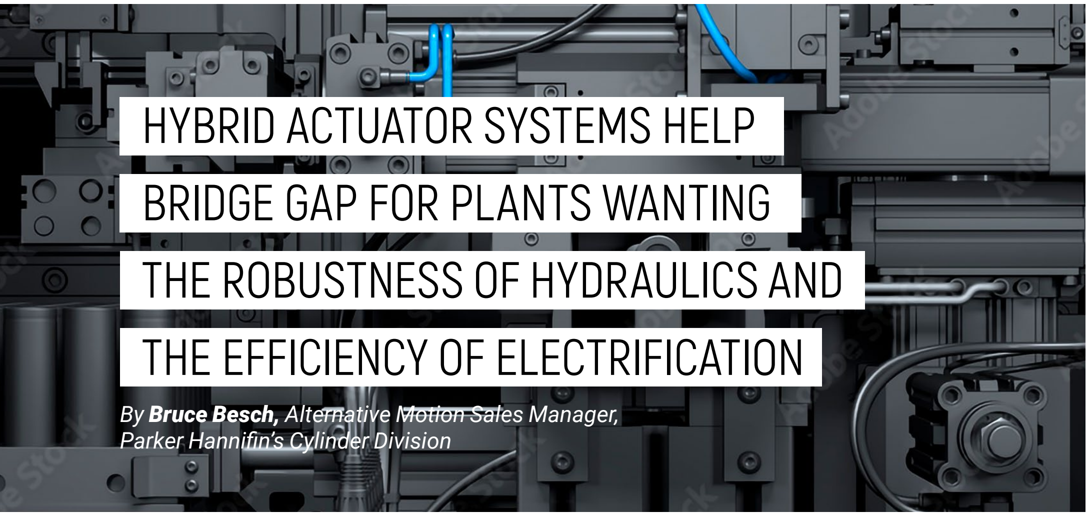

HYBRID ACTUATOR SYSTEMS HELP BRIDGE GAP FOR PLANTS WANTING THE ROBUSTNESS OF HYDRAULICS AND THE EFFICIENCY OF ELECTRIFICATION

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Traditional hydraulic systems have been the norm in most plants for decades. With the push to electrify and leverage greener solutions, machine builders have been exploring alternatives that combine these benefits. While it's unlikely that manufacturing will be only electric, innovative hybrid options exist that are highly efficient, affordable, and robust.

THE HYDRAULIC APPROACH

There's a reason that hydraulic systems have been around for so long. They represent a robust, reliable, and proven solution. They are controlled by a central power unit consisting of an induction motor, hydraulic pump, and valves to control direction, speed, and pressure. The fluid in the systems provides continuous lubrication and separates contaminants from moving parts, creating a self-cleaning, self-lubricating design. The fluid also provides dampening benefits to resist vibration and tolerate shock. The greatest benefit of hydraulics, however, is its power density. This is measured by its power-to-weight ratio.

Traditional systems do have limitations. First, there are components in the system that must synchronize to achieve motion. When one component fails, it takes time to identify a failed component, and it takes the skill of an experienced hydraulics technician to fix the problem. In this era of many seasoned technicians retiring, responsibility often falls on less-experienced professionals who may not possess the knowledge needed to diagnose and remedy the problem. In addition, consolidated valve configurations in hydraulic systems create pressure loss, which consumes energy and creates heat, thus requiring the addition of a heat exchange. This makes for an inefficient design. Adding to the inefficiency is the fact that a central hydraulic system must continuously operate, whether all functions are working or not.

Another serious concern is the potential for fluid leaks. Although hydraulics have a long-standing history of reliability, there remains the potential for fluid leaks. With numerous components requiring multiple connections, the risk of leaks is amplified. Additionally, the size of the system is another downside. Since it runs on centralized power, it requires a large motor, reservoir, and valving, taking up valuable machine space.

THE RISE OF ELECTROMECHANICAL ACTUATORS AND THEIR LIMITATIONS

Electromechanical solutions have been gaining ground in many applications due to their plug-and-play simplicity. Electromechanical actuators are typically fitted with permanent magnet alternating current (PMAC) motors. These motors have a high power-to-weight ratio and a high dynamic response. They allow for quick acceleration and can operate at a wide range of speeds, thus allowing for on-demand operation.

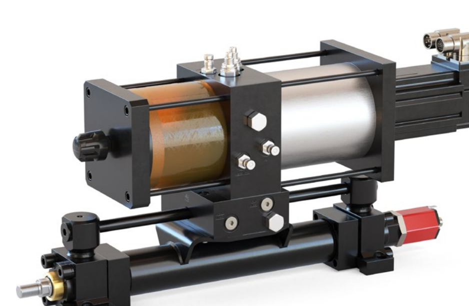
A screw drive is typically a ball screw or planetary roller screw with a lead that determines the travel per revolution. This serves as the prime mover. By controlling the screw speed (RPM), it's possible to control the speed of the electromechanical actuator by varying the motor speed with a frequency converter. Since torque on the screw results in thrust, the same controller can limit amps to the motor. This restricts the motor torque passed to the screw, thus limiting the EMA thrust.

The motor runs only when power is needed, saving energy in comparison with traditional hydraulic solutions in which the motor runs continuously. Additionally, electromechanical solutions are generally quieter, and their all-in-one modular design minimizes downtime since the entire actuator can be replaced for servicing. Despite these benefits, electromechanical actuators have a comparatively short service life and, on average, are three times the size of their hydraulic counterparts, which means more floor space. Because the systems are very rigid, they do not handle shock well. Any impact loading is passed from the nut to the screw, which means upsizing is required to handle any shock loading. Furthermore, they add a layer of complexity in programming, and cost per axis can be significant when compared to hydraulics.

