The CAD/CAM Challenge: Keeping the Complex Simple

New solutions offer more support for complex multitasking machines, optimized high-speed roughing, and better simulations

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To stay ahead in the game, manufacturers constantly seek an edge over the competition. With today’s CAD/CAM software, the builders of aircraft, automobiles and other complicated systems get the innovative programming tools needed to coax the most performance from complex, expensive machine tools. The latest CAD/CAM software features more support than ever for the complicated multitasking machines that can cut costs and boost production through “done-in-one” single setups. Highly realistic simulation capabilities help machinists visualize everything from the NC metalcutting process to full machine simulation.

The highly fragmented CAD/CAM market has continued on its long trend of consolidation, with many bigger players buying up technology by acquiring smaller CAM-centric companies. In November 2014, additive manufacturing developer 3D Systems Corp. (Rock Hill, SC) signed an agreement to buy Cimatron Ltd.
Last year, CAD giant Autodesk Inc. (San Rafael, CA) finalized its $286-million purchase of CAM-centric developer Delcam Ltd. (Birmingham, UK).

Rethinking Multitasking

With the complexity of today’s multitasking machines (MTM) rising, programmers of these systems need the best solutions available for handling multiple spindles and multiple turrets machining simultaneously. MTM operations necessitate precise timing of machining operations, and optimal simulation of machining operations to prove out processes before ever cutting metal. CAM developer Gibbs and Associates (Moorpark, CA) has taken a new approach to supporting these machines with its new Universal Kinematic Machines (UKM) shown last fall at IMTS.

“Some of the most important trends in CAM software today are the necessity of supporting the evolution of advanced CNC machines, and creating a single programming environment for end users that encompasses programming of all types, including integration with 3D printing,” said Bill Gibbs, president, Gibbs and Associates. “No longer are CNC machines simply a mill or a lathe. Instead, the variation of configuration of MTM machines continues to expand and blossom in pursuit of ever-greater manufacturing efficiency.

“The challenges include unlimited axes in unlimited configurations,” Gibbs said, “combining five-axis milling, multi-axis turning, multiple tools cutting at the same time, multiple part stations—all in pursuit of material in and finished parts out.”

GibbsCAM 2015 UKM is a next-generation architecture that aims to dramatically increase support of program generation and simulation of such machines. UKM offers “support of the simplest to the most complex CNC machines in the same integrated CAM environment, with advanced postprocessing capabilities, and machine simulation, providing a rich environment with the highest level of user interface consistency,” Gibbs said. “It’s easy for a programmer to support a variety of machines, as he only has to learn a single CAM software to do it all.”

Virtual Machining

More realism in simulations is key for any shops tackling advanced manufacturing processes, particularly with multitasking machines and simultaneous five-axis machining operations. Many choices proliferate in CAD/CAM, with improved simulation components in nearly every CAM system, ranging up to high-end, very detailed simulations offered by NC simulation, verification and optimization software like Vericut from CGTech (Irvine, CA).

“Simulation is being used more and more as a process validation tool, not just a tool to check for catastrophic errors such as machine collisions and gouges in the workpiece,” said Bill Hasenjaeger, CGTech product marketing manager. The latest Vericut 7.3 version features an updated desktop layout for improving customer experiences, and the software adds an enhanced status display for users to monitor machining processes. “With accurate representation of material removal in Vericut, it’s becoming practical to predict the effects cutting has on the tool and the workpiece at a very detailed level,” said Hasenjaeger. “This information can be used to validate a new cutting process, or adjust an existing one for better efficiency.”
The latest Geometric CAMWorks 2015, introduced at IMTS, has further refined the machine simulation capabilities of its G-code simulation, noted Nishant Saini, director, corporate marketing and communications, Geometric Technologies Ltd. (Scottsdale, AZ, and Mumbai). “We’ve added many machines and 25 different controllers,” he said. “It has full machine simulation that includes the fixtures, the machine envelope, and any of the moving parts. This way a machinist can say, ‘This is what I need to model, and that is what I don’t need to spend time on.’ These are ready-made, out-of-the-box solutions.”

This CAMWorks Virtual Machine functionality offers users true G-code simulations using the machine tool’s G-code, rather than using cutter location (CL) data as do other CAM systems. Virtual Machine offers full support for complex multitasking and mill-turn machines, and it includes synchronized simultaneous machining with multiple channels using timing codes, which are easily controlled using CAMWorks Sync Manager.

