

# Drive & Control profile

## Paper cup machine manufacturer uses Rexroth servo drive technology to shape greater flexibility and productivity



Industry leader Paper Machinery Corporation launches first-of-its-kind servo-driven paper container forming machine, using Rexroth digital servo drives and high-performance direct drive motors to deliver a machine engineered for faster changeovers and higher output in paper container production.

The paper cup is one of the most common containers we encounter every day. Yet, as with many of the seemingly simple packages we routinely use, the best forming machines to make paper cups and paperboard canisters utilize advanced engineering and system design, combined with high-performance components that can

sustain production of thousands of containers per hour, 24 hours a day.

Paper Machinery Corporation (Milwaukee, WI [www.papermc.com](http://www.papermc.com)) is the world's leading source of high-performance forming machines for paper cups, paperboard canisters and custom paperboard packages. With more

### Challenge:

Create industry's first all-servo driven paper cup forming machine to enable faster tooling changeovers at a lower cost

### Solution:

- Rexroth IndraMotion MLC controller-based motion control platform
- IndraDyn T direct drive motors
- IndraDrive Cs digital servo drives
- IndraControl L45 hardware

### Results:

- Produce up to 200 paper cups a minute consistently, with highest quality
- Faster changeovers for different size cups, within one shift
- Faster machine assembly and shorter deliveries
- Electronic cam profiles provide platform for easier machine changes and updates
- Remote diagnostics capability supports drive-level troubleshooting, eliminating need for technician travel

than 1,500 installations in over 45 countries, PMC has in-depth understanding of the evolving paper container needs of converters, food service and beverage company suppliers.

PMC recently decided to create a new paper container forming machine engineered to provide a more flexible platform for faster, easier tooling changeovers to support a wider range of container sizes and dimensions: the PMC 2000S—the industry's first fully servo-driven forming machine. To control the new PMC 2000S, PMC chose a complete servo drive, motor and motion control platform from the drive and control experts at Bosch Rexroth Corporation (Hoffman Estates, IL [www.boschrexroth-us.com](http://www.boschrexroth-us.com)).

#### **Market forces drive demand for flexibility**

Globally, consumer goods providers are introducing an ever-greater variety of products to satisfy regional, ethnic, lifestyle, age-related and gender-specific tastes. This is driving a demand for paper forming machines capable of running different containers—sometimes two, three or four different containers—in a single week.

PMC is an expert at building industry-leading machinery. Prior to their newest machine, all of the company's platforms utilized a mechanical drive shaft and cams to power the main machine components.

"For a growing segment of customers you need to run



Paper Machinery Corporation's new PMC 2000S, the industry's first all-servo driven paper container forming machine, is driven and controlled by Rexroth's IndraMotion MLC motion logic and control platform.

multiple sets of tooling on one machine," said John Baumgartner, president of PMC. "Our servo-driven machine is going to be a significantly better machine for customers with that kind of tooling changeover requirement."

#### **PMC 2000S:**

##### **The "S" stands for servo**

The new PMC 2000S is an 18-axis machine with three main sections: a feed turret that feeds the blank container sidewalls into the machine, a large mandrel turret that indexes the sidewalls through multiple wrapping, heating, seaming and bottom applications stations, and a rimming turret for curling the top rim of the container.

This configuration—the "top" of the machine—is similar to other PMC machines; the difference with the PMC 2000S is the complete Rexroth [IndraMotion MLC](#) (Motion Logic in Controller) motion, logic and drive platform that controls the system. Combined

with advanced Rexroth [IndraDyn T direct drive motors](#) and compact [IndraDrive Cs](#) servo drives, Rexroth equipped the PMC 2000S with a fully integrated drive and control platform capable of producing up to 200 cups-per-minute.

Just as importantly, the Rexroth IndraMotion MLC platform replaces mechanical cams with digital electronic cams for each of the 18 machine axes. It creates an operating framework that will support much faster product changeovers.

"Imagine changing from one complete tool set to another in a single shift," Baumgartner said. "Now each station on the machine runs its own unique electronic cam profile—one that has been optimized to that station's motion, and is integrated and synchronized with the entire machine."

Rexroth's IndraMotion MLC is an integrated, controller-based

motion logic platform that combines innovative software and firmware capabilities with printing and converting industry-specific technology functions. It features extensive motion sequence software libraries to give machine builders maximum flexibility to configure the optimum controls platform for their application.

IndraMotion MLC also provides a sophisticated array of programming tools to build and fine-tune electronic cams and motion sequences—tools that gave Rexroth a critical advantage as PMC assessed which platform to use to control the PMC 2000S.

