Multitasking machine executing complex five-axis machining operation.

How to Succeed in Medical Machining

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There is still demand today for medical devices generated by aging baby boomers and their desire to enjoy a sustainable quality of life for a longer period of time. That being said, reality is that the medical device manufacturing industry has seen significant layoffs over the last few years due to cost pressure, increased regulatory and public scrutiny, costly recalls and the demands of globalization. Cost-cutting initiatives in the healthcare sector have put significant pressure on prices. Original Equipment Manufacturers (OEMs) are moving more of their component manufacturing out to contract manufacturing suppliers while focusing their time and resources on enhancing innovation and bringing new products faster to market.

This opens up opportunities for contract manufacturing companies to become a bigger partner to the OEMs by providing competitive pricing for surgical instruments, spinal/trauma implants and orthopedic devices. So, reliability and highly efficient machining processes for high-performance machining are paramount to achieving the lowest total cost of ownership and thereby success in machining these medical devices. Other process improvements to consider are integrated manufacturing technologies, intelligent robotic machine-tending automation and a pre-engineered integrated automation solution.

High-Performance Machining

In order to achieve maximum machine tool performance, you have to find the optimum balance between speed (material removal rate), accuracy and surface finish based on the individual machine tool characteristics. Additionally, quite often the size and features of parts that are machined on

the same piece of equipment present significant differences based on highly customized production orders. So, it is necessary to optimize the process based on individual machine tool characteristics as well as size and features of the part family to be machined. Today's innovative CNCs feature an extensive suite of advanced path and acceleration optimization functions with on-screen guidance to select the set of parameter values best suited for the machining conditions to reduce cycle time with enhanced part accuracy and surface finish. Powerful integrated and advanced 3D servo and machine optimization tools aligned with expert services can fine-tune machine performance for a specific part or part family, even for the most complex medical machining applications.

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Finding ways to reduce costs when machining intricate shapes and exotic materials is not an easy task. The most effective way to achieve this goal is by using advanced features in the CNC that allow reaching the final shape and surface finish during the machining process and eliminate or at least reduce the need for postprocessing secondary operations such as grinding, deburring and polishing.

Only the most innovative CNCs and drive systems execute the programmed path at a nanometer resolution for the maximum precision and smoothest contoured surface finish. Advanced control systems are designed to simplify complex, high-performance five-axis machining applications by using advanced CNC functions that are essential to achieving the high quality standards that medical device manufacturing demands:

AI Contour Control function looks ahead (up to 1000 blocks) in the part program to eliminate the acc/dec and servo delays that limit feed rates when cutting short line segments or contours and effectively eliminates path errors in corners and small radii.

Jerk Control function can be used to effectively suppress vibration and machine shock in part program sections in which acceleration changes abruptly, such as where the cutting path changes from straight line to curve, thus reducing associated machining errors.

Smart Overlap function helps reduce cycle time by allowing overlapping of cutting feed rates and rapid traverse program blocks within a programmable permitted toolpath deviation range which can be easily confirmed using the CNC automatic calculation screen.

Nano Smoothing with spline interpolation recreates the shape in the 3D CAD model from line segment approximations. The five-axis CAD/CAM/CNC process chain is simplified by creating part programs that describe part geometry in workpiece coordinate systems. This in turn simplifies the CAM and postprocessor as well as allows for machine, tooling and setup data to be provided at the machine, similar to typical three-axis workflow.

High-Speed Smooth TCP function provides Tool Center Point Control (TCP) to allow part geometry programming independent of the machine kinematics and ensures that the tool tip follows the programmed toolpath precisely and at the programmed feed rate. To help maintain the accuracy of the five-axis machining center, an automatic cycle for measurement and compensation of inclined angular error of rotary axis is now available in today's most modern CNCs, making 3D rotary error compensation easier and faster.

