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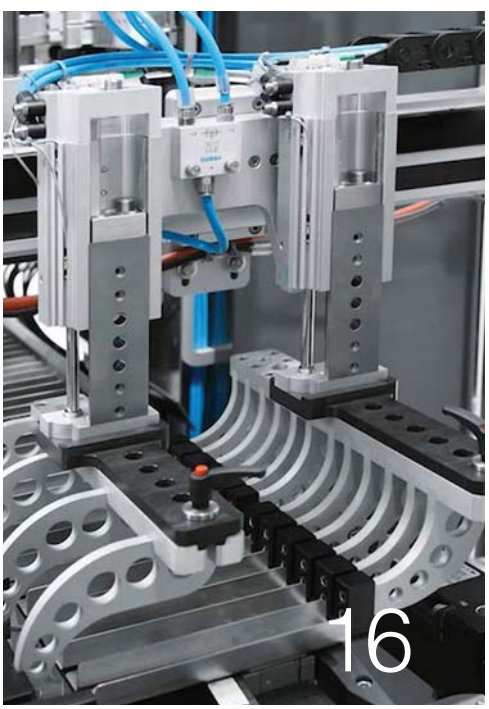

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SENIOR CONTENT EDITOR: **BOB VAVRA** bvavra@endeavorb2b.com
MANAGING EDITOR: **JEREMY COHEN** jcohen@endeavorb2b.com
SENIOR EDITOR: **STEPHEN J. MRAZ** smraz@endeavorb2b.com
SENIOR EDITOR: **REHANA BEGG** rbegg@endeavorb2b.com
SENIOR EDITOR: **MARIE MCBURNETT** mmcburnett@endeavorb2b.com
CONTRIBUTING TECHNICAL EXPERT: **PETER NACHTWEY** peter@deltamotion.com
CONTRIBUTING TECHNICAL EXPERT: **ROBERT J. SHEAF, JR.** rjsheaf@cfc-solar.com
CONTRIBUTING EDITOR: **RAY SCROGGINS** ray@scroggins.biz
CONTRIBUTING EDITOR: **TOM ANDEL** tandel4315@aol.com

ART DEPARTMENT

GROUP DESIGN DIRECTOR: **ANTHONY VITOLO** tvitolo@endeavorb2b.com
ART DIRECTOR: **BILL SZILAGYI** bszilagyi@endeavorb2b.com

PRODUCTION

GROUP PRODUCTION DIRECTOR: **GREG ARAUJO** garaujo@endeavorb2b.com

CIRCULATION LIST RENTALS & CUSTOMER SERVICE

USER MARKETING MANAGER: **DEBBIE BRADY** dmbrady@endeavorb2b.com
REPRINTS: reprints@endeavorb2b.com
LIST RENTAL / SMARTREACH CLIENT SERVICES MANAGER: **MARY RALICKI** mralicki@endeavorb2b.com
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SALES REPRESENTATIVES

NORTH AMERICA ACCOUNTS MANAGER: **PATRICK CARMODY** pcarmody@endeavorb2b.com
INTERNATIONAL SALES
ITALY: **DIEGO CASIRAGHI** diego@casiraghi-adv.com
GERMANY, AUSTRIA, SWITZERLAND: **CHRISTIAN HOELSCHER** christian.hoelscher@highcliffemedia.com
BELGIUM, NETHERLANDS, LUXEMBURG, UNITED KINGDOM, SCANDINAVIA, FRANCE, SPAIN, PORTUGAL:
LARA PHELPS lara.phelps@highcliffemedia.com
PAN ASIA: **HELEN LAI** helen@twoway-com.com

DIGITAL

SENIOR DIGITAL INNOVATION & STRATEGY DIRECTOR: **RYAN MALEC** rmalec@endeavorb2b.com

DESIGN & ENGINEERING GROUP

EVP, DESIGN & ENGINEERING GROUP: **TRACY SMITH** tsmith@endeavorb2b.com
GROUP CONTENT DIRECTOR: **MICHELLE KOPIER** mkopier@endeavorb2b.com
VP OF MARKETING SOLUTIONS: **JACQUIE NIEMIEC** jniemiec@endeavorb2b.com

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Editor's Page

BOB VAVRA | Senior Content Director | bvavra@endeavorb2b.com

The Box Score of Design

APRIL IS, WITHOUT QUESTION, my favorite time of the year. Why? The blossoming of new life? Blah, blah, blah. April is great because baseball is back, and after missing the joy of baseball in April a year ago, I'm even more excited about this season.

One of the things I most love about baseball is its geometric perfection. The bases are 90 feet apart. If the distances between bases were 80 feet or 100 feet, it would be a completely different game. The processes of pitching, fielding and running would be altered. The precise design of a baseball diamond is a strange and wonderful thing.

The other things I love about baseball are the numbers. There are few things as enthralling to me as a box score. If you know how to interpret the statistics, you can learn in greater detail why your team won or lost that day. Sometimes it's not the events at the end of the game that truly determine the outcome. There can be small things earlier in the game that affect how you use your players or how you change your strategy.

And since I'm also a fantasy baseball owner, the evaluation of player statistics is an all-consuming passion at this time of the year. When you're trying to assemble the best team, it's not just the skills in one or two key players that determines success. If you can find the right combination of 23 players to fill out your team, you can be a success.

These are the same skills we talk about all of the time when it comes to designing and optimizing fluid power systems. Building a successful operation is exactly like building a successful baseball team. You have to identify a plan at the start, execute on the plan, constantly evaluate data and performance, adapt to changing conditions and prepare for disruption when it does occur.

Data is key to analyzing performance. In both baseball and in manufacturing, the emergence of new and exciting data points have helped us understand not just why we won or lost today, but what trends could extend those streaks in one direction or the other. In baseball, a player with a .300 batting average is considered a high performer. But looking at that average today doesn't tell you whether he's been consistent at that level or whether just last week he was hitting .350.

We have to do the same with system data. We have to let the data speak to us, not just speak for itself, and we have to respond to what those numbers are telling us. It's that deeper dive into the data that uncovers great performance—or shows our impending troubles.

If you love numbers and are willing to learn how to interpret them, you can be a better baseball fan or build a better manufacturing operation. The parameters are set—the geometry of a baseball diamond or the laws of physics. It's time to start. hp

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PASSION TO PERFORM

News

NAHAD Convention Moves to Scottsdale for 2021

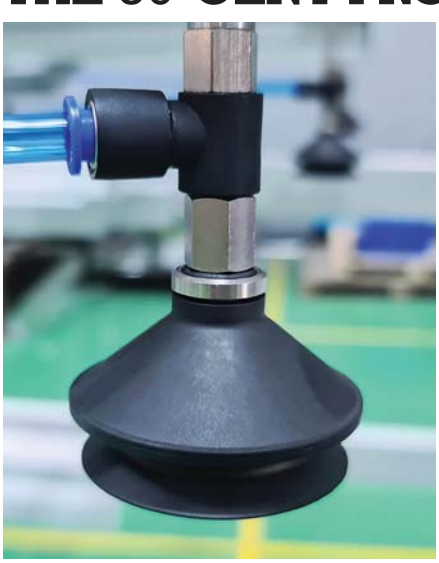
The event has been moved and delayed in the hopes that COVID-19 vaccinations become more widespread.

