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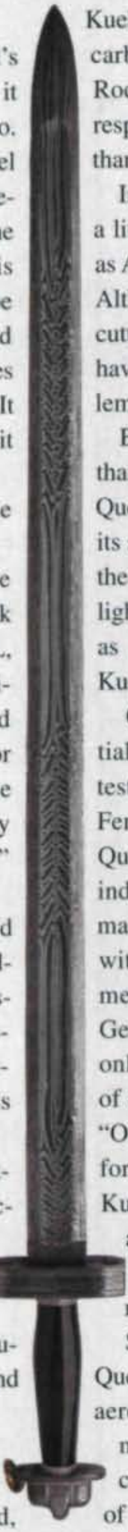
Dragonslayer Gears



According to legend, a samurai's sword was so strong and sharp that it could slice an opponent's blade in two. In medieval Japan, the forging of steel reached a high art among expert blademasters. A professional warrior, the samurai depended heavily on his blade's quality. The steel had to be extremely hard on the outside, to hold a sharp edge and withstand the forces of battle. But, it couldn't be brittle. It had to be tough on the inside, so it wouldn't shatter during combat.

Those properties are very like the ones required of modern gears.

At least, that's what Charlie Kuehmann, president of QuesTek Innovations LLC of Evanston, IL, says. His company develops materials, including steels for gears and swords. "We developed a steel for high performance helicopters that we figured out would also do pretty nicely for swords and knives," Kuehmann says.

Medieval bladesmiths learned forging by apprenticeship, trial-and-error and luck. QuesTek uses sophisticated computer modeling and a systems engineering approach to develop what the company calls Materials by Design®.

For example, QuesTek has software that models how different processing variables affect a material's strength. The models predict how materials will act under various processing variables, like carburizing and quench temperatures and cycle times, Kuehmann says.

QuesTek's GearMet® C61 and Ferrium® C69 alloys have been designed with gears in mind, Kuehmann says. These alloys can be carburized to a case hardness of Rockwell C61 and Rockwell C69, respectively, which is quite a bit harder than most gear steels.

In the annealed state, these steels are a little bit harder than gear steels such as AISI 9310 or 8620, Kuehmann says. Although this might lead to shorter cutting tool life, Kuehmann says: "We haven't had anybody have any problems with machining."

Because they can be made harder than gears made from other steels, QuesTek expects that gears made from its steels will last longer. Alternatively, the steels can be used to make smaller, lighter gears that perform the same job as gears made from other materials, Kuehmann says.

QuesTek has performed some initial rolling contact fatigue and wear tests on prototype gears made from Ferrium® C69 steels. According to QuesTek literature, these tests have indicated a longer life for the gears made of C69 steels when compared with gears made of some other commercially available steels. The GearMet® C61 steel has undergone only bending fatigue tests, not tests of actual gears made of the material. "One thing that's been a big hurdle for us has been getting good data," Kuehmann says. But the company has arranged to have gears made of its steels tested at a major gear research facility later this year.

So far, the primary applications for QuesTek gear steels are in racing and aerospace, Kuehmann says—where minimizing transmission weight is critical. But he adds that other types of companies are testing the materials for their own gear applications.

QuesTek also continues to develop materials for other applications. One of the company's showcase projects is to make a sword even better than the legendary samurai sword. That project is called "The Dragonslayer," a sword that—theoretically—could slice a samurai sword in two.

"We're pretty close to being there," Kuehmann says. QuesTek tested a blade made from its Ferrium® C69 alloy against a Japanese-manufactured hunting knife. C69 is the alloy that QuesTek sees as ideal for gears. The Japanese knife was the closest thing available to an actual samurai sword (without damaging a valuable antique).

The result: The C69 blade was virtually untouched, and the Japanese knife had a notch about 1/2″ deep, according to Kuehmann.

He believes he can make the Dragonslayer a reality by optimizing the nitriding process.

QuesTek hopes they'll be able to sell Dragonslayer swords to collectors. Just as important, they believe that one day soon they'll be selling Dragonslayer gears for your applications.

