➤ BY BILL KENNEDY, CONTRIBUTING EDITOR

cover story

Time to CELL?

Three shops discuss cellular CNC machining strategies that help them respond quickly to changes in markets and customer demand.

Back in the day, the top manufacturing technology was mass production. The goal was to make as many of the same part as quickly as possible and have customers buy them by the thousands.

That scenario has changed dramatically. It's a buyer's market now. Companies want product made to their custom specifications, and they buy only as many as they need right now, thank you.

Cellular CNC machining is manufacturing technology for today's customer-centric market. The manufacturing cell approach can generally be described as grouping machine tools, workhandling systems and other processing equipment and applying them with a specific strategic purpose. Actual cell configuration and implementation varies from shop to shop and industry to industry, but the common goal is shorter setup and cycle times, leading to just-in-time delivery of complex parts.

Immediate Response

Morsch Machine Inc., Chandler, Ariz., produces enclosures, support components and chassis—most from aluminum—for the electronics and avionics industries. Morsch also assembles, plates and adds hardware to many units.

CEO Joe Salontai said the company moved to cellular manufacturing to offer JIT delivery of small and variable lots. "We are not doing thousands of any one thing weekly," said Salontai. "One customer might want three a month; our highest volume is maybe 75 of a part per week."

As customer requests for JIT delivery grew in the late 1990s, Morsch could not inventory large numbers of finished parts, so it investigated manufacturing cells. "I wanted to be on the leading edge of the technology," said Salontai. "I thought a cell was the way to go. We got our first machining center along with 12 pallets about 7 years ago."

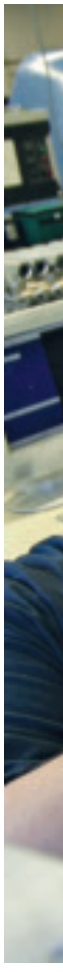
That initial setup evolved into Morsch's largest cell, with three 12,000-rpm, 4-axis Hitachi Seiki horizontal machining centers. One machine's automatic toolchanger (ATC) holds 210 tools, and the other two hold 120 tools each. A rail-guided vehicle (RGV) handles the cell's 44 pallets. Success with that initial cell prompted Morsch to add two more cellular-machining arrangements, each featuring an HMC with a pallet changer.

Getting the most out of a cell involves more than just grouping machines together. "I'd say that the learning curve was a good 6 to 9 months," said Salontai. "The key was understanding what these machines are designed to do."

For Morsch, that didn't mean just making lots of parts fast. "At one point, we wanted to keep the machine busy 24 hours a day, so we put on the

Morsch Machine

The largest cell at Morsch Machine consists of three Hitachi Seiki HMCs serviced by a rail-guided vehicle that handles 44 different pallets, each with a four-sided tombstone.



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Machinists Andrew Zvara (left) and Earl Kunf load tombstones mounted on the 18 pallets that service three Mazak FH580/40 HMCs, which machine paintball-marker bodies at Smart Parts.

highest volume parts we had," Salontai said. "But the real demand from customers was for rapid, flexible response. We weren't focusing on that. We were focusing on our own needs."

It became apparent that higher volume parts could be machined more efficiently in batches. For those parts, Morsch has a selection of stand-alone single- and twin-spindle machining centers, which are scheduled up to 6 weeks in advance. The choice between cellular or conventional methods depends on "whether you want real flexibility or whether you want a little higher volume production," Salontai said.

Morsch developed and fine-tuned ways to maximize flexibility and responsiveness. A key element of cellular efficiency is specialized, preconfigured workholding that drastically reduces setup time. At Morsch, workholding tombstones are configured to hold specific parts and mounted on pallets. When it's time to machine a certain part, the RGV brings the appropriate pallet to a loading station, where aluminum blanks are mounted for machining. The RGV then takes the work to the appropriate machine.