The National Association for Hose and Accessories Distribution (NAHAD) recently announced it will be holding its 2021 annual convention in Scottsdale, Ariz. rather than San Diego. Originally scheduled for this month, the event will take place June 12-15.

The association postponed the convention so that attendees and exhibitors would be more comfortable visiting the show after more people get the COVID-19 vaccine. The show will be at the Fairmont Scottsdale Princess. Attendees and NAHAD staff are expected to follow Maricopa County COVID-19 policies and procedures in place when the convention is held.

Visit youtu.be/PBStPGNPmR4 for a message regarding the move from NAHAD Executive Vice President Molly Alton Mullins. Visit www.nahad.org for more details on the upcoming convention.

THE 50-CENT PROBLEM



SUPARERGSUKSAI | DREAMSTIME

At its most recent virtual quarterly conference, the National Fluid Power Association and the Fluid Power Industrial Consortium focused on pneumatic power, with Jeremy King, product manager at IMI Precision Engineering leading a discussion on using condition monitoring to improve pneumatic efficiency.

One of the more interesting observations from King was that while all monitoring has value, it's very often the more basic components that can be overlooked in the monitoring effort. "As you start thinking about lifecycle, you want to look at which devices on your machines are going to cause the biggest problems," King told the audience. "If the 50-cent suction cup stops you from picking stuff up, that's going to be a problem." King said that in developing a comprehensive plan, it's important to look at the points of failure and the probability of failure in developing a comprehensive plan. The robot arm may be the piece with the greatest capital investment, but if a cylinder or suction cup fails, it's just as costly to the operation.

The next NFPA/FPIC regional conference is June 3, and that is scheduled to be another virtual event. After that, the group is cautiously looking forward to reconvening live events again. For more information, visit nfpahub.com.

THE CYBERSECURITY VIRUS

The lessons of the pandemic have been far-reaching for individuals and companies. Sid Snitkin of Arc Advisory Group (www.arcweb.com) suggested in his blog this week that those lessons can be applied to the vexing issue of cybersecurity. As more sensors are added in the fluid power process and more software is installed to make sense of that data, the cybersecurity risk goes up.

"While viral epidemics and cyber-attacks are certainly different, they wreak havoc in similar ways. An unprotected entity is compromised and becomes the base for spreading the infection to connected entities," Snitkin writes in the blog. "The impact on an individual entity may be minor or devastating but spreading raises the likelihood that some significant impact will occur. Efforts to manage the situation are also complicated when spreading occurs before the initial compromise is recognized."

Snitkin notes there are four stages of defense that apply to viruses that affect humans or machines:

- Reduce Entry
- Limit Spread
- Manage Infections
- Reduce Future Threats

"Recognizing the parallels between coronavirus and cybersecurity can help security teams drive better security in their organizations," Snitkin adds. "Relating cybersecurity activities to similar coronavirus tactics can help garner more support for cybersecurity efforts and educate managers about the need for certain practices and investments."

5G'S SLOW CLIMB to Relevance

At present, the impact of 5G on the communications market is largely limited to breathless advertisements about the speed and power of the fifth generation of data speed. For industries looking to take advantage of this technology, there still is more caution than anything else.

A recent study of industrial leaders commissioned by Molex (www.molex.com) found that almost half of industrial customers say they are behind in the deployment of 5G, which is considered the key to greater industrial use of augmented reality, robotics and artificial intelligence. The good news is that those industrial leaders expect to achieve their 5G business goals in the next five years. So while change is slow, it is accelerating.

"The 5G market is nearing an inflection point as carriers report steady progress despite continued challenges," said Aldo Lopez, president of datacom solutions for Molex, in a press release. "Fully realizing 5G's potential will transform multiple industries and markets."

IVAN N. SHEFFIELD | Director of Filtration at Des-Case

Cleanliness Programs are Key to Keeping Oil and Hydraulic Fluids at THEIR BEST

Programs based around ISO cleanliness standards ensures costs are low and productivity stays high.

Companies that rely on lubrication and hydraulic fluids have a vested interest in keeping those fluids clean and operating at their best for as long as possible. But some companies might not be aware of what the current standards on cleanliness are and how to begin what could be a cleanliness program that spans several facilities and hundreds of machines.

Here's a quick look at the current standards and the best way to achieve them in even the largest companies.

SETTING THE STANDARDS FOR CLEANLINESS

The International Organization for Standardization (ISO) provides the most trusted and up-to-date guidance for manufacturers, operators and service technicians on the best contamination control for machinery of all types. It has global teams that study cleanliness levels in OEM equipment and recommend expert guidelines for ensuring the best fluid cleanliness based on four international contamination control standards: ISO 11171, ISO 11943, ISO 16889 and ISO 4406.

For example, the ISO Solid Contamination Code (ISO 4406:2021, the Method of Coding the Level of Contamination by Solid Particles) is recognized as the gold standard for specifying the best contamination control in equipment. It breaks down precisely how many particulates are in an engine based on what is found in a 1 ML sample of a fluid. It also identifies those contaminants based on three size ranges: > 4, > 6 and > 14 microns.

BENEFITS OF CLEAN FLUIDS

Meeting ISO fluid cleanliness codes for hydraulic and lubrication fluids generates a host of cost-savings and benefits. These include:

DECREASED DOWNTIME. Contaminated fluids are a leading cause of equipment breakdowns and lost productivity. Investing in a rigorous cleanliness program can prevent tremendous costs just in lost

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Machine Type		Particle Level Target	Moisture Level Target
Hydraulics 1500-2500psi	With servo valves	15/13/11	125 ppm
	With proportional valves	16/14/12	150 ppm
	Variable volume piston pump	17/15/12	150 ppm
	With cartridge valves or fixed piston pump	17/16/13	150 ppm
	With vane pump	18/16/14	150 ppm

This table shows the typical ISO 4406 Contamination Codes and moisture level targets for hydraulic systems with certain components at 1,500 to 2,500 psi.

downtime. For example, lost production in a paper mill can cost as much as $12,000/hr. Factor in equipment repair or replacement over time, and it's easy to see why effective contamination control programs save money.

EXTENDED FLUID LIFE. Disposing of and replacing contaminated fluid can be a major expense. Maintaining adequate cleanliness standards rather than frequent wholesale oil replacement is a major cost benefit.

REDUCED WASTE AND SUPPLIES. Implementing fluid cleanliness standards extends filtration service life and reduces the frequency of change-outs. Every filter change is estimated to result in a 5 to 10% fluid loss, along with the additional costs of replacing that fluid and the labor involved.

LOWER LABOR COSTS. Although it may seem counterintuitive, maintaining higher cleanliness standards reduces costs associated with complete oil changes, component changes and other labor-intensive activities. These activities can create larger or less predictable blocks of downtime that whittle away at the bottom line.

REDUCED ENERGY COSTS. Contaminated fluids have higher viscosities, which make pumps work harder and the filter to load quicker, so pressure increases faster. With clean fluid in the system, pressure across the filter takes longer to build so the pumps don't work as hard, thus saving energy.

