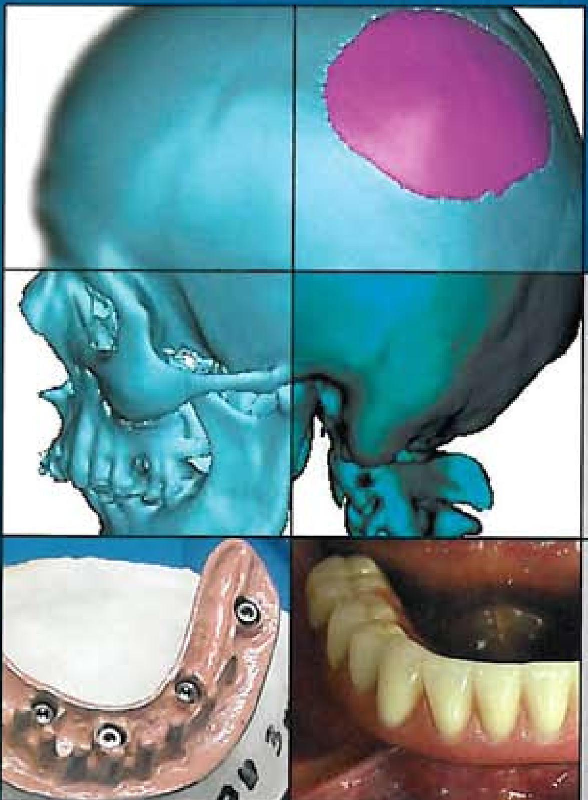
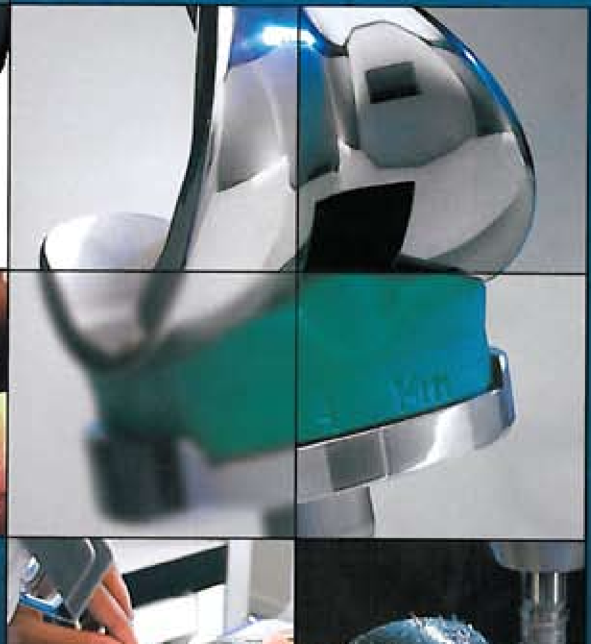
MEDICAL MANUFACTURING 2009





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Constant Velocity CONQUERS

VMC helps prototyping take a giant—and smooth—leap forward at Gore.

Conventional wisdom says there are two basic technological paths in prototyping die/mold work—EDM and machining.