The variety and complexity of the components Morsch machines dictated further refinements. The parts share basic features, such as holes and milled surfaces, but are distinguished by different details requiring specific tools. Typical parts require 14 to 40 tools, while more complex components call for as many as 90 tools.

Morsch started by grouping parts requiring similar tools into families and placing the tools needed to produce common features in the appropriate toolchanger. On a 120-tool machine, "we can run 30 to 35 different parts for nine different customers, all of which use the same family of tools," Salontai said. On rare occasions, rather than shift a few tools from one machine to another to process a new part, "we'll run it down to the other machine, but that's not typical."

The grouping of parts led Morsch to assign parts to specific machines. This strategy is contrary to some cellular tactics that move a part from machine to machine for a series of operations. "In 95 percent of the cases, a part is dedicated to a particular machine with a certain set of tools," said Salontai.

Each machine in the largest cell has a basic tool set. "The first 30 tools on all three machines are pretty much the same because several different tools match many different customers' parts," Salontai said. More than 70 jobs are programmed in the three-machine cell, and about a third of them can be run with the 30 common tools on any of the three machines. Were a machine to go out of service, having an identical basic tool set minimizes the tool additions needed to shift a part to another machine. To avoid confusion, however, parts are not moved between machines

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during normal operation.

Efficiently scheduling a variety of parts is "sort of a chess game and a challenge," Salontai said. Although it's a high priority for the future, Morsch does not have a facilitywide enterprise resource planning system. However, Salontai said, "We do have a system we developed internally that works fairly well; it's just not totally integrated." After a part number and volume requirement are entered, the system calculates the required machine time. "It automatically adds it up and says, 'You've only got 90 minutes left on this machine for Monday, Tuesday and Friday,' for example," Salontai said.

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Each week, the Morsch staff sets production priorities to minimize unused machine time. Salontai said juggling the order of jobs, such as using a shorter job to fill a small gap of leftover minutes on a particular night, can open up a larger window of time on another night to accommodate a longer job. Generally, he said, the shop maintains a utilization rate of 95 percent or higher.

As a result, the cell runs "pretty much 24/7," Salontai said. "We do a lot of lights-out machining. Things that require more specific inspection we'll do during the day, but other parts will run unattended early in the morning."

Morsch's cellular strategy allows it to provide quick response to customer demands. For example, customers with internal Kanban systems send electronic "pull" orders to Morsch and expect the requested parts to be shipped within 24 hours. "The parts typically are complex machined units requiring hardware, plating and so on," Salontai

Morsch Machine

Machinist Chris Szewc loads parts on a tombstone in a setup station in the largest cell at Morsch Machine.

Amera Seiki

In Frog Legs' "hybrid cell" are production manager Joel Farley (left) at an Amera Seiki TS-42 4-axis turning center, and Nathan Williams, assembly, at an Amera Seiki A-1 VMC. The cell arrangement gives Farley access to a variety of deburring and finishing equipment.

said. Just a few completed parts are stored in a bin system in the Morsch plant. "We pull the bin and ship the part, then the machining cell is immediately flagged to begin running the same part," Salontai said. Generally, 2 to 4 weeks elapse between pull requests. "Nevertheless, we immediately start machining parts in the cell and refill the bin," Salontai said. The bin-and-cell system currently supplies about 40 different components for three customers.

"The cell provides huge flexibility," said Salontai. "That's the neat thing about it. Manufacturing cells are very expensive, and a lot of smaller companies look at them and say, 'Man, it's tough.' It was tough, I'll admit. But it was an excellent move for our business."

Hybrid Productivity

Mark Chelgren of Frog Legs Inc., Ottumwa, Iowa, describes his company's cellular machining operations as a "hybrid" system. "To me, a cell is something that makes the same part repetitively using a shared interface. Ours is kind of a hybrid cell because we have a variety of parts, and we designed the cell so machines can operate in sequence as well as independently," he said.

