To develop a computerized numerical control (CNC) machine that could run autonomously with no human intervention for 50 hours, ANCA Machine Tools engineers turned to ANSYS Mechanical simulations for help. The solution helped a metal-cutting tools company to eliminate the night shift and free up weekends for their employees without reducing their production load.
Machine tools have been used for centuries to shape wood, metal or other solid materials. Machining generally involves cutting, boring, grinding or shearing a solid block to achieve the desired final shape of the part. Until the advent of modern computing systems in the second half of the last century, highly skilled human operators manually adjusted the position and speed of the cutting or grinding tool to machine the part to the required tolerances. Computers largely transformed machinists into high-tech craftsmen who program the speed and orientation of the cutting tool for automated operation.

ANCA Machine Tools, founded in Australia in 1974, offers a comprehensive range of computerized numerical control machines that can produce cutting tools — milling tools, drills, taps, indexable inserts, etc. — with the flexibility provided by five-axis machining technology. The five axes include the standard x, y and z spatial axes along with two rotation axes (a and b) around the x and z axes. Using five axes instead of three ensures that a piece can be oriented at all angles needed for complete machining without the need for manual reorientation at any step in the process.

When Fraisa, a metal-cutting tools manufacturer headquartered in Switzerland, requested a CNC machine capable of 50-hour autonomous operation, it was immediately apparent that this could not be done by one of ANCA’s four standard machines. Not only did the machine have to operate unmanned for that long, it also had to be able to switch among several tooling operations during this time, so different products could be manufactured. This required a robotic arm to load and unload pieces from a rotary table containing seven pallets — metal trays with circular holding cells for the feedstock and the finished parts. It also required automated gauging and measurement of finished parts for quality control. A customized CNC machine was needed.

SIMULATION AT ANCA
ANCA has been using ANSYS Mechanical solutions for their customization needs for four years. Prior to that, they tried simulation software from other suppliers but found the software to be hard to learn and use. Only four ANCA engineers were trained to use the simulation software for the frequent custom orders the company received, which created a design bottleneck. After the introduction of ANSYS Mechanical, the engineers found it much easier to learn how to set up and run simulations. Today, 20 ANCA engineers, including all the design and manufacturing engineers, use ANSYS Mechanical regularly.

The increasing demand for tighter tolerances in machining is one reason ANCA needs ANSYS Mechanical. Engineers are chasing tolerances in the range of 1 to 10 microns, and even sometimes sub-micron levels. In trying to understand how contact friction affects tolerances in this range, the nonlinearities of surface friction and how they affect deformation and surface pressure are quite complicated. ANSYS Mechanical simulations solve these complex problems.

At the macro scale of the five-axis machines, ANCA engineers use ANSYS Mechanical to understand how the large bodies and complicated movements of five-axis machines affect the machine’s modal and harmonic response. They then feed that information back into the simulation to determine how modal and harmonic responses affect the control system. Vibrations and resonances at the macro scale can throw off precision at the micro scale; ANSYS Mechanical is valuable at both ends of the size spectrum.

THE FRAISA CHALLENGE
The main challenge presented by Fraisa’s request was ensuring the stiffness and rigidity of the rotary table.
upon which the seven pallets containing feedstock and finished parts would rest. Because a robotic arm would load and unload the feedstock and finished parts, ANCA engineers had to ensure that the pallet table was accurately positioned after each rotation, time after time. This enables the robot to efficiently pick up the next part without fail.

This was a major challenge because the rotary table supports seven pallets containing between 48 and 100 tools of a variety of weights and sizes. The total weight could be hundreds of kilograms, so the downward deflection of the rotary table had to be considered.

Another challenge was to optimize the design of the grinding wheel dresser for this automated system. A grinding wheel is a solid abrasive wheel used for various grinding and smoothing operations. During use, the face of a grinding wheel might become clogged with machined particles or distorted from its true circular shape, rendering it inefficient for grinding. A wheel dresser, often made of diamond, is pressed against the rotating wheel to trim and clean its surface and return it to its optimal condition. On a manned machine, the dressing operation might be performed by a human operator who presses the dressing tool against the wheel. However, the dressing tool must be included as part of an automated machine. Because there is not a lot of space available in ANCA’s standard machines for this tool, engineers must optimize the rigidity of the dresser parts to make sure the dresser would fit into the physical space while maintaining its structural integrity.

ANSYS Mechanical helped ANCA engineers solve both of these challenges for Fraisa.

**ANSYS MECHANICAL SOLUTIONS**

ANCA engineers used ANSYS Mechanical to measure the deflections on the pallet table based on the changing loading conditions during operations. Deflection increased as parts were added to the pallet and decreased as they were removed. By reviewing the continually changing stresses on the system, they were able to optimize the design and increase the assembly’s overall stiffness at the robot load and unload points.

For the machine side dresser, engineers conducted ANSYS Mechanical simulations on the deflection of the assembly to minimize the size of the dresser mounting without compromising the system’s rigidity. Rigidity is important because the dresser must be pressed against the grinding wheel with sufficient force to remove embedded particles and return the wheel to its circular shape. Minimizing the deflection of the dresser mounting maintains the necessary pressure of the dresser against the wheel, which is critical to maintaining the true wheel form.

Engineers performed multiple iterations of both the pallet rigidity and the dresser mount deflection until the simulations converged on a solution. The rapid simulation iterations in ANSYS Mechanical made the process quick and easy.

**HOW ANCA BENEFITS FROM ANSYS SIMULATIONS**

ANSYS Mechanical simulations give ANCA engineers confidence in their design work. At a minimum, without simulation it would have taken an extra four to five weeks to build a prototype of the Fraisa system and test it. Simulation cut the required design time by about 25% overall, to under six months. It allowed them to validate multiple design iterations and have confidence in the designed solution going into final design testing.

Because they were designing a one-off custom solution, ANCA engineers really could not afford to prototype, get it wrong, scrap the solution and try again. They had to have confidence that their design was right the first time. Fraisa is using the 50-hour autonomous machining solution now to eliminate the nighttime shift and weekend work for their employees.

**ANCA Machine tool is supported by ANSYS elite channel partner LEAP Australia.**