KOLLMORGEN
A REGAL REXNORD BRAND

WHITE PAPER

Compliant Robotic Tooling Mitigates Risk and Delivers a Human Touch in Finishing Operations

Many dimension-driven manufacturing processes require force-controlled blending or finishing operations. These operations have typically been performed by human operators who can offer the compliance required for subtle grinding, deburring or polishing. But there are inherent risks to the workers who perform these operations, as well as a safer alternative.

Manual finishing operations are not only strenuous, but also repetitive and prone to operator injury. The environment is dirty, dangerous, and puts human operators in direct contact with hazardous metallic dust and continuous sparking. Many manufacturers find it difficult to recruit and place new workers in these tedious, potentially harmful tasks.

To preserve their workers' health while maintaining productivity, manufacturers are automating finishing operations with compliant end-of-arm robotic tooling that continuously applies pressure against the work piece. Such compliant robotic tooling usually requires a motor to drive a deburring, grinding or polishing tool. It is essential to minimize the weight of the end-of-arm tooling to provide the quick dynamic robotic response required to achieve high productivity and product quality.

PushCorp Inc. further increased the performance of their servo-driven, end-of-arm tooling product lines by using Kollmorgen frameless servomotors that deliver up to 5 horsepower in a package about the size of a "can of soup." This unique, extraordinary power density enables PushCorp to build tooling that can deliver the high performance demanded by industrial users to improve operator safety, productivity and quality.

The PushCorp motor is an application-optimized version from the Kollmorgen family of standard KBM™ Frameless Motors