OSC: A STEP-BY-STEP APPROACH

As a company plans its ISO-approved cleanliness program, there are critical initial steps to take:

1. EVALUATE AND ESTABLISH CLEANLINESS LEVELS USING GLOBAL ISO CODES. Identify and document target cleanliness levels for each fluid and corresponding piece of equipment using ISO Code ISO4406:2021. Global OEMs can provide specific codes that will best improve performance for specific equipment.

The ISO standard quantifies contamination levels per milliliter of fluid for three sizes of particulates: 4, 6, and 14 μ[c]. They include three scale numbers that represent the range of particle counts per milliliter for each particle size. These counts are combined into a single code number. Each time a code increases, the quantity of particles doubles. What may seem a minor shortfall in hitting a code represents a significant decrease in that fluid's cleanliness.

To get the most from establishing a cleanliness program with ISO codes, all parties responsible for fluid cleanliness (i.e., any service provider) must closely follow the standards.

2. CHOOSE THE RIGHT FILTER MEDIA FOR THE JOB. A cornerstone of the ISO Solid Contamination Code is to assign the proper cleanliness levels based on specific filtration media used in a system. That makes it critical to match the ISO 4406 Cleanliness Code

Drums of hydraulic fluid and oil should be protected and filtered as soon as they enter the plant, and this can be done with easy-to-use drum adapter kits.

to the filter rating specified for your specific equipment for the most protection and reliability.

Filtration ratings from supplier provide a guide for specifying filter media to support target ISO codes. Filtration evaluation criteria should include fluid compatibility, pressure-flow drop, dirt capacity and other technical requirements.

Using the filter media that can filter to a target code provide cost savings (ROI) quickly on a per-job basis or over time. And media with longer service live adds to those savings.

It's important to independently or in partnership with a filtration supplier to conduct bi-annual reviews of available filtration technology using clearly defined evaluation standards. Findings may reveal new opportunities to improve the ROI of filtration media and further increase profitability.

3. ESTABLISH AN OIL ANALYSIS PROGRAM AND SAMPLING SCHEDULE. Regular oil analysis provides three valuable indicators for fluid cleanliness programs:

- Current state of fluid cleanliness.

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This Des Case drum topper provides filters new oil directly from the drum to remove contamination.

When maintenance leaders can work with their filtration supplier to implement cleanliness initiatives, both partners can profit.

- Efficacy of the contamination controls.
- Presence of upsets or abnormal conditions.

This data helps determine the appropriate proactive (or reactive) steps to support fluid and system performance. Some steps might seem expensive, such as using spectroanalysis, but they are minor compared to the cost of fluid replacement or equipment repair.

Fluids should be checked monthly and tracked overtime to uncover trends and problems. If budget or personnel restriction prevent this, quarterly analysis and tracking will still provide program benefits. Changes in element compounds, such as iron or brass in the fluid, may identify equipment wear entering and contaminating the system. Filtration suppliers can help in establishing a regular fluid analysis program and scheduling fluid sampling.

4. FILTER ALL NEW FLUIDS. New fluids are not clean. It has become common practice to bypass this initial filtering to cut costs. But the price of high-quality, cost-efficient filtration of new fluids is substantially less than the cost of letting contaminated oil into a system.

When it's necessary to add or replace fluid, the new fluid should be filtered to meet the minimal threshold of the company's established ISO standards, if not to one scale number above those target codes.

If you outsource this responsibility, talk to the service provider about the costs of cleaning new oil to meet the ISO standards. Then conduct a joint review of their filtration equipment to assess its cost effectiveness following the guidelines in step 2.

5. SEAL ALL RESERVOIRS AND BULK TANKS. The air is filled with contaminants smaller than 40 microns and invisible to humans. If reservoirs and tanks aren't completely sealed, these contaminants can easily get into the fluid and hydraulic system and wreak havoc. If the reservoir breather is never checked or replaced, it directly degrades fluid cleanliness, which in turn lowers fluid performance and raises operating costs.

6. CHECK LINES FOR LEAKS AND MINIMIZE THEM. Leaks fluid-carrying lines put a double-dip into your bottom line made up of the costs to replace the fluid and the cost of ridding the system of any contaminant that got in through the leak or the repair process.

The small cost of replacing an O-ring is less than that of replacing oil or damaged equipment. A thorough monthly review of the system to check for leaks enhances the value of a cleanliness program. When it is synchronized with monthly oil analysis, it can efficiently track completion of both tasks.

If maintenance managers find it too challenging to adopt ISO cleanliness codes for every system component at the same time, they can opt for a step-by-step approach to standard adoption. For example, they can begin with one area. Then, as good maintenance habits are developed, challenges corrected and results tracked, the program can be expanded to cover other areas. Profits will increase as each new area is brought under the standards.

PARTNER WITH WORLD-CLASS SUPPLIERS

When maintenance leaders can work with their filtration supplier to implement cleanliness initiatives, both partners can profit.

Fluid power and industrial hydraulic filtration suppliers can be trusted resources and committed partners in reducing costs by "managing" contamination. They can provide training, evaluation, scheduling, analysis, and reporting working in a disciplined approach to oil decontamination. The team approach between company staff and filtration suppliers will help control costs.

The entire team can include facility managers and maintenance professionals, along with service providers such as oil reclamation companies—and with suppliers such as filtration firms—to revise and follow maintenance standards that create facility-wide savings.

Remember, the financial rewards from being proactive in reaching total level cleanliness far outweighs the small investment made in more rigorous maintenance practices. hp

IVAN N. SHEFFIELD is director of filtration at Des-Case (www.descase.com), a manufacturer of filtration products.

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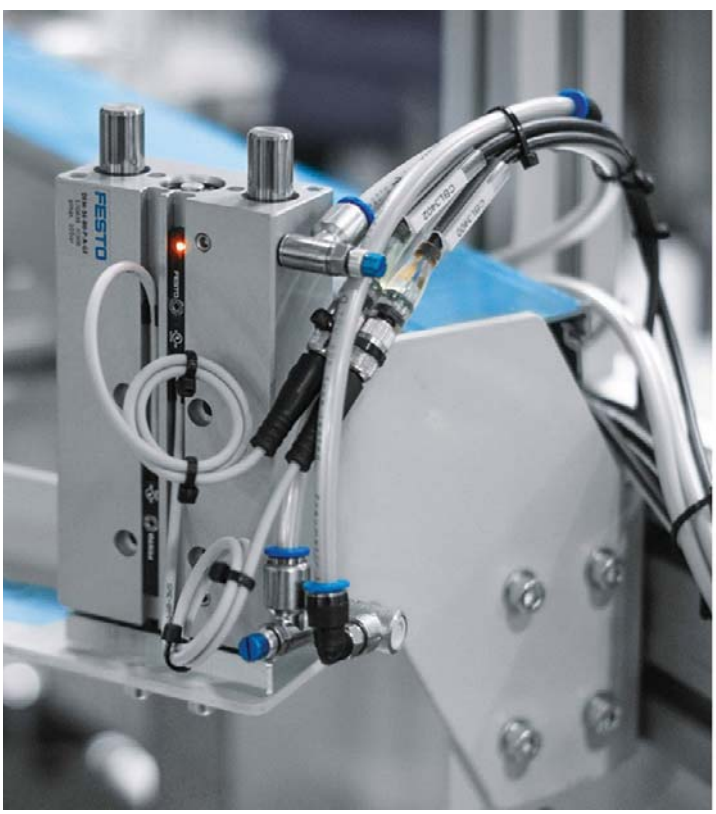
Choosing the Right Pneumatic Guided Drives and Slides

If an engineer knows the options, there's a guided drive or slide for most applications requiring stability or repeatable precision.

