

# Linear Motion Q&A

## CUSTOMIZED MACHINERY BUILT WITH OFF-THE-SHELF COMPONENTS

(Courtesy Thomson Systems)

### Introduction

Machine builders strive to achieve the right balance of functionality, performance, price, durability, energy consumption and other attributes that will enable their products to excel against the competition. In the past, OEMs designed their machines around readily available standard components or had to add the cost and development time needed to obtain custom components designed especially for the application.

The growing breadth of standard offerings via the methodical evolution of electromechanical linear actuators, linear motion bearings, clutches and brakes, and linear slides now enable machine builders the benefit of a precisely matched “custom” solution while using cost-effective “standard” motion components.

### Linear Slides and Stages

James Marek, business unit manager

#### *What linear slides and stages are the most innovative in the marketplace? Why?*

Linear slides that meet the technical and commercial demands of customer needs are the most innovative in the marketplace. The demands that I constantly hear are enhancements to performance, the ability to perform in adverse environments and a quick “selection-to-delivery” cycle. Enhancements in performance include increased footprint-to-load capacity ratio and longer system lengths, along with improvement in positioning accuracies and repeatability. Linear slides are being deployed in adverse environments, and customers expect them to survive with

little or no maintenance. Particularly challenging are environments where there are airborne contaminants that have a tendency to migrate into the linear guide system and ball screw. There are some novel sealing strategies that protect the internal components of the system. Engineering resources within organizations are leaner than ever. Web-based tools that allow them to do their job more efficiently are also in demand. There are tools that support not only the sizing of all components within the system but also output smart part numbers and CAD models.

#### *How has linear slide and stage technology advanced in the past five years?*

There are a number of relatively new technologies that address the challenges

associated with deploying a linear system in an application. These technologies address the mounting orientation, loading conditions, move profile and environmental conditions associated with customer applications. Extrusion technologies and post-processing of the extrusion have enabled systems of over 12 meters in length to be developed from a single piece of extrusion. In the case of a ball screw-driven system with long lengths, the system is often limited by the critical speed of the screw. A solution to this problem was to design screw supports that are dynamically transferred within the system at pre-defined locations. This has enabled 12 meter-long systems to rotate at input speeds of 3,000 rpm without hitting the critical speed of the screw. A number of unique sealing strategies have been developed to minimize particles and fluids from penetrating the interior components of a system. These seals allow linear systems to perform in paper and pulp, woodworking and painting applications.

A motor mounting system that is designed to mount to a wide array of motor interface dimensions—yet be flexible enough to produce the interface in 24 hours—has addressed this need. Lastly, there are software tools that have been developed to take the input



The Thomson RediMount System provides mounting to virtually any customer-specified motor. It eliminates the need for a custom motor adapter, greatly reducing cost and delivery time (all photos courtesy Thomson Systems).

parameters for a specific application and to process this data against the performance characteristics of all systems in the database. Safety factors are displayed for each system that satisfy the application, and solid models for these systems are dynamically created and available for download to the user.

**How has the marketplace benefited from these technological advances?**

The benefits of commercial innovation are speed to market and reduction in product development costs. Engineers are quickly able to optimize their solutions and obtain solid models that can be dropped into their machine models. The benefits related to technology advancements are the same, although not as obvious. Take the improved sealing technology as an example. Prior to having such a robust seal design for linear slides, the engineer would have had to make provisions for protecting the linear slide. This could have been providing external shrouds or bellows or locating the slide adjacent to its optimal position to avoid direct contact with the contaminants. Cost and development time are compromised when the designer is required to fortify the design to protect the linear slide.

**How, if at all, will linear slide and stage technology continue to advance in the next five years? Who stands at the foreground of this potential innovation? Why?**

Customers will determine the advancements as the leading manufacturers will react to their needs. My sense is that companies that are flexible to modify their standard products to the specific needs of the customer will lead the way in the innovation of new technology. This technology will be in both the product and service spectrum. Companies that are “easy to do business with” by providing exactly what the customer needs, rather than giving them 80 percent of the solution and forcing them to engineer the last 20 percent will not only survive but grow in the challenging economic times that we are facing.

**Has linear slide and stage technology become outdated/obsolete by other solutions in the market? If so, how?**



**Linear Motioneering from Thomson is a web-based sizing and selection tool that reduces the time required to utilize economical and proven standard components to meet the vast majority of linear motion requirements.**

No, if anything, the motor-driven slide table is replacing existing applications that are based on hydraulic or pneumatic technology. Servo motor and position feedback technology are at a more competitive cost point. They offer benefits of better control, safety and environmental friendliness.

**Clutches and Brakes**

**John Pieri, product line manager**

**What are the best (or most common) brakes and clutches on the market today?**

This depends entirely on the application and market, but in general, electromagnetic friction and wrap spring clutches and brakes are the two most common. There is a trend to provide electric actuation over fluids and pneumatics. As electric motors have become smaller, energy efficient, more powerful and lightweight, so has grown the demand for electromagnetic clutches and brakes.

