package obviously determines the final footprint and application volume requirement. The term subminiature is a common description for pressure sensors in a smaller than usual package. Honeywell's recently introduced Model S Series subminiature pressure transducers provide an excellent example.

The sensing technology in the Model S Series is four active bonded strain gauges in a Wheatstone-bridge design. Additional packaging details include a flush diaphragm manufactured from 17-4 PH Stainless Steel.

"This is one of the smallest of Honeywell's line of pressure sensors," said Brian Duffy,

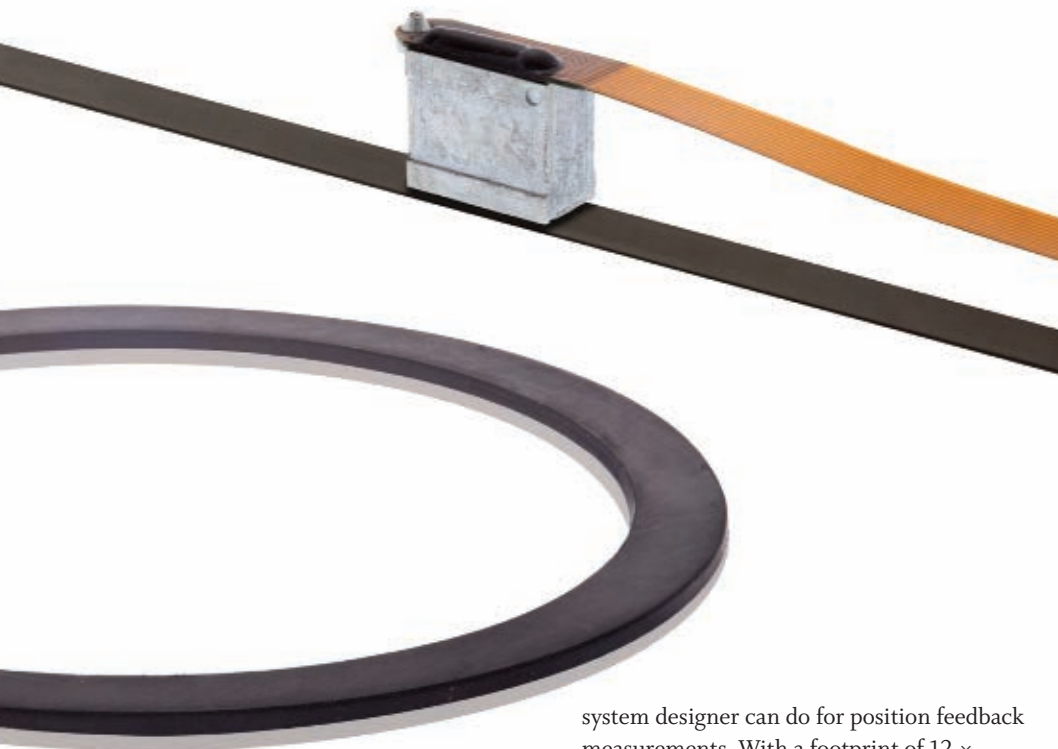
application engineering manager for Honeywell Sensing & Control. "Most are larger."

The Model S series has two packaging options: the BP357 and BP358. With a 17.53-mm length and 12.7-mm diameter, the BP357 is the smaller of the two packages; for the BP358 it's 19.05 × 14.22-mm diameter.

"The Model S Series of subminiature pressure transducers fit into tight spaces with little clearance, and can accurately measure pressure ranges from 100 psi to 15000 psi," said Duffy. "Because of its design, it allows you to get very close to the media that you are measuring; hydraulic fluid, for example."

Two different techniques are used to handle the signal conditioning. Temperature compensation is performed

The RoLin magnet encoder allows radial, axial and linear readings.



with temperature-sensitive components located inside the sensor. A small circuit board in the lead wire (approximately 1 × 0.087 in. thick) addresses the zero balance. This balance board does not have to be in the same temperature as the transducers.

Based on the smaller size, potential applications for these sensors include: down-hole tools for oil and gas applications with temperature extremes of -54°C up to 150°C that can be configured as a gauge type or differential sensor, as well as automotive testing applications such as transmission test stands, pressure brake testing, and hydraulic sensor testing.

#### **Redefining the sensor**

As a component-level contactless magnetic encoder, the RLS RoLin redefines what a

system designer can do for position feedback measurements. With a footprint of 12 × 5-mm for the version that direct solder attaches to a printed circuit board (PCB), RoLin is a position sensor designed for very small devices or motion systems and is available packaged, or unpackaged for low cost linear or rotary precision feedback.

"RoLin's small size and price allows linear, rotary or partial arc position feedback at the point of interest eliminating issues associated with long-chain mechanisms," said Howard Salt, Business Manager, Encoder Systems and Group RLS Marketing Manager. Designed as a low cost alternative to small but expensive optical encoders, the system consists of a readhead and magnetic scale or ring with electronics inside the readhead. Radial or axial reading of the ring is possible.

"RoLin has been aimed squarely at the emerging low cost, small size, linear angle and rotary motion markets which are

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## Sensors ||||

becoming much more prevalent in robotic, AUV, drone, electric motor, manipulator, medical, instrumentation and optical control markets,” said Salt.