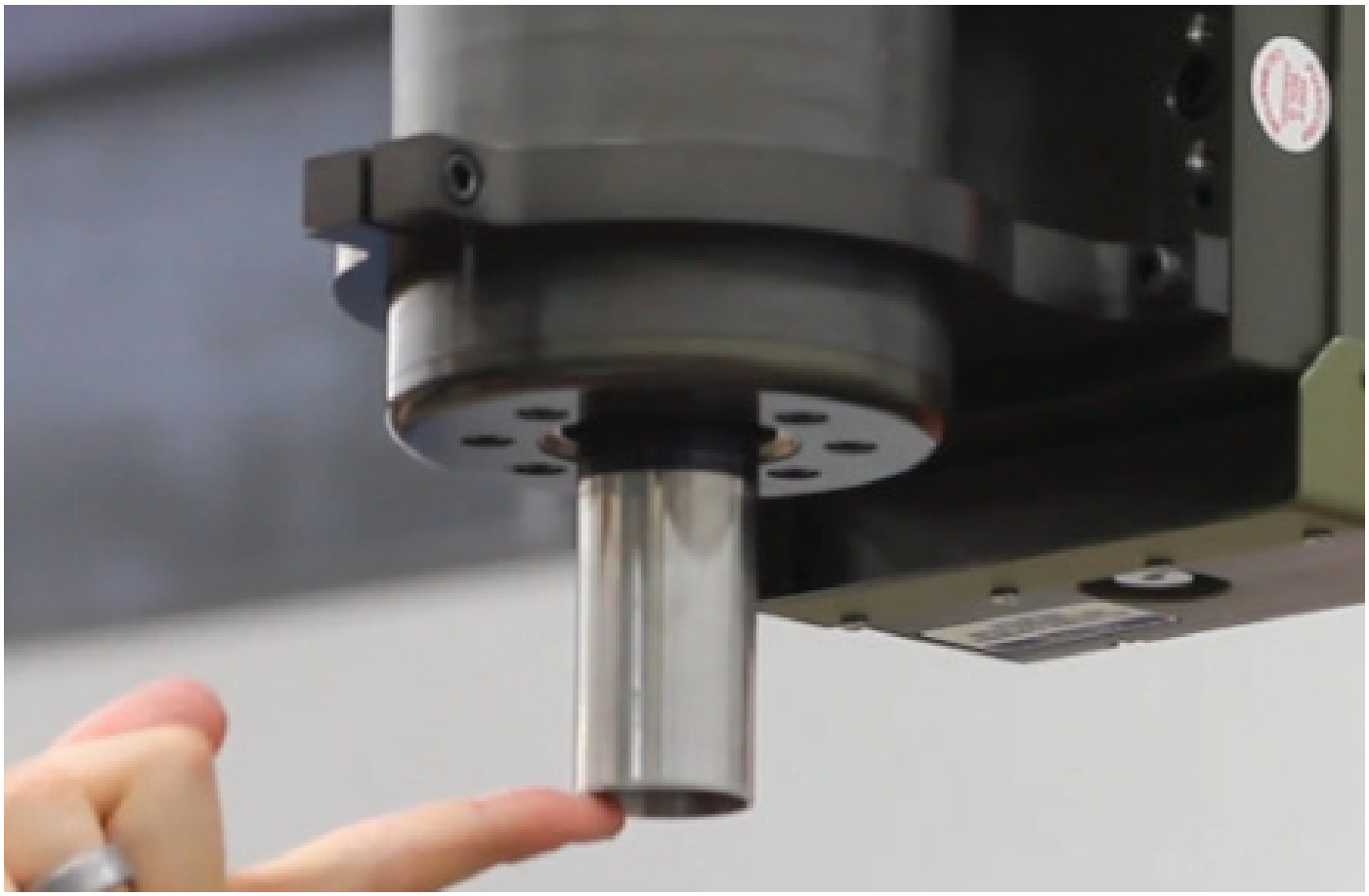
FORCE-COMPLIANT FINISHING CHALLENGES

Parts are typically brought to a net dimensional shape by machining, casting, forging, molding and similar manufacturing processes. These parts often meet specifications but require additional processing to achieve the required surface finish. Tool marks and scallops need to be removed from machined parts. Parts produced by injection molding, casting and forging require the removal of flashing, gates and parting lines. These finishing operations require a force-controlled process, a type of compliance not offered by rigid, position-based machine tools, so they are nearly always performed by operators holding power-driven tooling and using the human touch to provide just the right amount of force. But the weight of the tooling and the need to maneuver into "nooks and crannies" to fully finish the part makes these operations very difficult for a human operator. For example, a supplier of cast aluminum automotive wheels previously had several hundred workers manually polishing the wheels using power sanders. The company experienced worker injuries, high turnover, low productivity, high training costs and quality issues as a result.

The leading solution to automate these operations uses the robot arm for positioning and motion control and the end-of-arm tooling to provide the compliance needed for automated surface finishing. Mounting the force control device to the robot wrist requires special consideration due to the changing axis of compliance. The weight of tooling, media, and carriage always acts in a vertical direction downward while the compliance axis of motion, on the other hand, continuously changes as the robot moves through space. The actuator force must be increased or reduced depending on the direction in which gravitational force is acting relative to the compliance axis.

PushCorp's force control device allows the robot to maintain a consistent yet adjustable force when in contact with the part's surface. It emulates the 'human touch' required for delicate grinding and polishing by applying constant force for consistency and precision.

In addition, its range of force (.2 - 250 lbf) provides exacting compliance for sanding, grinding, polishing and many other material removal applications.