AT A GLANCE:

- Guided drives have the power to handle lifting, pressing, pulling, pushing, clamping, stopping, holding, cutting and separating.
- Guided slides do well when precision and repeatability are required.
- Guided slides and drives can be used in a wide range of pack-and-place applications.
- Pneumatic guided drives and slides are the workhorses of industrial automation. They are well-proven and can adapt to a growing range of applications in which adding guidance improves performance. They are cost-effective as well, with many variants and configuration options to assure great reliability and longevity.



Unlike standard drives, pneumatic guided drives maintain complete stability and pneumatic guided slides provide greater stability and precision, all of which is critical in many pick-and-place functions. With both types of actuators, adding stabilization for the piston rod ensures better performance and a longer service life than the non-stabilized alternatives. The market for guided drives and slides is growing as more engineers learn it is easier and more convenient to buy a single product with linear movement and guidance rather than buying both functions separately.

In a standard pneumatic drive, the piston rod creates linear motion and can freely rotate as it extends and retracts. In many industrial applications, that rotation is immaterial; but it is unwanted if the user needs stability, such as maintaining a stamping tool perfectly parallel to the item being stamped. Additionally, if the piston rod applies force on an object, the resistance it meets can create a lateral force or torque against the actuator assembly.

For example, if the actuator is positioning a circular saw cutting through wood, external forces on the actuator when the piston rod is extended can create deflections that cause an imperfect cut. This generates excessive wear on the saw and cylinder.

Pneumatic guided drives have just one piston, with the piston's stability guaranteed by two guide rods. These guide rods typically run on sets of bushings or ball bearings for stability. The guide rods and piston attach to a yoke that holds tooling, preventing the piston from twisting or turning if lateral force is applied for operational stability. These drives are found in applications

involving lifting, pressing, pulling, pushing, clamping, stopping, restraining, holding, cutting and separating. They come in many sizes and variants, can hold almost any tooling, deliver stroke lengths up to 400 mm and can apply great force where required.

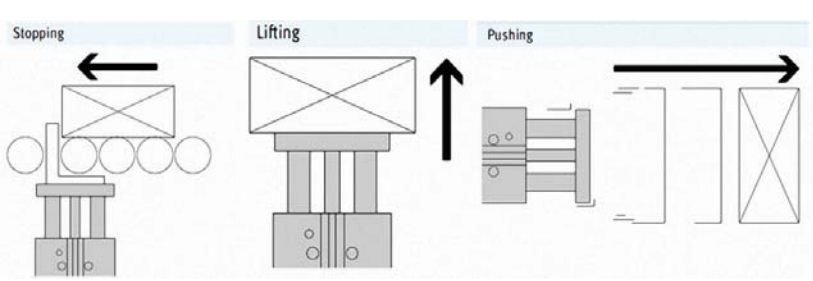
Guided slides excel in tasks where high levels of precision and repeatability are essential, such as in assembling

electronics or small auto parts, in food and beverage handling, and in dispensing applications in other process sectors. Guided slides typically have single or dual piston rods and a guiding rail running on precision ball bearings in the slide housing for precise movement and repeatable accuracy, despite lateral loads and torques.

The slides provide the linear motion, whether fixed horizontally or vertically. They make excellent tools attached to a gantry, such as a dual axis (X, Z) multi-slide configurations and can be added to pick-and-place and piggy-back configurations which have one slide mounted atop another for longer strokes with stops along the way, often without adapters.

In duplex applications, a compact mini-slide attached to a small mechanical gripper or a vacuum cup typically delivers a repeatable accuracy of 0.01 mm and linearity and parallelism within the 1/100 mm 0.01-mm range over millions of cycles.

Guided slides come in a range of sizes with different mounting options and many damping choices to assure the shortest cycle times with minimum vibrations. In apples-to-apples comparisons between guided slides and drives and not-rotating cylinders with identical piston bore size and stroke length, guided slides are the largest and heaviest of the options with built-in piston guidance, thanks to their wide, flat guides that deliver highly precise motion.



Guided drives often perform one of three simple tasks: stopping, lifting or pushing. Guided drives often perform one of three simple tasks: stopping, lifting or pushing.

Assuming the same bore diameter (20 mm) for the piston rod and the same stroke length (50 mm), the guided slide has the largest profile (footprint or length, height and width). Guided drives fit in-between, being smaller than a guided slide and larger than a non-rotating cylinder.

Comparing a non-rotating cylinder, guided drive and a guided slide, all with the same piston bore size (20 mm), stroke length (50 mm) and an extended force of 188 N (see graph) the non-rotating drive's force-to-weight ratio is 65%, the guided drive's is 16% and the guided slide's 15%. So, a non-rotating cylinder would be smaller and less-expensive, but for higher torque load capacities or precision, a guided slide or drive is needed and they would be larger for the same bore/stroke. Adding guidance adds more weight relative to the non-rotating drive to provide more stability.

ALTERNATIVES TO GUIDED ACTUATORS

Non-rotating cylinders and combinations of external guides and standard cylinders are often considered alternatives to pneumatic guided drives and slides. They have limited load capacities, so they are better suited for applications that require maintaining a specific orientation but with small loads.

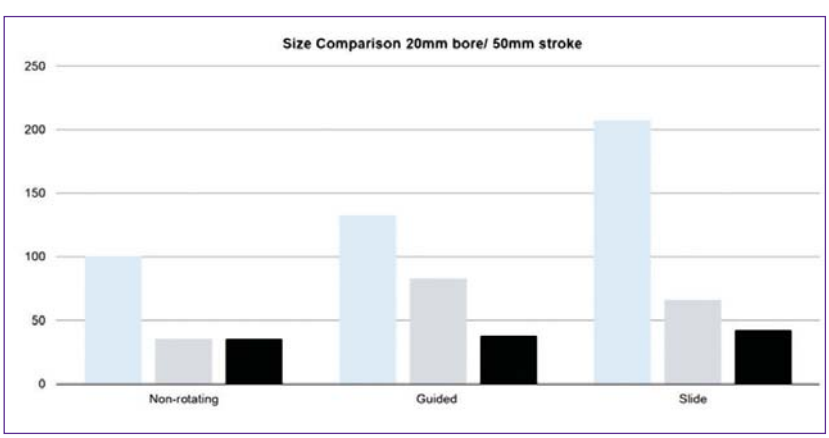
Non-rotating drives and cylinders with non-rotating piston rods are less expensive, but guided drives and slides are more durable and precise and can handle higher lateral loads and torque. When performing the same function, such as lifting a load or moving a gripper, the non-rotating drive will have the greatest amount of deflection from bearing clearance and lateral force. Deflection in this case is the distance the piston or front plate moves due to play with the bearings or any external forces. Increased deflection means decreased precision.