With partner company Renishaw, RLS offers more than an encoder in a standard form factor. A large part of the duo’s small sensor business is custom manufactured to specifically suit OEM’s size, resolution, communications and price targets. “RoLin is not the smallest linear sensor we manufacture, it is the smallest sensor we offer as a standard product,” said Salt.

### **Integrating encoders in linear motors**

A postage-stamp size (26 × 12.5 × 16.5-mm) scanning unit from HEIDENHAIN addresses the encoding requirements of linear motor applications.

“For certain motion systems, excess weight is a parameter to avoid, especially for those motion systems that can position

to less than 1  $\mu\text{m}$ ,” said Kevin Kaufenberg, Product Manager at HEIDENHAIN Corp. “By reducing the size of the scanning unit and glass, the weight of the LIF 400 series linear encoder has been decreased, ensuring compatibility to these fine resolution motion systems.”

The miniature incremental exposed linear encoders also target motion systems that are decreasing in size to accommodate even smaller footprint machines. “The LIF 400 series is roughly  $\frac{1}{3}$  the size of a standard 20- $\mu\text{m}$  resolution encoder,” noted Kaufenberg. “So, it perfectly fits to linear motors and motion systems using air bearings.”

**At 17.53-mm length and 12.7-mm diameter,** the Model S series is one of the smallest of Honeywell’s line of pressure sensors.

### **Sense torque in a small space**

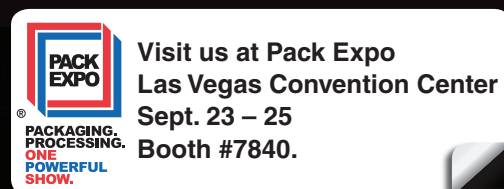
A smart miniature screwdriver (TAT200) from FUTEK enables precise torque measurements in limited space. While customers may have had some input to the sensor’s design, engineering and production teams provided an active role in defining product requirements as well. They use the TAT200 within several of the company’s own sensor assemblies.

“The Miniature Torque Screwdriver is an auditing/assembly tool used to ensure that the torque applied is always proportional and never excessive upon a fixture/screw/bolt,” said Ehsan Mokhberi from the FUTEK Applications Team. “This Reaction Torque Sensor measures 50 in.-oz and 100 in.-oz capacities; the entire sensor only weighs in at 3 oz.”

Using the TAT200 with FUTEK’s USB Solutions and SENSIT Software creates a laboratory tool for data logging and displaying

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**The TAT200 Miniature Torque Screwdriver**  
fits in small spaces and works with other  
FUTEK products.

the graphing measurements on the operator's computer screen. Alternatively, the sensor can be used with the company's IHH500 Handheld Digital Display as an industrial tool for production and quality control measurements.

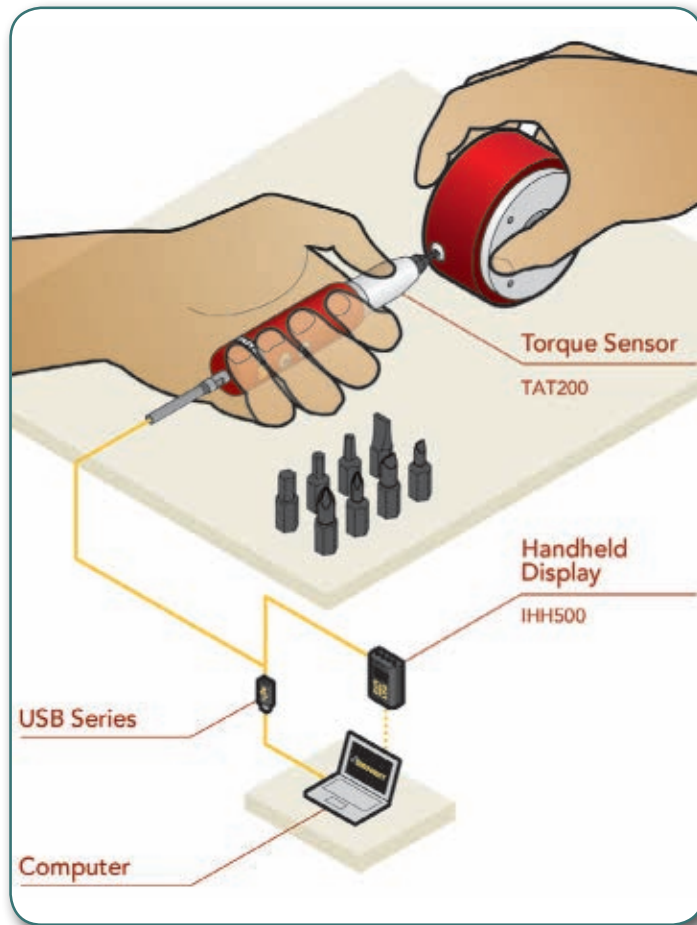
#### **Linear position sensing with membrane potentiometers**

Novotechnik engineers addressed the need for linear position sensing in a narrow space with LFP Series membrane potentiometers.

"We saw a general need for a very low profile sensor on the scale of an open sensor element but protected from fluid and dust so it could be applied 'as is' in some applications," said Ivan Masik, President of Novotechnik U.S. "The first application uses the sensor as part of a linear electrical actuator and measures the vertical position of a surgical table."

