



Customizing motion control solutions for high-load, high-speed automotive and robotics applications

Ensuring reliability and performance in harsh manufacturing environments

Automotive awareness white paper



The road ahead: The shifting automotive landscape

The automotive industry has entered a transformative era defined by rapid innovation, shifting consumer demands and unpredictable market forces. Ten years ago, the question was “gas, hybrid or electric?” Now the landscape is in flux—electric vehicle (EV) manufacturing experienced a 20% global increase from 2023 to 2024.ⁱ

EV manufacturing requires motion systems capable of handling lightweight materials and delivering unmatched precision. But the demand for greater battery capacity continues to rise with renewed interest in PHEVs and hybrid vehicles and sustainable, energy-efficient solutions. Battery electric vehicles are likely to grow by 20% or more in 2025, according to Tech Insights.ⁱⁱ

An increased interest in autonomous vehicles and the software-defined vehicle have forced automakers to invest significantly in design changes to integrate advanced electrical and electronic architectures into vehicles. And a growing appetite for personalized features presents new opportunities—but only for manufacturers agile enough to meet this demand.

At the same time, external forces continue to reshape the industry. Factors such as inventory volatility, political shifts affecting EV incentives and rising tariffs on overseas components only compound the complexity.

How harsh environments impact manufacturing quality

Harsh environments can have an adverse effect on manufacturing. Extreme temperatures, dirt, vibration or other conditions inside a plant can impact the quality of assembled products, especially when comprised of components not engineered to compensate.

Temperature

While technically indoors, automotive assembly plants are not sheltered from the effects of the environment. One study found a week with six or more days of weather exceeding 90°F (32°C) reduces automobile production by 8% on average.ⁱⁱⁱ Temperatures at automotive test sites can drop as much as 68°F in three to five seconds,^{iv} making it challenging to use components that behave unpredictably.

Contamination

Dust, oils and moisture can also accelerate wear and corrosion in motion control components. Killer particles—contaminants that attach to the surface of a metal component—may have detrimental effects on the quality of the surface. These particles may spread to uncoated surfaces from workers’ hands or surfaces that workers place the parts on, especially if the parts are wet.^v

Vibration

Robotic arms and high-speed machines can also create high vibration loads which may lead to component misalignment or reduced precision. In addition, high vibration loads can decrease the durability of machinery, especially when not specifically designed to counteract the effect of vibration.^{vi}

These challenges are in addition to the typical challenges of harsh environmental conditions which may reduce accuracy or increase damage to susceptible components. Robotics components must withstand corrosion, heat and wear.

Mitigate these issues to prevent performance degradation and downtime. Invest in expert design which considers these challenges and well-manufactured components built to minimize the effect of dust, vibration and temperature fluctuations on accuracy and alignment.

i. Autodesk. (2024). [Driving the future: 10 automotive industry trends and predictions.](#)

ii. Tech Insights. (2025). [Tech Insights Analysis: Five Key Trends for Automotive in 2025](#)

iii. The Wharton School. (2012). [Severe Weather and Automobile Assembly Productivity.](#)

iv. MPS. [Accurate and Precise Automotive Extreme Temperature Testing.](#)

v. SPC Surface Treatment Experts. [IMPACT OF KILLER PARTICLES IN AUTOMOTIVE MANUFACTURING & FINISHING.](#)

vi. Countervail. (2019). [INCREASING LONGEVITY OF VEHICLE COMPONENTS THROUGH VIBRATION CANCELING.](#)

How custom engineering reduces potential damage

Custom engineering can also mitigate the effects of extreme environmental pressures and improve reliability. IMI has the experience to understand how different materials perform and can use this understanding to create more reliable components. For example, surface applications that resist corrosion and other chemical damage, composites with a compatible coefficient of expansion to allow for better seals between glass and metal, or materials with a very low coefficient of thermal expansion (CTE) for high-precision applications. Other examples of custom engineering include:

Specialized enclosures

IMI experts can help your engineers with designs that include custom enclosures with moisture resistance and ingress protection to keep liquids and dust from sensitive electronics.

