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# Looking at CAM with Another Set of Eyes

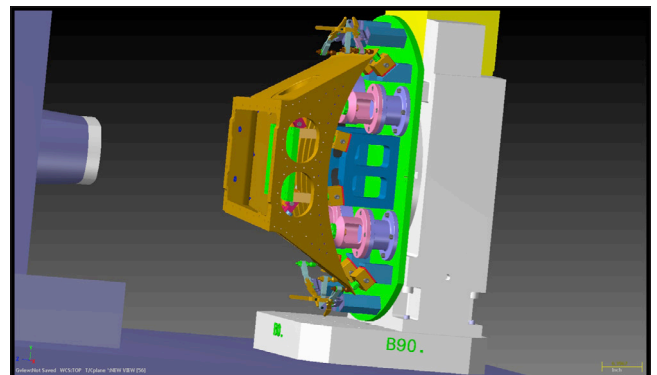
A CAM programming consultant reveals how enlisting another set of eyes can dramatically improve manufacturing quality and productivity

Ron Branch, owner of 5th Axis Programming, Anaheim, CA, makes his living by regularly working himself out of a job as a manufacturing process and CNC machine programming consultant. The typical employment scenario would be to sign on to help a manufacturer fill a CNC programming skills gap by writing CAM (Computer Automated Machining) programs for newly acquired advanced manufacturing capabilities. At the same time, he would coach the company's existing programmer(s) on the organizational requirements and skills needed for being successful in such disciplines as reverse engineering, high speed machining, or 5-axis manufacturing.

When he was through with his assignment, whether in two weeks or 6 months, Branch's customers rarely called him back for a second engagement. That's because his protégés had mastered the skills he was called upon to teach,

and they had lined up additional resources for learning on the job to keep up-to-speed with inevitable advancements in CAM technology.

"That's OK with me," he said. "My customers wind up operating so much more efficiently that they are actually bringing manufacturing work back to the USA. I get a kick out of that."



**Workholding Solution:** Incorporating a workholding solution into Mastercam makes it possible to develop a more complete and efficient manufacturing process before the part is ever set up for the first time on the machine. When families of parts are involved, carefully designed workholding can be used with many different parts to reduce the cost of the fixture and make manufacturing processes more consistent.

## Ron's Rules

Branch has formulated a number of rules that help him teach customers why they need to more effectively harness the model for increasing productivity and quality.

**3 For 1:** The first of these he calls the “3 for 1 rule.” For every dollar you seem to be wasting on a scrap part, you are actually wasting 3—the initial loss, the time and money that will be spent replacing the scrapped part, and then the time and money you spend fixing what went wrong in the first place, so you won't do it again.

**Model Based Part Definition:** When Branch works with customers, he places a heavy emphasis on using Model Based Part Definition throughout the manufacturing process. He said, “With the model as our constant directional focus, we use it to ask questions and receive answers about what we can do to reduce sources of error and improve productivity.” But there is even more to it than that. The model can be used not only as an information set, but also as an intelligence set. In other words, CAM software can take advantage of intelligence embedded in the model so that it can do things like simultaneously adjust cutter feeds and speeds based on the part geometry (as in Mastercam's Dynamic Milling Toolpaths).

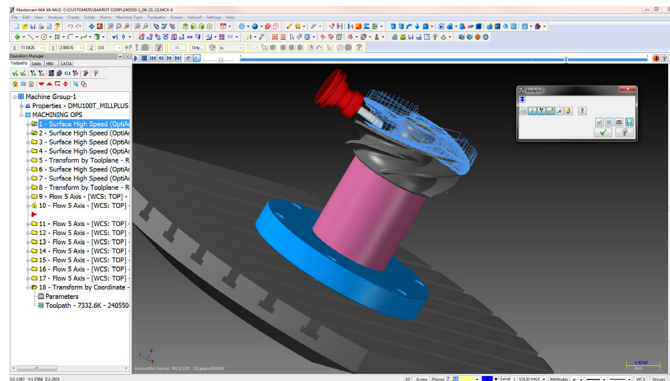
**People, Processes, Technology:** This aphorism provides Branch's customers with a handy framework for analyzing manufacturing problems as well as potential opportunities. “People” has to do with the availability of appropriate staffing, along with their current skill levels and motivation. Problems in this area can be solved via hiring and training. “Technology” is self-explanatory; it reminds the problem solvers to assess whether or not the equipment and software currently available are up to the job at hand. Companies can have adequate people and technology in place, and still miss the boat because their processes are incomplete or inappropriate.

