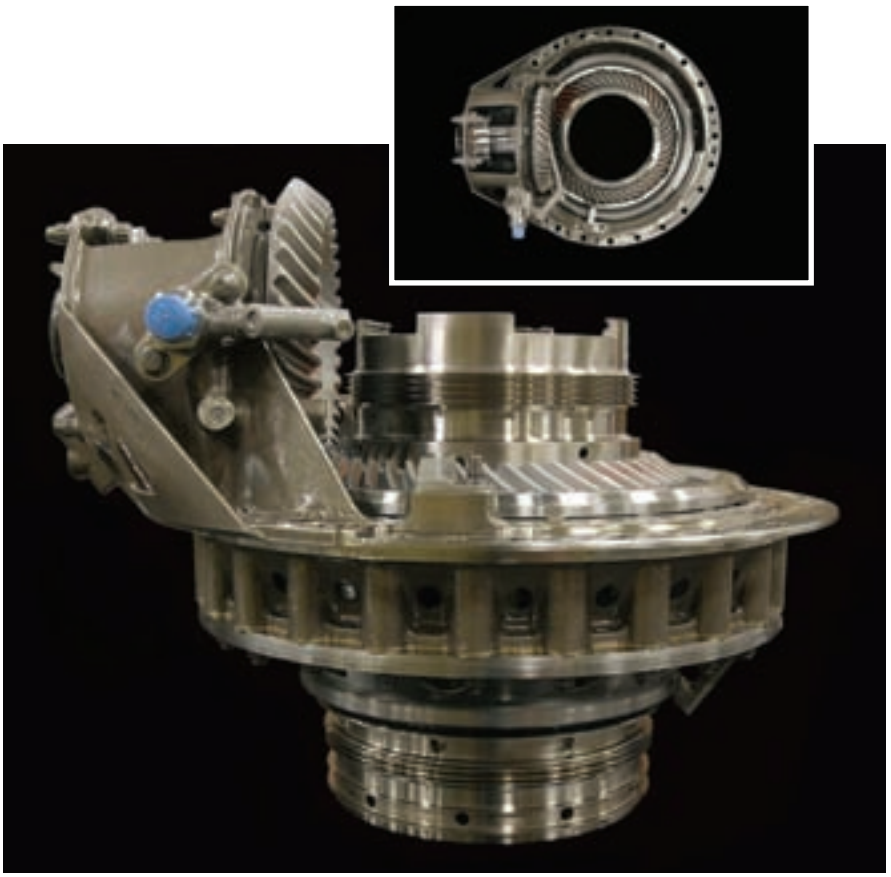
For Aerospace, the Proper Tool for the Proper Job is Key

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



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).

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 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.

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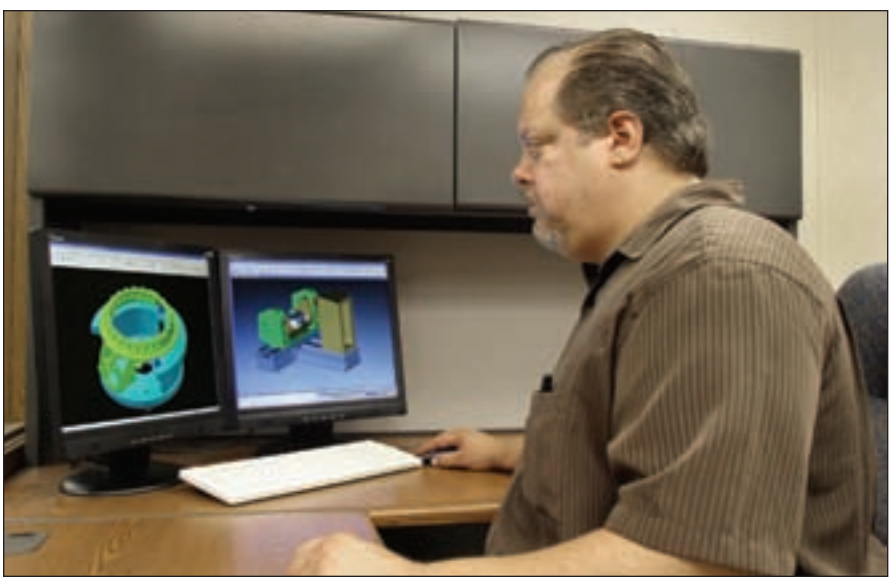

