



# Optimized Power-Dense Servomotor Technology Improves the Automation of Finishing Operations

**KOLLMORGEN**

Many dimension-driven manufacturing processes require force-controlled blending or finishing operations. These operations are normally performed by human operators because the human touch provides the compliance that is essential for these operations but is lacking in rigid position-based machine tools.

Manual finishing operations are not only strenuous, but also repetitive and prone to injury so manufacturers are looking into automating them with compliant end-of-arm robotic tooling that can hold a tool with a constant pressure against the work piece. 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 in order to provide the quick dynamic robotic response needed to achieve high productivity and quality.

[PushCorp Inc.](#) further increased the performance of their servo-driven, end-of-arm tooling product lines by using the new [Kollmorgen frameless servomotors](#) that deliver up to 5 horsepower in a package about the size of a “can of soup”. This unique 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. As a result, the company experienced worker injuries, high turnover, low productivity, high training costs and quality issues.

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.

Active force control uses a stand-alone controller to manage a closed-loop system and correct for any errors based on input from a load cell that continuously monitors the applied force. An accelerometer tracks the orientation angle of the compliance axis of compliance so that corrections can be made for the effects of gravity.

## 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 rotary systems comprised of a separate rotor and stator without bearings, housings, or feedback devices. These components are intended as a kit to be designed into and become a direct part of PushCorp tools.

The system operates as a closed loop servo with the load cell and accelerometer designed into the tooling. An electronic drive amplifier runs the motor and manages the feedback device.

As PushCorp expanded the penetration of its products into larger companies it found that many of its customers want to run its compliant end of arm tooling 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. The same motor and drive are backwards compatible to lower voltage levels so PushCorp can address all of its customers' requirements with a single motor and drive family.

PushCorp engineers brought up the importance of power density for liquid-cooled motors in their application and the need to improve performance from the previous generation of motors. Kollmorgen engineers developed a 5 horsepower, 6,000 rpm brushless DC servomotor that weighs only 6 pounds and is 3.2 inches in diameter and 4.6 inches in length. Kollmorgen also provides a 3 horsepower, 15,000 rpm motor with the same envelope for different finishing applications. These Kollmorgen motors provide higher power density, running a significant 8% cooler which makes it possible for the PushCorp tools 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 volt application. PushCorp reports their customers have been running their tools for the last two years without experiencing motor issues.

**Wide Range of Successful Applications**



*PushCorp Servo Toolchanger Integrating Kollmorgen Frameless Motor with Force Compliant Device in Robotic Polishing Workcell*

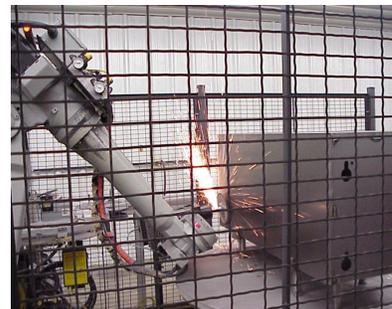
PushCorp has used the family of [Kollmorgen frameless servomotors](#) in end-of-arm tooling that has successfully met the needs of a wide range of manufacturers. The auto supplier mentioned (*from page one*) that produces cast aluminum wheels uses PushCorp end-of-arm tooling to remove 100% of scratches 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 24X7 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 precise. 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.

A Tier 1 automotive supplier uses PushCorp force control tools and servo tool changers with sanding drum, the latter using a [Kollmorgen servomotor](#), to perform edge finishing on sheet molded compound (SMC) automotive body panels. The work cell removes flashing from the edges of the panel and applies a radius for better paint adhesion. The work cell has 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 a company that produces steel enclosures for automated teller machines (ATMs).



*PushCorp Servo Toolchanger Integrating Kollmorgen Frameless Motor with Force Compliant Device in Robotic Grinding Workcell*

The system blends weld beads and removes splatter from the enclosure 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 automatic disc dispenser for a new pad. This automated system has replaced a very time consuming, dangerous manual operation.



*PushCorp Servo Toolchanger Integrating Kollmorgen Frameless Motor with Force Compliant Device in Robotic Finishing Workcell*

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.



*Diagram showing High-Speed Servo Tool Holder Model #1503-BT30 Integrating Kollmorgen Frameless Motor*

The PushCorp STC1503-BT30 High Speed Servo Toolholder is an ideal solution for heavy duty applications. The STC1503-BT30 has a powerful 3 horsepower (2.2 kW) [Kollmorgen frameless servomotor](#) and integral Toolholder to give the muscle, speed control and holding torque to perform many operations.

## 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 demanded by their industrial users.



*Rigidly Mounted High-Torque Servo Tool Holder Model #0605-BT30 Integrating Kollmorgen Frameless Motor*

The PushCorp STC0605-BT30 High Torque Servo Toolholder is an ideal solution for heavy duty applications. The STC0605-BT30 has a powerful 5 horsepower (3.8 kW) [Kollmorgen frameless servomotor](#) and integral Toolholder to give the muscle, speed control and holding torque to perform many operations.



The PushCorp STC1503 High Speed Servo Tool Changer is an ideal solution for fully automated workcell. The 15,000 rpm STC1503 has a powerful 3 horsepower (2.2 kW) [Kollmorgen frameless servomotor](#) and integral Collet clamping to give the muscle, speed control and holding torque to perform sanding, grinding, drilling and routing operations with ease. The small size and low weight make this unit ideal for robotic applications.

*High-Speed Servo Tool Changer Model #STC1503 Integrating [Kollmorgen Frameless Motor](#) on Force Compliant Device Model #AFD1000-2*

## 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.

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 across a broad range of voltages. 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.

Optimizing frameless motors to customer specific applications allows the machine developer to get the most efficient embedded motor technology available. By applying Kollmorgen’s electro-magnetic design knowledge and leveraging components from existing production motors, the best value in frameless motors can be a powerful element in your next generation machine development.

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### ABOUT KOLLMORGEN

Kollmorgen is a leading provider of motion systems and components for machine builders around the globe, with over 70 years of motion control design and application expertise.

Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

For more information visit [www.kollmorgen.com](http://www.kollmorgen.com), email <mailto:support@kollmorgen.com> or call 1-540-633-3545.