The design uses a screw-style pin attached to the application that runs across the membrane. Pressure applied through the pin connects the sensing track to a conductive ink track printed on a substrate. Movement across the membrane changes the resistance. This approach leads to a narrow design and opens up new application possibilities.

Masik said, "Other applications that this thin profile sensor



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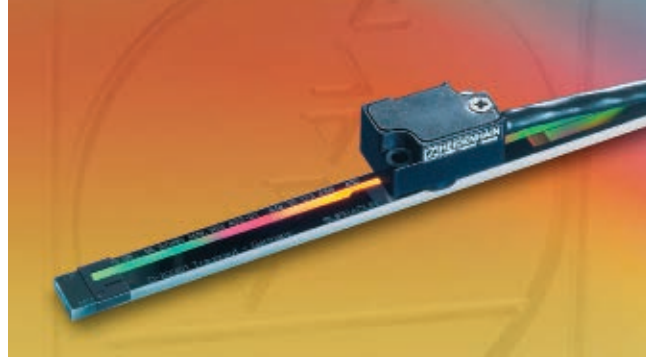
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## Sensors ||||

**HEIDENHAIN's LIF 400 series** is roughly 1/3 the size of a standard 20- $\mu$ m resolution encoder.



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would be a great match for include power windows and seats in vehicles. The LFP Series is well suited for applications where linear movement of an actuator already exists, therefore a shaft mechanism to drive the potentiometer is not needed. A simple electrical connection is provided by a three-pin connector."

### **Compact may be small enough**

Depending on the amount of added functionality that is squeezed into the package, compact may be small enough for some applications. Keyence engineers have determined that this is important for greater applications of bar code readers. The SR-750 Series of Auto ID products reflects this design philosophy. With new and advanced decoding algorithms, the company claims best in class reading capability.

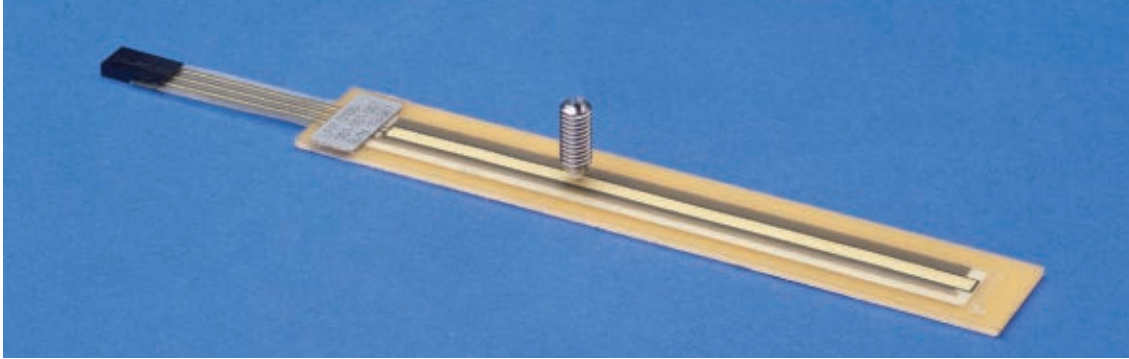
"The SR-750 Series has the power to stably read the most difficult direct part marks despite its compact body," said Eric Krupiczewicz, Sr. Technical Marketing Specialist at Keyence. "The small size allows installation close to machinery such as automated drills or welding irons [and yet] read codes without adding an index point or process step."

Integrated lighting, lensing, processing, and communication are all achieved inside the unit's footprint. Built-in communications include EtherNet/IP, TCP/IP, PROFINET, FTP, RS-232c and Power over Ethernet as well as data editing functionality. The trick is the added capability does not increase the reader's size.

"The SR-750's volume is 50% to 80% less than competitors' similar 2D code readers," explained Krupiczewicz.

### **For sensors, smaller is better**

Whether the size reduction results in a sensor that is the industry's smallest, one that is smaller than the competition or one that is smaller than other products within the same company, a reduced form



A pin's location provides the indication of resistance for the linear potentiometer measurement in Novotechnik's LFP Series.

factor opens the path toward increased applications. Additional features and improved performance increase the likelihood of being designed into those applications. 

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

#### HEIDENHAIN Corp.

[www.heidenhain.us](http://www.heidenhain.us)