Triumph's Dave Czerw uses *Mastercam X3* software (left) along with an integrated *Vericut* software package to generate and analyze tool paths for manufacturing gearbox housings (courtesy Triumph Gear-Macomb).

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,

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

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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).

"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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Nano-technology-Based Lubricant

TESTED TO REDUCE GEAR WEAR

ApNano Materials's NanoLub lubricant was demonstrated to significantly decrease wear pits on gear teeth in a test conducted by the FZG Gear Research Centre of the Technical University of Munich, Germany.

NanoLub uses nano-sized particles of tungsten disulfide structured as nested spheres, known as inorganic fullerenes. Layers of the fullerenes slip off under loads to form an adherent film, which reduces friction and wear. The particles are added to liquid oil or grease to increase the lubricating properties. NanoLub also "wraps" moving parts with a thin lubricating film, referred to as tribofilm, which

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serves as an uninterruptable lubrication source during severe oil leakages.

"The test proves that NanoLub significantly enhances automotive and industrial gear oils, improving pitting resistance," says Dr. Menachem Genut, ApNano Materials' president and CEO. "Gear teeth are especially vulnerable to micropitting, and reducing this damage can save high costs of replacement and repair, making the gears operational 24/7. For example, Anglo-American, one of the largest mining companies in the world, has begun to use NanoLub in its heavy mining equipment in Chile."

The FZG Gear Research Centre test follows other tests performed on gears with heavy duty gear oil blended with NanoLub powder. No wear damage was observed with an optical microscope on the steel lubricated by NanoLub, but significant wear was detected when using reference oil. Tribofilm was noticed on the NanoLub lubricated gears. The tribofilm lubricates the moving parts even in circumstances where oil supply is interrupted.

"The new test further enhances NanoLub's position in the automotive and industrial markets, opening new horizons for our innovative lubricant as a necessary additive to gear oils," says Aharon Feuerstein, ApNano Materials' chairman and CFO. "NanoLub is distributed worldwide in Europe, Asia and the Americas by local agents and distributors. Due to the large demand, we have increased the capacity of our production plant."

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Expanding Twist Mandrel

PERFORMS WIDER RANGE OF APPLICATIONS

Gleason Corporation has grown the LeCount expanding mandrel line

with the Type G Twist Mandrel, which can accommodate a wider range of applications, including O.D. and face grinding operations where parts have a smooth bore, as well as non-gear grinding processes like cylindrical grinding.

The LeCount Type G Twist Mandrel uses a sliding-jaw design that features a mechanical rotary device for clamping workpieces. The mandrel provides 0.0050 mm (0.0002 in) TIR accuracy, considerable holding power torsionally and axially and a wide expansion range that fits bore sizes from 25.40 mm (1 in) to 76.20 mm (3 in).

For more information:
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Semi-Synthetic Metal Cutting Fluids

RESIST BACTERIA AND FOAM

Henkel Corporation introduced two water-soluble metal removal lubricants designed to generate minimal foam for years with little biological degradation.

The Multan B 236 and B 414 are for machining and grinding ferrous and non-ferrous alloys. They are intended for applications in which soft water or process requirements make controlling foam difficult.

The Multan B 236 is appropriate for most water conditions and multi-metal applications. It performs well on cast iron and steel applications that require rapid cooling, corrosion protection

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and moderate lubrication. The fluid rejects tramp oil and maximizes fluid life without using routine additives, according to a Henkel press release.