These simple conceptual tools make it easy to focus in on and identify the root cause of almost any manufacturing process dysfunction.

## Another Set of Eyes

In 2012, Branch was enlisted by the Mastercam programmer at a precision CNC machine shop that wanted to make the transition from 3-axis work into 5-axis machining. This shop had a reputation for doing high-quality work and had acquired an excellent 5-axis machining center. The programmer was very adept at using the Mastercam Mill Level 3 software for 3-axis work, and wanted Branch to spend a couple weekends with him helping write the company's first 5-axis machining programs. Branch wound up staying on this job for the next four months.

Branch does not claim to be any sort of a manufacturing guru, only someone who has worked for or with dozens of manufacturing companies. So he has seen what works and what doesn't. He said his primary value is to be another set of eyes that can see things from a somewhat different perspective. In this case, the people (i.e. the programmer) and the technology were not going to be issues that would re-



**3 + 2 Machining:** Branch's clients frequently purchase 5-axis machines for projects requiring full-five axis work. Once they get up and running, they discover 3 + 2 machining on their 5-axis machine results a super-productive manufacturing when multiple 3-axis operations are required because the technique eliminates multiple set-ups .

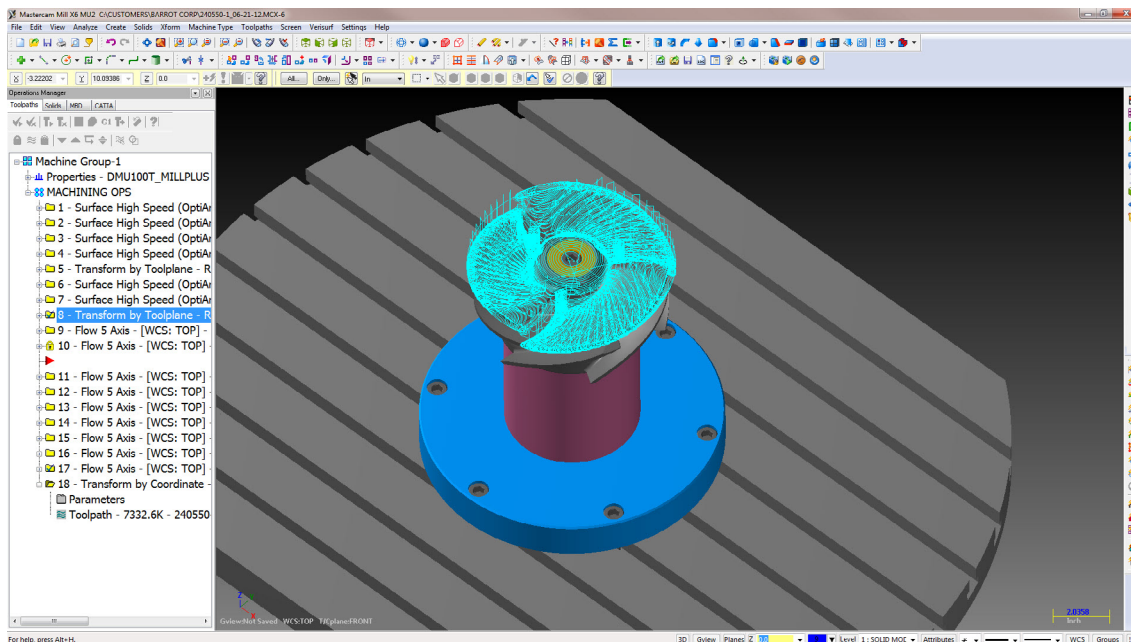
quire a lot of work. However, there were process issues that needed to be solved so that this company could effectively use 5-axis technology to the fullest extent. The first part the company wanted a program written for was an impeller blade, which immediately brought the first process issue into focus:

**Workholding:** This company was used to clamping workpieces in a vice and then doing multiple set-ups until the work was complete. Branch worked with the programmer to help him design a modular fixture that would provide the necessary rigidity for 5-axis machining, along with tool accessibility so that the part could be completely accessed in one or two set-ups, instead of upwards of a dozen. This was done working in Mastercam Design, using the actual part as a template around which the fixture would be created, and using simulation to assure that all critical features could be accessed with the shortest possible tool.