An external guide can be matched with a larger range of cylinders to handle a variety of tasks and situations such as clamping, adjustable air cushions and working in high temperatures, but

Pneumatic mini slide guides are useful for precise motion in tight spaces.

The DFM base model series from Festo is a popular pneumatic guided drive.

A guided drive (left) includes guide rods and requires no assembly, but many guide units such as this FENG actuator and standard cylinder from Festo (right) do require assembly.



the two must be connected. Guided slides and drives have fewer configuration options and a more-limited performance envelope, but they are also less expensive. In pick-and-place applications, a compact unguided cylinder with its freely rotating piston might be considered, but it will not assure consistent positioning and orientation of parts being moved as well as a guided mini-slide would.

PNEUMATIC AND ELECTRICAL GUIDANCE

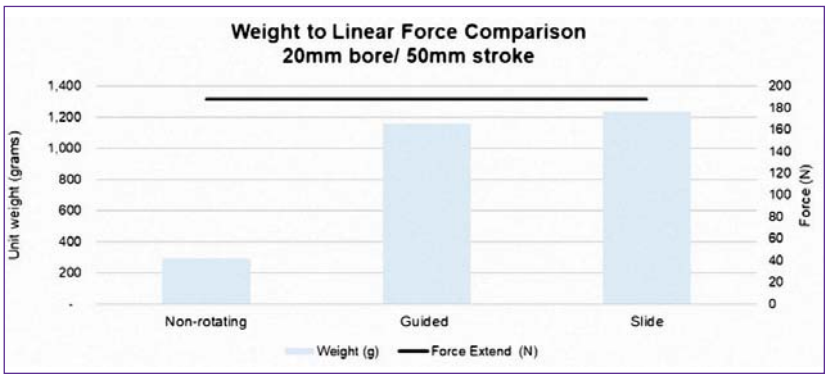
Pneumatic and electric guided drives and slides can perform similar missions but have different strengths. With a properly scaled, well-maintained compressed air source, pneumatic drives deliver higher force densities and speeds for lower installation and operating cost, along with longer service lives.

Comparing actuators in similar pneumatic and electric mini-slides, the pneumatic version is shorter with shorter positioning times. Electric versions offer gentler stopping and starting, a programmable drive profile and constant, precise speeds. As a general rule, pneumatic drives and slides take up less space. Today, energy management and compressed air diagnostics can reduce air use and unscheduled maintenance and downtime, making them a more economical choice.

Relative efficiency is a prime consideration in making the right engineering choice among potentially suitable pneumatic drives with guiding.

The chart compares prices of a non-rotating cylinder, guided drive and a guided slide (all base models with the same 20 mm piston and 50 mm stroke), and the percentage of the guide used when subjected to identical offset loading conditions. For the purpose of this example, the non-rotating cylinder is at 100% guide use. It is at its limit and a poor choice in terms of its ability to handle offset loading. The guided slide is the most expensive of the three, and with just 12% guide

use, it over-performs for this application. The guided drive achieves 54% guide use, and although it's about 2.5× the cost of the non-rotating cylinder, it provides the best cost-performance of the three options.



GUIDED DRIVES FOR ALL SCENARIOS

Growth in the use of pneumatic guided drives and slides reflects their usefulness for an extraordinary range of tasks. These actuators are available in off-the-shelf as well as specialty or customized models, and in metric and inch versions.

Off-the-shelf models account for half of the market and are cost-effective for most applications. Most are maintenance-free and require little or no assembly. Many are available with a choice of plain-bearing guides for high rigidity or recirculating ball-bearing guides for applications with torque loads. Base models are extremely versatile and take up less space for the forces they deliver than the alternatives. These basic drives come in many sizes, with many piston diameter and stroke length combinations. Stroke lengths up to 200 mm are generally considered standard products. Larger versions with stroke lengths of up to 400 mm

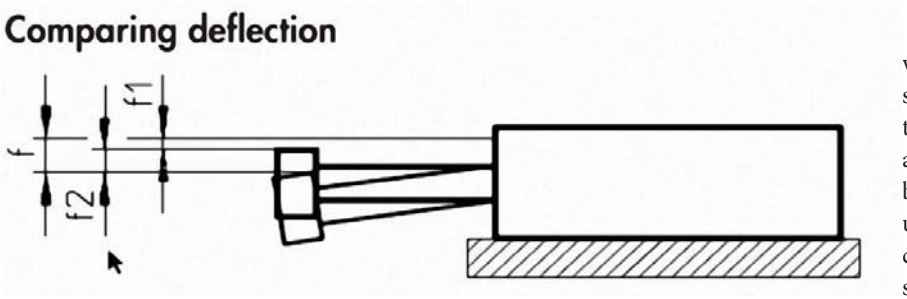
Today, energy management and compressed air diagnostics can reduce air use and unscheduled maintenance and downtime, making them a more economical choice.

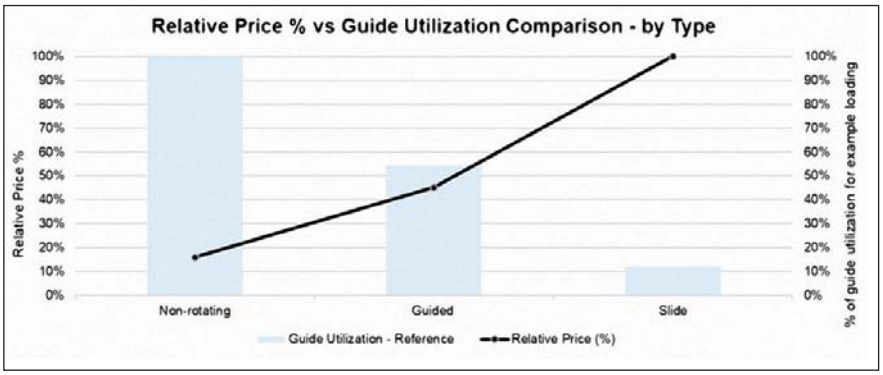
Two Festo DGSL mini-slides are mounted on an electric axis in the side loading unit of a packaging machine.

are available. These larger versions include a choice of damping and end cushioning options, including manually adjustable and, in some models, self-adjusting air cushioning.

There also are specialty models and variants for dry food and splash zones, clean room and ATEX applications, and variants with heat-resistant designs. Hygienic drives for food and pharmaceutical applications provide the same easy cleaning and corrosion resistance as standard hygienic cylinders as well as NSF-H1 compliant lubrication. Hygienic guided drives have a smooth, clean design that will not let water, dirt or dust collect on them.

Many of the same benefits of large, guided drives are available in mini-guided drives where short stroke length and less force are sufficient and space is at a premium. Particularly compact models offer stroke lengths of just 5-30 mm.





Guided slides offer similar variety with both standard and specialty models and options that can be adjusted for most applications. The range includes base models with stroke lengths up to 200 mm and multiple cushioning options, flat and slim designs, and ultra-compact models as small as 8-mm wide with 1 to 10-mm stroke lengths. The latter is ideal for small pick-and-place and other short stroke applications. The development of ever more compact guided slides reflects the industry trend, especially in electronics assembly, toward miniaturization which requires guided mini-slides and micro-slides perform with the same precision, repeatability and long service life of larger actuators.

