

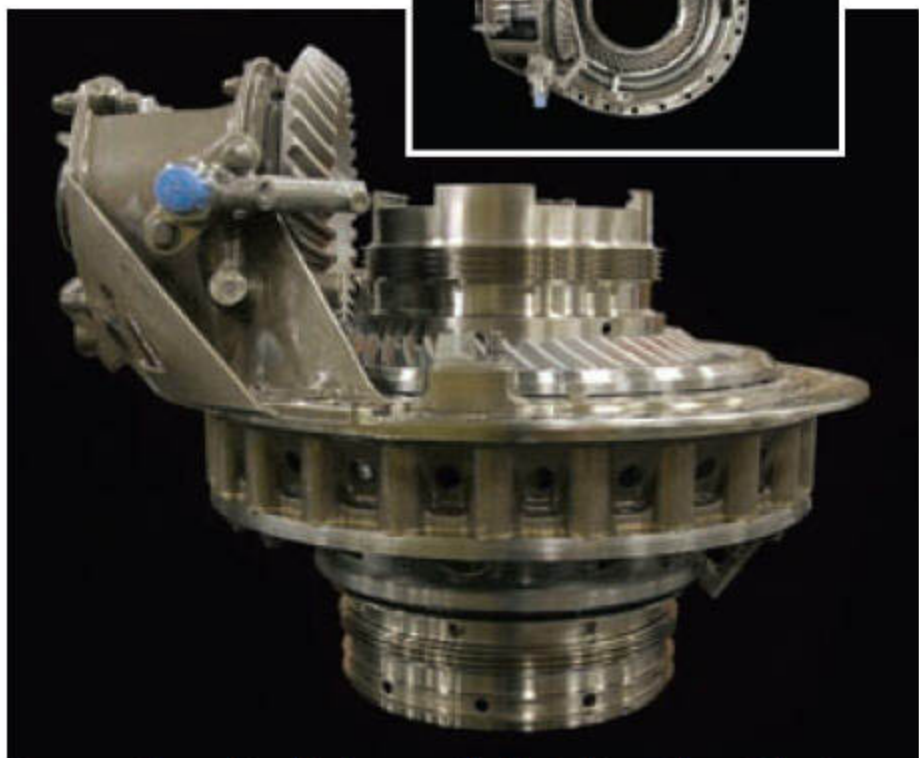
For Aerospace, the Proper Tool for the Proper Job is Key

TRIUMPH GEAR SYSTEMS-MACOMB BUILDS CUSTOM INFRASTRUCTURE FOR MANUFACTURING LARGE, HIGH-PRECISION AEROSPACE GEARBOX AND ASSEMBLY HOUSINGS.

Late in 2006, Triumph Group Inc. negotiated an agreement with GE Engine Systems that would allow its Michigan-based subsidiary, Triumph Gear Systems-Macomb, Inc., to supply the critical CFM56 engine inlet gearbox and related parts for the life of the program. The CFM56 engine, which propels the Boeing 737 and many Airbus models, is the most popular in aviation history.

Based on the volume and cost/performance requirements of this business, as well as other opportunities on the horizon, Triumph has made substantial investments in CNC manufacturing cells, tooling, modular fixturing and software to further streamline the manufacturing of housings for gearboxes and complete assemblies.

