

Competing On A Multi-Spindle

For many high-volume applications, multi-spindle automatics are the right technology for production machining. Increasingly, that production efficiency has been pressured by changes in the needs of shops in the form of shorter run jobs and higher tolerances. This article looks at some of the steps one OEM has taken to address quick change-over issues on its multi-spindle machines and their tooling.

Edited by Chris Koepfer

Back in the day, a screw machine shop was easily defined. Many used multi-spindle automatics of various configurations and capacities to crank out large volumes of relatively uncomplicated parts.

A shop could literally set up a machine and run a job for a year, 2 years and even longer. Such production runs allowed for a high level of fine tuning to the process to get the most efficient production, usually measured in cycle time.

This environment gave rise to the Davenport Model B and many other iconic multi-spindle automatic brands. Today, only a few of those builders are left. Those who have survived have done so by adapting to the changes in the market that uses multi-spindle technology.

Today, high-volume manufacturing includes the need to turn over jobs. Too many jobs are ordered in volumes that are insufficient to dedicate a piece of capital equipment to a single part number. The rub comes to shops and suppliers that have built the business on low-mix, high-volume work. They both must adapt to a new production machining metric.

This article looks at some of the developments that Davenport Machine (Rochester, New York) has implemented in the past few years to help its dedicated customer base adapt and compete using multi-spin-



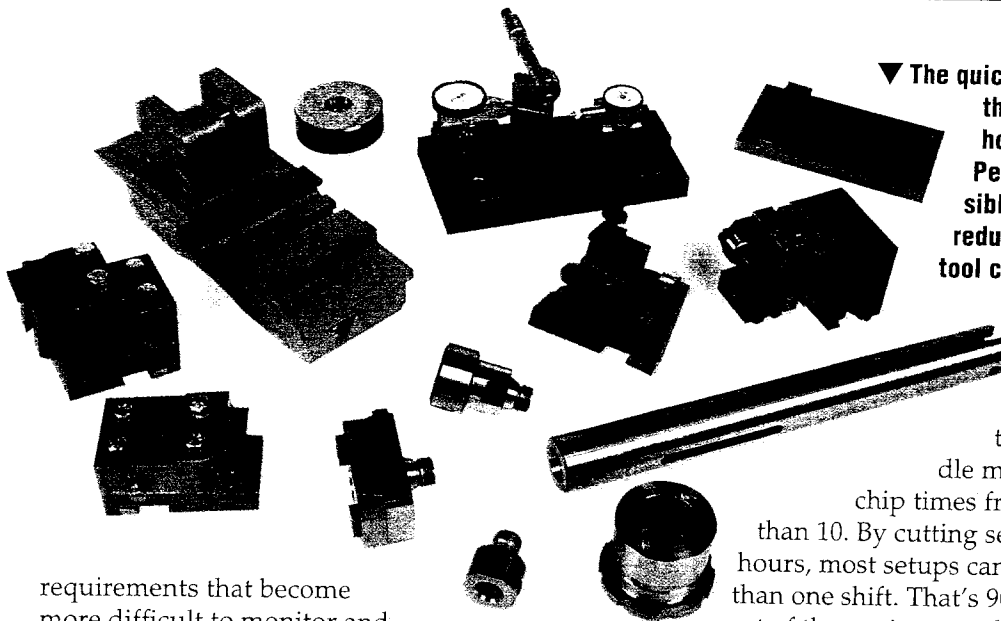
dles in a market that has dramatically changed. Most of these developments focus on setup reduction and improved accuracies that are keeping this venerable builder and its customers in the game.

Shorter Run Issues

Short jobs are particularly troublesome to most multi-spindle automatic shops for three main reasons. First, the ratio of setup time to run time increases. For example, a typical Davenport job at a contract shop will be in setup for 10 to 18 hours. This is because of the variety in product mix that a contract shop must deal with.

In addition, this setup time must often be spread out over two, three or even four shifts, leading to a chip-to-chip time (the time a machine is not running efficient production) of up to 100 consecutive hours in many cases. In a short-run environment, that can equal or exceed the actual run time of the job, effectively making short-run jobs twice as expensive as long runs.