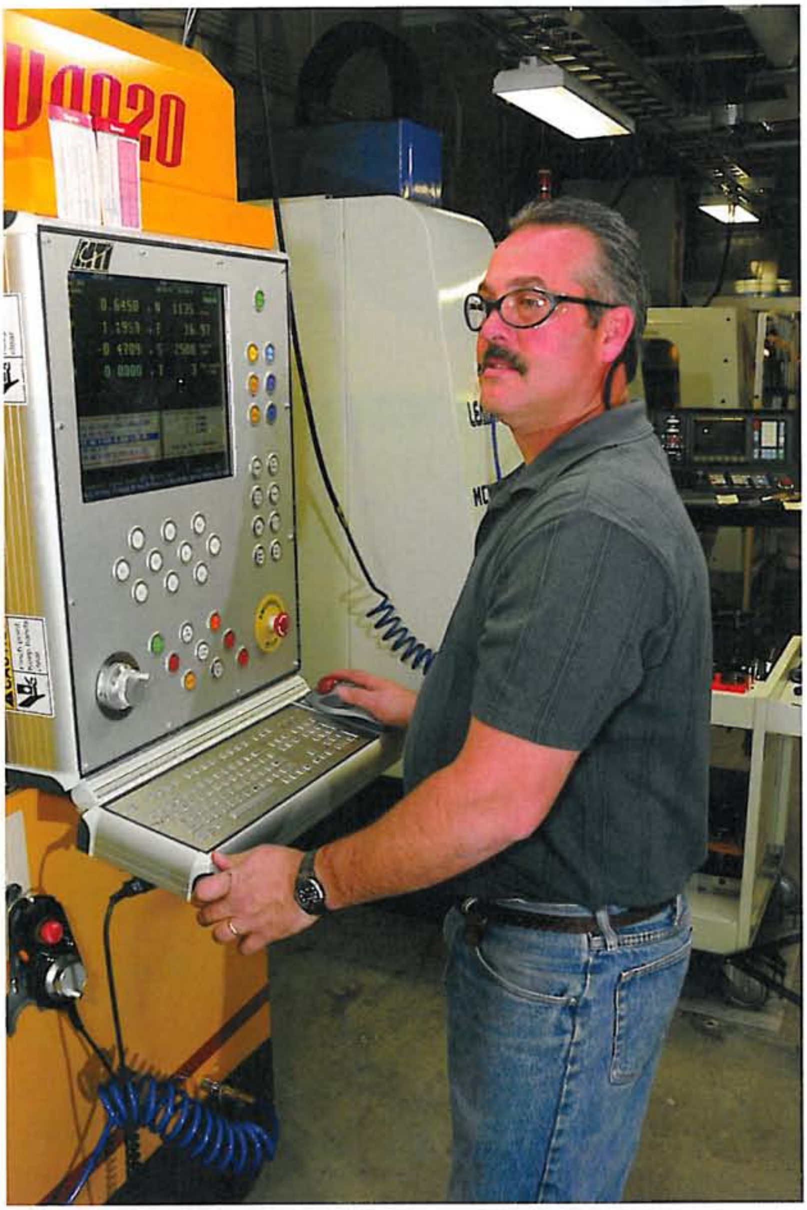
Yes, 3-D imaging is making inroads, and there are several other prototyping alternatives. But if you are looking for the latest wrinkle in high-speed machining, look no further than a VCM that employs constant velocity (CV) processing rather than relying on brute horsepower and the complexities of controlling variable speeds and feeds.

End mills are small, from 0.010" (0.25 mm), and generally long, 6–10× D. "Pre Revolution, we'd break a lot of these small, thin tools. Now we don't break tools; we change them out when they begin to dull," says Ed McCracken.

Michael C. Anderson
Yearbook Editor

The W.L. Gore & Associates Inc. facility in Landenberg, PA occupies some 106,000 ft^2 (9858 m^2), employs some 500 workers, including machinist Ed McCracken, and is the result of a recent consolidation of three plants. It is one of 17 manufacturing plants that make up Gore's eastern US cluster. Other manufacturing facilities are in the western US, Germany, Scotland, Japan, and China.

When asked about his title within Gore, Ed McCracken says, "Machinist," and while he is that—a real machinist, a noble but vanishing breed, and not to be confused with "operator" or "technician"—he does more than what that title infers. He travels frequently to build machinery, set up machines, and on occasion has installed entire production lines in Mexico.



The Revolution's MTI processor with a minimum processing speed of 50,000 blocks/sec maintains a nearly constant speed over complex prismatic workpieces being machined by McCracken at W.L. Gore's Landenberg, PA facility.

"In the 25 years I've been with Gore, I've done just about everything," he says. "But now I'm creating prototypes—primarily die/mold work for EPD [Electronic Products Division]—but then I handle anything that comes in from R&D, including medical. We're using a new VMC to service customers everywhere, the West Coast, Europe, Asia, China, you name it. Basically, if I can get the part on the machine, we get the prototype to them. Very, very fast turnaround."