The software also allows automating specific routines with color-coded definitions that enable easy viewing of simulation components, which can be useful especially in the medical industry. “These are based on scans of actual body parts, taking the cloud information and converting it into surfaces,” added Vivek Govekar, head of R&D for Geometric. “There are a lot of facets, so that takes a lot of time. Color coding those gives you the advantage of seeing which ones need machining.”

In Siemens PLM Software’s (Plano, TX) portfolio, many simulation options are available, from simulations in its recently updated NX 10 CAD/CAM/CAE software to the company’s Tecnomatix digital manufacturing solutions and also newer testing simulation functionality in its LMS simulations. “We certainly see simulation having gone mainstream,” said Aaron Frankel, Siemens PLM Software’s director of product marketing. More simulation is now available within the NX 10 line, including CAE applications for multiphysics and new production line design capabilities for automotive assembly that allow engineers to visualize layouts of production lines within NX, and use Siemens’ Teamcenter product data management and Tecnomatix to manage, validate, and optimize manufacturing processes.

Speeding Roughing Operations

Faster metalcutting methods are in high demand, and users get a lot more high-speed roughing material removal choices among the latest CAD/CAM releases. By speeding
up roughing operations, the most time-consuming part of any metalcutting, many manufacturers are seeing cost payback that helps make economic sense for reshoring mold-and-die work from the Far East (see “Advanced Programming Makes the Case for Reshoring Moldmaking Operations” in the December 2014 issue of Manufacturing Engineering).

Roughing options abound in CAD/CAM today, with many CAM providers licensing the VoluMill high-performance toolpath technology from Celeritive Technologies Inc. (Cave Creek, AZ), while others employ their own home-grown strategies. Those solutions include Delcam’s Vortex controlled-engagement toolpaths and also the Dynamic Motion toolpath technology developed by CNC Software Inc. (Tolland, CT), developer of Mastercam software.

“The key trends in CAM software are still simple but powerful: constantly increase the speed and efficiency of the software, automate where possible, deliver programming methods that make the best possible use of machine tools, tooling, and material, and make the software capable of handling the increasing variety of jobs a shop encounters,” said Ben Mund, CNC Software marketing manager.

“A great example is the wider adoption of dynamic-style toolpaths, a technique we’ve been developing and expanding across our products,” Mund said. “This technique is a different philosophy on creating cutter motion that uses more of the tool and deeper cuts, while reducing machine time and tool wear.”

Another example, he said, is better understanding of a part’s changing stock model—using the changing stock model to automate and streamline subsequent operations helps create the most efficient motion possible. “This is especially useful with mill-turn machines and repositioning for multiaxis manufacturing.”

CAD/CAM customers want software that is more powerful, flexible, easier to learn and faster to use, said Peter Dickin, Delcam marketing manager. “Software companies are working hard to meet those needs. On the CAM side,
much of the development is being driven by developments in machinery and cutting tools,” Dickin said. “Machines are becoming more complex, especially multtasking equipment with multiple turrets and spindles, so CAM software needs to be able to program these more advanced machines.

“At the same time, cutting tools are able to achieve metal-removal rates that would have been unthinkable even a few years ago,” he added. “New strategies are needed to take full advantage of these capabilities.”

The Delcam Vortex high-speed roughing functionality, which can achieve up to 60% faster machining cycle times, is now available across its entire CAM line including in PowerMill, FeatureCAM and Partmaker.

Another option for high-speed roughing is ProfitMilling in the Esprit 2014 CAM software from DP Technology Corp. (Camarillo, CA). “In smoothing the toolpath and combining engagement angle, chip load, lateral acceleration with feed rate optimization, Esprit ProfitMilling technology drastically reduces machining time,” said Cedric Simard, DP Technology’s director, global marketing and communication, noting that ProfitMilling supports two, three, four and five-axis machining.

“CAM users will benefit from bottom-up roughing cycles,” he said. “Rather than traditional top-down strategy, bottom-up roughing allows users to tremendously reduce cycle time by taking the full depth of a cut in the first pass.”