Examples of growing markets include medical, aerospace and defense, robotics and electric vehicles (includes hybrid automotive, electric lifts and

other mobile off-highway).

How have brakes and clutches changed in terms of functionality and performance to fit harsh environments?

When there is a need for operation in harsh environments, special coatings for corrosion resistance have been developed. Also, with the use of magnetic FEA, special alloys with built-in corrosion resistance are being used. There have also been innovative solutions on sealing/covering the moving parts.

An example of harsh environments would be in the aerospace and defense market segment. There have been many advances in materials used in clutches and brakes in these applications.

**How have brakes and clutches changed in the past five years?**

There has been an increase in the demand for brakes, mainly power-off, spring-set, while clutch usage has been flat. In some cases the use of clutches and clutch couplings is now threatened by the use of low-cost motor/drive technologies.

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**Deltran high-performance solution in OEM or after-market applications. Their higher torque rating enables users to install a smaller, less expensive unit than would otherwise be possible with competitive options.**

***How will they continue to change in the next five years?***

I believe there will be a continuation in the drop of clutch and clutch coupling usage and an increase in the use of spring-set, power-off brakes.

***What is the future of regenerative braking?***

Regenerative braking utilizes AC motor/drive technology to generate electricity (like a generator), only the energy source comes from back-driving those motors (like slowing down a vehicle going down a hill). Regenerative braking increases the use time of a vehicle's battery and is an alternate solution for dynamic stopping. Clutches and brakes are partnered with this technology (spring-set brakes are used in tandem as the parking or emergency brake) and are gaining momentum in these emerging markets.

***How will energy-harvesting technology change brake and clutch market demand?***

Power-off, spring-set brakes will participate in this expanding market segment for parking and safety.



**The two major types of linear guides are round rail bushing bearings and profile rail bearings. Round rail ball bushing bearing systems accommodate torsional misalignment caused by inaccuracies in carriage or base machining or machine deflection with little increase in stress to the bearing components. Profile or square rail systems offer higher accuracy, higher rigidity, higher load-life capacity and are also very compact.**

**Bearings**

**Alison Ng, director, engineering—rails, guides and components**

***What are the best (or most common) bearings on the market today? What do they feature?***

The most prevalent linear motion bearings on the market today are split between linear ball bearings that run on round rails, and profile rail bearings that run on ground guide-ways, with a bias toward the profile rail bearings. The balance of the linear bearing market is taken up with specialty bearings that vary from non-contact to limited stroke, to cam followers, to plain contact, etc. One type of bearing will have various advantages over another type of bearing, but the overall benefits and suitability are dependent on the application needs and requirements.

Both of the most popular linear bearings are rolling contact bearings, but each has some design differences that provide certain advantages for certain conditions—quality, function and perception all play a factor in the application preferences for bearing types



and manufacturers. Both bearing types consist of inner and outer races with re-circulating rolling elements that run between them, configured such that they can effectively support very high loads while enabling extremely high-precision and repeatable, anti-friction linear motion.

Re-circulating rolling contact bearings provide the best overall performance, reliability, precision, accuracy, repeatability, speed, low friction, predictability and value for the linear motion market.

***How, if at all, do bearings change in terms of functionality and performance to fit harsh environments?***

Adaptive bearings that transform to better handle changes to the conditions are not typical, although there has been quite a bit of work done to provide compliant structures that enable bearings to handle high loads or slight installation or surface preparation errors or imperfections. Rather, linear motion bearings are selected or accessorized specifically to be able to function and perform in the design environment. Certain types of bearings are better capable of handling extreme temperatures, like bearings with all-steel construction, or special high temperature range materials. Material selection is a key aspect to a bearing's ability to survive in environments that are exposed to chemicals or radiation. Proper bearing type selection is required for survival in harsh physical operating conditions, such as high impact or vibration. Proper accessorizing of the linear bearing is necessary to address poor maintenance and lubrication practices, such as incorporating lubrication options and seals or incorporating bellows and scrapers to protect against physical contaminants.

There have been changes in the value aspect of linear bearings, rather than the design aspects of the linear bearings. Lower-cost but sometimes also lower-quality bearings have been introduced to the linear bearing market, causing a focus on the actual installed and end user value as being a significant parameter, rather than just performance and functionality.

On a longer time scale, as mentioned before, compliant designs and structures have been introduced to help



**Thomson RoundWay Linear Roller Bearings boast a dynamic load capacity of up to 70,000 lbf (310,800 N)—more than 20 times the load capacity of a conventional linear ball bearing, even at extreme operating temperatures (up to 500 degrees Fahrenheit; 260 degrees Celsius) and speeds (up to 100 ft/s; 31 m/s).**

improve bearing performance and ability to function at an optimum level with imperfections in installation or set-up. Rolling element separator elements have been introduced to attenuate bearing noise. Segmented and modularized designs help the manufacturer tailor solutions better.