McCracken says the parts he machines are usually very small—from the size of a finger to that of a fingertip. Materials include: plastics, delron, Teflon, norel, nylon, aluminum and some steel. When he had the time and machines, McCracken would mill a prototype, then shoot a couple hundred parts (injection molding) using the just-finished prototype mold, checking that the product coming off the mold is what he wants.

The typical mold shop would likely "burn" (EDM) these prototypes, a capability Gore has in this facility. "But when I can put the part in the VMC, and the finished prototype meets the specified tolerances or better, why would I use another technology?" he asks. "I finish these parts right in the Revolution. I put the part in one time, machine it, and it comes out finished. And when we set up the fourth axis, these prototypes will come off perfect, every time, ready to ship."

The VMC McCracken's using is a Revolution CV4020 by GBI Cincinnati Inc. (Cincinnati, OH). It's a new entry in a VMC market that is already bloated with competitors. However, the Revolution, a lean, limber, deceptively quiet machine, stands apart. "I swear," McCracken says, "I actually have to check to confirm the thing is running—it's so quiet. Quietest machine on the floor."

McCracken's CV4020 is a 40-taper general-purpose/die-mold machine with a 15,000-rpm, 20-hp (14.9-kW) spindle (8,000, 10,000, 12,000 and 24,000-rpm units are available), a 24-tool magazine and double-arm toolchanger (ATC) delivering a 1.9 sec chip-to-chip tool change. *X* and *Y* axes feature linear guides and the *Z* has a box way design.

Axes travels are 39.4" (1 m) in *X* and 20.5" (521 mm) in *Y* and 19.9" (505 mm) in *Z*. Rapids: *X* and *Y*, 1.417 ipm and *Z*, 1.102 ipm. Positional accuracy is 0.0003" (0.0076 mm) and repeatability is ±0.00012" (0.003 mm). The control features a high-speed multiprocessor from MTI (Essex, Ontario, Canada) capable of simultaneous eight-axis, 50,000 blocks/sec processing speed, allowing the Revolution to achieve constant velocity machining, permitting up to a 50% reduction in cycle time when milling complex prismatic parts.

But, aren't there alternative ways to meet customers' on-demand criteria? "Sure," McCracken says. But, he continues, none he can think of would really work—theoretically, let alone, practically. "We could put a bank of three and four-axis VMCs in here, and perhaps have one or two assigned a certain percent of idle time, just waiting for the next hot job," McCracken says, "but that's just bad thinking. Planning-in idle time. In other words, building waste into a strategy designed to eliminate it. And from a practical point of view that approach wouldn't work. We don't have the space here. We used to do some runoff injection molding using prototype molds, but we had to part with molding when we moved in here. This facility is a huge space, but it's a space that's full to the walls.

"The key for us with this machine
is processing speed and constant velocity."

"Each Gore facility operates as its own independent business," McCracken says. "We bought the Revolution strictly for R&D, in particular R&D for EPD. And while EPD is paying for the machine, paying for my time, I pretty much run every R&D project or hot job on the Revolution."

For example, Gore develops and builds its own equipment, including machinery, and McCracken notes he uses the Revolution to quickly mill parts in those cases as well. "I use it for everything," he says, "but a major reason we purchased the GBI machine was to have the ability to get our product in our customers' hands, right now. This is what today's customers demand. Everybody wants quick turnaround despite greatly compressed lead times. The days of Just-In-Time are over. That's not fast enough. Customers now expect on-demand results. If you can't deliver to their expectations, they'll look elsewhere."

Gore: Way More Than Waterproof Fabric

W.L. Gore & Associates Inc. (Gore), was founded January 1, 1958 (Newark, DE), by Wilbert L. and Genevieve Gore. The privately held company lists 8000 employees in 45 plants and sales facilities worldwide. Although its most universally recognized product is Gore-Tex Fabric, the company also has a large presence in the medical-implant field.