#### Honeywell Sensing & Control

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

#### Keyence

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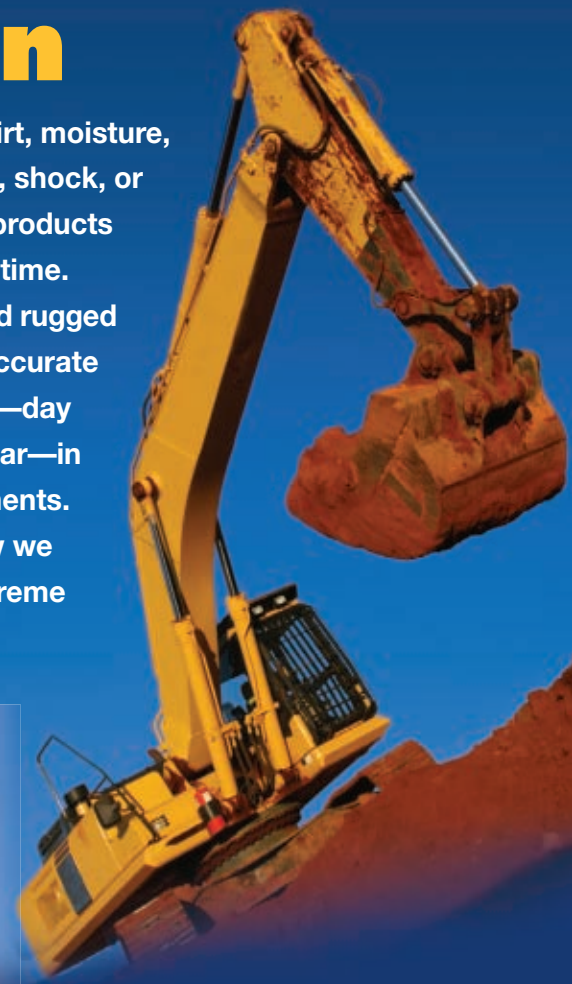


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# Product World

## Computer numerical controllers

The M70V Series, part of the new M7V Series CNC platform, offers increased processing speed (up to 33.7K blocks per minute) for faster cycle times and greater production output. In addition to rapid processing speed, features include: increased PLC capacity to a maximum 128,000 steps, increased part program memory up to 2 MB, the option of a vertical or horizontal operator station and a vertical keyboard. The M7V Series CNC platform also includes two other multi-axis models.

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## Integrated production control system

The CENTUM VP R5.03 is an enhanced version of the company's flagship production control system platform. New features include: wide area communication (WAC) router for control through public communications networks; enhanced batch functions based on ISA-88; and enhanced functions that allow greater flexibility when accommodating changes in production procedures. The number of operating procedures has been increased and the recipe procedure has additional levels of granularity, simplifying the process of making recipe changes. It supports the IEC 61850 communication protocol. This latest version can integrate data from intelligent electric devices such as protective relays, switchgear, motor controls and power distribution equipment and can be used to monitor the operations at process plants whose electrical facilities have been designed based on the IEC 61850 standard.

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# Product World

## Feature packed controllers

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They are available with 12 (8 inputs, 4 outputs), 24



(16 inputs, 8 outputs), 40 (24 inputs, 16 outputs), and 48 I/O (30 inputs, 18 outputs) with and without embedded LCD/keypad. Each CPU is equipped with 2 to 8 point 0-10 Vdc analog inputs, a real time clock, 10 A relay contacts, remote I/O, 4 to 6 high-speed counters up to 100 KHz, and a USB mini B programming port.

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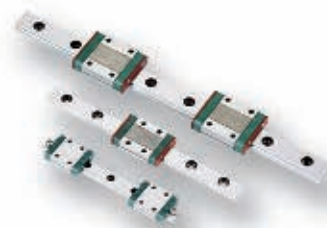
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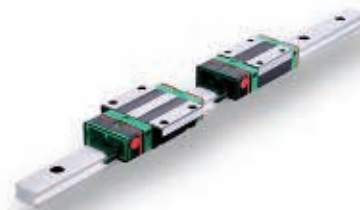
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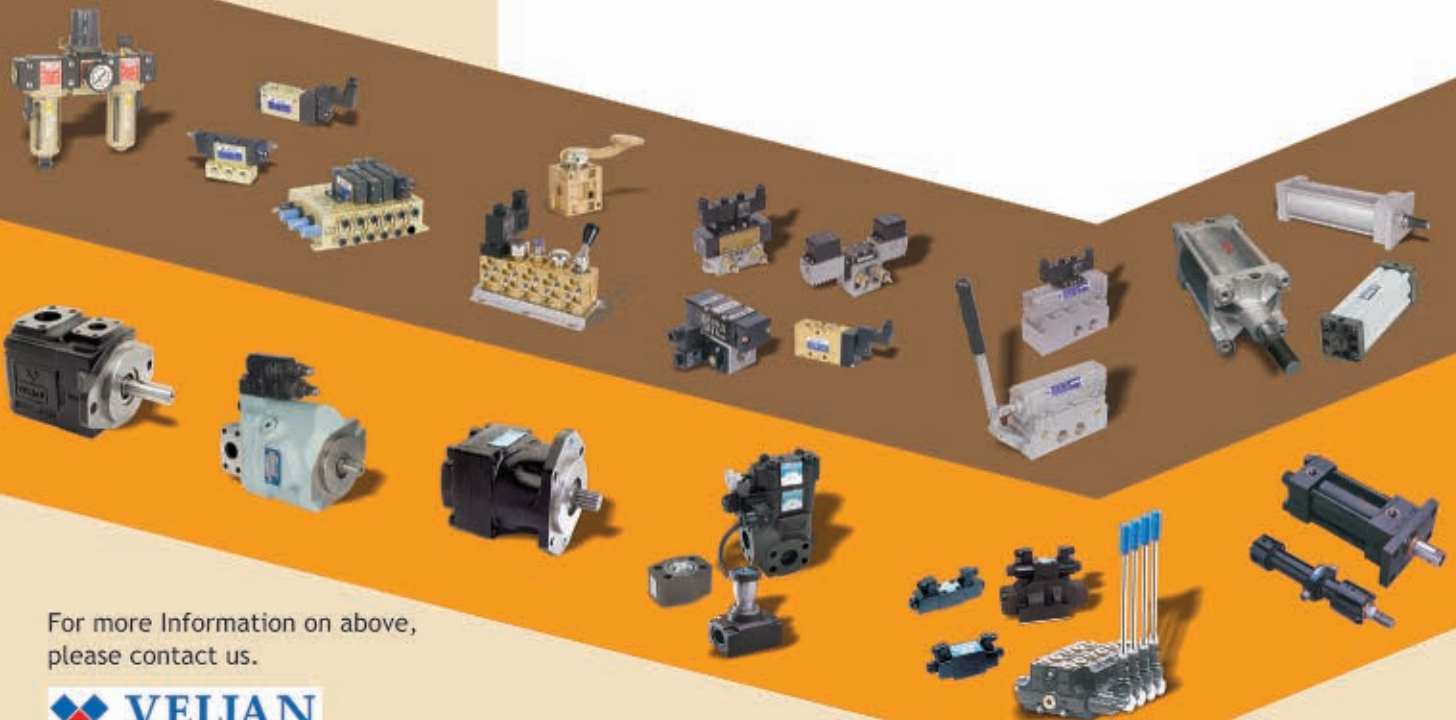
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# Product World