#### **Competitive comparison of servo platforms**

PMC had utilized Rexroth servo technology for infeed subsystems on its machines in the past, according to Liz Lind, controls manager at PMC. For this project, she said multiple servo component suppliers and integrators were evaluated, including Rexroth with its local automation distributor partner CMA/Flodyne/Hydradyne (Brookfield, WI and Hanover Park, IL [www.cmafh.com](http://www.cmafh.com)).

“We invited them to participate in a competitive comparison, putting their servo drive platforms and direct drives on a test mandrel turret, so that PMC could assess a broad range of performance parameters,” she said.

Each supplier designed and engineered a control, drive and motor platform and installed it on the test mandrel turret. PMC then

tested each company’s platform, assessing its ease of use, ability to carry out a full range of motion sequences, and system tuning and diagnostic tools.

“We took many different kinds of readings, whatever their systems provided, such as oscilloscope traces,” Lind said. “Rexroth has an excellent scope-trace system in their IndraMotion platform, and we continually used it to tune the motors and test their position. Based on the performance of the direct drive motors, the control system and the troubleshooting system, Rexroth was the clear winner.”

#### **Advantages of Rexroth’s CamBuilder system**

Once the IndraMotion MLC platform was chosen, building and refining the electronic cams was one of the most critical engineering steps. Rexroth’s [CamBuilder](#) program was the perfect solution to this challenge.

CamBuilder is a Windows-based software tool specially designed to enable fast, sophisticated design, testing and fine-tuning of electronic cams. Lind said her team found CamBuilder to be invaluable.

“It’s extremely easy to use, and provides many different profile types and options to build your cam table,” she said. “Once you’ve built your table, you can numerically enter motion sequence information, and see it as a graphical depiction. You can also move the graphic, and see the numeric values change.”



Rexroth's IndraDyn T direct drive motor rotates the mandrel turret through multiple stages to create the paper cup.

Lind said CamBuilder also enabled PMC to export .csv files, which can be imported into an Excel spreadsheet, and converted into an AutoCAD drawing to visualize an axis’ real-world motion. And by utilizing the oscilloscope capabilities in the IndraMotion platform, Lind said they can run each machine axis separately, or in combination, capture motion data and verify that the real-world motion results are the same as the theoretical.

“In the theoretical world, you may build something, but in the real world, the mechanical apparatus may react differently, so you’re not at the exact point where you think you should be,” Lind said. “With the tools that the Rexroth platform

offers, we can build a cam table and verify its solidity.”

Another valuable feature the IndraMotion platform offers is remote diagnostics. PMC can access any PMC 2000S controls platform anywhere over the Internet and troubleshoot machine issues down to individual servo drives. This will significantly increase machine uptime and reduce maintenance and support costs.

#### **Direct drive motors power precision**

One of the other engineering challenges presented by the PMC 2000s was selecting and sizing the motors for each axis—in particular, the direct drive motors to turn the mandrel turret, transfer turret and gripper turret. According to Lind, the motors for these turrets needed to move profiles that were very demanding.

“The profile that we move is very aggressive, very exact and needs to finish in an exact amount of

time,” she said. “The strength and high pole count of the Rexroth direct drive motor, which drives the mandrel turret, is able to accomplish this motion where none of the other suppliers could.”

Rexroth’s IndraDyn T series of torque direct drive motors are optimized for high torques of up to 13,800 Nm. They feature high pole counts that enable exceptionally rigid, stable motion and high stiffness at endpoints. This enabled PMC to satisfy another key machine requirement: stopping the machine motion within one index when needed (i.e. if a container fails to be ejected on the cup diverter) without harming either the machine’s mechanical systems or the drive itself.

#### **Savings on assembly time and costs**

PMC has targeted its new machine at a segment of the paper cup and container manufacturing market that seeks a lower cost machine, and one that can be delivered in a faster

timeframe. According to PMC’s Baumgartner, the Rexroth servo drive platform is helping accomplish this goal.

“This machine should have a shorter assembly time than our standard mechanical machine,” he said, “which can allow for shorter delivery from PMC.”

Lind added that one of the keys to improving PMC’s ability to manufacture and assemble the PMC 2000S faster is the engineering support and insight provided by Rexroth and CMAFH, who not only provided onsite programming and sizing help, but also local stock of components.

“One of the reasons we chose Rexroth and CMAFH is because of their flexibility and excellent engineering support,” she said. “It’s a different control system than what we’ve used in the past, and they were eager to help us learn it. We worked very well together to design this package.”

**Rexroth**  
Bosch Group