

# Reconfigure It Out

Reconfigurable manufacturing systems gain ground in the automotive sector.

An area of study that could benefit the automotive industry is the design of reconfigurable manufacturing systems. The RMS concept is a bold one—developing manufacturing systems capable of rapid change in structure, hardware and software components to quickly adjust production capacity and functionality in response to market circumstances.

Perhaps the biggest proponent of RMS is the University of Michigan, where the Engineering Research Center for Reconfigurable Manufacturing Systems (ERC/RMS) has been set up to investigate and develop the necessary RMS components.

“Reconfigurability means to design large manufacturing systems with the technical and engineering means to quickly change them when needed by the market,” said Dr. Yoram Koren, director of the ERC/RMS. “Some system changes may be [done to give users] the ability to produce a new type of product or part. More sophisticated system changes would be the ability to change the part quantities produced and change the mix of products.”

## Need for RMS?

Scott Walker, president of Mitsui Seiki Inc., Franklin Lakes, N.J., who is chairing a conference on RMS at IMTS 2004, said he sees the need for such research.

“Eight percent of the costs involved in manufacturing are operating costs, and 92 percent are other stuff, includ-



Phil Bojda, senior research engineer with GM R&D, demonstrates GM's new agile machining fixture, which incorporates modular, self-contained elements.

ing capital expenditures,” said Walker. “To lower the cost of doing business, that 92 percent has to be tackled. A big item in that area is the cost of capital equipment.”

Walker likened the move from today's equipment to RMS to the change that took place when CNCs became an integral part of machine tools. He said developing RMS will require a fundamental change in the way machine tools are designed.

Dedicated transfer lines are reliable and capable of producing high volumes of the same parts, but retooling them takes significant time and money. On the flip side, general-purpose CNC machine tools are versatile and accommodate part changes easily, but they are

not capable of the high volumes of parts that transfer lines can produce.

That is where RMS comes into play. The goal is to combine elements of dedicated and flexible machining to create systems that have high productivity, volume scalability and convertible functionality, yet still are economically feasible for manufacturers.

“The concept of reconfigurable machine tools falls somewhere between today's CNC technology and fixed manufacturing systems,” said Gerard Vacio, national product manager for workholding products at BIG Kaiser Precision Tooling Inc., Elk Grove Village, Ill. “Reconfigurable machine tools would be faster than CNC machines and more flexible than transfer systems.”

Automakers have increasingly outsourced parts production to their Tier 1 suppliers, while at the same time demanding continual price reductions throughout the contract. To meet volume demands, these suppliers are typically forced to fork out the expense for dedicated lines with little assurance of continued part volumes or duration of work. RMS theoretically would provide some flexibility if change were necessary and also could be scaled up or down as part volumes fluctuated.

Vacio said RMS technology would be suitable for a company that needs to process parts quicker than CNC equipment allows, but is doing runs of parts that are not long enough to justify fixed automation. However, he said this type of company is rare.

“The only time a company would really benefit from this type of technology would be if they were running high-volume parts for 2 months to a year and then switching to a different part and running it for 2 months to a year.”

## RMS at GM

General Motors Corp. is one of several companies that have been experimenting with the RMS concept.

Pulak Bandyopadhyay, laboratory group manager at GM, has been working with the ERC/RMS since 1996. Bandyopadhyay said GM has developed reconfigurable elements and is working to put them into its manufacturing processes. One is a reconfig-

urable fixturing system that can be quickly changed to produce different engine blocks or cylinder heads.

Typically, GM’s machining operations have been designed to process one specific product, because the fixtures cannot accommodate more than one particular type of part at a time.

The new “agile” machining fixture will enable the company to run 4-, 6-, and 8-cylinder engine parts on the same machine, reducing changeover times and costs.

According to Steve Holland, director of GM’s Manufacturing Systems Research Laboratory, GM’s agile machining fixture has a unique flexible design, which allows it to be easily reconfigured to machine multiple product designs in a matter of minutes vs. several months, the time it usually takes to re-tool such a fixture.

“Basically, we have a fixture that has a bed with an electropermanent magnetic base,” explained Bandyopadhyay. “On top of that, we have integral elements for the clamps, the supports and the locaters. The clamps are hydraulic units; we don’t need to run any plumbing lines to the fixture. We built some special adapters to pick and place those things right on the pallet system to build the fixture. So, if we go from one fixture configuration to another fixture configuration, whether it’s operation 10 or 20 on a part, or even go from a 4-cylinder engine to a 6-cylinder engine, we can redo the whole configuration in less than 15 minutes.”

The agile machining fixture will be installed within a GM powertrain plant in the first quarter of 2005 to help maximize capacity utilization and enable more efficient part changeovers.