Buying a manufacturing cell was one of a series of decisions that started with the idea for the business, an idea Chelgren had on vacation in 1996, when he encountered a group of quadriplegic rugby players. They described muscle spasms and low back pain caused by the inability of their wheelchairs' rigid front castors to absorb shock. A physicist and avid mountain biker, Chelgren applied mountain bike suspension concepts and designed shock absorbers to replace the wheelchair's original front castor forks. His now-patented clamshell-shaped designs feature polymer shock-absorbing elements instead of springs.

Beginning with drawings on graph paper, it took about a year to get the parts into production and establish Frog Legs Inc. Today, the company offers a high performance, lighter version of the original design, a lower-priced nylon, glass and urethane composite version, and a heavy-duty version made of drop-forged steel for use in electric wheelchairs.

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Frog Legs annually sells about 10,000 pairs of shock absorbers and 20,000 pairs of wheels to fit them. In addition to other wheelchair components, the company provides custom fasteners to mate the shock absorbers to various wheelchairs. The fasteners are based on conventional items but are re-engineered for lightness and feature smooth, radiused surfaces designed to eliminate high stress areas where cracks can begin. "The shocks vary from chair to chair, so we have to make a variety of fasteners. In some cases, we have bearings and the connection port custom made into them," Chelgren said.

Bring It on Home

Frog Legs outsourced all of its manufacturing until recently, when it began machining certain parts to reduce costs and control delivery. "We're not replacing all of our outsource machine shops, but we do want to manufacture the parts we need to grow our business," Chelgren said. In-house manufacturing is focused on the aluminum components of the shock absorbers as well as machining of wheels.

While some shops purchase machine tools and then seek parts to make on them, Frog Legs had 10 years worth of developed parts to match to machines. In early 2007, Frog Legs purchased an Amera Seiki A-1 vertical machining center with a 10,000-rpm spindle and 20+1 double-arm ATC. The machine is equipped with a two-pallet automatic pallet changer. The company also bought an Amera Seiki TS-42 4-axis turning center with a 4,000-rpm spindle. With its drilling slide, the machine can machine a part's OD and ID simultaneously.

Chelgren said the cell setup at Frog Legs enables the machines to be used both sequentially and independently and also permits machine operators to perform value-added operations as machining continues.

Amera Seiki

Aluminum castor forks after machining on the Amera Seiki A-1 VMC in the "hybrid cell" at Frog Legs.

The cell's VMC and turning center are positioned about 15' apart. Material must transfer between the machines efficiently so they can work in tandem, but the machines must not interfere with one another. Placing the machines too close together can produce process flow and part handling challenges, "especially if you are making a variety of parts," said Chelgren.

Frog Legs moves small batches of

Three variations of paintball-marker body styles machined in "Op 2" at Smart Parts.

parts between machines on rolling carts. "We always have 15 to 20 parts in process so if we have a problem with one of the machines or somebody goes on break, we don't slow the other machine down," Chelgren said.

After the VMC operator loads parts onto the tombstone, he is available to perform initial inspection of finished parts. The cell's circular design places a variety of deburring and polishing equipment within easy reach. "The operator can simply pivot in his chair and hit the part with a Scotchbrite pad and manually deburr it," Chelgren said.

A good example of sequential machine operation is the machining of three-spoke soft-roll wheels from 6061 T6 aluminum. First, the VMC machines the windows between spokes in the center of a round wheel blank. Then the turning center finishes the wheel's OD. "The VMC and turning center are timed to work simultaneously on the same order," Chelgren said.

As demand for wheelchair products changes—often in response to shifts in government health-care reimbursements—machine requirements change, too. For example, early production runs of wheels are machined on two machines, as described above. As volume increases, Frog Legs changes to an extruded workpiece that already features the center spokes, eliminating the need for VMC operations. Because extrusion dies are expensive, the company makes sure the market is established before purchasing them.

