TECHNOLOGY TASK FORCE

Museum T-Rexroth Exhibit Shows the Future of Decentralized Hydraulic System Architectures

As defined in NFPA's technology roadmaps, there are several machine-level technology trends that are actively shaping the future of the fluid power industry. One such area of development is exploring new system architectures, especially to improve the capabilities of controls, energy, noise reduction, reliability, power and safety.

The Fluid Power Forum is a leading industry podcast that features discussions on interesting and innovative applications of hydraulics and pneumatics. In August 2026, Jim Diehl and Chris Parisse from Bosch Rexroth US joined the Fluid Power Forum – a giant in the fluid power industry, Bosch Rexroth produces a vast range of products for both hydraulic and factory automation motion control system solutions. Jim and Chris discussed how they had recreated a giant of their own. In 2023, they collaborated with the Da Vinci Science Center, a science-focused museum in Allentown, PA, to revitalize a popular exhibit they had contributed to years ago: the hydraulic animatronic T-Rex dinosaur in their "Science in the Making" exhibit.

While it was developed as a fun, hands-on learning experience for children, the 8-foot animatronic dinosaur (affectionately nicknamed "T-Rexroth") also offers a compelling demonstration of how fluid power innovation can translate into practical system design. At the center of its movement is a **decentralized drive solution** for hydraulic circuits. This type of architecture is increasingly used in mobile machine applications to improve control, efficiency, packaging, and responsiveness. In the Da Vinci Science Center's stationary exhibit, Bosch Rexroth applies the same concept in a highly visible way, combining localized hydraulic power with **advanced sensors and controls** to make each axis of motion precise, interactive and easier to understand. The result is more than a memorable museum attraction; it is a real-world example of how decentralized hydraulic systems can make complex motion quieter, more compact, more maintainable and more intuitive for users.

What makes the new dinosaur's architecture a unique application of hydraulics?

It has multiple independent axes which can be either self-controlled, such as when there's no one interacting with it, or controlled by an operator such as when the children play with it. One of the axes lets T-Rexroth "rear" upwards and appear larger than life as it gets taller and taller in front of the visitor. This is a reincarnation of the previous dinosaur exhibit, which Bosch Rexroth had contributed to decades ago, and had demonstrated their capabilities at the time. The original exhibit used a gear pump and servo valves with a PLC that was common to the fluid power industry 30 years ago.

When the Da Vinci Center planned its move to a new state-of-the-art facility, it asked Bosch Rexroth to build a modernized dinosaur exhibit that reflected visitors' deep affection for the original. The team responded with a fresh, engaging design built around a decentralized hydraulic system, which helps control T-Rexroth's movements in a quieter, more compact and reliable way. As the team explained, the project began with a clear set of museum-specific requirements: the exhibit had to be quiet enough not to distract visitors, compact enough to fit within the available space, simple enough for museum staff to maintain (especially as there are no hydraulic experts on site), easy to understand without lengthy explanations, and visually appealing as both an exhibit and a promotional feature for the museum. The combination of challenges for design also needed to align with the end goal of creating a fun, interactive experience for children to engage with, and the decentralized system proved the best way to make that possible.

T-Rexroth's decentralized hydraulic architecture is organized around four separate axes of motion, each with its own power and actuation elements. This setup lets visitors see how individual functions work together to create coordinated movement. To make the technology easy to follow, the exhibit uses color-coded flow paths, body-panel cutouts and integrated lighting to show which components are active. For example, when a visitor moved the yellow joystick, a matching yellow section in the bell housing lights up to reveal the rotating coupling while another illuminated cutout shows the yellow hydraulic cylinder extending. As the dinosaur moves, visitors can watch the motors speed up and change direction of rotation in real time, connecting each control input to the motion it creates.

Sound also plays an important role in the experience. Bosch Rexroth's CytroPac technology, which combines the reservoir and charge pump system, helps keep the overall system extremely quiet, allowing conversation from around the Da Vinci Center to be heard while operating. At the same time, each axis produces a subtle sound that changes with the speed of the motion, adding another sensory cue without overwhelming the exhibit. Even the control panel components can be seen through a window and visitors can see them operating and flashing in tandem with the dinosaur's motions. Overall, this exhibit creates a powerful yet quiet system of various parts working together with visibility and educational qualities.

