Carving Machines Help Otto Bock Shape Its Future

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Through the use of advanced CNC machine technology, one manufacturer of prosthetic and orthotic devices is making substantial improvements to its production. Otto Bock, a leading supplier of these devices based in Germany, worked in cooperation with the CNC carving machine builder, Bornemann, to produce a series of machines, two of which currently produce prostheses and seat cushions in the Otto Bock facility in Plymouth, Minnesota. From this location, Otto Bock markets these devices to prosthetists and orthotists throughout North America.

Because of the unique nature of this field, the majority of devices produced at this facility are custom, one-off productions. According to Otto Bock vice-president Bill Clover, this creates operational challenges, at every turn. “Otto Bock has operated in Minneapolis since 1958, acting as a sales and distribution location for the company’s many product lines. In the case of the prosthetic and orthotic devices, we quickly realized the need to manufacture here, so we’ve constantly evaluated the available technologies for machining. We were using ABT carvers, which mirrored our operation in England for the last ten years, then we have been using Thermwood routers for our foam products. Our biggest challenge is how to remain flexible in our manufacturing, given the constant flow of one-off work. We knew

something was needed."

This led to the development of the Bornemann machine alliance and the development of carving technology, utilizing the latest CNC protocols. Since the product lines at Otto Bock run the gamut from orthotic support seating to various prosthetic shapes, cosmetic covers and neck-to-pelvis body jackets, often made from very large blanks of specially formulated and costly material, it was critical to have machines that will not only run efficiently, but also have the flexibility for fast changeover and interpolation of large data files.

The company uses its Bornemann carvers, each equipped with Siemens [1] SINUMERIK 840D CNC technology, to cut proprietary rigid and flexible polyurethane foams into the seat cushions used to support spinal injuries, as well as the various upper and lower limb prosthetic devices and supports produced at this Otto Bock facility.

Otto Bock's facility in England provides the software used to capture the patient's particular characteristics, such as limb length, circumference and degrees of soft tissue containment. Once the prosthetist or orthotist collects the data, Otto Bock's fabrication software support engineering supervisor, Dennis Miller, enters the picture. "It's critical to have the data accurately interpolated into the tool path for cutting these blocks of foam and rigid materials. You might draw some analogy to the aerospace industry and the contours of a wing. The human body has no straight lines, so the movements of the cutting tool are extremely complex machine programs."

Bill Clover detailed the previous carving method for the seating systems produced at Otto Bock, contrasting that method with the Bornemann robotic five-axis milling machines now used. "We can now model the end-user and directly carve the product from the material blank. Previously, a plaster cast would be made, then

that mold would be used to reverse engineer the cutting path on the router. It was very slow and very imprecise. Today, we've developed the OBSS, Otto Bock Seating System." As Clover explained, the patient is seated in something similar to a bean bag chair, the bag is then evacuated and the bag surface is digitized, using Otto Bock proprietary software, developed in cooperation with Polhemus, originators of the FasTrack 3D contact laser scanning system. This version of a CAD program is then translated through ProfiCAM into the Windows-based, CNC machining program. Otto Bock recently upgraded the NCU/PCU for its Siemens SINUMERIK CNCs to accept the most advanced version of this translation.

Clover further described the work done by Otto Bock in conjunction with Polhemus, a manufacturer of various devices used for digitizing. Polhemus, located in Colchester, Vermont, is a global leader in providing three-dimensional position tracking systems. Polhemus supplies a complete range of these high-quality 3D motion tracking and digitizing systems for various industries including medical, military training and simulation, computer-aided design and virtual reality. Clover explained that through the use of this advanced, clean and non-invasive laser scanning technology, an extremely accurate image can be made of the patient's torso from the seat bag surface used to initiate the design process. The software is then manipulated from CAD to Proficam and finally to the CNC on the machine, through the proprietary OBSS, the Otto Bock Shape System.

As Otto Bock software engineer Dennis Miller noted, compared to the old tool path generation method, the same

path that took two to three hours now takes perhaps 10 minutes. A wheelchair cushion that used to take 90 minutes to manufacture on the old system, takes Otto Bock less than 20 minutes to produce. In terms of overall productivity, both Miller and Clover commented that a typical month's seat cushion output was once about 20, but is now averaging about 250. Clover further stated, "We could never have achieved these levels without the Bornemann machines and Siemens CNC technology."

In a typical manufacturing operation for a seat cushion, a 26" x 26" x 14" H block of material is secured in the vacuum bed on the Bornemann machine. A probe determines the zero offsets on the blank. For a prosthetic device, a rotary axis, two-ribbed, cone-shaped arbor is mounted on the machine. A predetermined coordinate fixture is used to verify the offsets and rotation angles. For foam cutting, a 12" long hollow tube of tool steel and 40mm ball end rasp are used. On the rigid polyurethane blanks, the same design of cutting tool, only 7" in length with a ball endmill, is utilized.

In the work envelope of the machine, one axis is used to move the seat cushion, two axes are used to move the tool. A 0º rotation achieves most material removal with a 30º undercut typical. On the prosthetics, three axes rotate the material in a vertical helical pattern.

Once made, a prosthetic device is checked, using a specific diameter check ring, as well as digital calipers, to verify the contour surfaces as accurately as possible.

The machine operators at Otto Bock generally do not require extensive G-code programming skill as the program is directly downloaded to the NCU onboard the Siemens CNC. Since the part programs are usually quite large, they run directly from the NCU on the machine.

Miller also noted the service contract on the machines has worked well for his staff, with phone support quickly provided to troubleshoot both Bornemann's and the CNCs. This support is especially critical, Clover noted, as there are currently only seven such machines in operation worldwide. Training on the machines was done at the Otto Bock world headquarters factory in Duderstadt, Germany.

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