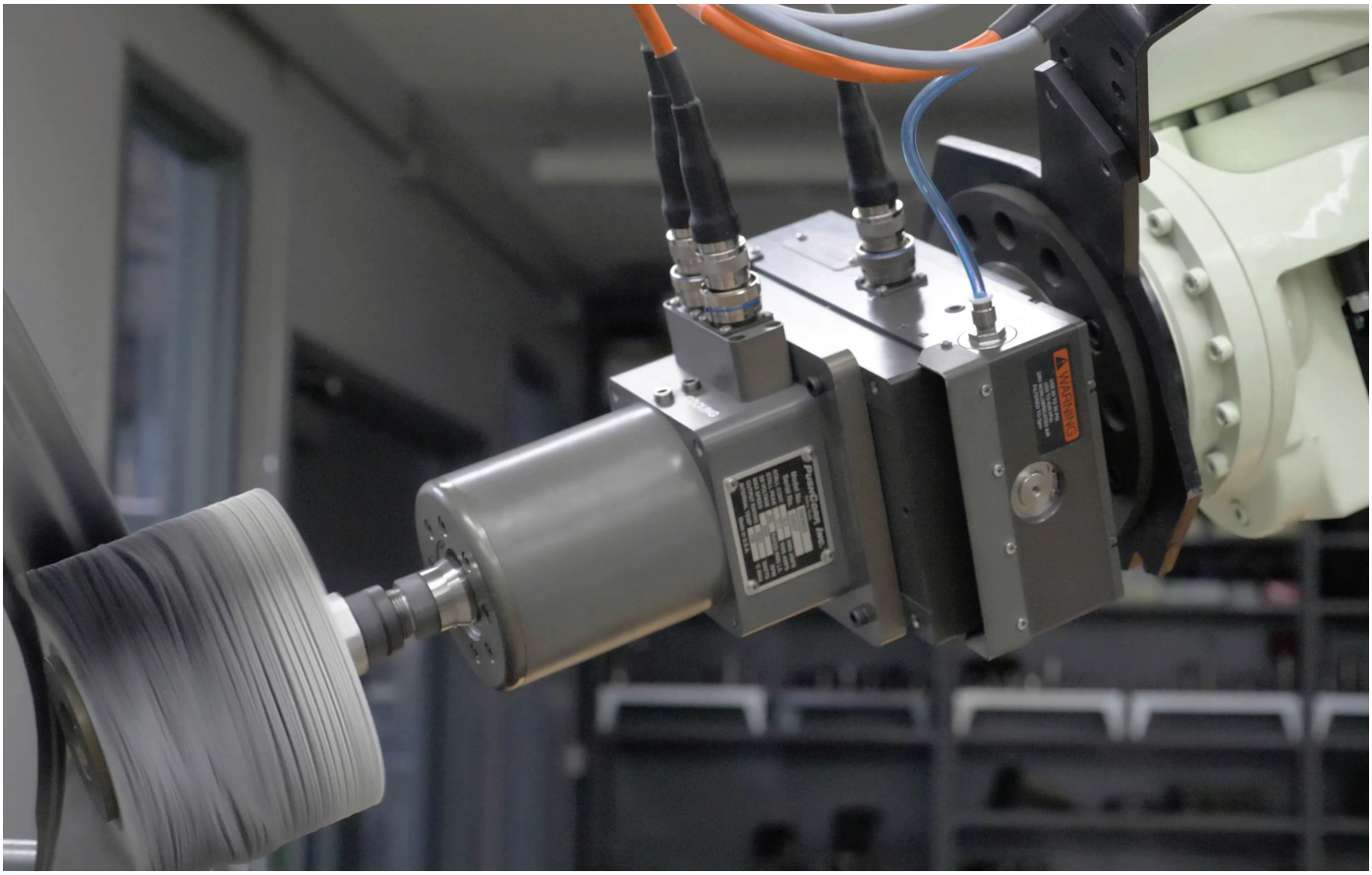


NEED FOR POWER DENSE MOTOR DESIGNS

PushCorp is a leader in the field of developing custom force-compliant end-of-arm tooling for a wide range of blending and finishing applications. This tooling demands very power-dense motor designs because the performance of the robot depends on the size and weight of the end-of-arm tooling. PushCorp uses frameless direct-drive motor systems comprised of a separate rotor and stator part set. These components are intended as a kit to be designed into and become a direct part of PushCorp tools.

As PushCorp expanded the penetration of its products into larger companies it found that many of its customers want to run its servo motors on 480 VAC supply that are commonly found in these plants. But the drives used to power its earlier generation of frameless motors could not support voltages this high so the company's customers were forced to install a step-down transformer which added cost, floor space and complexity to the solution. PushCorp consulted with Kollmorgen to see if a solution could be developed to address its customers' higher supply voltage needs. After detailed engineering discussions, Kollmorgen confirmed that it could provide an optimized frameless motor solution that operates at 480 VAC and exceed the existing tool performance.

PushCorp engineers developed their latest spindle, the SM1202 (12,000 RPM 2 hp) Series High-Speed Robotic Servo Spindle in order to fill a need in the market for smaller, lightweight spindles. This spindle was designed with "lighter-duty" applications in mind, such as aluminum weld grinding, light duty plastic and wood routing, and sanding for a myriad of materials. However, like the spindles before it, the importance of power density was top of mind during the design phase and resulted in a powerful compact spindle that punches above its weight. Kollmorgen engineers created the 12,000 RPM design as well as a 20,000 RPM version that PushCorp will release later in 2023. Both designs boast 8% cooler operating temperatures over previous models that make it possible for the PushCorp servo spindles to run at higher performance with increased reliability. Kollmorgen's integration of an optimized electro-magnetic design and proprietary insulation system enabled a longer product life in the 480 VAC application. PushCorp reports their customers have been running these SM1202 servo spindles for the last two years without experiencing motor issues.