The Multan B 414 offers the same advantages as the B 236, but it also contains more oils and contains more extreme pressure additives. It acts as a universal lubricant on soft metals and more exotic alloys like aluminum, stainless steel, titanium, inconel, brass or copper.

Once machining or grinding is finished, both products leave behind a very light film residue to protect parts during storage. They eliminate smut and buildup on a machine's interior, tools and the finished parts.

For more information:
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Ipsen VFS Furnaces

SHIPPED TO NORTHEAST, MIDWEST AND SOUTHWEST

The Ipsen HIQ2624-10 horizontal internal quench (HIQ) vacuum furnace was shipped to a customer in the Northeast. The furnace was designed to accommodate the customer's sintering process requirements. It is the second

VFS vacuum furnace this customer has purchased.

The furnace features a 10-bar nitrogen quench system with an energy efficient graphite hot zone that can process temperatures up to 2,400 degrees; Graform curved graphite heating elements, a CompuVac supervisory control system and a TruLock autoclave door. The unit hot zone is 18" x 14" x 24", and the unit handles loads up to 750 lbs.

Ipsen also shipped a HEQ3836-2VDS horizontal external quench furnace to a Midwest medical device manufacturer. The furnace is capable of both vacuum debinding and vacuum sintering. It includes a two-bar argon quench system with a similar graphite hot zone, molybdenum heating elements, the CompuVac control system and TruLock autoclave door. This is the 19th VFS furnace this customer has bought over the course of 25 years.

The HEQ3836-VDS horizontal external quench furnace also achieves both vacuum debinding and vacuum sintering in a single vacuum furnace, and it was recently shipped to a new customer in the Southeast United States.

The furnace features a two-door design with a pneumatically activated clamping system. A -5 HG argon quench system is included along with an energy efficient all metal hot zone that can process temperatures up to 2,500 degrees, all molybdenum heating elements and the CompuVac supervisory control system. The unit hot zone is 24" x 24" x 36" (610 mm x 610 mm x 914 mm), and it can be loaded from either end with loads up to 1,000 lbs.

Ipsen's HIQ2624-I0 horizontal internal quench vacuum furnace shipped to a customer in the Northeast.

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Omega Portable

OPTIMIZED FOR REVERSE ENGINEERING

Romer Inc. is calling the Omega portable measuring arm their most economical tool to date for multi-purpose non-contact measurement. The system is packaged for 3-D scanning applications like reverse engineering, rapid prototyping and no-contact inspection. The entire package includes the Omega articulating arm, the R-Scan line laser scanning probe and *PC-DMIS Reshaper* software.

The metrology device is lightweight due to a seven-axis arm comprised of advanced carbon fiber and aluminum construction. The R-Scan non-contact laser scanner has infinite rotation to scan areas difficult to reach. The system also features large capacity inspection, repeatability, automatic color recognition and real-time display of point clouds and point data.

The *PC-DMIS Reshaper* software uses a 3D point-cloud processing program to handle quickly generated point clouds and produce quality 3D meshes. The software collects live data from the measurement arm and creates 3D polygon mesh models, which users can export in various formats to bring into a CAD program or STL files for printing. Arm, probe and software all come with a Romer warrantee.

"The Omega arm is tailor made for the engineer or designer who wants a contemporary solution for the age-old problem of quickly acquiring accurate surface data from the most complex forms," says Jeff Freeman, Romer product line manager. "In the past, reverse engineering systems have either been very expensive, hard to use, or lacked a well-rounded toolset of both hardware and software to get the

job done. Omega is our cost-effective answer to this market need. We are confident that Omega's advanced features and ease of use will render efficiencies for a very broad range of reverse engineering and quality control applications."

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Wind Energizer

EXTENDS GEARBOX LIFE

Leviathan Energy has officially begun sales and marketing in the U.S. market for its Wind Energizer, a patented technology that increases the power output of large wind turbines.