UTS, AGMA Offer New Gear Rating Software

Universal Technical Systems Inc. and the American Gear Manufacturers Association want to make work easier and more efficient for engineers who have to rate gears according to AGMA 2001 C-95 and ISO 6336.

To do that, UTS and AGMA each have new software for analyzing and calculating capacities of spur and parallel-axis helical gears according to both standards.

Based in Rockford, IL, UTS released its new rating software in August. The software consists of two programs, or modules: one for the AGMA standard, one for the ISO standard.

Those two modules were part of a larger release of 70 updated UTS modules. That software includes modules for designing, analyzing, rating and manufacturing gears and gear systems. The modules cover external spur and helical gears, internal gears, worm gears, face gears, planetary gear drives and involute splines.

Located in Alexandria, VA, the AGMA is scheduled to release its new program, the Gear Rating Suite, in October.

George Lian, a developer of AGMA's software, sees the program as useful to gear manufacturers and users, especially to their design and application engineers. Lian is senior project engineer at Amarillo Gear Co. of Amarillo, TX, and a member of AGMA's Computer Programming Committee, which created the software.

The committee's vice chairman, John Rinaldo, expects engineers to save time and aspirin entering gear data because of the program's "very flexible" input routine. Rinaldo is senior development engineer for Atlas Copco Comptec Inc., located in Voorheesville, NY.

The software's "flexible" input routine lets engineers enter their data in whatever way they want. For example, they can enter tooth thicknesses as x factors (profile shift coefficients) or as any of the six common measuring methods. Also, they can switch between those methods, entering a span measurement, then asking for display of the equivalent measurement over balls or of any other method.

More than that, they can enter their data in inches, metric units or a combination of both units, switching between the two "on the fly."

Engineers with a gear drawing that has a mix of both units don't have to convert them to one system before entering them. They can enter a face width of 20″, convert the screen to metric units, enter an outside diameter of 1,000 mm, switch the screen back, and continue to enter the rest of the drawing's data.

The UTS modules likewise use inches and metric units and can switch back and forth between them.

Also, UTS designed its modules so people wouldn't have to re-enter data as they moved from one module to another while working on a gear.

Similarly, AGMA's software lets engineers enter a set of common gear geometry, then add just those factors needed to rate a gear with ISO 6336 or with AGMA 2001—without having to re-enter the whole set of geometry data for each standard.

The AGMA software also has a gear geometry checker. Providing a gear's geometry data and hob information, an engineer can obtain a geometry review to make certain the gear's numbers are internally consistent. Rinaldo says the checker also helps people select the proper tooling.

Similarly, the UTS modules will warn people if a gear parameter, like center distance or outside diameter, goes beyond what would be considered good practice. They can override the warnings; but if they stray too far from good practice, the module alerts them that their gear is flawed.

Lian adds that the AGMA program was created to "faithfully" rate according to either standard—that is, to rate without injecting personal design rules or limitations from the program's authors.

"Whatever the standard allows," Lian says, "this program will allow."

The program's users also can enter their own design limits, and the program will warn users if those limits are exceeded.

The two UTS rating modules cost $1,200 a piece. Gear manufacturers can buy UTS's 70 updated—and integrated—modules separately, customizing their software sets to their particular needs.

The AGMA program will cost $1,195 for AGMA members and $1,495 for nonmembers.

AGMA's Windows-based software consists of screens created using Visual Basic and calculating routines that use Fortran.

"Any standard PC would be able to run (the software) without problems," says Frank Uherek of Flender Corp. of Elgin, IL. A developer of the software, Uherek designs gearboxes for power transmission applications and manages Flender's quality assurance program.

The UTS modules also were designed to operate with Windows. They consist of Visual Basic interfaces and TK Solver mathematical modeling engines.

Rinaldo sees the AGMA software as helping American gear manufacturers who are trying to sell gears overseas and need to rate them with the ISO standard.

"The international community is trying to move to one gear rating standard and that is ISO," Uherek says. "Through this software, people who are not familiar with the ISO standard but are comfortable with the AGMA method can compare their design."

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