CHOOSING THE RIGHT DRIVE

Software like Festo's pneumatic sizing tool (found in the company's online catalog under the blue "Engineering" tab) supports customers in the selection and configuration of pneumatic products. Customers can enter their application parameters, factors such as the load to be moved, the distance and speed, and the operating pressure. They are provided with suitable product recommendations, as well as an idea of the type of cushioning that meets their needs—from a simple bumper type or shock absorber to manually adjustable or self-adjusting air cushioning. That sizing tool also addresses bearing guide use, providing an indication of whether plain bearing or ball bearing styles would be better-suited to their operating requirements.

Demand for pneumatic guided drives and slides is growing steadily, reflecting the further expansion of automation and improvements in actuator design. These actuators are an excellent choice wherever compressed air energy is available. They are cost-competitive, easy to configure and install, often maintenance-free and robust, ensuring a long service life. They are versatile and available in a huge range of piston sizes and stroke lengths, with base models to suit most applications and specialty variants for many others. Their guiding capability is already designed and built-in, so minimal if any assembly is required. It's no exaggeration that there is a guided drive or slide for most applications requiring stability and/or repeatable precision. hp

Comparing Drive Characteristics

	Not rotating	Guided drives	Guided slides
Price	+++	++	+
Size	+++	++	+
Weight	+++	++	+
Resistance to torque loads	+	++	+++
Accuracy	+	++	+++
Mounting flexibility	++	+++	++

DARREN O'DRISCOLL, MICHAEL GUELKER and JULIAN BECKLER are product managers, and THOMAS MARTIN heads product management (piston rod actuators), at Festo AG & Co. (www.festo.com). .

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ANDY ZASKE and SEAN HALVERSON | Tolomatic, Inc.

3 Tips for Choosing the Right Electric Actuator for Hygienic Applications

Food and beverage applications pose special challenges for electric actuators.

Machines that process and package food and beverages (F&B) are continually being redesigned and refined to meet food company demands for increased automation, less production waste, greater efficiencies and lower costs. In addition to these criteria, food processing machines must meet stringent requirements to keep food clean during production and ensure it arrives to consumers safely. Standards such as the European Hygienic Engineering & Design Group (EHEDG), 3A, USDA and others define the hygienic design principles for these machines and components to prevent bacterial contamination. Actuators are critical to food processors as they are one of the most common way products are moved efficiently. Electric actuators, in particular, are the technology of choice for an increasing number of F&B applications due to their inherent cleanliness.

(l-r) 3A, U.S. Dept. of Agriculture, European Hygienic Engineering & Design Group

Machine designers can meet manufacturer expectations and comply with food-safety standards by applying the following three best practices for specifying electric actuators for F&B processing equipment. These principles create open, clean-in-place designs that reduce the risk of bacterial contamination and improve overall machine cleanliness. Along with following these best practices, it is always a good idea to consult with EHEDG, USDA or appropriate governing agencies to ensure a design complies with current regulations.

1. SELECT HYGIENICALLY DESIGNED ACTUATORS.

There are several criteria that go into making a design hygienic.

Proper materials. Actuators made of non-compliant materials may corrode and shed particles into the processing environment. Stainless steel is a good

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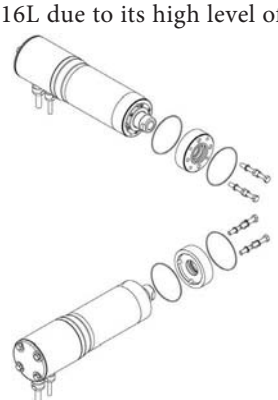
Hygienic electric actuators in this filling machine help make it accurate in dispensing product and easy to adjust in case of product changeovers.

choice for these components as it resists corrosion, withstands tough processing conditions and complies with industry standards.

Several stainless-steel alloys are well-suited for food processing applications. For example, best practice in hygienic design for linear actuator bodies call for motor housings and fasteners to use type 316/316L due to its high level of



Technicians must take care to install and then replace seals properly.

corrosion resistance. Type 304/304L stainless is also used in some cases.

• According to the EHEDG (Hygienic Equipment Design Criteria Doc 8, April 2004): For good resistance to general atmospheric corrosion for components that will be used only with solutions having a pH between 6.5 and 8, low chloride levels (<50mg/l), and low temperatures (<25°C) the most common metal is AISI-304 stainless steel.

• If chloride levels and temperature exceed approximately double these values (100 mg/l and 50°C), the material will need greater resistance to the crevice and pitting corrosion which can result from local chloride concentrations. Adding molybdenum to AISI-304 to make AISI-316 improves its corrosion resistance.

• 316 steel can handle temperatures up to 150°C.

This IMAS actuator cylinder has a rounded body, smooth finish and food-grade seals, making it well-suited for handling washdowns.

The steel actuator components should have a number 4 ground finish or better, and be free of pits, cracks, folds and other imperfections. This makes parts suitable for washdowns. Welded junctions, however, should be electro-polished, glass beaded or shot peened to a number 4 ground finish.

Metal alloys other than stainless steel (such as aluminum) may be suitable under certain conditions. Alloys containing lead, leachable copper or other toxic metals should be avoided.

Proper seals. Electric actuator rod seals must be made of a durable material that withstands the application's operating conditions. Such seals are often made of Viton or ultra-high molecular weight (UHMW) polyethylene to keep contaminants and water out during washdowns and resist corrosion.

When choosing an electric actuator, companies should ensure the supplier factors in seal interference and friction for the proposed motion profile and desired life estimates. Friction between the rod seal and rod can damage the seals. Design engineers should also research the material composition of all polymers proposed for the design to ensure FDA-approved seal materials are used.

IP69K ratings are the best for actuators that will see service in the F&B environment. The most challenging area of IP69K design is the seal on the thrust rod. Seals age and wear during operation, and it takes a properly designed seal to meet and maintain an IP69K rating. Seals with tight dimension tolerances assure a correct fit on the thrust rod and the durability to withstand many extend/retract cycles.

Seals will eventually need to be replaced. Seal manufacturers generally provide guidelines for replacement frequency, but how fast a seal really wears depends on many factors, including frequency of motion, alignment, cleaning frequency and compatibility with sanitizing agents.

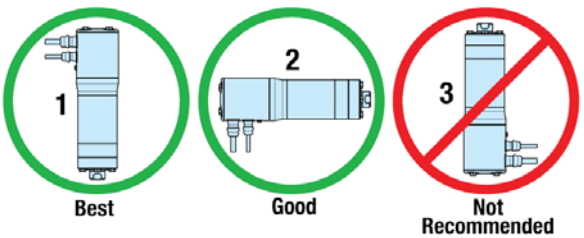
Made for easy cleaning. Actuators with domed or rounded bodies, rounded edges and a smooth finish prevent moisture, food particles and microorganisms from collecting and pooling. Particles and cleaning fluids easily drain off, improving the washdown process and minimizing the chances of contaminates lingering on the actuator after cleaning.