THE PROMISE OF HYBRID ACTUATOR SYSTEMS

Given the shortfalls of both hydraulic and electromechanical systems, engineers have been focusing on ways to design a system that combines the benefits of both approaches without bringing along any inherent weaknesses. Doing so has opened the door to hybrid actuation systems that provide the desired speed and torque control with greater efficiency. This includes up to 80% energy savings and up to 90% space savings.

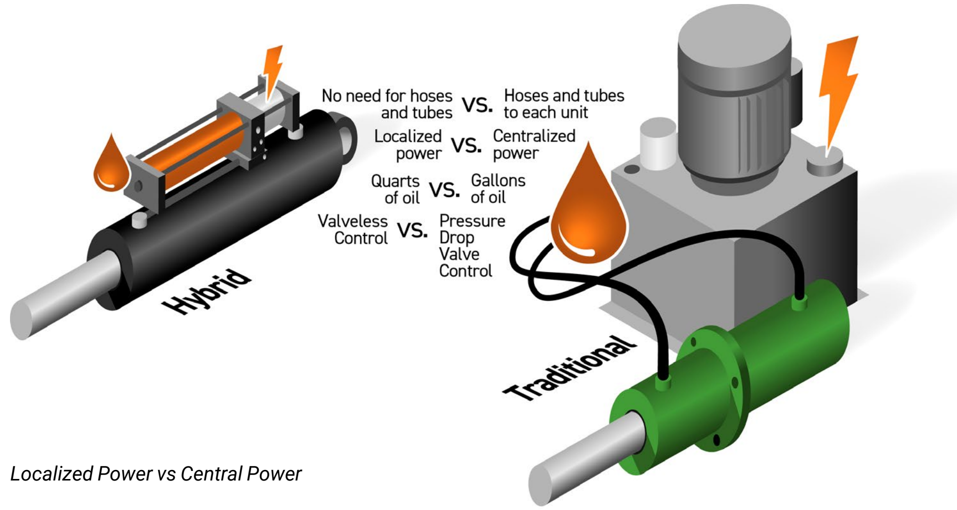
Hybrid actuator systems are self-contained linear actuation systems that bring electrification and efficiency to where the work needs to be performed. This type of localized power optimizes energy consumption, increases machine performance, and reduces downtime. They look and feel like an electrical actuator yet have the power density and failsafe characteristics associated with traditional hydraulics. Hybrid actuator systems use many of the same concepts of an electromechanical system, but these systems turn a pump rather than turning a screw, using fluid transmission to move the actuator. With hybrid actuator solutions, the direction is controlled by changing the direction of the motor, speed is controlled by regulating the pump's RPM, and thrust is managed by controlling motor torque.



The Hybrid Actuator System consolidates the entire hydraulic system into a single component integral to the actuator with all the controllability of electromechanical plus the fail-safe features and power density of a traditional hydraulic cylinder.

The result serves as an OEM machine design game-changer. This innovative approach allows engineers to strategically place actuators in locations previously deemed impractical or impossible due to electromechanical size constraints. Utilizing this method, designers can optimize machine layouts, enhancing performance and efficiency while reducing the overall footprint. This implementation of node-based hydraulics facilitates machine diagnostics and operational learning, which maximizes uptime. If maintenance is needed, the entire system can be replaced; this reduces downtime to only a few minutes. Additional advantages over a hydraulic and electromechanical approach include:

- **Easier Maintenance:** An all-in-one design creates a type of plug-and-play actuator that facilitates troubleshooting and is easy to install and set up.
- **Superior Power in a Smaller Footprint:** Since the actuator is hydraulic, it delivers three times the power density of a comparably sized electromechanical solution.
- **Easy to Install and Control:** Hybrid systems provide the desired control and accuracy without the use of valves.
- **Energy Savings:** This approach reduces pressure loss and significantly lowers wasteful energy consumption.
- **Quieter Operation:** Power On-Demand shortens the system's activation time, thereby reducing machine harmonics. Additionally, incorporating proportional control without relying on valves mitigates the "bang-bang" behavior commonly associated with traditional solenoid valves.
- **Reduced Leak Points:** A self-sealed design and fewer components means there are fewer potential leak points.
- **Reduced Oil Reservoir Volumes:** The size of these reservoirs is only a fraction of the size of those found in traditional hydraulic systems. These typically require less than a gallon of fluid.
- **Longer Service Life:** Environmental contamination is not a concern because of a sealed reservoir, which allows it to function in dirty environments. These systems offer up to 8,000 hours of maintenance-free operation.
- **Greater Shock and Vibration Resistance:** The fluid used is slightly compressible, so it can dampen any shock or vibration. This makes it ideal for heavy-duty applications that are too rugged for rigid electromechanical systems to handle.
- **Superior Connectivity:** The serial bus/network is able to provide health and performance feedback. The potential exists to monitor direction, speed, and thrust. Machine operating thresholds for scheduled maintenance and actuator replacement may also be assessed.



Localized Power vs Central Power

CONCLUSION

Hybrid actuation systems leverage the best of hydraulic and electromechanical solutions. They are quickly gaining popularity in mobile and industrial applications that require the power, toughness, and resiliency of hydraulics in a smaller, smarter, and greener package. The improvements in safety and productivity made possible by advances in IoT connectivity are expected to transform numerous industries and operations dependent on linear motion. ●