Designs created to seamlessly integrate in your system with a precise fit also allow for reduced weight, volume or cost. When temperature-regulated, humidity controlled clean rooms are not feasible, investing in robust motion control systems minimizes the risk.

Protective coatings

Elastomeric coatings protect components from various environmental factors, including extreme temperatures, UV exposure and chemical exposure, preventing cracking and damage from repeated movement.

Key takeaway

Investing in robust motion control systems minimizes downtime, ensures durability and maintains precision in challenging environments.

Best practices for reliable motion control in harsh environments

Expert component manufacturers such as IMI have strategies for maintaining reliability in extreme conditions. These can involve materials and sealings, design or maintenance. As Industry 4.0 expands the scope of process automation, corrosive environments that have previously been poor candidates for automation are now coming into the fold.^{viii}

viii. Plant Services. (2024). How corrosion affects electric actuators, and what you can do to prevent it.

Materials and coatings

The first strategy is to use durable materials built for extreme conditions. Using stainless steel, nickel plating and advanced polymers resist corrosion and wear. For example, IMI supplies corrosion-resistant pneumatic cylinders engineered for oily, high-temperature environments.^{viii}

Advanced sealing and protective coatings are the second strategy, such as actuators designed with advanced sealing for automotive applications. Incorporating IP67-rated enclosures prevents contamination by dust and moisture.

Design engineering

In the previous section, we touched on the special requirements of high-load, high-speed motion-control systems. High speed high-load applications call for precision designs. Maintaining tight tolerances ensures repeatability and accuracy. For example, IMI’s proportional valves for robotic paint booths provide dynamic airflow control.

An often-overlooked advantage of custom-engineered components becomes evident during maintenance or repairs. By incorporating designs that allow for quick and efficient disassembly, these components reduce downtime and streamline the repair process, ensuring operations resume with minimal disruption. For example, the IMI Norgren Excelon® Plus air preparation series features a Quikclamp system that simplifies component replacement during service and repairs.

Predictive maintenance

Appropriate materials design and precision engineering reduce the frequency of repairs, but even the best-engineered machine will eventually need maintenance. Predictive maintenance and condition monitoring allows manufacturers to minimize the potential disruption of downtime caused by unexpected failures.

Studies reveal that predictive maintenance solutions enable cost savings of up to 40% over reactive maintenance and 8% to 12% over preventive maintenance. Additionally, predictive maintenance can decrease equipment downtime by up to 50% while increasing machine lifespan by 20%^{ix} One strategy is incorporating industrial Internet of things (IIoT) sensors which can monitor wear and performance in real-time. For example, IMI provides feedback-enabled pneumatic systems which trigger maintenance alerts.

In a PwC report, 51% of survey respondents cited asset uptime as the main driver of their interest in investing in advanced predictive maintenance.^x

When selecting components for a new manufacturing machine, long-term maintenance and repair costs might not be top of mind. IMI prioritizes these considerations, delivering solutions designed to minimize downtime and reduce costs over the machine’s lifecycle—providing manufacturers with lasting value and peace of mind.

The high cost of downtime

Unplanned maintenance from poor quality components leads to significant costs. For example, overheated seals in actuators often require frequent replacements. Replacing these actuators involves several steps, which can take anywhere from 30 minutes to several hours. The cost of this downtime can be as much as **\$2.3 million per hour** in the automotive sector.^{xi}

Key takeaway
Best practices including advanced materials, predictive maintenance and modular designs improve reliability and uptime in harsh manufacturing conditions.

viii. <https://www.norgren.com/en-us/products/actuators/stainless-steel-cylinders>

ix. Infosys BPM. Revolutionising efficiency: The power of predictive maintenance in manufacturing.
x. PwC. (2018). Predictive Maintenance 4.0 Beyond the hype: PdM 4.0 delivers results.
xi. Siemens. (2024). The True Cost of Downtime.

Reliable motion control in action

Here are some potential scenarios which IMI can address by offering custom components.