## Reconfigurable Machine Tools

Reconfigurable machine tools fall into two groups: adjustable-functionality RMT and adjustable-capacity RMT.

The ERC/RMS has already developed a prototype under the adjustable-functionality RMT banner. It is a 15-hp machining center called Arch-type that has a spindle for milling and drilling on an adjustable arch-shaped mount.

The machine builds on the basic concept of machining: Presenting the part



This prototype RMT, designed by the ERC/RMS and built by Masco Machine, offers enhanced functionality by fitting a milling/drilling spindle on an adjustable arch-shaped mount.

so the surface being cut is perpendicular to the cutting tool. However, instead of adding accessories to accomplish this task, the machine itself is capable of accommodating a variety of needs.

Unlike standard CNC machines with vertical spindle columns, the arch-type has an arched column, which allows the cutting tool to traverse over a full range of  $-15^{\circ}$  to  $45^{\circ}$ . With a conventional X-axis table and an extendable column, according to the ERC/RMS’s Koren, the tool can do the job of a 5-axis machine with 3 axes of motion.

The ERC/RMS has patented the arch-type system, and, according to Bandyopadhyay, some machine tool builders are looking into building production models.

The idea behind the adjustable-capacity RMT is that it’s more cost-effective to purchase a single-spindle machine and add spindles when the market justifies it than to buy a multispindle, dedicated machine that is underutilized when market conditions wane.

## What’s the Hold-up?

Vacio speculated that the initial cost of an RMT would be around 40 percent

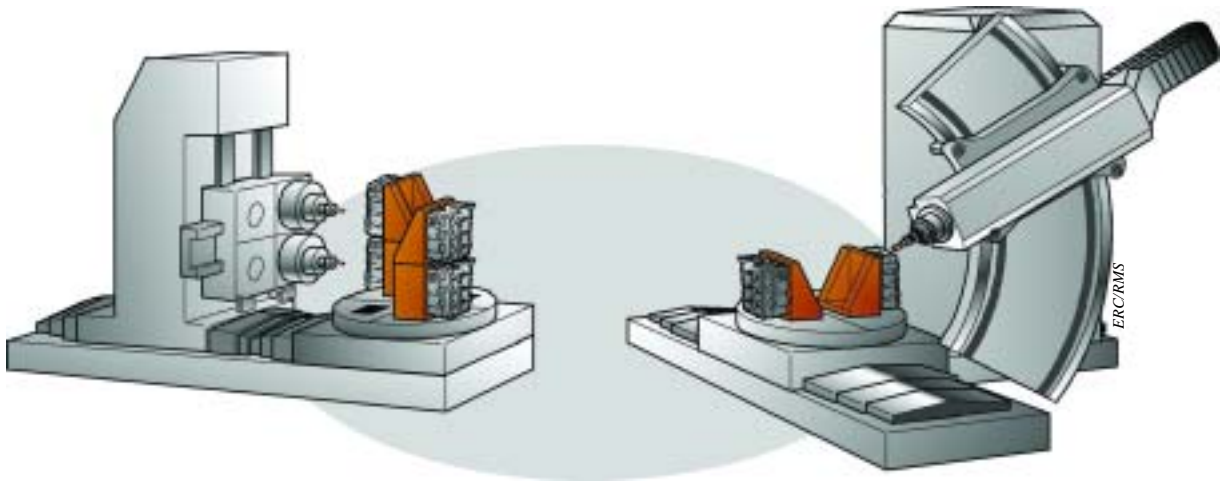
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These drawings represent the two classes of RMTs—adjustable capacity (left) and adjustable functionality. Adjustable-capacity RMTs are designed to allow the addition of machine components to meet increasing volume demands. Adjustable-functionality RMTs are made to allow a single machine to perform multiple tasks.

more than today's CNC machine tools. Bandyopadhyay agreed that the initial cost may be higher but said that over time a reconfigurable system would pay for itself.

He added that it may be a while before this type of system hits the market. "There are other mechanisms, like trunnion tables and angle heads, that

accomplish the same task as the arch-type machine," said Bandyopadhyay.

If this is the case, why would machine tool builders offer reconfigurable systems? Because of user demand, said Bandyopadhyay. "It is a good technology, but someone that builds machines has to pick it up. As soon as one major machine tool company picks it up and

offers it as a solution to the OEM, we will buy it."

The ERC/RMS has predicted that by 2006, 25 percent of IMTS exhibitors will be showcasing RMS products or services, and in 15 years the reconfiguration paradigm will be fully accepted by the industry. For now, though, it seems to be a matter of wait-and-see.