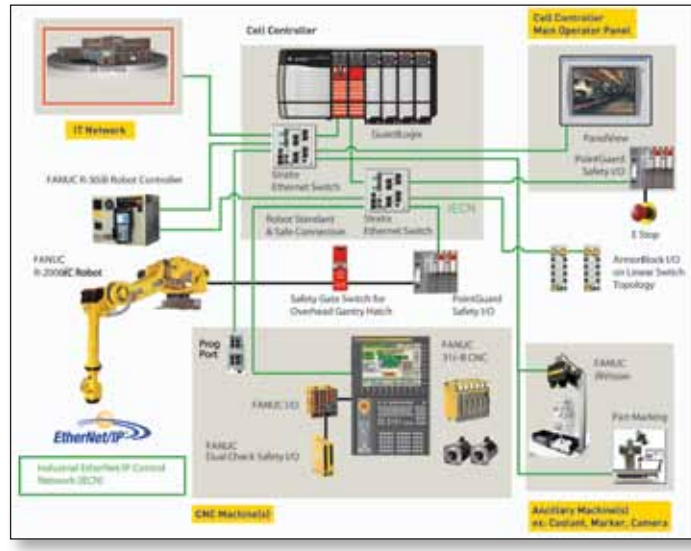
Integrated Manufacturing Technologies

An additional process improvement worth investigating to significantly reduce cycle time and produce more accurate medical parts is multiaxis machining operations in a single setup. Machine designs for five- and six-sided machining operations have blurred the line between milling and turning. In recent years there has been a flurry of activities around integrating multiple manufacturing technologies such as traditional metalcutting (milling, turning, grinding) with laser machining and additive manufacturing into a single machine tool platform. Advanced and versatile CNCs provide high-performance, multiaxis, multipath nano technology in a flexible and scalable CNC platform. This is ideal for high-speed, highly accurate complex medical part manufacturing by seamlessly combining milling, turning, laser machining and cladding in a single part program. This in turn reduces the number of machines and operators required to manufacture the final medical part which decreases cycle times and reduces costs.

Intelligent Robotic Machine Tending Automation

Robots can increase machine production by up to 20% over traditional methods while allowing for greater flexibility to accommodate for small batch production. However, quite often when we talk about automation in a machining department, the first thing that comes to mind is a generic robot loading and unloading parts into a machine tool. But today's intelligent robots in conjunction with highly sophisticated CNCs can do so much more. Servo doors can be incorporated on the machine to allow high-speed synchronization with the CNC to allow faster part load/unload. Intelligent vision systems

can be used for part confirmation or 2D barcodes can be read for part identification to ensure that the correct part program is executed on the machine tool. Both 2D and 3D vision systems can be used for picking randomly placed parts from a bin, flexible feeding device, trays/pallets, or a moving conveyor to take advantage of noncutting cycle time, minimize expensive fixtures and allow for untended operation. These systems can be used to identify and track parts as they are fed into the machine tool and unloaded for the next operation, and this information can be provided for SPC data collection. Additionally, while the machines are cutting, the robot can be utilized for other processes such as material removal, gaging, inspections, part cleaning, and assembly.



FANUC/Rockwell Automation integrated machining cell architecture with EtherNet/IP.

A standard interface between a robot and any machine tool significantly reduces the integration time and cost. Robots and multiple CNCs can be easily connected over Ethernet, I/O Link, and FL Net using the Machine Tool and Robot Connection functions. Robot operation and monitoring can be performed through one of the integrated or custom CNC screens in an automated cell without entering the safety zone of the robot. Conversely, screens on the robot teach pendant can be used for complete CNC and robot system operation when the CNC control panel is located inside the robot. This allows for a more efficient use of floor space as one operator can run multiple machines/cells while reducing part setup time and increasing flexibility.

Pre-Engineered Integrated Automation Solution

In today's complex regulatory and highly competitive medical market environment, it is critical to have a coordinated manufacturing system and the supporting infrastructure to keep the workflow organized, efficient and documented. To address the market challenges, a pre-engineered integrated automated solution for medical device manufacturing is available. This integrates CNCs and robots to cell controllers to provide cost efficiencies, better part quality, usable manufacturing intelligence and overall increased productivity. Simplified machining system architecture reduces start-up time and system engineering costs for machine tool builders to integrate CNCs and robots with a cell controller. Process and machine condition data is easily transferred to enterprise IT systems enabling better decision making and cost reduction. EtherNet/IP is an example of a network that can be utilized to connect the cell controller to CNCs, robots and other devices. An integrated solution is ideal for an automated machining cell comprised of one or several CNCs cutting parts, and robots handling part load/unload, coolant and chip removal systems, deburring and washing machines, part marking and identification, inspection stations, and more. Common connectivity to EtherNet/IP simplifies system engineering and maintenance significantly.

Lowest Total Cost of Ownership

The first and most critical step to succeed in machining the highest quality medical parts at the lowest total cost of ownership is with a CNC system that is reliable, efficient and innovative. Specifically, a CNC system that has nanometer resolution throughout the system achieves superior precision and surface finish quality. Advanced innovative CNC technologies assure the fastest cycle times without sacrificing quality, lowering the cost per part and increasing machining capacity to avoid the need to add equipment or increase overhead. Select CNCs that have the features necessary to support the most efficient CAD/CAM/machine workflows for five-axis and complex medical machining applications. To support even more advanced process automation, CNCs need to support Ethernet connectivity to manufacturing and business networks for process monitoring and validation, and robots for cellular automation. Additionally, look for a CNC system with the highest Mean Time Between Failure (MTBF) in the industry coupled with lifetime maintenance which will ensure the lowest total cost of ownership. In the end, a CNC manufacturer that supports their CNC for its entire production life will increase ROI for medical device manufacturing companies.