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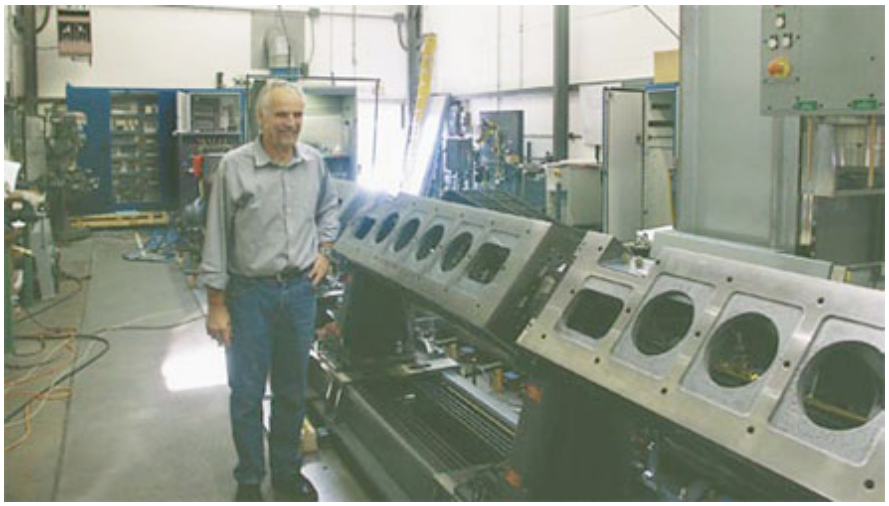
FLOOR PLANNING

JANUARY 2006 / VOLUME 58 / NUMBER 3

Special Focus: Making Aerospace Parts
A flexible and reconfigurable machine tool is used during assembly of aerospace parts.



Richard Bertsche, president of Bertsche Engineering, next to the FG machine during the build process.
Photo Credit: A. Richter

Not all metalcutting machine tools are designed for parts production. One machine custom-built for The Boeing Co. by Bertsche Engineering Corp. is part of the assembly process.

The floor grid, or FG, machining center is primarily for putting hole-location features into the structural floor beams of airplanes. These features allow Boeing to attach components if the airplane's configuration changes. For example, it might need to add attachment points so more cross members can be put in place.

The flexible, reconfigurable FG machine enables a lot of last-minute customization to be performed. An airplane's configuration, such as how the interior space is arranged, is not always finalized at the time the airplane is sold. Depending on whether it is for domestic or overseas flights, the airplane may require more or less kitchen space and lavatories, for example, which has an impact on the floor grid.

Of course, Boeing tries to manufacture the floor grid at the time it gets an order for the plane. But because Boeing has implemented a "deterministic assembly" process for building floor grids, it is able to add final features as needed just prior to final assembly.

A deterministic assembly process means each part has location features that allow it to be precisely mated with adjoining parts. Basically, every floor grid for the 767 and 777 airplanes has final-assembly hole-location features cut on the FG machine for each floor beam just prior to final assembly.

The floor beams are manufactured by one of Boeing's Tier 1 suppliers. The supplier lays up the composite floor beams, machines precision-hole patterns and then affixes a variety of interconnecting hardware to each floor beam. The layup process involves arranging, in varying grain directions, layer upon layer of Toray tape (a carbon-fiber composite) and epoxy bonding material against a form tool. The entire assembly is then put into an Autoclave to form the finished part.

The FG machine installed at the Boeing assembly facility in Everett, Wash.

These floor beams are then shipped to the Boeing assembly facility in Everett, Wash. After Boeing drills the final hole locations on the FG machine, the individual floor beams are assembled to form the floor grid directly adjacent to the machine. From there, the assembled floor grid is moved to the assembly line where the grid is placed into an airplane.

assembly facility in Everett, Wash. Machine is shown without its proprietary workholding fixtures. Photo Credit: Boeing

INTELLIGENT FIXTURES

One of the key features of the FG machine is its "intelligent" parts-fixturing systems. It is intelligent because each fixture is equipped with its own group of sensors and actuators that control the workholding clamps. Each sensor and actuator I/O is mapped to an M-code and a parameter that can be used to actuate one or more clamps for the connected fixture. Clamps can be repositioned, opened, swung away and dropped down to prevent them from interfering during the cutting process.

The FG machine's control console. Photo Credit: A. Richter

The machine's trunnion consists of six horizontally oriented and serially connected tombstones. Each tombstone accepts a multitude of fixtures that accurately locate to and can be installed on any face of the trunnion. Up to four different fixture assemblies can be connected to a single face of the trunnion. With four faces and six tombstone sections, up to 24 different fixtures can be attached to the trunnion. These fixtures are immediately available for machining various part families.

For long parts, two to six fixturing sections on a tombstone face are used. For parts less than 72" in length, only one tombstone section is used. Each tombstone face has a set of precision locators that allow a new fixture to be bolted to its face without extensive realignment. Because the fixtures need only be exchanged periodically, the fixturing system is considered semiautomatic.

EXPANSION CONTROL

The FG machine features a thermal length-compensation system, because different metals, such as steel and aluminum, expand and contract at different rates. A laser is used as the primary position feedback device for the machine. The laser system is equipped with material-temperature sensors for the machine and the material being cut, so the operating temperature for each is known.

For the material being cut, the operator selects or inputs its specific coefficient of thermal expansion and the CNC and condition-measuring-interface unit process that information. This basically tells the machine to move a longer distance if the part is growing faster than the machine structure and a shorter distance if the part is shrinking at a faster rate. To further enhance accuracy of where holes are machined, the machine is operated in a temperature-controlled environment.

Having a machine with all the necessary tools and fixtures already mounted to the machine and available by simply indexing to the needed fixture, Boeing is able to finish-machine several different families of parts with minimal setup. Because the tooling is of the quick-change variety, entire workholding assemblies can be exchanged on short notice, as part configurations are modified.

This gives Boeing the ability to build planes to a firm order and offer its customers maximum flexibility to configure the airplane right up to final assembly.

**Article based on information provided by Richard Bertsche, president of Bertsche Engineering Corp., Buffalo Grove, Ill. For*

information about the company's machine tools and automation equipment, call (847) 537-8757 or visit www.bertsche.com.