WIDE RANGE OF SUCCESSFUL APPLICATIONS

PushCorp has used the family of Kollmorgen frameless servomotors in end-of-arm tooling that has successfully met the needs of a wide range of manufacturers. The auto supplier mentioned (from page one) that produces cast aluminum wheels uses PushCorp end-of-arm tooling to remove 100% of scratches and blemishes from visible surfaces prior to chrome plating. The tooling utilizes a tool changer to access several different media types required to handle all the complex surface features. The manufacturer currently has eight robots working 24/7 on this application which made it possible to move several hundred operators to less difficult and dangerous jobs.

This system includes a light-weight, high-power density Kollmorgen frameless motor in the servomotor toolchanger and when coupled to an active force compliant device it is able to blend and smooth the work surface quickly and precisely. The process requires several different media types to handle all the complex surface features. This is a high volume operation with eight robots working continuously.

Several automotive manufacturers (and counting) use PushCorp force control tools and servo tool changers with a stack of bristle brush abrasives (the latter using a Kollmorgen servomotor) to perform weld spatter removal on automotive body door openings. The work cells remove the weld spatter that is a result of the welding process. With precise force and speed control the weld spatter can be removed without damaging the parent material. These work cells have removed personnel from hazardous conditions and helped deliver improved quality, repeatability and throughput.

PushCorp also provides end-of-arm tooling driven by Kollmorgen frameless servomotors to process different types of metal enclosures such as ATM machines, safes, server room racks and electrical cabinets.

The ATM enclosure system, for example, blends weld beads and removes spatter from the steel surface. The ATM enclosure is placed on a rotary table to allow the robot easy access to all of the sheet metal seams. As the grinding media is worn out, the robot cycles to the tool rack to pick up a new toolholder with a fresh abrasive.

This automated system has replaced a very time-consuming, dangerous manual operation.

A major motorcycle manufacturer uses PushCorp tools that incorporate Kollmorgen servomotors for deburring, routing and finish sanding of saddlebags. The injection molded saddlebags are produced with flashing on the edges and rough flat surfaces. Right and left robotic cells deburr the edges and drill mounting holes before sanding the large surface areas with light grit media. The prep work is accomplished using a light-weight, high-power density Kollmorgen frameless motor in the servomotor toolchanger mounted on a PushCorp force compliance tool. The work cell uses hard carbide bits and a shaft mounted orbital sanding disk.

OPTIMIZED SERVOMOTOR TECHNOLOGY TO SOLVE DEMANDING INDUSTRIAL CHALLENGES

Sanding, deburring, grinding, and polishing of parts produced in highly automated machining, molding, casting and forging operations is frequently a time-consuming, high-cost, injury-prone manual operation. Automating these finishing operations with robots demands very power-dense motor designs to minimize the size and weight of end-of-arm tooling for peak robotic performance.

Kollmorgen has worked with PushCorp to optimize several different high torque servomotors for their end-of-arm tooling products. Kollmorgen's electro-magnetic design knowledge and high voltage insulation expertise enables PushCorp to build tooling that can perform at the highest productivity rates and reliability demanded by their industrial users.

CONCLUSION

A wide range of blending and finishing operations in the manufacturing process can be significantly optimized when they are automated with compliant end-of-arm robotic tooling which requires a motor to drive a deburring, grinding or polishing tool.

The manufacturing process now benefits from a range of operational advantages including:

- Safer, more productive working environments that don't require human exposure to harmful metallic dust and unsafe processes
- Precision force compliance via end-of-arm robotic tooling that features embedded software for path planning, seamless operation and a "human touch" when grinding or polishing
- Full range of force (.2 - 250 lbf) provides exacting compliance for sanding, grinding, polishing and many other material removal applications
- Optimized power density from a smaller, lightweight frameless motor

Real-customer applications demonstrate that machine builders can successfully increase the performance of their servo-driven, end-of-arm tooling product lines by using Kollmorgen frameless servomotors. These high-power density motors that deliver up to 5 horsepower in a package about the size of a "can of soup" and enable machine builders to deliver the performance demanded by industrial users to improve operator safety, productivity and quality.

READY TO MOVE FORWARD?

Contact Kollmorgen at www.kollmorgen.com/en-us/service-and-support/contact-us to discuss your needs and goals with a Kollmorgen expert for manufacturing applications.

About Kollmorgen

Kollmorgen has more than 100 years of motion experience, proven in the industry's highest-performing, most reliable motors, drives, linear actuators, AGV control solutions and automation platforms. We deliver breakthrough solutions that are unmatched in performance, reliability and ease of use, giving machine builders an irrefutable marketplace advantage.

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