The second problem that short-run jobs present such a shop is today's ever tighter Cp and CpK



▼ The quick-change tooling family includes the preset gaging, off-line tool-holder blocks and the tool bodies. Performing as much work as possible externally on the machine can reduce setup time for new jobs and tool change time for running jobs.

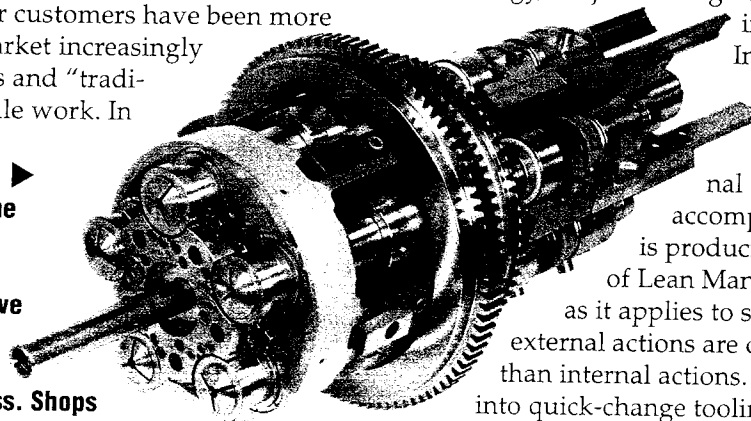
requirements that become more difficult to monitor and hold. It can often take several shifts to determine reliable tool wear trends and anticipate when tool changes are required. Longer runs provide sufficient time to tweak the process. By the time a short-run job is proved and running well, it's ready to be pulled for the next job.

The third challenge is scheduling. It takes roughly five times as many jobs to keep a machine at capacity than it used to. That is five times as many jobs to schedule, and five times as many customers to keep supplied and happy.

Tooling Plays A Big Role

Implementation of quick-change tooling strategies can help a shop manage these problems. In the case of Davenport, a tooling company (C.J. Winter Machine Technologies) is part of its corporation. With both companies applying their resources into a co-engineered product development focus for the last 3 years, many of their customers have been more competitive in a market increasingly driven to short runs and "traditional" single-spindle work. In

The heart of a multi-spindle machine is the spindle carrier drum. Improvements to the Davenport spindle have resulted in a significant increase in accuracy and stiffness. Shops are able to run jobs that previously would have run on other equipment.



real world metalworking, quick-change tooling applied to the company's multi-spindle machines can reduce chip-to-chip times from up to 100 hours to fewer than 10. By cutting setup times to less than 10 hours, most setups can now be accomplished in less than one shift. That's 90 hours of extra production out of the equipment already on the floor and with a labor force already on the payroll.

Quick-change tooling also allows machine operators to quickly change to sharp tooling more often, without the hassle of readjusting taper, tool alignment and size. That keeps part tolerances tighter and helps achieve the tighter Cp and CpK values without the necessity of learning tool wear trends. Moreover, with comparatively short one-shift setups, and 90 extra hours of production per setup, job mix flexibility has increased, and a major obstacle to scheduling short-run jobs has been removed.

Internal And External Setups

An immediate advantage to the shop that applies quick-change tooling as part of its setup and production strategy is an ability to begin the setup process for the next part run while the machine tool is making parts for the previous job. In a quick-change strategy, job change-over is broken down into internal and external steps. Internal steps are those that must happen while the machine is turned off and not making parts. External steps are those that can be accomplished while the machine is producing product. A principle of Lean Manufacturing, especially as it applies to setup deduction, is that external actions are considerably less expensive than internal actions. The features engineered into quick-change tooling allow an operator to take many actions that previously could only be done internally to a setup and make them external.