At the heart of the new additions are two large pallet-loading Mitsui

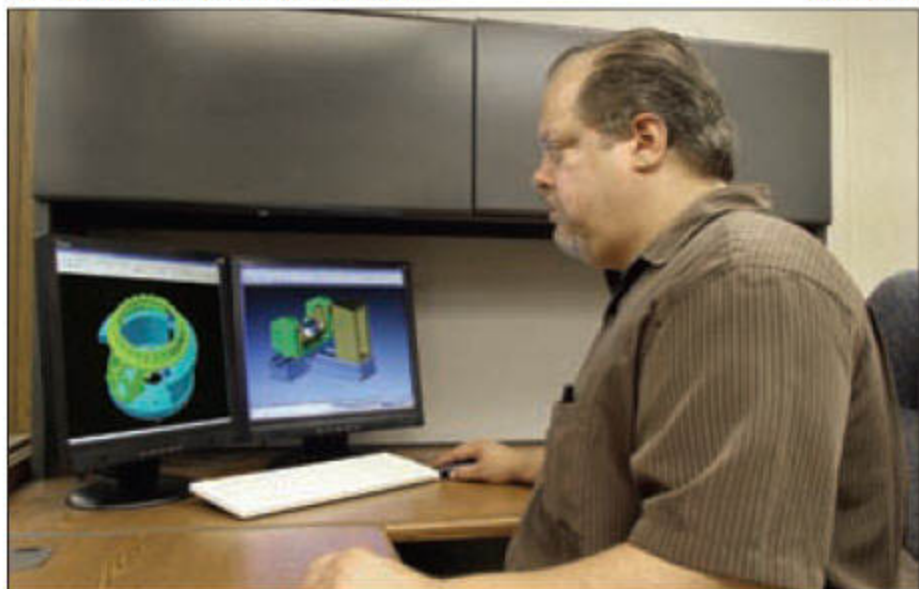


To ensure a long and trouble-free operating life for its gearboxes, Triumph manufactures the housings on Mitsui Seiki horizontal CNCs capable of holding critical dimensions within 0.0003" (courtesy Triumph Gear-Macomb).

Seiki CNC horizontal machines—a 4-axis (HS6A) and 5-axis system (HS6A 5-axis) capable of manufacturing housing components up to 1,000 x 900 x 750 mm. These machines, mounted on 5-foot-deep cement foundations to

ensure ultra-precision cutting at high speeds, are in addition to the six other machining centers (six Mitsui Seiki's and one Toyoda) that Triumph already operates.

continued



Triumph's Dave Czerw uses Mastercam X3 software (left) along with an integrated Vericut software package to generate and analyze tool paths for manufacturing gearbox housings (courtesy Triumph Gear-Macomb).

Opportunity Driven

"Things have changed a lot in the 26 years I have been with this company," says Bob Maggetti, director of engineering. "When I started out, we were privately owned and the only milling we did was to drill lightening holes in the web of a gear. But our customers wanted us to do more, so in

the mid-'80s we started making simple gearboxes. Today, ones like the CFM56 inlet gearbox are very complex. But that's not the end of it. In the near future we will be partnering with our sister company, Triumph Gear Systems-Park City (UT), to manufacture complete assemblies. Many of these will be larger than anything we have made

previously, and that business is likely to be driven by the demand for helicopters and the offshore oil industry. These new directions demand that we simultaneously make improvements in both our precision and high throughput manufacturing capabilities."

Indeed, Maggetti says the helicopter project was one of the reasons his company purchased the new CNC machines.

Supporting Systems

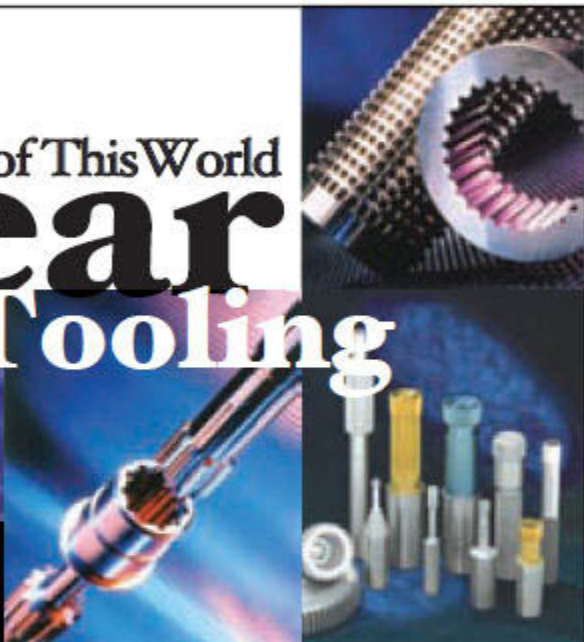
Milling was the most heavily burdened department in the shop. The purchase of the two large machining cells was justified, based on the volume of work and a fast payback of only two to three years, thanks to increased productivity. According to Dave Czerw, milling department manager, "We were looking for larger machines for our larger work. We selected horizontal Mitsui Seiki machining centers because of the accuracy, repeatability and dependability they provide."

The new manufacturing cells would be a further extension of an ongoing, specialized system for high-precision,

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Triumph Gear Macomb's veteran staff is exploiting CNC capabilities for automatically manufacturing challenging parts and assemblies with high levels of precision and productivity. Shown here is Brent Berger (courtesy Triumph Gear-Macomb).