***How, if at all, will they continue to change in the next five years?***

With the global economy and manufacturing in its current state, the changes to linear bearings will continue to be on the value-focused side and will tend to be very incremental, or special-application oriented. This does not mean the linear motion systems designers will only look at price, but rather at the overall installed end user cost. This will mean demands for improved reliability, ease of installation, ease of maintenance, low operating cost and low power consumption, without a reduction in performance. This will in turn drive the desire for better sealing and lubrication accessories, better quality products that are more consistent, downsizing bearings, alternative materials for demanding environments and perhaps even hybrid bearings.

***Is there such a thing as a “conventional”***

***bearing, or have they become customized to fit each unique application?***

In the linear bearing industry, there is definitely a move to make “conventional” bearings. Several standards exist for the linear bearing products, ranging from several ISO metric, to JIS metric, and inch standards. These are used as guidelines for the bearings that are the building blocks for the linear motion system designer to create a unique, tailored solution. For any given opportunity, however, the development of unique linear bearing solutions is always available.

***What quality/performance specifications do you look for in bearings when putting together your BOM (bill of materials)?***

While there has been a move to standardize bearing performance for “conventional” bearings, this has been less than completely consistent, as the bearing designs and methods are highly subject to the level of the bearing house creating the product. Many bearings cannot be considered “conventional.” The quality bearing manufacturers will produce bearings that perform better. The innovative bearing designers will design bearings that perform better. Sometimes, two bearing companies can

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**Electromechanical linear actuators, such as the Electrak Pro Series from Thomson, are those that are derived from flexible platforms customized to meet the needs of specific OEM customers.**

claim the same performance numbers per the same standard, but the two bearings will not have equal performance. Ultimately, it is the degree of trust you have in the linear bearing manufacturer, because not all linear bearings are created equal.

### Actuators

Al Wroblaski, product manager,  
industrial linear actuators

*When it comes to linear, hydraulic, electrohydraulic and piezoelectric actuators, has one particular type of actuator come to stand out in front of the others? If so, why?*

Electromechanical linear actuators currently offer the widest range of performance and most direct compatibility with machine microprocessors, or PLCs.

Electromechanical linear actuators that achieve the highest success are those that are derived from flexible platforms that are easily and cost-effectively customized to meet the needs of specific OEM customers.

*What actuators are the most innovative in the marketplace? Why?*

In each major market segment where actuators play a predominant role, there is typically one key manufacturer who develops a platform that addresses the specific needs of the marketplace. Usually, shortly thereafter, “clones” of this product arrive on the scene, typically competing on price.

The leading actuator companies

have resident, dedicated engineering design capability and core manufacturing competency (e.g., lead screws, flexible assembly, motors, etc.), coupled with aggressive marketing programs to identify the future needs of customers.

Innovation is currently defined by offering significantly increased functionality while reducing envelope or footprint, and maintaining or reducing cost of ownership. Similar to the model of the “personal computer,” where the same money spent five years ago buys a product with a dramatic increase in capability.

*How has functionality been enhanced in linear, hydraulic, electrohydraulic and/or piezoelectric actuator technology in the past five years?*

By increased compatibility with the low-power microprocessors being used to control “machine functions” on equipment, and integrated, on-board electronics that enhance the controllability of electromechanical linear actuators.

*How has the marketplace benefited from these technological advances?*

The ability to provide “low-level” power switching has facilitated the use of microprocessors controlling actuators to perform manual devices, or manually operated hydraulic cylinders. This has led to automation and optimization of machine functions, which in the past had to be operator-monitored and controlled. It has also reduced the cost of hardware and wiring systems, as lower-current handling components can be used.

Onboard, electronic functionality-integrated internally to electro mechanical linear actuators:


- Internal feedback devices such as potentiometers, encoders, or Hall effect sensors reduce performance issues by removing them from the external environment, and reduce labor costs of assembling external feedback devices, and accompanying hardware.
- Onboard, internal microprocessors allow actuators to replace external electromechanical devices to provide electronic, clutching and end travel limits.

- The ability to provide outputs to external devices for facilitating interlocks can be programmed into actuator “chips.”
- This internal integration reduces overall “system” size, cost and performance issues.

*How, if at all, will actuators continue to advance in the next five years? Who stands at the forefront of this potential innovation? Why?*

The “winning” actuator companies in the next five years will be those that partner closely with OEMs, who themselves are technology innovators who will exhibit high growth during the period. Prerequisites will be strong engineering and global manufacturing operations, highly robust design proven by thousands of applications in harsh environments, as well as customization capability allowing for design optimization.

The key advancements will come in the following areas:

- Increased onboard, electronic functionality reducing the amount of control the primary machine PLCs need to provide.
- Increased thrust, speed and duty cycle will allow electromechanical actuators to address the environmental concerns in many applications where the risk of contamination from fluid power alternatives is becoming unacceptable.
- Increased product platforms ranging from small to large will allow equipment designers to put an increased number of machine functions under automated control, reducing operator interaction. 

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