Even motor housings should be rounded to promote runoff. A properly designed electric hygienic actuator has no sharp edges or angles (≤ 90 deg.) and no flat surfaces (even transition features should have a radius of ≤ 6 mm.) that could create edges or pockets where food can lodge and stymie the cleaning process.

Operating temperatures. Ambient temperatures during food processing

This actuator cap has a breather cap to prevent overpressurizations inside the cylinder and to keep out contaminants.

Misaligning the actuator and the load or force axis creates off-center side loading. It can put too much wear on the seals, let water leak past the seal and get in and lead to premature actuator failure.



Actuators should be oriented so that the rod extends down or horizontally, not up. This reduces the risk of contaminants getting into the actuator.

can range from warmer environments to refrigerator cold or even freezing environments. Several cold-warm-cold temperature cycles can occur daily, depending on the temperature of the environment, the equipment and the water (up to 176°F/80°C) used for cleaning. These variations can create condensation and put a pull vacuum in sealed equipment due to fluctuating pressures. In these environments, the combination of an IP69K rating and a breather/purge port becomes essential to keep moisture out of the actuator.

Adding a breather port. A breather port is usually placed in the back of the actuator near the cable(s). Correctly used, it keeps moisture out of the actuator by equalizing pressure inside and outside the during operation and temperature changes. This calls for an IP69k-rated face seal. Any air supplied or exchanged should be dry and clean, and the air line periodically inspected for moisture and cleaned as required.

DRAWBACKS OF FLUID-POWER ACTUATORS

SOME FLUID POWER cylinders are hygienically designed for F&B processing with water-tight construction to keep out contaminants and stainless-steel components to reduce corrosion. But fluid power devices that rely on pneumatic or hydraulic cylinders can still create contamination risks.

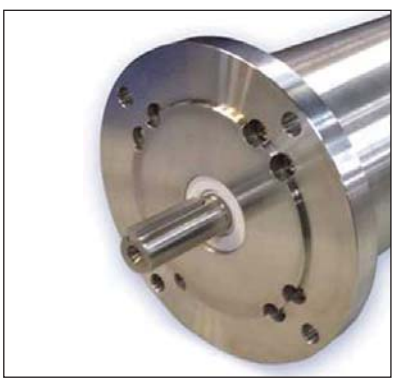
Pneumatic cylinders require clean, filtered and dried air to prevent condensation. Bacteria thrives in wet, damp areas, and it is difficult to monitor or prevent condensation in the vast compressed air networks found in F&B processing plants. Frequent washdowns create hot and cold cycles that typically cause condensation. Pneumatic cylinders also typically only have two positions and must be manually adjusted to change the stroke and be suitable for flexible manufacturing.

Hydraulic cylinders can leak high-pressured fluid and contaminate food products. Oil is slippery, so leaks create slip hazards and are difficult to clean up. Hydraulic cylinders can use food-grade oil, but these oils are often used for long periods of time and can become dirty.

Fluid-power cylinders also rely on wearable seals for operation and containment. Oils circulated at high pressures puts stress on seals and hoses. These seals require constant scrutiny and periodic replacement for consistent operation and to prevent leaks in the tubing and cylinders.

In contrast, electric actuators mitigate the risks associated with fluid power devices and offer a clean technology for hygienic, sanitary environments. Preventing just one contamination event by replacing fluid power cylinders with electric alternatives could justify the entire replacement costs.

An XXX C-Type flange (Rockwell VPH).



An XXX D-Type flange (Elwood W-Series).

2. DESIGN THE ACTUATOR INTO AN OPEN-ARCHITECTURE SYSTEM.

Stainless steel actuators let the entire machine use an open-frame architecture. This eliminates or minimizes large steel enclosures, improves cleaning and ensures regulatory agencies will likely approve the design.

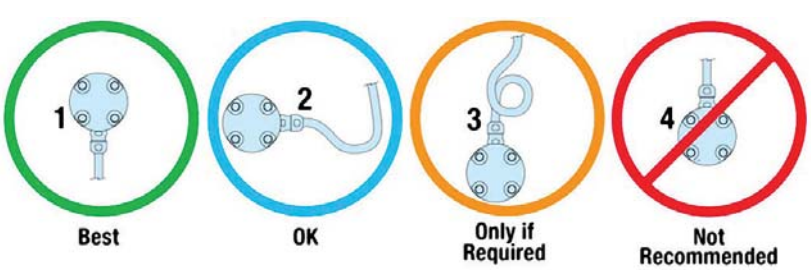
Alignment and mounting compliance. Properly aligning the actuator with respect to the application load and axis of motion minimizes side loading. But even moderate side loading exposes the extended rod and rod seals to wear and damage. This means the actuator rod must be guided or supported to minimize side loads. Loads should be aligned in parallel with the thrust rod's line of motion.

Actuators should be oriented so that the rod extends up or horizontally, not down. This reduces the risk of contaminants getting into the actuator.

It is also important to add some level of compliance to at least one of the actuator's two mounting points. Despite best efforts on installation, there will likely be some variation in components. So, giving the actuator some ability to move (compliance) will help avoid any binding or side loading. Using a clevis, spherical rod eye or trunnions for mounting can add compliance.

Combining servo motors with actuators. Servo motors used in hygienic applications fall into two classes:

- Those rated IP67 and painted with white epoxy. These are suitable for dry, non-contact areas rarely subjected to washdowns. Their environmental sealing, epoxy paint and nickel-plated connectors do not stand up well to common cleaning agents applied with high-pressure sprayers. The epoxy paint can flake off, cleaning fluids can enter through shaft seals and nickel-plated connectors discolor from oxidation.
- Those rated IP69K and made of stainless steel. Motors that carry the IP69K rat-



The preferred cable gland orientation is below the actuator and does not require loops or bends: 1. Cable glands at the side; 2. Requires bends or loops in the cable, if the cable glands must be at the top of the actuator; 3. A loop in the cable must be added; 4. Cable glands at the top without a loop are not recommended.

ing are ideal where hygiene and cleanliness are critical, as they are proven to be durable and resist water, chemicals, high pressure and high temperatures associated with demanding cleaning and safety measures.

Flanges available on hygienic motors include the XXX C-Type flange (Rockwell VPH shown), which is easier to seal and clean, reduces areas for harborage and should include an FDA compliant O-ring. Before choosing a C-type flange motor, make sure the motor supplier provides an O-ring (some motor suppliers force the user to source the O-ring separately).

Another option is the XXX D-Type flange (Elwood W-Series shown), which is difficult to seal and clean. It frequently does not provide O-rings or gaskets and just suggests using RTV to seal the motor-to-actuator interface.

Cable management. Over time, liquid contaminants such as oil and cleaning solutions may accumulate on the cables and cable glands. To minimize the introduction of contaminants to the glands, mounting the actuator with the cable gland down is suggested. Mounting with the gland to the side requires a bend or drip loop. Actuators should not be mounted such that the cable gland points up. If mounting the actuator with the cable gland facing up is unavoidable, the cable should be routed with a drip loop prior to entering the cable gland. Units mounted with the cable glands on the bottom surface of the actuator require no looping.