The four 4- and 5-axis Mitsui Seiki horizontal CNC machining centers are staged with custom modular fixtures to ensure exceptionally fast setups and secure workholding for gearbox manufacturing precision (courtesy Triumph Gear-Macomb).

high-volume manufacturing of housings that has evolved at Triumph in recent years. Major elements of the system include:

Robust horizontal CNC. The new Mitsui Seiki 4- and 5-axis pallet-loading CNCs have a 1,000 mm cube work area, glass scales for high precision and 240 and 360 tool carousels, respectively. The 5-axis machine is particularly important for single-setup manufacturing of parts, which should be set up in the fixture only once to preserve positional accuracy. For example, in the case of housings made of magnesium that are very temperature sensitive, single setup manufacturing on the 5-axis avoids positioning errors due to clampout (minor changes in the part's shape when it is released from the fixture).

Parts like those made for the CFM56 engine inlet gearbox have many exceptionally tight tolerances. "For example," says Czerw, "we have a couple of bores with diameters that must be held to within 0.0003". As for positional accuracy, the two bores have to be in-line within 0.0005", and they must be positionally located to other features 90 degrees from them to within 0.0002". So that's why we bought the milling machines that we did."

The CNC machining centers must meet these requirements with "error budget" to spare to compensate for such things as tool and fixture variability.

CAM capabilities. For programming

all of its CNC machining centers, Triumph uses *Mastercam X3* software. This package allows the company to tap into all of the capabilities of the equipment, including large tool libraries and 5-axis capabilities, as well as 90 degrees and indexable heads. "Surfacing" allows rapid creation of

sculptured toolpaths from surface modeling.

Custom modular fixturing. A key to productive manufacturing of gearbox and assembly housings is minimization of setups. To achieve that, Triumph uses Stevens Engineering Inc. modular

continued

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fixturing systems, which it uses on all of its Mitsui Seikis and are virtually resident in its *Mastercam* libraries. Each machine is fitted with a grid plate of dowels so that fixturing plates can be moved and accurately located on any machine. This gives the shop the flexibility to use a variety of machines for the same part with exceptional

repeatability of dimensions.

In the past, making a part that required 150 tools to manufacture might have required a day and a half of setup time. With this system, Czerw says his shop has whittled the setup content of these jobs down to a couple of hours.

Toolpath verification. *Mastercam* allows Triumph to manually fine-tune

any cutting operation. However, a given part can have hundreds of these, so Triumph uses *Vericut* software in interaction with the CAM software via proprietary "C-Hook" technology to automatically analyze geometries and toolpaths and modify them to improve cutting efficiencies and check accuracy. The part is observed being made in a realistic virtual machining environment in *Vericut* before posting it to the CNC machining centers for efficient real-world manufacturing.

Czerw says he is continually using the program's verification feature to avoid potential tool and toolholder crashes.

Keep Chips Flying

Czrew says that, 15 years ago, it would take his company several days to set up and perform as many as 20 operations on eight machines to make housings similar to the ones they make today. Now all of these operations, including bores that used to be ground, are being performed on a single 4-axis CNC, with one or two fast setups using the modular tooling. Today, CFM56 inlet gearbox housings are being manufactured at a rate of better than three a day.

With the high rpm and rotational stresses placed on helicopter assemblies, high-precision, single-setup manufacturing with the 5-axis system will become even more important. Even so, Czerw says the name of the game is to still "Keep the chips flying."



Steven Bisson checks a part that 15 years ago would take Triumph several days to set up and manufacture (courtesy Triumph Gear-Macomb).

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"We get paid for doing that and nothing else," he adds. "My programming is overhead. The guy setting tools is overhead. We get paid for cutting chips. That's our main goal—to keep the machines making chips. That's what we are investing in."

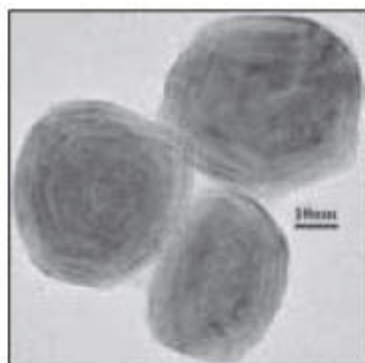
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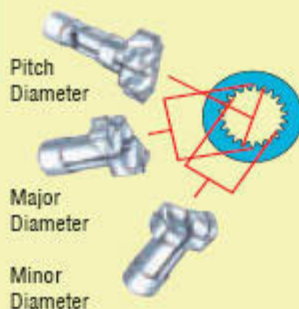
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