Chelgren refers to "teething problems" with the cell as "speed bumps; nothing that was unanticipated. The nice thing is that we have a strong group of employees." Frog Legs' Ottumwa facility is across the road from Indian Hills Community College, so it has ready access to graduates of the school's machining program. "There are no other machine shops in the area, and we have pretty much our pick of the best talent," Chelgren said.

Still, staffing the machine shop was a challenge. The company was founded in Vinton, Iowa, near Cedar Rapids, where competition for machining talent was fierce. "We literally moved our company headquarters (to Ottumwa) to find the proper machinists," Chelgren

said. Of the company's 11 employees, seven are involved in machining.

Marking Time

Cellular manufacturing enables Smart Parts Inc., Latrobe, Pa., to efficiently produce large volumes of standard products and smaller runs of custom variations. For the global market, Smart Parts makes premium paintball guns (markers) that list for $800 and up. The lightweight, electropneumatic markers can fire a 0.68"-dia. paint-filled gelatin ball at a muzzle velocity of 300 ft./sec. and a rate of more than 20 per second.

The company's main manufacturing cell consists of three Mazak FH5800 HMCs, each with a 25,000-rpm spindle, 80-tool capacity ATC and M640 control, serviced by 40 pallets that are moved by an RGV and fed with two load stations.

"We may make one Shocker marker body, but customers want different configurations with different cosmetic milling," said Glenn Perry, manufacturing engineer.

What Perry calls the "first op body" is machined on HMC No. 1. The operation includes milling the marker's basic shape, drilling functional bores and passages, and threading and reaming various holes. The machining of "second op body," on HMC No. 3, consists of creating external visual details and is performed with ball endmills and other detail tools.

The parts are moved in and out of the machines on pallets with fixtures designed for the two operations. For the first op body of the Shocker marker, 2011 aluminum hex stock blanks are clamped horizontally, eight to a pallet. The pallet travels on an RGV to HMC No. 1, the blanks are machined and the pallet returns to the loading station. The machined parts are removed and fixtured vertically on another pallet, which travels to HMC No. 3 for the second, largely cosmetic, operation. The cellular process enables the shop to "run first op and second op at the same time on two different machines," Perry said.

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At Smart Parts, a rail-guided vehicle retrieves pallets from racks on the left, takes them to the loading station in the right foreground and then moves them between the three Mazak FH5800 HMCs.

Smart Parts balances output "so that we don't have 45 or 50 parts of first op sitting there waiting for the second op to run." However, that situation can be unavoidable for custom bodies whose detailing might require an hour of machine time in the second operation, as opposed to 15 minutes for a standard body.

Perry said the company might machine 2,000 Shocker bodies per month, while a batch of 100 custom bodies might be run every 2 or 3 months, depending on demand. He gave the example of special markers Smart Parts machines for a professional paintball team in Russia called the Boston Red Legion. "We sponsor the team with markers, and within that sponsorship we give them a custom marker machined how they like it. It's a very intricate and time-consuming part," Perry said.

Scheduling is based on work orders. Perry said the cell's flexibility enables the shop to react immediately to special orders. "We have all the setups ready to go. We don't have to tear down our pallets and set them back up." Pallets configured for lower-volume products are "sitting there waiting to go when we get an order. If we are running standard bodies on pallets 2 and 36 and we have to run a custom body, the system brings out pallets 5 and 18. All we have to do is put parts on them. That's where we get our flexibility."

The third machine in the cell, HMC No. 2, runs first- and second-operation grip frames, in addition to other components.

Smart Parts has another cell with three Mazak FH580/40 HMCs serviced by 18 pallets and a Palletech system. It runs custom grip frames and accessories.

Celling Points

Global competition forces manufacturers to continually fine-tune their product offerings to address specific customer demands. Effectively implemented cellular machining equipment and strategies can enable part production to fulfill those demands on an almost made-to-order basis. What the cell looks like and how it's run depend as much on the creativity and perseverance of the manufacturer as they do on the nature of and volume requirements for the part being machined. △

The following companies contributed to this report:

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