Gore's portfolio of medical implants consists of materials and components that are designed to work with the body's own tissues to aid healing, and in many applications, to restore normal functions. Gore manufactures products used in vascular, endovascular, interventional, general-surgery, cardiothoracic, oral, and orthopedic procedures. Gore membranes in medical devices and surgical fabrics create reliable barriers to viral and bacterial contamination without compromising airflow. The company's Medical OEM offerings include Gore Medical Wire and Cable and Gore Ultrasound Probes and Cable Assemblies.

Gore technology is also found in consumer goods, electronic and electrochemical materials, fibers, geochemical services, fabrics, filtration, pharmaceutics, sealants, venting, and many others.

"A last thought on the idea," McCracken continues. "No matter how many machines we'd put in here to do parts—hot jobs, prototypes—none of the parts coming off those machines would compare to the quality coming off the Revolution—especially the superior surface finishes, hugely important in successfully prototyping die/mold work."

"The key for us with this machine is processing speed and constant velocity," says McCracken.

According to McCracken, conventional controls have a forward processing capacity of 600–3000 blocks/sec. High-end controls may provide 5000 blocks/sec. But a processing capacity to 50,000 blocks/sec for eight simultaneously controlled axes has a significant effect upon machine tool performance and efficiency.

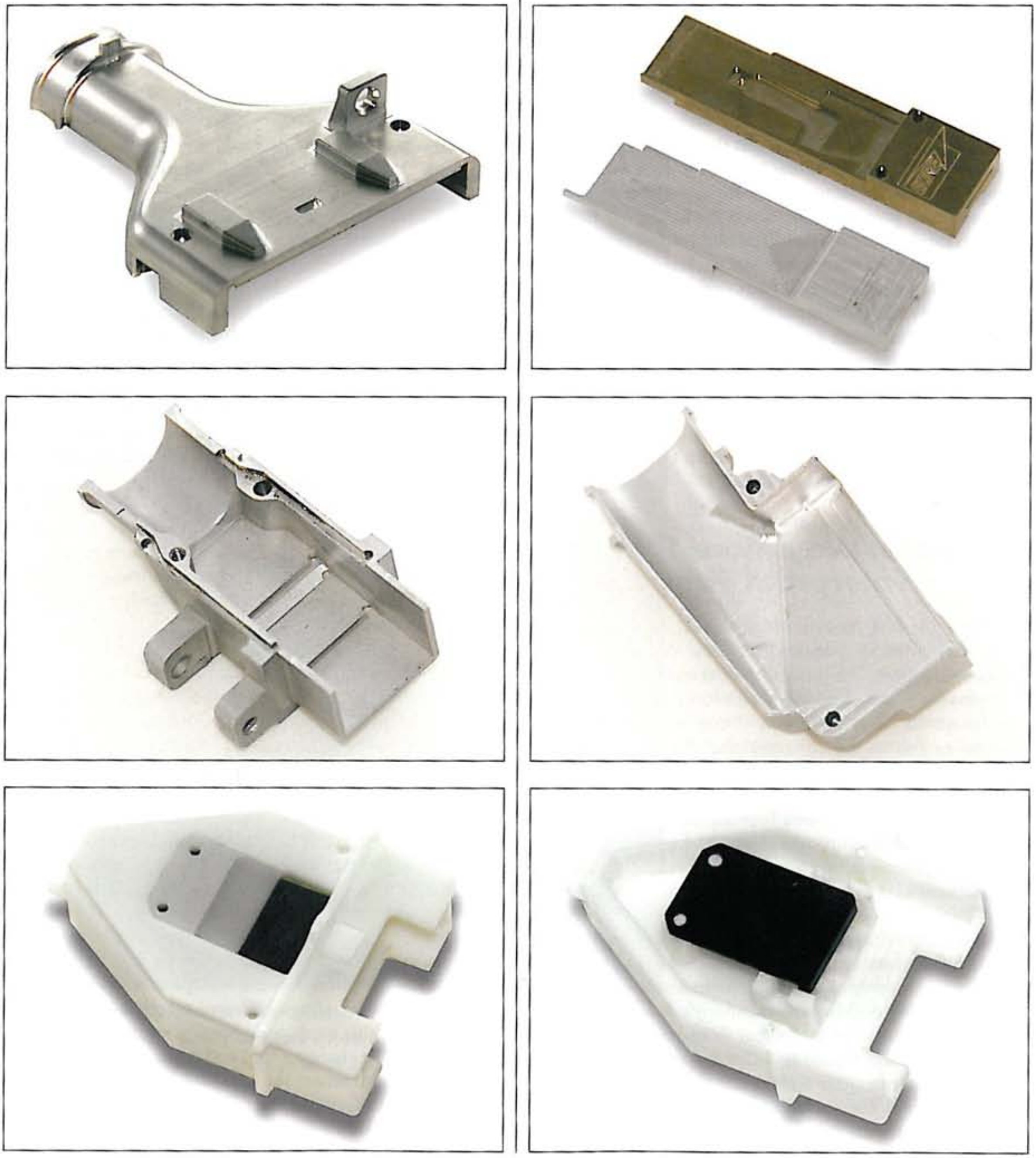
Because the Revolution's MTI processer can handle the very high volume of data that describes, in detail, the cutting tool path, the tool can maintain a nearly constant speed over the workpiece. This constant velocity along the cutting path eliminates the accel/decel experienced by the cutting tool as a conventional control tries to move through a complex prototype contour.

