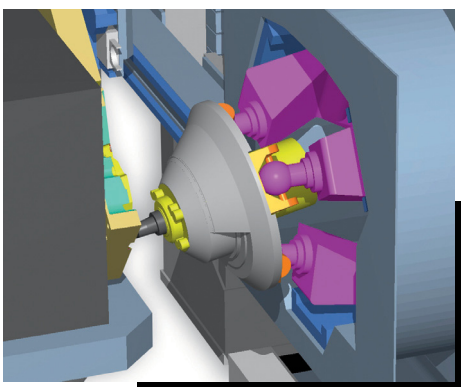
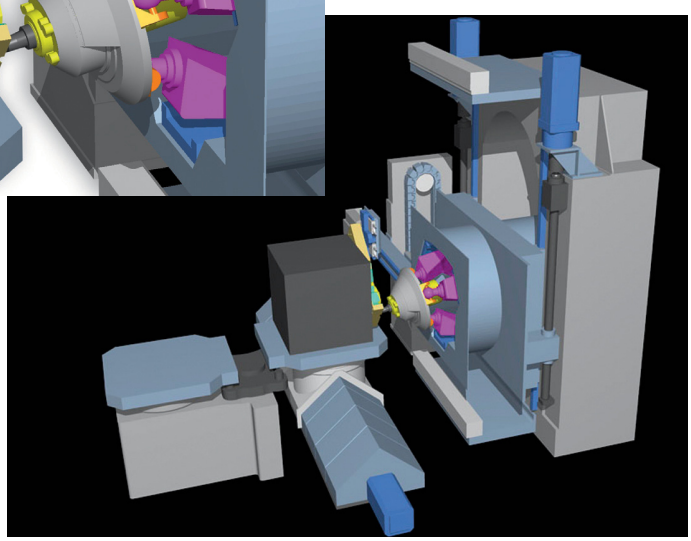
Simulation and verification tools have become critical in complex manufacturing environments, where multiple axes are in motion simultaneously and hundreds of thousands of pounds of investment are at stake. CGTech has been at the forefront of research for two decades now and is ever expanding its areas of expertise. By Martin Oakham

Laying down the future





CGTech has seen a growth of simulation for non-traditional cutting operations such as machining with a parallel-kinematics machine eg the Ecospeed Z3 Sprint tripod spindle head from DST.

CGTECH'S expertise in NC/CNC program simulation and analysis software began in 1988 in Irvine, California, when founder and President Jon Prun responded to a growing need to verify NC tool path programs without wasting machining time cutting 'prove-outs'. The software – Vericut – ran on UNIX workstations and used a 3D solid model to graphically show how material would be removed; PC versions followed in 1993. Any potentially damaging errors such as axis over-travel, collision between tooling and work-holding devices, rapid moves in material, and tool change collisions would be detected and written to an error log where they can be addressed.

The software was quickly adopted by companies running complex CNC cycles, most notably the aerospace, automotive and power generation sectors. Once established, CGTech was able to extend Vericut by offering toolpath optimisation, which could reduce machining times by up to 50% by adaptively adjusting feeds and speeds based on material removal rate. This in turn improved surface finishes and extended tool/machine life. CGTech then focused on simulating the kinematics of multi-axis and multi-spindle machine tools, so that the entire cutting process including any jigs and clamps could be 'proved-out' virtually. CGTech then included an additional AUTO-DIFF module for model analysis, allowing a cut model to be compared with a design model from a CAD system. The Model Export option also allows the cut model to be exported to a CAD system as a solid model.

The latest release added more NC program-checking tools, with a user-configurable syntax checker in addition to the program's already supplied control emulation. 'We've found that syntax checking not only has to do with checking what's valid for a specific brand or model CNC control's logic, but also what meets a specific company's standards and preferences,' says CGTech's John Reed.