The Wind Energizer is a passive, land-based structure that can be used with a wind turbine from any manufacturer. The product directs surrounding wind flow to the most important areas of a turbine's blades, which increases wind velocity to the blades. Power output jumps 20–40 percent when the turbine is moving and over 100 percent in marginal or poor wind speed. The Wind Energizer balances wind velocity load and shearing forces, so the blade and gearbox lifespan are both extended by 2–3 years, Leviathan estimates.

"We expect that with the very fast return on investment the Wind Energizer can deliver, sales will be quite strong," says Dr. Daniel Farb, CEO of

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Leviathan Energy. "We look forward to witnessing the transformative effects our technology will have on the wind industry throughout the country."

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GE Turbines

CONVERT TO MOBIL GEAR OIL

North American wind turbine owner and operator enXco has converted 32 of its 1.5 MW GE turbines to Mobilgear SHC XMP 320 synthetic gear oil at the Chanerambie and Viking Wind Farms in Minnesota. These sites generate energy to power thousands of homes in the southwest region of the state.

"enXco's selection of our premium Mobilgear SHC XMP 320 gear oil for many of its GE wind turbines is just another example of how our first-rate application expertise and lubricant technologies continue to help our customers maximize productivity and gain a competitive edge," says Brad Prickett, industrial sales engineer for Mobil Industrial Lubricants.

ExxonMobil's exclusive service provider, COT-PURITECH, executed the four-week conversion process with help from ExxonMobil field engineering and analytical support. Existing contamination and residual oil from the gearbox and lube system was removed by COT-PURITECH's proprietary gearbox flushing procedure.

"Developed through years of experience and working closely with leading gearbox and turbine OEMs, COT-PURITECH's proprietary gearbox flushing procedure was performed for enXco to help ensure optimal gearbox performance and to minimize possible compatibility issues," says George Mazzaro, market manager for COT-PURITECH Wind.

For more information:
Mobil Industrial Lubricants
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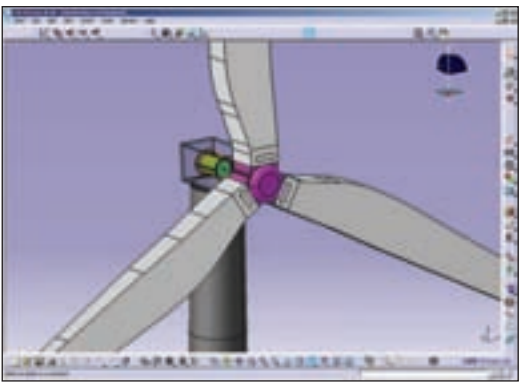
LMS Software

PREDICTS WIND TURBINE FATIGUE LIFE

The latest software release from LMS International, the *LMS Virtual.Lab Rev 8B*, features the Motion Aerodyn Wind Loads feature, which allows users to predict transient dynamic loads and input the information for fatigue life and radiated noise emission calculations. The software can create the wind turbine blade and its structural flexibility and wind behavioral traits while incorporating the modeling of the other critical elements, including the gearboxes, bearings and controls.

Pre-processing options help create formatted wind input data and include wind behavior traits. IEC wind standards are used to validate the turbine design. Based on wind information and blade orientation and speed during each time step, the *LMS Virtual.Lab Aerodyn* calculates the apparent wind speed on the blades and the subsequent wind load for each blade section for dynamic simulation studies.

"We integrated the Aerodyn functionality used to apply accurate loads on a turbine into our advanced 3-D multi-body code to model the entire wind turbine interaction with the wind in a much more scalable way," says Guillaume Lethé, product manager. "An easily accessible 3-D environment for cross-attribute multi-disciplinary simulations, *LMS Virtual.Lab* is the only 3-D CAE environment that addresses the specific challenges of wind turbine design, including precise blade-wind interaction and load cascading, thanks to the new Aerodyn Wind Loads feature."



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