## Toggle and stem valves

HV-HTV valves are compact and feature #10-32 inlet and outlet ports. They are available as toggle or stem actuated, in addition to offering cartridge styles. They are rated for flows to 15 scfm @ 100 psig.

The HV-3 Series is a fully-ported 3-way valve. It can be used as a selector valve for choosing between two separate pressures or fluids going to a single output. Being fully ported, the inverse will work as well, when using the valve as a diverter, sending a fluid to two separate outputs. Also, the valve may be used as a Normally-Closed or Normally-Open 3-way valve. The HV-4 series is a 4-way valve that vents its exhaust ports to atmosphere and is ideal for powering simple cylinder applications.



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## Protection for line-to-ground currents

The F200 Ground Fault Equipment Protector (GFEP) protects equipment against damaging line-to-ground currents by disconnecting all ungrounded conductors of the faulted circuit. The unit immediately detects ground faults by continuously measuring the current balance between live conductors and the neutral using a toroidal current transformer. It trips when the system leaks a significant current to ground, immediately preventing the potential short circuit before such damage can occur.

The product line consists of the 2-pole F202 for single phase networks, and the 4-pole F204 for split phases, Delta and Wye networks. All variations are compliant to the UL 1053 standard for ground fault sensing and relaying equipment, and in accordance with the National Electrical Code, ANSI/NFPA 70 for use in ordinary locations.

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Launching the OCULUS Surveillance and Telepresence Robot with a fully-funded Kickstarter campaign, Colin Adamson's open hardware project recently earned his company, Xaxxon Technologies, a spot in Entrepreneur Magazine's top 100 Brilliant Companies of 2012. He uses his Tormach PCNC 1100 to prototype aluminum components for the OCULUS Laptop Conversion Kit; a motorized frame and software combination that converts a small laptop into a telerobotic remotely operated vehicle. Colin says of his

PCNC, "I use the PCNC 1100 for pretty much all of the prototyping. The laptops are laser cut in production by one of the other guys, but I cut the plastic parts on the mill. I also cut a few little production parts like the aluminum axles and acrylic mirror."

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# Product World

## Temperature controllers

Concert series temperature controllers offer an economical way to increase application flexibility and capacity of material melters. The controllers allow individual temperature control of up to six heating zones for each melter, enabling a single melter to serve multiple individual applications at the same time. The controllers use the Optix touch screen interface for easy set-up and operation as well as system status-at-a-glance. Upper and lower temperature limits can be established for each individual channel. And, the temperature standby mode reduces adhesive char and degradation.

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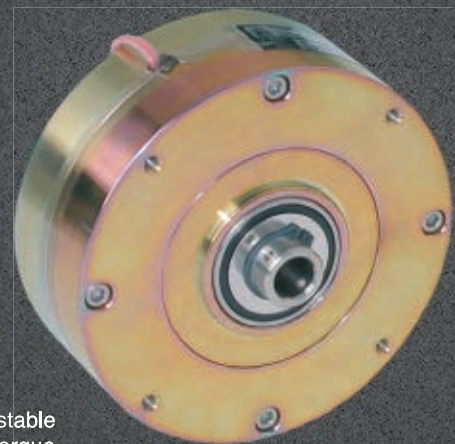
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## Motor delivers low temperature operation

The 22ECS brushless motor delivers efficiency in high-speed applications; it runs up to 30% cooler than similar motors, at speeds greater than 50,000 rpm. The motor is constructed with a high efficiency magnetic circuit that reduces both iron and recirculation losses. The motor coil also achieves higher available torque and mechanical power than similar high-speed motors in the market, up to 160 W or 45 mNm of continuous torque. As a result, this brushless, slotless motor stays cooler and offers greater power density than equivalent models at a given operating point. Due to its high power, efficiency and low rotor inertia, the motor can change speeds and accelerate rapidly.

