

**Trunnion Machine Helps Automotive Parts Manufacturer
Boost Driveshaft Production and Save Space**
*Story and photos provided by Bosch Rexroth Corporation,
Hoffman Estates, IL.*



For Dana, two new Trunnion machines have proven they can significantly increase part production.

There's more than one way to machine a part. Some machine shops find that tried-and-true work cells using the one-operation/one-machine method get the job done. Others are adopting newer technologies such as CNC-based machining centers that fold many operations into one machine with one controller. And still others are keeping their old cell methods while adding some of the new machining center technology to increase production capacity and save valuable plant floor space.

One manufacturer that has successfully complimented its old cell style with new machining methods is Dana Corporation's Spicer Driveshaft Manufacturing, Inc., Bristol, VA. The Bristol plant has added two new Trunnion Manufacturing Systems designed and built by City Machine Tool & Die Co., Inc., Muncie, IN, to increase production of end yokes and yoke shafts used in the Spicer driveshaft assemblies. In less than a year, the two new Trunnion machines, each featuring a single Rexroth MTC200 CNC system from Bosch Rexroth's Electric Drives and Controls division, have already proven they can significantly increase part production when compared to the same parts produced by Spicer's cell machining.

The CNC Trunnion Manufacturing System is a one-machine-does-it-all solution that performs up to six operations. It not only addresses the issues of single-control programmability and efficient tool changeovers, but at 150 inches wide, 189 inches long, and 121 inches tall, also satisfies a growing need for a smaller machine footprint.

According to Jan de Nijs, City Machine vice president of engineering, the Trunnion is a multi-station indexing machine that is similar to a dial indexing machine, except that the Trunnion has a horizontally-oriented axis of rotation. (The word "trunnion" comes from the horizontal pin that old civil war cannon barrels used to rotate around.) Every station on the Trunnion performs independent operations, ranging from drilling, tapping, and threading to full CNC turning and boring.

"It is extremely important that our end users can operate this multi-station machine as one fully integrated machining center," explains de Nijs. "Our customers do not want to feel that every station is a separate entity with its own screens and programming quirks. They want to be able to control every aspect of the machine by just pushing a few control buttons."

For de Nijs, usability was the key to the machine's design and the main reason the company selected the MTC200 CNC system for the Trunnion. A single MTC200 is able to simultaneously control up to seven independent CNC processes and all PLC tasks while communicating diagnostics and performance data. It can command multiple machining operations involving various spindles and slide groups while coordinating automated handling and measuring systems. Up to 32 axes can be assigned to seven CNC processes, including main spindle, rotary axis-capable main spindle, linear axes, rotary axes, and combined

spindle/turret axis. The CNC performs all functions required for 3-D, circular and helical interpolation, polar coordinate transformation, main spindle synchronization, and follower (synchronous) and gantry axes.

In addition, the CNC's C-axis functionality improves machine efficiency by performing complex turning, milling, and drilling operations without the need to re-clamp the workpiece. Additional time and cost savings are realized by simultaneously performing multiple axis functions in one or more CNC processes.

Other Rexroth components complimenting the MTC200 system include Bosch hydraulics, a RECO12 I/O rack mount unit for I/O modules, and a BTV06 handheld operator terminal. The handheld terminal is used for machine set up procedures and simplifies operating tasks by allowing the operator to control the machining axis in jog mode or to fully run the machine from the hand pendant.

Notes de Nijs: "So although you're dealing with an inherently complex system with multiple stations performing a variety of tasks, the user interface represents all of these tasks in a clear way to give users the feeling they are operating one machine."

Another important feature, says de Nijs, is changeover. If operators want to retool for a different part, they should be able to easily convert programs, offsets, and other part-specific information. And that, says de Nijs, can only be done if many systems are integrated to the point where they behave like one system.

A Working Relationship

Hannah Dahl, a line engineer at the Dana Spicer plant, knows firsthand what it's like going from cell-based production to a machining center. Dahl has a history with Spicer's cell machining, but now spends most of **her days managing Spicer's three Trunnions. Under Dahl's supervision, the Trunnions, featuring six** workholding stations and 30-second-per-piece or faster production speeds, typically produce tube or ball yokes and yoke shafts from forgings. The forgings are placed in a pallet and then loaded by the Trunnion's **robotics into the system's first station for clamping and indexing. Since the Trunnion's MTC200** control supports turning, milling, drilling, and probing, complete machining can be accomplished with a single workpiece clamping operation. From there, the forging proceeds through a series of operations, including cross-hole drilling, facing, broaching, and lathe and groover cutting, adhering to very close tolerances.

By using SERCOS interface digital communications, the Trunnion's CNC system provides high precision and high speed cutting as a result of velocity and position loops that are closed in the drives and are independent of the network data rate. A servo response of 250us without following error assures high precision at the fastest machining rates and chip-to-chip times. Likewise, contour accuracy at high path velocities is achieved through fast NC block processing times, dead-time-free NC block switching, and look-ahead NC block preparation, resulting in excellent surface finish and extended tool life.

When running at maximum efficiency with an average 30-second or less cycle time, Dahl reports the Trunnion can produce 1,000 pieces per shift compared to 600 pieces per shift in similar cell production. But despite greater production, for the Spicer plant it's not really about "out with the old and in with the new."

"Cell production still works for us and we have an investment in those machines," explains Dahl, "but what we were looking to do was increase production within the physical limitations of the plant, and traditional **cell production couldn't give us both.**" **Because each of the six spindles** on the City Machine Trunnion performs the work of a single turning machine or horizontal machining center, the Spicer plant can achieve increased throughput, reduce operation costs, and save floor space by using only one machine.

Dahl also explained that despite all of the talk that surrounds transfer machining technology and trunnions - **- either they're more efficient and easier to troubleshoot because they only have one controller or they're** less efficient and harder to do tool changeovers -- she feels the truth about trunnions is really neither of those.

Says Dahl: "The Trunnion is very efficient because it only has one controller, and we've found troubleshooting in most cases to be relatively easy; however, as with any new machine, there is a learning curve. The way the Trunnion performs operations is not the same way each operation would be performed **independently in a cell environment. It's a different approach entirely, and one that we've had to learn.**"

De Nijs agrees there are many misconceptions about trunnions and finds many manufacturers believe trunnions can only be used to manufacture one dedicated part, but he says that's not the case. "The City Machine Trunnion System with Rexroth controls provides for a hassle-free, operator-friendly experience. To

change to a new part, the operator need only change appropriate tooling and the program/offsets. Part changeover has never been easier."

The CNC system's integrated line editor, ASCII editor, and optional graphical NC editor provide a wide range of programming tools for all levels of expertise. Externally created or post-processed CNC programs can be imported and exported from serial interface ports or local or network disk drives. The system also features turning, milling, drilling, and probing cycles to simplify programming of repetitive machining tasks.

De Nijs added that the Trunnion also features durable sliding spindle carriers. By using this unique design, says de Nijs, most cutting tools can be conveniently changed outside of the machine and in less than one minute. With the push of a button, the sliding spindle carriers retract from the machine base, allowing the operator easy access to the tooling area. Spindles are furnished with quick change tooling adapters, enabling even faster tool changeovers. With another push of the button, spindle carriers slide back into the base and the machining process continues.



Quick and easy tool change via sliding spindle carrier.