The Revolution's control has 80 smart data buffers, as compared to four to five buffers found in conventional controls. Able to run any CAD/CAM brand that can run in a Windows XP environment, the control can handle mid-program restart without difficulty. In fact, such restarts can be handled in four different ways—by line number, block number, percentage of program run, or by having the operator position the cutter over the workpiece and start.

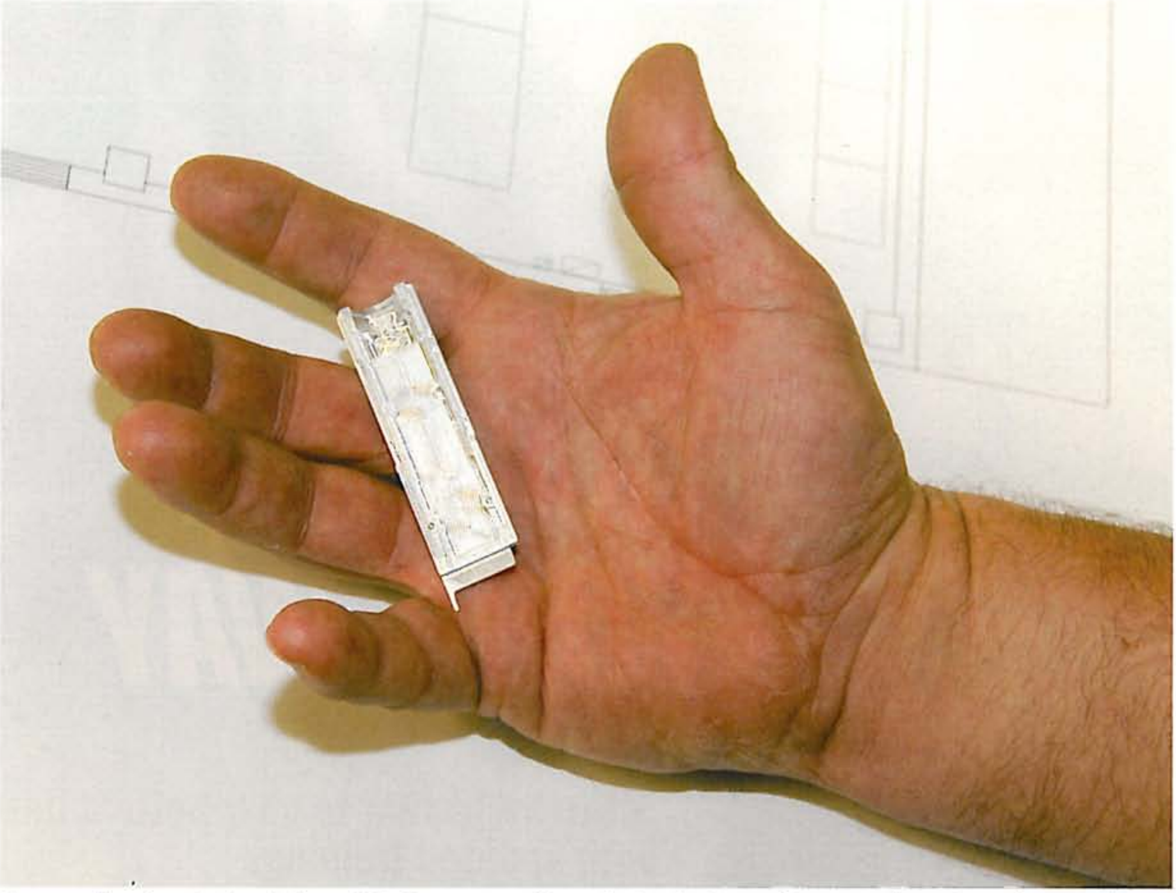
"When we were using a different machine—now retired—to do this work, we'd break a lot of tools," McCracken. "To change a tool and go back in the program to the point where the tool broke meant wading through code to find just the right point. With the Revolution, we don't do that. We go straight in and pick up right where we removed the tool. We save a lot of time, and it's easy.