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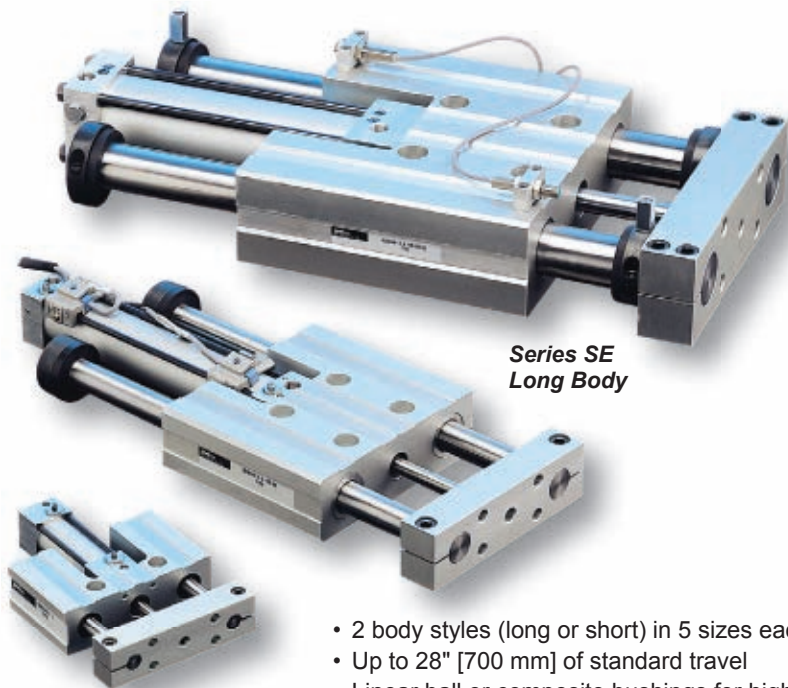
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## Spray nozzles for pressure fed applications

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With them, you can coat, cool, treat and paint a variety of products. Used with water, atomizing nozzles are an efficient way to evenly cool hot items in your automated process. Because they are external mix, airflow and liquid flow can be controlled independently. The stainless steel construction of these nozzles is durable and resist corrosion.

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## Plug connector housing

The new heavy-duty housings come in B6, B10, B16 and B24 sizes and will replace the original aluminum die-cast HEAVYCON sleeve housings. The cable entry on the new housings is available with a metric thread (no collar) or with a Pg thread (with collar). The connectors have an IP65 rating, protecting the electrical connections from damage due to ingress of dirt, water and other contaminants. The redesigned shape of the housing provides a rounded surface for easier gripping while plugging and unplugging the connector.

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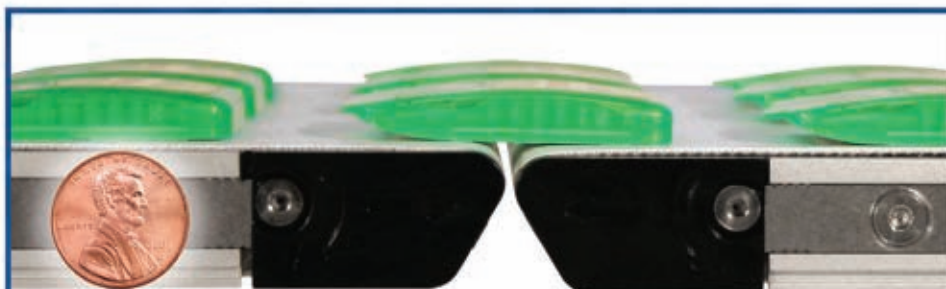
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## Communication, control cables for stationary applications

C 304 and D 304 Series communication and control cables are intended for stationary wiring applications with minimal or no exposure to oil and flex cycles. These 300-V designs cost approximately 30% less than premium signal and control cables. They feature UL CSA CMG and AWM approvals. UL CMG allows routing of the cable from the machine through the industrial infrastructure directly to the control panel. They offer high flame resistance (FT4). Shielded versions are available for EMI-sensitive signal, audio, instrumentation and broadcast applications.

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[lappusa.lappgroup.com](http://lappusa.lappgroup.com)





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## 32-mm planetary gearhead for high radial loads

Single-stage gearheads with heavy duty radial bearings suit such applications as toothed belt drives, applications that place enormous stress on the output stage due to the radial forces at work. The design of the GP 32 AR and GP 32 CR gearheads takes these forces into account. Both bearings of the output stage have been positioned as far apart as possible. As a result, radial forces of up to 140 N can be compensated. The planetary carrier has been reinforced and given separate bearings. The axles of the planet gears are securely fixed in both halves of the planetary carrier. To achieve the maximum torque and life span, customers can select these axles in ceramic. The short-term permissible torque reaches up to 1.25 Nm. The gearheads are available with output shafts in 6 and 8 mm diameter.

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# Product World



## Integrate legacy networks easily

Two series of EtherNet/IP and PROFINET-enabled managed Ethernet switches are pre-configured for plug-and-play simplicity. The EDS-405A/408A-EIP and EDS-405A/408A-PN switches deliver a cost-effective way of integrating legacy networks, eliminating the need for additional configurations and modifications, and reducing deployment time.

Ready-to-use Turbo Ring and Turbo Chain network redundancy technologies ensure that if a connection failure occurs, the switches will enable fast network recovery under 20 ms (with 250 switch loads). Booting time is less than 10 s.