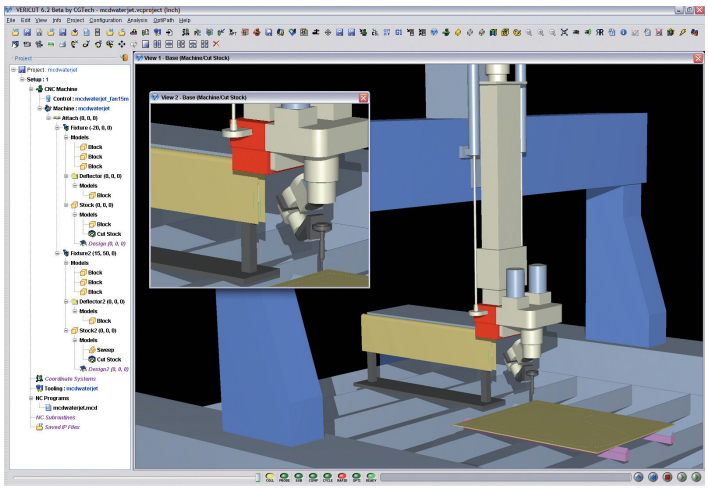
Other new functions include simulation of tapping operations, reading the machine's tap cycle commands, and applying a parametric tap tool to create a tapped-hole feature in Vericut's simulated cut part. This also allows several error checks for common tapping problems such as wrong spindle direction, wrong feed rate for the tap's lead, missing or undersize drilled holes, and improper motion.

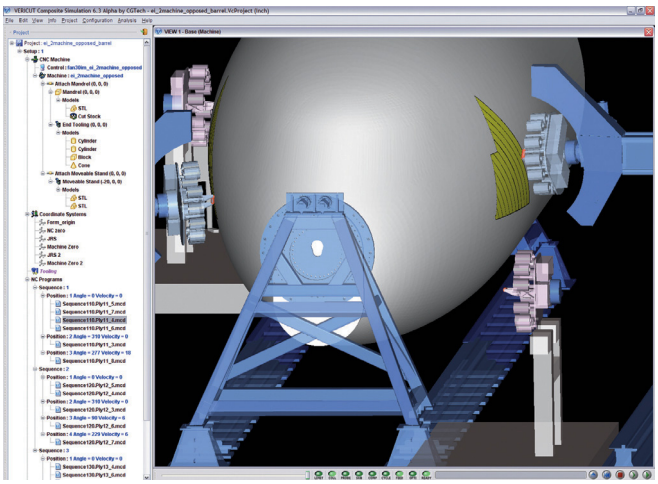
CGTech has successfully modelled machine tools and palletising systems from many companies, including 'Technology Partner Program' members – Cincinnati, Mazak, Mori Seiki, Chiron, Makino, Hermle, Okuma, Matsuura, DMG and DIXI – who freely help with details of critical design criteria, for modelling purposes. The company enjoys a worldwide presence, with wholly-owned subsidiaries in France, Germany, Italy, Japan, China and the UK. Approximately 40% of revenue comes from Europe, 30-35% from the USA, the remainder from growing establishment in Asia Pacific, primarily in Japan and China. UK users go back to around 1990 in the aerospace business.

CGTech's success has been born from its independence; simulation is based on the actual NC-code generated by the post processor output, ie the machine-specific data actually used to cut the part. Most verification products associated with CAD/CAM products derive their simulation data from the APT/CL-File, or system's internal toolpath. This is effectively like 'marking their own homework', and, while useful as part of the CAM process, does not provide the necessary confidence to allow users to eliminate prove-out on the machine tool.

A comprehensive machine tool and controller definition is essential for precise simulation, taking into account factors such as tool length compensation (multiple driven points, 5-axis 'RTCP' etc), Subroutines (both part program and controller resident), Cutter Radius Compensation, XC Interpolation (typical on mill/turns) etc. Furthermore, Vericut's ease of configuration, allow easy support for steadies, sub-spindles and tailstocks – without which it would be impossible to detect machine tool collisions.

