At the Boeing Company facility in Macon, GA, where they build subassemblies for the C-17 Globemaster III airlifter, two Broetje-Automation Integrated Panel Assembly Cells (IPAC’s) have been added to increase Boeing’s complex process capability. These multi-axis riveters incorporate four CNCs, controlling a total of 77 servo axes on each machine, which are currently used for automating the process of building fuselage panel assemblies for the C-17.

This Boeing facility produces major sub-assemblies for both the U.S. Air Force’s C-17 and the Army’s AH-64D Apache helicopter.

To meet this challenge, it operated CNC-controlled Gemcor multi-axis riveters for a number of years. Because of continued demand for lowering cost and increasing quality and schedule, Boeing recently added the Broetje IPAC’s to the operation. The IPAC’s have multiple CNCs onboard to control all the movements from a single operator station. One benefit of this newer system is the lowered set-up time and loading of workpieces. Boeing also maintains a full part program library on its own server and can instantaneously call up any program needed, via the control supplier’s software.

On the Broetje riveters, the four main machine controllers are Siemens Sinumerik 840D CNCs, all interfaced to a central operator station through PROFIBUS fieldbus communications protocol. The machine’s Siemens SinDNC links to the captive Boeing servers to access part programs. In addition, the Broetje riveters incorporate the Siemens Simodrive 611U drives packages and SIMATIC PLC/HMI terminals.

Video Monitoring
Each of the riveters has four CNCs to control a total of 77 servo axes in normal operation. The entire sequence of rivet selection, position, and completed actions is monitored from the central operator station, which also includes video monitors for visual inspection.

Interfaced CNCs Control 77 Servo Axes Aircraft Riveter

Technology is the key to efficiency. To efficiently rivet aircraft panels, four interfaced CNCs control 77 servo axes on an automated riveter.
Additionally, a “MOS” (Modular Optical System) camera is used to fine-tune positioning, so that temporary fasteners can be removed, thus improving the automation process.

The previous generation machines utilized two CNCs to operate an automated riveting sequence, but the older hardware was very cumbersome to operate and often had difficulty recovering from unplanned events.

The Broetje IPAC’s have perfected the master/slave relationship of multiple CNCs. Having the entire multiple NCU system integrated on the machine allows for a much more seamless operation that’s easier to use and maintain.

The CNCs are used for axis positioning of X, X1, Y, Y1, Z, W, A, A1, and E movements. Each control, through separate channels, manipulates the Universal Panel Holding Fixture portion of the machine, which holds the part during processing. Typically, it runs about 16 rivets per minute on the C-17 fuselage panels.

And, owing to a variable spindle range from 500 rpm to 24,000 rpm, the machine has the ability to handle the various materials used on the C-17, namely, aluminum and titanium.

Operators find these controls very user-friendly, compared to older generation CNCs. The controls are far more flexible and much more capable of performing the complex operations needed to produce the panels efficiently. The training provided was critical in this area. By having both Siemens instructors and the OEM (Broetje) conduct training on-site, Boeing was able to capitalize on applying supplier knowledge to the machines directly.

With the Broetje riveters, technicians have been completely familiarized with every aspect of the machine, in ways never experienced previously. Boeing techs, for example, have utilized Siemens training specialists for assistance on enhancing screens, developing specialized tables for troubleshooting, and implementing process counters for use on the machines.

**In-House Programming**

Additional benefits of the new system involve increased efficiencies in both NC programming and machine performance.

All NC programming for the IPACs is accomplished at the Macon facility with full simulation capabilities. With the combined efficiencies offered by the Siemens controls and Broetje’s Off-line Programming System, the Macon NC programmers have realized as much as a 50% reduction in the time required to develop machine programs. The system also allows the same part programs to run on both IPACs. This equates to a huge cost savings in programming effort and program maintenance.

Apart from NC programming efficiencies, Macon operations have realized efficiencies that are a result of the Broetje IPAC machines coupled with the Siemens controller. This advanced technology of combined programming and operational efficiencies has provided the Macon facility a truly competitive advantage. Not only is machine run-time improved, machine set-up time has also been greatly reduced. Since every machine axis is operated by the Siemens controller and NC programs, changing machine configuration from one C-17 panel to the next is as simple as loading a new program and pushing a button. No manual intervention is required, as with the older machines.

The C-17 Globemaster III is considered the workhorse of Air Force airlift transports. Rolled out in 1993, it has flown support missions for all combat and humanitarian actions in Bosnia, Kosovo, Afghanistan, and Iraq. Because of its ability to take-off and land on short, unimproved terrain, the C-17 is utilized near the front lines, as well as for various humanitarian air-drop missions.