"Equally important," McCracken notes, "is that we're using very small end mills, from 0.01" [0.254 mm] on up. The average endmill is 0.0625" [1.59 mm]. An end mill of 0.125 or 0.250" [3.17 or 6.35 mm] is a big end mill. Plus, these tiny thin tools are generally long, a good 6 to 10 times their diameter. Pre-Revolution, we'd break a lot of these small, thin tools. Now we don't break tools; we change them out when they begin to dull."

A conventional look-ahead system relies on feedback as the machine operates; the Revolution control calculates look-ahead before the machine starts and adjusts cutter movement as the machine runs. Its data-process-



A number of Gore prototypes. Note the geometric complexity, the shapes, contours, numbers of operations.



Parts machined on the Revolution at W.L Gore are small, ranging in size from a finger to a fingertip, and are made from engineering plastics, Delrin, Teflon, nylon, as well as aluminum and steel.

ing capacity enables the control to monitor operations and update toolpaths in real time. And 50,000 blocks/sec processing speed is the minimum achieved when interpolating eight axes; in a three or four-axis system, the processing speed is faster.

"This would be a great production machine, although that's not, of course, why we bought it," McCracken says. "We don't need all the speed, the very high rpms, a tool change in less than 2 sec—in fact, we had to dial the ATC down. We don't need those capabilities in prototype work. What we do need is the constant velocity, the accuracy, repeatability, and the designed-in rigidity and stability.

"Now if we were a production house, we could easily retire a couple of conventional VMCs and replace them with a single Revolution," McCracken continues. "The machine the Revolution replaced was a 6000-rpm, multi-axis VMC, and the Revolution gives us 15,000 rpm. Do we need 15,000 rpm? No, at least not now. Will the Revolution hit 15,000 rpm? We tested it. We ran it up to 15,000 rpm, and it wasn't even working hard. And its impact? With this single purchase, we've slashed prototype times by hours, if not days.

"We recently ran a 0.010" [0.254-mm] end mill at 12,000 rpm about 0.100" [2.54-mm] deep in Delron, and we made the part without a problem. I was shocked," McCracken says. "With an end mill that small, if you don't have through-the-spindle coolant just right, and if the machine isn't rock stable, and the speed variable not constant, you'll break the tool, snap it right off. At that speed and depth, end mills that small can't survive changes in the toolpath. But at constant velocity, they handle complex prismatic work like nothing."

> **"When a tool breaks,** we go straight in and pick up right where we removed the tool."