With EtherNet/IP embedded, the switches are visible with custom faceplates in FactoryTalk View industrial management software. AOIs and EDS Files are available for all Moxa switch models to ensure a truly integrated switch installation.

With embedded PROFINET, the switches can be easily integrated into the Simatic Step 7 engineering tool. The switches are available in 5- or 8-port DIN-rail mount designs. They also support a variety of useful management functions to accommodate just about any application that requires an Ethernet switch, such as IGMP snooping, IEEE 802.1Q VLAN, QoS, port mirroring, SNMP, bandwidth management, and warning by email or relay.

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## High speed wireless networking

The FL WLAN 5101 radio offers high-speed wireless networking up to 300 Mbps. The "CM" (Cluster Management) technology simplifies wireless network management. All access points in a WLAN network can be configured and managed through a single web interface using any access point within the network, without additional costs for expensive hardware or software.

The radio is 40 mm wide in a metal housing. The data and antenna ports are placed on the top and bottom of the housing, reducing clearance issues. The FL WLAN 5101 covers a range up to four times larger than legacy Phoenix Contact WLAN radios. When incorporated with access point/repeater mode, the new radios cover larger areas.

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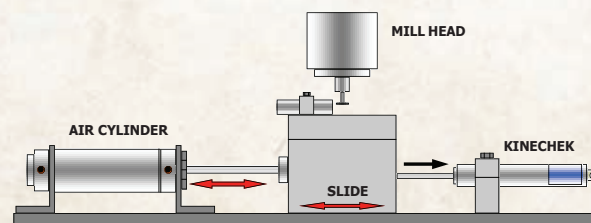
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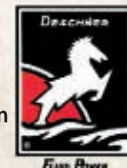
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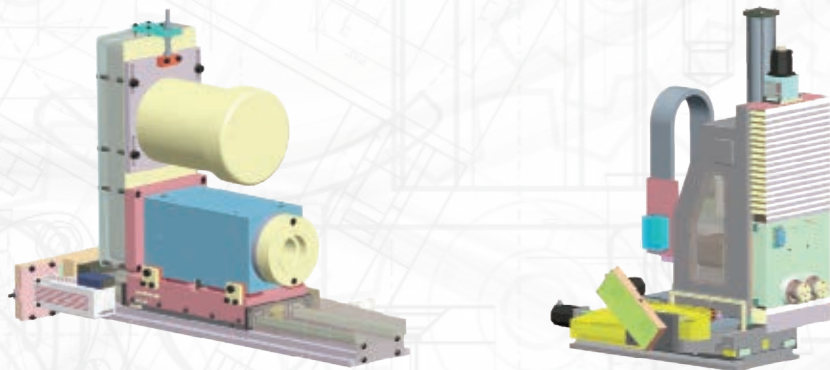






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## Subminiature press transducers

Featuring 1% accuracy, Model S Series of subminiature pressure transducers fits into tight spaces with little clearance, and accurately measures pressure ranges from 100 to 15000 psi. These rugged transducers handle high pressure and temperatures, with a high natural frequency and flush diaphragm for applications such as engine and transmission test stands, pressure brake testing, and hydraulic sensor testing.

Temperature compensation is accomplished by using temperature-sensitive components located inside the transducers. The transducers have a small electrical zero balance circuit board which is in the lead wire (approximately  $1 \times 0.087$  in. thick).

**Honeywell**  
[measurementsensors.honeywell.com](http://measurementsensors.honeywell.com)



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## Unsealed connector system

The hinged Terminal Positioning Assurance (TPA) device, which is molded as part of the housing, allows simple terminal insertion and secure terminal seating. The MX150 unsealed receptacle and in-line connectors are available in 2-, 3- and 4- circuit versions as standard, though other circuit counts can be developed on request, with custom clip slots for increased design flexibility. The unsealed connector system offers high mating performance for mid-power (14 to 22 AWG) applications by using an integral locking latch. The reinforced front-beam terminal design provides a high contact normal force while minimizing the insertion force.

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# Product World

## Integrated XY Linear Motor Stage



The PlanarDL-series of stages offers geometric and dynamic performance in a compact, low-profile package. Available in nine different travel and performance configurations, this stage is for applications ranging from high-accuracy surface profilometry to high-speed semiconductor and LED wafer scribing.

The stage includes components with exacting precision, a direct-drive motor technology and an integrated cable management system. The structural elements are suited for high-dynamics and high-stiffness. Capable of achieving 1 m/s velocities and 1.5 g accelerations, the stage enables high-throughput and high-accuracy processing. The anti-creep crossed-roller bearings deliver smooth motion.

The PlanarDL-200XY and -300XY stages are both available with one or two motors per axis. Regardless of the number of motors selected, the resulting drive force acts through the centers of friction and stiffness for geometric performance and accuracy.

## Aerotech

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

## 608 washer sizes

These 608 new flat washer sizes enable custom-built options with many metallic and non-metallic materials, sizes, thicknesses and production quantities, for millions of washer possibilities. They are manufactured to exact specifications in more than 2,000 material options and no tooling changes. The size range includes outside diameters from 0.080 to 5.140 in. and a substantial range of inside diameters.