CytroPac Hydraulic Power Unit

(Source: Bosch Rexroth US)

A key part of the design is Bosch Rexroth's CytroPac hydraulic power unit. To meet the museum's

requirements, the team needed a source of hydraulic flow that was both compact and extremely quiet. CytroPac meets that need because it is a ready-to-use hydraulic power unit with an integrated variable-speed drive, allowing it to deliver power only when needed. That made it possible to incorporate the power unit into the decentralized architecture, with each axis of the dinosaur driven by its own independent motor-pump group. The result is a compact, quiet system that gives visitors a visible example of Bosch Rexroth's latest hydraulic technology.

How do controls play a special role in the dinosaur's system architecture?

According to the Bosch Rexroth team, the controls architecture is what makes T-Rexroth truly come to life. Developed in collaboration with several companies, the system uses a hydraulic motion controller to manage the speed and position of each cylinder. This allows each function to operate independently while creating coordinated, lifelike movement, including the dinosaur's jaw motion. Initially, visitors used joysticks to control each axis, while a programmable circuit lets the dinosaur run on its own when no one is interacting with it. In idle mode, there are several pre-programmed motion profiles which are engaged at random; when visitors step up to the controls, they can immediately take charge. The dinosaur was a hit even before it reached the museum - while it was being built on the Bosch Rexroth shop floor, employees such as pipe fitters and electricians often stopped by to test its functionality. After the exhibit was installed in 2023, the engineering team quickly learned that a museum environment creates maintenance demands unlike those of a typical hydraulics application. The joystick controls supplied by an external vendor were quickly replaced by buttons to meet the rigorous demands of a museum environment.

Controls Table for T-Rexroth at the Da Vinci Science Center Museum

(Source: Bosch Rexroth US)

Beyond a few hands-on repairs, however, the dinosaur's online maintenance-monitoring system gives Bosch Rexroth a much clearer view into system health. Built around the CytroPac, Ctrlx servo drives, and connected controls, the system allows the team to track data such as hydraulic pressure, temperature, cylinder strokes per minute, and fluid cleanliness through the PLC. A remote monitoring display at Bosch Rexroth provides real-time status information, helping engineers identify issues sooner, troubleshoot more efficiently and determine when an on-site visit is truly needed. Because the decentralized architecture uses a simpler layout with each motor-pump group tied directly to its own axis, there are also fewer connection points and fewer

potential failure points to monitor. For the museum, that means easier upkeep and more reliable operation; for visitors and industry audiences, T-Rexroth becomes more than an engaging exhibit. It serves as a practical case study in how advanced controls, online monitoring and decentralized hydraulics can work together to improve maintainability, reliability and system visibility.

What can the fluid power industry learn most from the T-Rexroth exhibit?

Per the Bosch Rexroth team, the real-world applications that closely align with T-Rexroth's decentralized hydraulic architecture are found in pressing and testing markets. In pressing applications, customers often need machines to accelerate very quickly, then decelerate and hold a precise position for an extended press-and-cure cycle. Because a decentralized system can deliver speed and force only where and when they are needed, it can maintain that position with less fluid flow, reduced noise and improved energy efficiency. Testing applications benefit in a similar way, especially when they require fast, rigorous and repeatable motion. In both markets, decentralized technology stands out because it places power-unit components closer to the actuators and rotates only as much as the application requires, creating a quieter, more energy-efficient and space-saving system.

More broadly, the T-Rexroth exhibit shows how hydraulic systems can continue to evolve through modernization, miniaturization and smarter control. By taking advantage of advances in electromechanical components, variable-speed drives, servo drives and integrated controls, customers can build hydraulic systems that are more compact, more energy-efficient and better connected to digital information. These technologies make it possible to control pressure, speed and position with greater precision and repeatability while also providing more insight into machine performance. For the fluid power industry, that combination of power density, reliability, controllability and digital visibility points to a strong future for distributed hydraulic architectures. It also reinforces hydraulics' continued relevance as machines move further into a more connected and data-driven age.

Watch this video to see T-Rexroth in action!

(Source: Bosch Rexroth US)

Want to Know More?

Listen to NFPA's Fluid Power Forum podcast episode **"Quiet Power, Big Motion: Engineering the Da Vinci Center Dinosaur"** featuring Jim Diehl and Chris Parisse from Bosch Rexroth!

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