Multi-Spindle

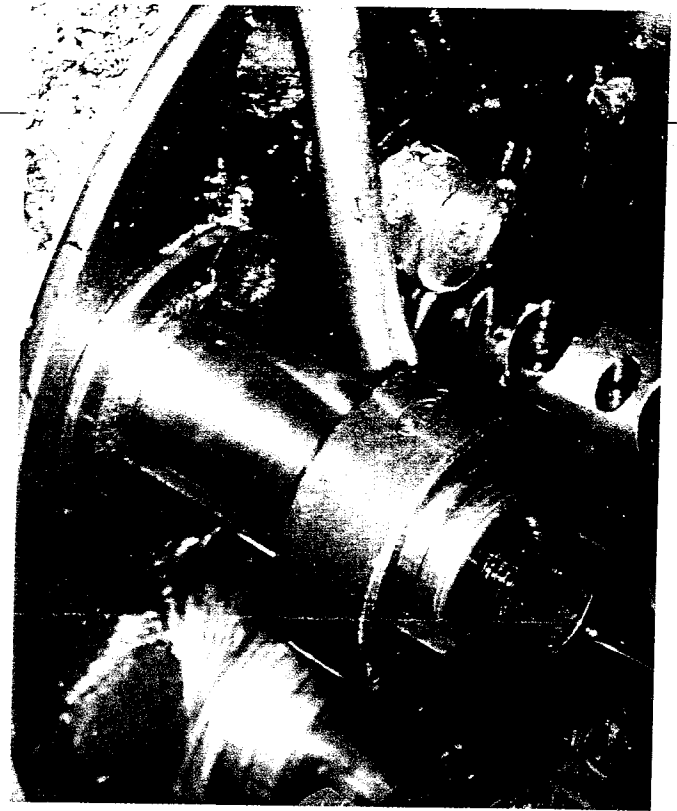
Tool spindle change-over, stationary or revolving, has been reduced from hours to minutes. The quick-change front box eliminates the need to realign spindles after a tool change.

Some of these actions include tool mounting, tool alignment between positions, taper and centerline adjustment and size. All can be preset before shutting off the machine from the prior run. During longer runs, sharp tooling can be preset in spare holders to replace worn tooling with minimal or no adjustment made to the machine. This saves operator and machine time and increases the efficiency of the job's run.

Making A Better Multi

As the tooling division has developed quick-change tool strategies, the machine tool division has addressed several critical issues on its multi-spindles. The goal of these developments is to enable the company's traditional customer base to move into new areas of production that were previously unthinkable for these multi-spindle shops.

An example is the new high-precision head being applied to the Servo B models. Any multi-spindle must have an accurate and rigid spindle carrying head. On these new machine models, replacing bronze or needle bearings with angular contact



radial bearings has reduced runout for the spindles to consistently less than 0.0005 inch. Jobs thought impossible for the Davenport, such as 52100 bearing steel parts, are now running on these new machines because of the increased rigidity provided by the bearing upgrade.

Applying servomotor technology has enabled all of the clutches and brakes to be replaced with main-

Quick Change In Production

Stegg Ltd., a precision machining plant established in 1956, specializes in close-tolerance, high-precision components and assemblies with challenging design features using brass, steel, aluminum, Teflon, stainless steel, titanium, polycarbonate, Delrin and more. The company is able to machine parts requiring production volumes of up to 20,000,000 pieces. It houses multi-spindle, CNC lathes, CNC Swiss turning, plating and heat treating to provide precision part production to its customers' specifications.

The plant, located in Belleville, Ontario, Canada, realized the time-saving benefits in using C.J. Winter's quick-change shave tool when machining a close-tolerance shaved part. While running a large automotive part $\frac{7}{8}$ -inch diameter in 12L14 material, the shop needed to hold a tight ± 0.0003 -inch tolerance, and they had to hold ± 0.00015 inch on the diameter to maintain the required Cpk.



Shaving was necessary to hold these tight tolerances, and Stegg chose to use a quick-change Model

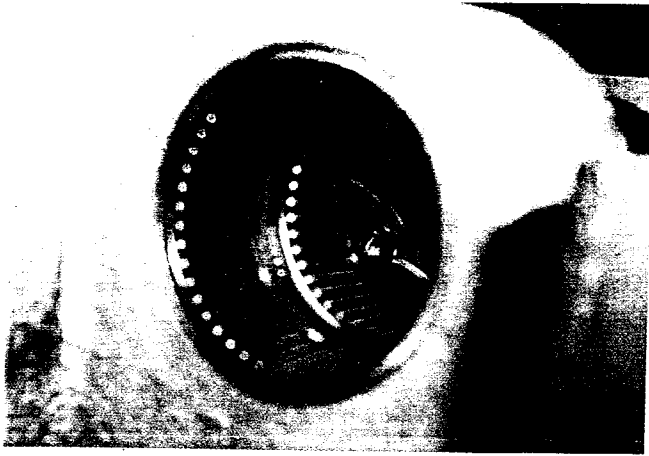
111 shave tool. "Once we set the taper, we're done," says Roger Johnston, Davenport shop supervisor for Stegg. "We pull the tool out and put it back in, swap from one tool to another and never have to reset the taper. We can change the tool over in less than 5 minutes now, when it used to take us half an hour."