The families of impellers needed by this prospective customer were diverse; so it was important to have a modular, interchangeable fixture design that could be used for manufacturing up to 40 different impellers. The meticulous engineering of the fixture impressed the customer, which was one of the reasons it decided to initiate a business relationship with Branch's client.

**Model of the Table:** The fixture design issue immediately led to the question of where and how the workpiece would be located on the 5-axis machine's table. Before they started designing and building the first workholding solution, Branch worked with the programmer to incorporate a model of the table into Mastercam. This eliminated the need to be continually running out to the machine and measuring the table to obtain appropriate locations. The table model has been an on-going time saver, assisting in the placement of work holding systems for various jobs set-up and aligned for continuous manufacturing, one after another.

**3 + 2 Machining:** To make the most of good 5-axis equipment you have to keep it in constant motion making parts. If shops reserved 5-axis equipment for only simultaneous 5-axis machining, few would be able to keep the machine



**High Speed Machining:** Branch believes that many shops operate at feeds and speeds that are far less than optimal. This tendency can be countered by relying on high speed machining

productive on a full-time basis. Many shops get most of the value out of the 5-axis equipment using it to do 3-axis machining on parts that previously required multiple machine set-ups. Branch spent some time helping the programmer become very proficient in this 3 + 2 machining.

Branch estimates that about 75% of the time this company's 5-axis system was in the 3 + 2 mode, rather than full 5-axis. When it is in this mode, the machine is not making all of those incredible swooping 5-axis moves that some proud owners call "dancing". Instead of dancing, the machine is being super-productive, in many cases roughing out parts with stubby features that give it 3X the throughput than when it is roughing in the full 5-axis mode.

**Work Coordinate Systems:** He introduced the programmer to Mastercam's WCS (work coordinate system) which allows the programmer to set up a coordinate system for every orientation in which the machine will be locked for each operation. This makes it easy to switch from one orientation to another simply by clicking on a menu item, which is an important programming timesaver.

**Out of the Comfort Zone:** During his stay, Branch noticed that some of the feeds and speeds being used on equipment in the shop were far less than optimal. That was because it was the shop's policy to allow machine operators to run equipment at the feeds and speeds they were comfortable with. For example, spindles capable of operating at 18000 rpm were only being run at 8000. It is really difficult to stay competitive when other shops in the same market are running the same equipment nearly twice as fast.

As a test case, Branch and the programmer took a high production aluminum part that was typically running at 22 inches per minute and adjusted and used high speed machining techniques to adjust feeds and speeds upwards, but within safe limits. The part was taking 3 hours to complete

before the adjustments, but only 45 minutes after them. Based on these results, the company changed its policy on feeds and speeds, mandating that all production work would be produced at the highest reasonable throughputs.

**Managing Tool Libraries:** Another way to machine faster is to invest in tools that have been designed to take advantage of high speed toolpaths. The tool may cost more and have to be replaced far more often. "But, if it can make parts 5 times faster, the additional tool cost becomes a high ROI investment," Branch said. "Powerful tool libraries within Mastercam allow programmers to develop a history of tools, usage, and their cost relative to machine productivity. This ongoing data collection grows deeper over time and becomes a competitive advantage for the shop using it."

**Little Things Add Up:** The programmer was annoyed because it was sometimes taking 45 minutes to an hour to load CAM programs into the machine controller from the computer via standard RS232 communications. While the program was loading in this manner, the machine stood idle. At the cost of a small length of Ethernet cable, the upload method was changed to one that took only 3 minutes, recovering nearly an hour of machine time per job changeover.

The programmer at this company was a very fast learner. All of the 3D visualization tools in the software accelerated his progress because they made it easy for him to actually see the concepts Branch was trying to convey. Within the space of four months, all of the issues Branch had raised in regard to the companies 3D manufacturing processes were resolved. Since then, the company has grown, added new 5-axis equipment, and is looking to move into a larger facility. It continues to produce 3D and 5-axis work at consistently high levels of quality and productivity. Branch talks to his programmer friend from time to time, but his services won't be needed any time soon. He worked himself out of a job.