More Automation, Smart Machining

Another key area in CAD/CAM development is automating best practices and leveraging knowledge-based systems to help speed up machining processes. “A significant advancement has been the introduction of software intelligence, which reduces reliance on CAD/CAM experts,” said Steve Sivitter, CEO of Vero Software (Tuscaloosa, AL, and Cheltenham, UK), developer of several CAM packages including Edgecam, Radan, Machining Strategist, Surfcam, WorkNC and the VISI Mould.
and Progress moldmaking packages. “This can be achieved with a knowledge-based database, which adapts over time and can be used by anyone to achieve the same results, following proven and tested rules and conventions.”

Manufacturers that establish plant-wide database defaults that represent company standards will ensure that, from user to user and job to job, the company produces consistent results and high-quality tooling, Sivitter noted. “Intelligence can be added to the software so that the system can automatically select the best strategy or machining parameters based on remaining stock or geometrical attributes,” he said. “One example of this is the ability to take a standard three-axis toolpath and convert it for use as a five-axis toolpath, rather than having to rework it from the beginning. This is particularly useful for dealing with both short-reach cutters and deep pockets.”

The integration of a CAD/CAM system ensures that data can be successfully passed from CAD to CAM, he said. “Those same features, diameters, hole depths, etc., can be automatically read by the CAM system, instilling confidence in the user regarding programming and automation,” Sivitter said.

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Automating the know-how of frequently performed operations is key for many manufacturing processes, particularly for machining operations such as pocketing on large aircraft structural components, noted Jean-Marc Cauzac, Delmia Manufacturing Consultant, senior machining expert, Dassault Systèmes (Paris).

Reusing this captured knowledge is important. “Especially for manufacturers working on one domain, like aerospace, this is key because you’re working on the same kind of parts. CATIA V6 includes a lot of knowledgeware inside,” Cauzac added. “You want to reuse the same parameters because you know it’s working.”

CAM in the Cloud

New cloud-based systems also are another positive development in CAM, Cauzac said. “The cloud solution is very good. With the cloud, I think we’re at the beginning. When you take a look to your daily activity, everything is done through the Internet. This allows you to manage the supply chain through the cloud.”
mended cutting tools based on machining features and machining sequences, and simulates with accurate 3D models of tool components and assemblies.”

Adding Additive

With the growing interest in additive manufacturing, CAD/CAM developers are also looking into programming alternatives for innovative new hybrid additive-subtractive machining systems coming onto the market. But most see this as a complementary technology to traditional subtractive manufacturing techniques and software, given the current limitations of AM on part precision and for manufacturing in large volumes.

“An additive toolpath is not a CAM toolpath in reverse,” said Frankel of Siemens PLM Software. “We are working with DMG Mori to develop research and development on this. It’s research at this point in time.”

Manufacturing processes have evolved in many ways over many years, said Vero’s Sivitter, noting that the advancement of polymers made many previously machined components unnecessary. “So it’s certain that additive manufacturing will negate the need for some machining operations and—in the cases of some prototypes and patterns—it already has,” Sivitter said. “It’s also worth noting that production speed and build window will always be a restriction for 3D printing. However, new machines such as the DMG Mori Lasertec 65—which can deploy metal powder, weld with a laser, and mill in five axes—can improve production and costly reworking procedures.”

Developments on GibbsCAM include the integration of 3D printing as another machine and process that manufacturing companies will need to consider and support in the future for integration into their processes, Gibbs said. “In my opinion, the future of manufacturing is Digital Fabrication. This is not my term, I first heard it used by Avi Reichental, CEO of 3D Systems,” Gibbs said. “He uses it to describe the growing integration of functionality from part design through multiple integrated manufacturing steps all the way to a finished part. The separate component pieces exist today, but not in a single, coordinated solution.

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“The dream is smart, integrated software that allows engineers to design with full consideration of optimal, integrated manufacturing,” Gibbs said, “including seamless transitions from 3D printing to whatever CNC processes are required.”
Some aspects of what that software would look like include managing with the entire process from a single software package and the inclusion of manufacturing knowledge-based assistance for designers and manufacturing engineers, Gibbs added. "It would make standard full associativity to automatically reprocess changes in the design, all the way through the manufacturing processes. It would support the most advanced multi-axis CNC machines, while providing simulation and digital prove-out to perfect programs before they get to the machine, eliminating human error from endless edits.

"Many CAD/CAM software systems can do some pieces of this. But the fully integrated Digital Fabrication environment promises so much more than a hodgepodge of patched together software," Gibbs stated. "Working towards this goal has to be the most important trend in CAD/CAM today. It is a mighty undertaking. But you can see major companies acquiring the technologies they need to pursue it."