A proprietary dovetail design used on all C.J. Winter quick-change toolholders allows a simple slide on and off installation and removal from the slide. Stegg is saving more than 4 hours a week in tool change-over time, according to Mr. Johnston. This savings translates to lower part cost.

The original plan was to run the part on an eight-spindle automatic until Stegg realized the benefit of running it on a Davenport. Mr. Johnston adds, "The Davenport is a less expensive machine, making our work center cost less. This yields a lower part cost and lower overhead."

The quick-change shave tool can be mounted in multiple positions on the machine. Stegg is using the tooling to shave in the third position. With a zero-clearance matched assembly, the tool holds a more rigid running mechanism and virtually eliminates chatter. "The shave tool basically had no chatter," says Mr. Johnston. "The dovetail holds better, and we don't need to adjust the set screws anymore."

Two roll brackets come standard on the shave tool for inboard



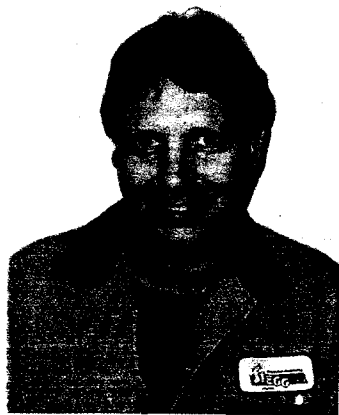
▲ For swing arm attachments, needle bearings have replaced bushings. The use of bearings increases the attachment life and improves accuracy and stiffness over the previous design.

tenance-free motors provided for a simplified gear train. Spindle speeds, index and cycle times can be changed instantly without spindle change gears, belts or pulleys, cutting setup times substantially. In threading operations, the speed adjustability of the servomotor helps produce better threads with less fuss.

Quick-change tool spindle boxes eliminate the need to realign the spindles and help reduce tool spindle

or center roll positions. Each covers the entire range of diameters. Taper adjustments on the shave tool can be made within 0.0001 inch. It can be removed from or installed on the machine without losing the taper.

The company improved efficiency by saving time in tool change-over. This makes it more competitive in the long run by lowering costs and enables a more productive use of its capital equipment.



For more information about Stegg Ltd., call (613) 966-4000 or visit its Web site at www.stegg.com

◀ **Roger Johnston, Davenport shop supervisor for Stegg Ltd., has used the quick tool change packages from C.J. Winter successfully on his Davenport multi-spindles. In production, quick-change tool strategies for tool replacement and job change-over have saved the company significant time on the shop floor.**

change-over from 1 hour to less than 5 minutes. Needle bearing tool arm studs increase the useful life of swing arm tooling and reduce chatter. A similar needle bearing setup does the same for the backside countersink attachment. A two-position servo backworking attachment allows more complex parts to be dropped off complete, without the need for secondary machining.

Lowering The Volume

The process flexibility and speed of multi-spindle automatics is well understood. They are the original multitasking machine tool technology. According to the company, a Davenport machine can form, shave, drill, ream, backwork, cross mill, cross drill (multiple holes at various timed positions), thread roll, burnish, stamp, flat generate, slot, broach, swage, keyway mill, gear hob, thread mill and more.

The increased efficiency enjoyed by a shop using a quick-change tooling strategy coupled with the machine enhancements on the Davenport will allow them to compete in short and medium job run markets that require 5,000 to 75,000 parts. These market segments were recently considered unprofitable on a multi-spindle because of the excessive cost of 18-hour setup times and 100 hours of lost production for every change-over.

With single-shift setups now possible, multi-spindles can compete. Parts will typically be complete, deburred and ready for shipping. No secondary machining work is required on most of the parts produced. ■



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