In fact, so strong is CGTech's argument for total NC-verification, that CAM developers are forming partnerships with CGTech and developing interfaces to Vericut within their product. CAD/CAM Software Partnerships include leading developers such as: PTC, Siemens, Dassault Systems, Mastercam, GibbsCAM (Cimatron) and Edgecam





Left: crash prediction/simulation for water jet cutting; Right: composite layup programming

(Planit), TopCAM (Missler). Both Delcam and Open-mind have written their own Vericut interface, as it is used prominently in aerospace companies which they are venturing into.

'Due to the increased openness of CAM; tier 1 suppliers to the aerospace, automotive and power generating sectors are increasingly opting for multiple CAM systems, in a "best in class" software selection fashion, rather than using just one corporate wide CAM system. Here, CGTech is finding that it is becoming the common link, as it is able to handle NC data from any CAM system' says John Reed. Most recently, CGTech has seen a growth of simulation for non-traditional cutting ops eg composite trimming with a waterjet machine or machining with a parallel-kinematics machine (PKM) like SMTs (Vasteras, Sweden) Tricept 805, or the Ecospeed Z3 Sprint tripod spindle head from DST. The trend seems to be towards speciality machines and techniques specifically for machining composite structures.

Composite applications

In aerospace, more composites means more machining of titanium (Ti) parts, since Ti is required for internal structures. The Ti used is changing as well, from the traditional 6AL/4V grade to stronger grades such as 6AL/6V 2Sn. These new materials can be used to design lighter structures, but they also tend to be more complex and difficult to machine. This has instigated an increase in the use of Vericut's OptiPath feed-rate optimisation software. The tougher materials require closer control of the feed rates when cutter contact changes during cutting.

Further, the rapid increase in composite-related demands has led CGTech into simulating composite layup for automated fibre-placement machines, and even into NC program path generation and post-processing for fibre-placement. The Vericut Composite Applications Suite is machine-independent off-line programming and simulation software for automated composite tape and fibre placement CNC machines. It consists of two separate applications: Vericut's Composite Programming VCP and Vericut Composite Simulation (VCS).

VCP reads CAD surfaces and ply boundary information and adds material to fill the plies according to user-specified manufacturing standards and requirements. Layup paths are then linked together to form specific layup sequences and output as NC programs for the automated layup machine. VCS reads CAD models and NC programs, either from VCP or other composite layup path-generation applications, and simulates the sequence of NC programs on a virtual machine. Material is applied to the layup form via NC program instructions in a virtual CNC simulation environment. The simulated material applied to the form can be measured and inspected to ensure the NC program follows manufacturing standards and requirements. A report showing simulation results and statistical information can be automatically created.

Boeing was a key instigator, when it asked the company to develop a program for Automated Fibre Placement (AFP) machine simulation of its 787 fabrication. This project progressed in 2005 to include the development of a programming solution for AFP machines. In 2006 Electroimpact was selected to supply Spirit Aerosystems with a multiple machine AFP lay-up cell for the Boeing 787 fuselage section 41. The lay-up cell features multiple independent machines each with automatic head changers, resulting in a high continuous lay down rate. For nearly three years now, Electroimpact has been in a non-exclusive co-operation with CGTech to develop AFP programming and simulation software. Following more than two years development and testing this software will be used by Spirit Aerosystems to program the new Electroimpact AFP machines being installed.

CGTech has also partnered with AFPT, a Dutch developer of a thermoplastic tape that instantly bonded when applied to a surface. AFPT has been developing its fibre placement head for over three years and is using a diode laser to cure the material as it is applied. The placement head is attached to a standard industrial robot (eg Kuka or ABB). Vericut Composite Programming and simulation software is designed to be independent of any specific CNC fibre- placement machine in the same way a modern CAD CAM application supports CNC machining. CGTech believe that this approach will ensure that the software and underlying technology expands.

Finally, a new trend is emerging, where companies looking to invest in new machinery are using Vericut to evaluate machines and determine if they meet their requirements for cycle times etc. In just 20 years, Vericut has become the industry standard for verification. Its continual enhancement of Vericut reflects the company's ongoing commitment to delivering innovative, powerful, and robust solutions for manufacturers. This is a strong company, which has truly come of age – now that additive and subtractive manufacturing processes have reached new levels of complexity. **www.cgtech.com**