Case Study

Sector	Consumer Products
Company	Taylor Made Golf
Project	Golf clubs
Solution	ThermoJet™ printer

3D Printing Helps Taylor Made Skin the Competition

If a golf club manufacturer wants to get attention for its products, the ideal method is to be associated with winning golf professionals. By dominating the PGA Tour in the 1980s, Taylor Made Adidas Golf Company of Carlsbad, Calif., became one of the top three golf equipment manufacturers in the U.S. When Taylor Made introduced the "Bubble Shaft," it was the club used to win the 1994 Masters at Augusta and generated more than $200 million in sales over the next two years.

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So when pro golfer Mark O'Meara wanted a new set of irons made to his specifications for the annual Skins Game tournament, Taylor Made's design group jumped at the challenge. "We had three days to produce two sets of irons, and no tooling in place," says Jeff Blasius, Taylor Made's Computer Numerical Control Supervisor. "So we created 50 wax patterns on our 3D printer, sent them to the foundry for casting and finishing, and delivered them to O'Meara on time. It was the first time anyone had ever used this type of club, and he won the Skins Game with them."

Blasius continues, "Without using 3D printing technology from 3D Systems, we never could have completed this project in time. In addition, the cost savings were tremendous. Conventional tooling would have cost about $5,000 for each club. When you figure nine clubs in a set, times two sets, that comes to about $90,000. Bottom line, our printers more than paid for themselves on just this one project."

Putting Rapid Back into Prototyping

Taylor Made has been an innovator in golf club design from its beginning in 1979, when it introduced the two-piece, thin-wall metal driver to the PGA Tour. Within five years, virtually every other golf club manufacturer was producing metal-headed clubs. In 1994, Taylor Made introduced its second revolutionary product, the Bubble Shaft— ushering in a new era of shaft perimeter weighting, which made it easy to swing with more power and less effort. These developments occurred only as a result of the company's commitment to research and development, which is second to none in the golf industry. Furthermore, when it comes to marketing golf clubs, aesthetics are as important as performance. The clubs have to hit well, but they must also be stylish and appeal to the players.

Taylor Made uses computer-aided design (CAD) software to create new clubs, and then uses 3D Systems' solid imaging technology to quickly transform their virtual ideas into physical realities. The company then turns to market research, testing, and focus groups to determine which of the new designs are preferable. Finally, they use their 3D printer models to go directly to investment casting and put the clubs right into production.

Design engineers at Taylor Made had heard about solid imaging, but the first time they tried it, the system they used was not very successful. "We started out with a product that was not manufactured by 3D Systems, and this other technology took the 'rapid' out of rapid prototyping," says Blasius. "The system we were using could produce a 3D model of a golf club head, but it took 40 hours to make each one."

He continues, "We liked solid imaging, because we could go directly to investment casting from our designs. Without this technology, it would be very difficult to create a wax pattern with very thin walls and intricate undercut geometry. The closer we could match our prototyping system to the production process, the better."

Because the system they had was far too slow, Taylor Made investigated all the solid imaging printers available on the market. Ultimately, they chose 3D Systems' Actua® 2100 solid imaging printer.

Now Taylor Made creates their club designs in CAD, then sends the file to their 3D Systems printer. The system uses an approach similar to ink jet printing; however, the jets in the printhead dispense a plastic-like material to create the solid model.

"With the Actua printer, we could create six club heads in 24 hours—about ten times quicker than the other, less competent brand," reports Blasius. "It was incredibly fast, which helped us immensely during product testing."

Freedom of Design

"A golf club is a very emotional product purchase," says Blasius, "so it's important that we generate a lot of different ideas to find the one that appeals to the most people. Everyone has a different idea of what a perfect golf club should look like. The more designs and variations we can produce, the more we can test for performance and utilize focus groups."

When Taylor Made's design engineers saw a tenfold improvement using their new solid imaging printer, "they went kind of crazy," says Blasius. "Previously, it took a week to produce a new design, which was a lot of time to spend on something that may never make it to market. Now, they could see a 3D model of a new design in a day."

Blasius continues, "We were so pleased with our Actua printer, we then purchased the next generation ThermoJet™ printer from 3D Systems as well. The ThermoJet printer is three times faster than the Actua system, so we can now see designs in less than a day."

The increased speed allows Taylor Made to produce a complete combination of designs, and makes it easier for the industrial designers, product engineers, and CAD groups to collaborate. It also allows them to marry the aesthetic design and performance characteristics when they generate a prototype. "The club designer may have three or four concepts in mind," says Blasius. "So we may generate a four-by-four matrix of prototypes that represents all the different variations in design and performance parameters for the new club."

Taylor Made makes most of its clubs with the investment casting process, and it creates wax molds directly from the 3D printer models. They also use the prototypes to generate casting trials, because they are stretching the limits of the metal and deciding what thickness can be cast successfully. For example: During production of its latest product, the Supersteel Driver, Blasius reports that they needed to use many prototypes for testing. "We had stretched the material to the limit. Anything thinner or bigger would fail or break. Thanks to the ThermoJet printer, we generated a lot of different trials, and eliminated defects that can lead to face cracking and face caving."

Taylor Made also makes the FireSole Rescue Club, but this club is forged from titanium and tungsten. "We can't use a 3D Systems printer for prototyping in forging, but we did use it to communicate to our outside vendors what we wanted," says Blasius. "The vendor was having difficulty visualizing the internal shape, because of its undercut geometry, no straight lines, and no nice circles. So we built one on the ThermoJet printer, and they were able to see exactly what we were talking about."

With everyone on the Taylor Made team able to see the design details of a new golf club, Blasius expect golfers everywhere will benefit. For Taylor Made Golf, that equals a marketing hole-in-one.

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