In addition to flat washers, other shapes and styles are available in metallic and non-metallic materials. Metallic washers include low-carbon sheet steel, various spring steels, stainless steel, aluminum, brass, copper and nickel silver. Non-metallic materials include ABS, acetal, polyester, nylon, MD nylon, polycarbonate, fiber, polyethylene and phenolics.



## Boker's, Inc.

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## Linear encoder for linear motors

The LIF400 Series, for linear motor applications, includes a postage-stamp size scanning unit with very high accuracy. With travel up to 1 m, the encoders maintain a scale accuracy grade of  $\pm 3 \mu\text{m}$ . These encoders meet the needs for both coarse and fine measurement applications ( $4 \mu\text{m}$  down to 10 nanometers of resolution).

The encoders use SUPRADUR grating, a style with high tolerance to contamination such as oil, dust, and fingerprints due to the precisely measured layers of glass and reflective material that prevents contaminants from interfering with the light-based, non-contact scanning principle.

Other features include optical limit switches that allow the user to place limits anywhere directly on the scale, thus also enabling the scale to be mounted closer to a motor than scales with magnetic switches. Additionally, the scale has a separate homing track with an integrated reference mark allowing the encoder to differentiate



which side of the reference mark the scanning unit is located on upon power up. Versions for vacuum applications are available with the encoder's electronics located either inside or outside the vacuum chamber. Finally, the scale and reader head reticle material can be made of ZERODUR, which helps improve accuracy by eliminating thermal growth.

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| Atlanta, GA     | April 3 & 4      |
| Monroeville, PA | April 17 & 18    |
| Schaumburg, IL  | May 7 & 8        |
| Santa Clara, CA | May 22 & 23      |
| Minneapolis, MN | June 5 & 6       |

### Fall Shows

|                  |                   |
|------------------|-------------------|
| Greenville, SC   | September 11 & 12 |
| Phoenixville, PA | September 25 & 26 |
| Pasadena, CA     | October 9 & 10    |
| Marlborough, MA  | October 30 & 31   |
| Covington, KY    | November 20 & 21  |

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<http://dwo.me/166HQvI>



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### Launching U.K.'s First CubeSat Mission

<http://dwo.me/16RLyhm>

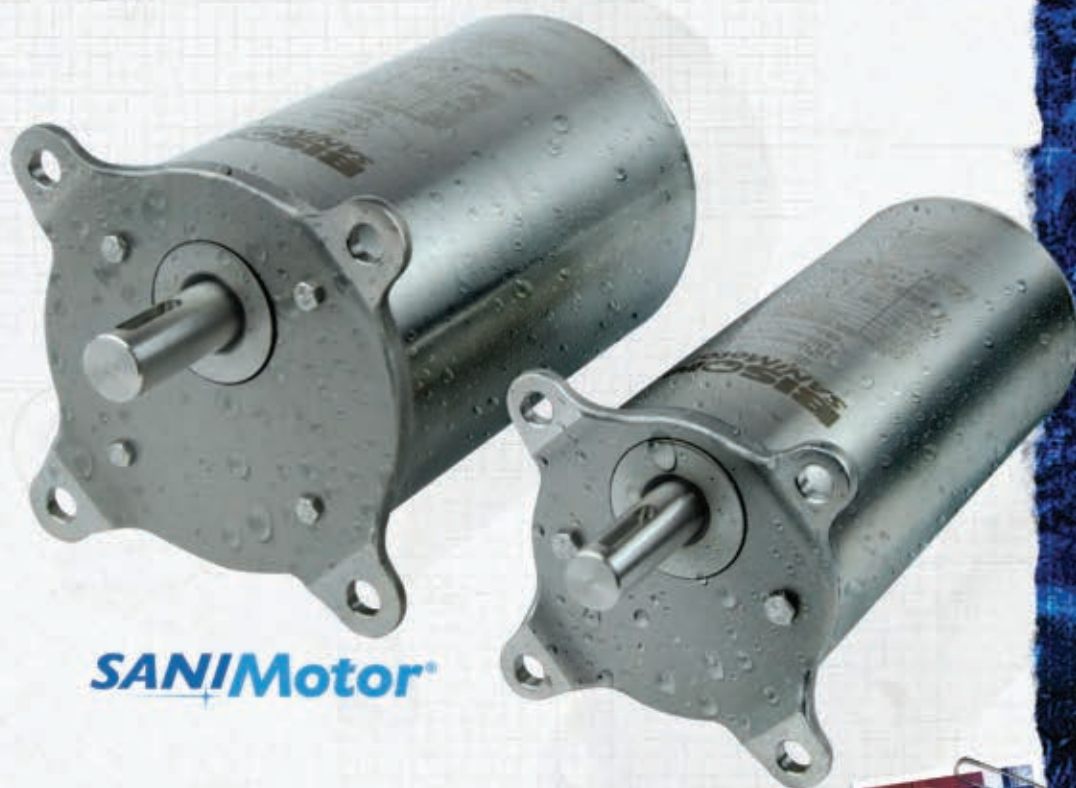


UKube-1 is the UK Space Agency's first CubeSat mission and Scotland's first satellite. Its journey into space is expected to launch from the Baikonur Cosmodrome in Kazakhstan later this year.





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