3. COMPARE ACTUATORS.

Design engineers must also choose between an integrated motor/actuator design and a more traditional design with the motor separate from the actuator and attached before installation on the final machine. With just an actuator, an in-line motor mounting configuration or a reverse parallel (RP) design can be used. In the reverse parallel design, the motor mounts parallel to the actuator and uses a belt and pulley or geared mechanism to transfer power. This design makes for a much smaller footprint but has have some significant additional costs.

An actuator and motor combined in single piece eliminates the typical seals between the motor and actuator. This reduces the number of points for possible moisture to get in or bacteria to thrive. It also eliminates the risk of seals being ripped or off-center when installed.

The accompanying table provides a quick comparison of both types of actuator/motor designs. hp

Differentiation Specification	Traditional	Integrated
Ease of integration	Matched motor set	
Motor mount, envelope & weight		More compact overall & lighter weight
System costs		Competitive & no motor mount time
Ingress protection	Motor mounting	Fewer ingress points
Maximum stroke	Better screw support	
Anti-rotate	Standard, internal	
Efficiency & reliability		Fewer torque components & bearings
Positional accuracy & repeatability		Rigid coupling, aligned
Force capacity	Motor flexibility for more applications	
Force repeatability		Rigid coupling, lower torque ripple
Continuous/peak force ratings	Motor/screw heat are separated	
Acceleration & responsiveness		Higher resonant frequency, stiffness
Shock & vibration		Closer center of gravity, rigid coupling
Safety (vertical loads)	Belt or coupler breaking	Rigid coupling

All-in-one integrated motor/actuators have distinct advantages over traditional motors connected to an actuator.

ANDY ZASKE is vice president of sales and marketing and SEAN HALVERSON is a mechanical engineer at Tolomatic, Inc. (www.tolomatic.com).

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MOTION INDUSTRIES

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Wheel Drive

THE MPW86 WHEEL Drive features a high torque-density brushless DC motor with a heavy duty integrated planetary gearbox mounted inside the hub of a lightweight aluminum wheel with custom tread. Designed for mobile robot applications, the MPW combines optimum performance with high efficiency, quiet soperation and long life. The MPW86 provides peak torque of up to 35 Nm (310 lb.in) at up to 4.3 meters/sec., while carrying up to 227 Kg (500 lb) per wheel.

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www.electrocraft.com

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franklinwater.com/subdrive-connect-plus

Liquid Level Sensors

The EchoPod and EchoTouch reflective ultrasonic liquid level sensors feature proprietary Reflective Technology. Both models include a general-purpose version and an intrinsically safe version for hazardous environments; both are available with continuous level measurement, switching and control capabilities. The standard 4-20 mA output can be monitored by a PLC or other controller. Models with four relays can be configured for level alarms and/or standalone level control, such as automatic fill or empty functions. All sensors are configured using the free-to-download WEBCAL software and provide limited configuration via the integral pushbutton display module.

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Servo Drives

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Pain Points for Mechanical Engineers

Can mechanical engineers succeed if they only handle mechanical problems, ignoring electrical and electronic technologies?

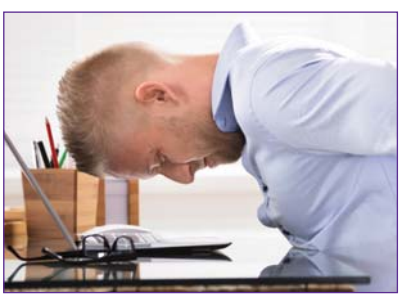
There still are a host of purely mechanical products being developed. But the spread of smart, connected technology into even the most mundane mechanical design niches means mechanical engineers must incorporate electronics, sensors and wireless connectivity into many of the products they design. Here's a look at the four top challenges facing mechanical engineers, keeping in mind that the drive toward IoT only further complicates their jobs.

1. CAD MODELS LOOK TOO GOOD. As the CAD tools of the trade have evolved, even the crudest, concept-phase mechanical designs can be rapidly rendered to look realistic on screen. This is not a bad thing, generally. However, in presenting the ideas of mechanical engineers to a non-ME audience, computer screen images can be deceptive, making designs appear far more complete than they actually are.

The role of a mechanical designer is more than just creating a product's outward appearance. It is also necessary to provide the unseen features needed to deliver functions and performance. Likewise, on-screen images do not reflect the work required before and after to ensure the correct materials are chosen, product costs have been minimized, and the structural and environmental requirements have been analyzed and are reflected in the model.

2. SIMULATION TOOLS HAVE ADVANCED, BUT BASIC ISSUES REMAIN. Basic geometry modeling capabilities have evolved to a high level of function and simplicity over the years, but some of the biggest and most radical changes have been related to simulation tools. Engineers can now very quickly and easily build simulation models for analysis and then run those analyses to quickly generate results.

However, the old rules still apply. If the simulation models are not constructed with the right boundary conditions, they will quickly generate beautiful results that in no way represent the design's real-world performance. If you can't understand what an expected result from manual analysis will be to within 25% accuracy, then you probably



shouldn't run a computer model.

Without a sense of what may be a reasonable answer, it is still far too easy generate ridiculous results from simulations. One has to be able to assess the quality of the simulation results to know whether it yields new, useful information or a false sense of reality.

3. MECHANICAL ENGINEERS ARE THE "GLUE" BETWEEN INDUSTRIAL AND ELECTRICAL DESIGN. The perennial challenge of "smaller, faster, lighter" oftentimes falls on the shoulders of mechanical engineers to resolve. It remains a challenge to balance the competing demands of the industrial designers around aesthetics, brand presentation and ergonomics with the growing demands to stuff ever more powerful and energy-dense electronics into a single enclosure. Throw in the need to include antennas with the right geometry and placement, and one has a very multi-faceted problem. It often falls to mechanical designers to combine the needs of the other product functions into a single structure.

Additionally, the mechanical system engineers are responsible for the fully integrated product cost, including pulling together the full bill-of-materials. It is here focusing the design on a unit product cost must come together. MEs must also negotiate with industrial designers around features that may be driving material or process costs above the realm of acceptability. As has always been the case, mechanical engineers must have solid negotiating skills to "herd all the cats" into alignment.

4. THERE'S NEVER ENOUGH TIME OR MONEY FOR ADEQUATE TESTING. Testing is most often thought of as a downstream activity. In product development, time is usually not a friend. There is always pressure to cut down or eliminate sub-system or full system testing. And when it comes to full system testing, the costs of building and testing models can be high. But testing serves two key functions. First, it provides another point of confidence in the accuracy of the simulation models (and provides insights for refinement towards greater accuracy). Second, it reveals flaws not readily captured in simulation models despite the incredible simulation capabilities now in the hands of engineers.

Like their cohorts in electrical engineering, the adage holds true for MEs too, that "Nobody said this would be easy." While it is certainly true many products are simple to design, today's MEs need to be masters at balancing tradeoffs inherent in developing Internet of Things (IoT) solutions. Even in relatively simple products, the bar has been raised in the expectation that products will be exceedingly attractive, engaging and durable. These are the challenges that keeps engineering careers interesting and ever-changing. hp

Mitch Maiman is president and cofounder of Intelligent Product Solutions (http://www.intelligentproduct.solutions).

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