Use case 1:
Robotic welding in automotive manufacturing

Challenge: Frequent failures due to heat and dust

Solution: Actuators with high temperature ratings reduce maintenance

High temperature conditions can degrade actuator components similarly by affecting sealing materials, leading to reduced mechanical reliability and precision. In industrial automation, compromised seals may allow contaminants or dust ingress, affecting actuator performance and longevity. For pneumatic and electric actuators used in robotic and material handling systems, damaged seals can reduce force output or cause premature wear, impacting cycle accuracy and machine uptime.

Investing in high-quality actuators designed for industrial automation environments ensures durability and consistent performance under demanding operational cycles. Advanced sealing and robust construction minimize maintenance needs, enabling actuators to achieve continuous duty cycles and reliable operation for hundreds of thousands of cycles, critical for high-throughput robotic and assembly applications.^{xiv}

Use case 2:
Hot forming gripper meets challenge of extreme operating environments

Challenge: Extreme heat damages standard transfer grippers

Solution: Gripper package eliminates common failure points

Automotive stampers need to produce hot formed parts to increase structural strength while keeping vehicles lightweight. Standard transfer grippers fared poorly with this increased exposure to extreme high temperatures. The customer needed grippers that could operate consistently at 1112°F. They also wanted sensors that could confirm the grippers were holding a blank and detect double blanks. And they wanted to integrate the new grippers into existing hot forming transfer systems.

IMI Precision Engineering created a gripper package that exceeds customer requirements. The hot metal gripper and sensor is designed for temperatures up to 1652°F. It can be supplied with a sensor on top for part sensing or double blank sensing. The gripper is capable of 450 pounds grip force, the highest force available for any gripper this size. And with all the pneumatics, fittings, airlines and electric cables in a package on the rear of the gripper or in steel tubes and heat sleeves, the system eliminates failure points common to most other hot forming transfer systems

Use case 3:
Compact valve module frees valuable under-dash space in truck cabs

Challenge: Long pneumatic tubing consumed precious space and increased risk of leaks

Solution: Air Solenoid Accessory Pack (ASAP)

A truck cab is a command center for multiple operations, many of which are critical for safety, but having individual valves in the dashboard for each air-driven accessory lift axle, air horn, suspension dump etc. takes up too much under-dash space and makes air leaks difficult and expensive to service. One the truck manufacturer contracted with IMI to create a more reliable system that was simple to install and adaptable to various chassis configurations.

IMI Precision Engineering integrated heavy-duty truck valves into a flexible stack that can be mounted on the chassis near the applications they power instead of under the dash. The ASAP connects to dashboard-mounted switches via the standard electrical harness. This integrated system reduces tubing and eliminates under-dash leaks, and the valve sequence can be configured to fit any truck’s accessory options. Push-in fittings colored to match accessory tubing simplifies installation. Most important, better visibility and a more spacious, comfortable cab improves driver safety.

Key takeaway
Customized motion control systems enhance reliability, reduce downtime and improve quality.

xii. Valworx. [Temperature Effects on Actuated Valves](#).

xii. IMI. (2016). [Hot forming gripper meets challenge of extreme operating environments](#)

xiii. Plant Services. (2024). [How corrosion affects electric actuators, and what you can do to prevent it](#)

xiv. Machinery Lubrication. [Vibration: The Cause or Effect of Machine Failure](#).

xv. Big Daishowa. [Your Ultimate Guide to Reduce Vibration in Machining](#).

xvii. Rheonics. [Automotive painting and coating quality control and optimization](#).

xviii. Rowse Pneumatics. (2021). [Compressed Air in the Automotive Industry](#)

xix. IMI. (2015). [Compact valve module frees valuable under-dash space in truck cabs](#)





Solutions tough enough for automotive manufacturing

Partnering with industry experts in motion control systems is key to maintaining the strictest compliance standards despite the harsh environmental conditions of auto plants. By leveraging tailored solutions that combine speed, reliability, compliance and flexibility, OEMs and manufacturers can stay ahead of market demands while ensuring efficiency and sustainability.

Need a custom solution capable of handling rigorous conditions?

→ Talk to Us



About IMI for robotics and automotive

IMI is a unified company comprised of three well known and well-trusted names in the manufacturing industry: Norgren, Bimba and Bahr. Under this combined umbrella, manufacturers can gain the components they need, backed by more than 150 years of collective experience.