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Associate Editor

FEATURE

Forgers Hammer Out a Future in Orthopedics

With new technologies and materials come new challenges and opportunities in the field

Early forgers such as Turkish cymbalsmiths used to hand-hammer smelts of tin, copper and brass to produce warm tonal qualities in musical cymbals. Workers in the fiery furnaces of the Pittsburgh steel mills helped shape America by supplying steel for the Empire State Building and the Golden Gate Bridge. Forgers of today, however, do not use hammers, anvils or a variety of fullers and hardies to build nations or to shape gongs. Instead, they use pinpoint-accurate, automated equipment, highly engineered materials and a dose of science to create high-tech orthopedic implants designed for fit, strength and durability.



Hip prosthetics are forged using a multitude of high-tech metals, such as cobalt chrome and titanium. Photo courtesy of Symmetry Medical.

As new and improved processes and materials are introduced, so are new obstacles and challenges. Shorter lead times, tighter tolerances and competition abroad all continue to be a proverbial thorn in the forger's foot, but with highly advanced automation and Lean manufacturing principles in place, forgers have been able to stay ahead of the game.

Forging Faster

Dating back to the days of Benjamin Franklin, various types of Lean manufacturing processes have given industry the leading edge against fierce competition. The forging industry is no exception. With a concentration on minimizing waste and a quest for zero defects, forgers have been able to maintain their position against the ever-increasing tide of shorter lead times.

According to Bob Kervick, CEO of Worcester, MA-based KomTeK Technologies, many in the forging industry are employing Lean manufacturing to build efficiencies and reduce tact time as a product makes its way through production. Ed Van Note, director of engineering and process development at Orchid Stealth Orthopedic Solutions in Holt, MI, agrees.

"One of our highest priorities is to continually seek out more efficient and precise methods of manufacturing that will allow us to eliminate any variables in our process," said Van Note. "As far as new technologies,

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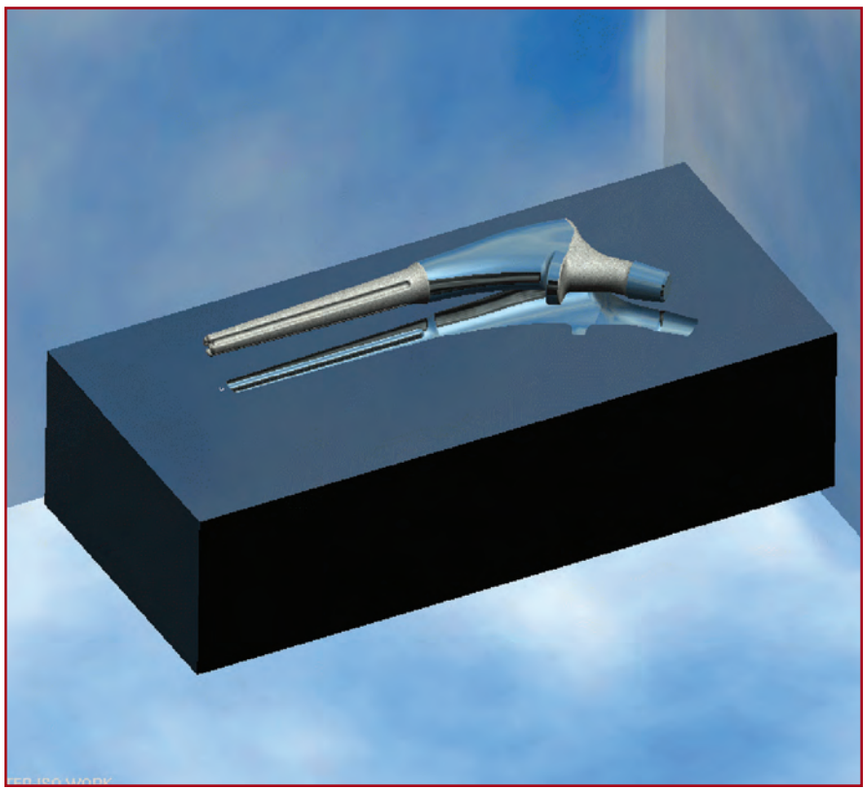

Forgers use a full complement of software to create 3-D die design models. Photo courtesy of VIASYS Orthopedics.

automation, robotics, high-speed milling and simulation software are a few of the areas that we have recently taken advantage of."

Jean-Paul Burtin, vice president of marketing and international sales at VIASYS Orthopedics - Tecomet in Wilmington, MA, said his company has embraced Lean manufacturing to achieve quicker machine setup and shorter lead times while maintaining small run sizes.

For other forgers, interaction with customers has helped increase the speed of the forging process.

"What's really helped us in addressing shorter lead times is working with our customers to co-develop a lot of the processes with us up front," said Andy Miclot, senior vice president marketing/sales for Warsaw, IN-based Symmetry Medical Inc. "The sooner we can get involved with our customer, the better off we're all going to be."

Lean manufacturing, however, is only one key to producing quicker forgings and staying competitive. Technology plays a part as well.

Forging in Computer Age

Modern technologies such as robotics and 3-D computer models help speed the manufacturing process along to meet customer demands. In fact, only during the past 10 years has forging been considered a "precision" process due to advancements in computer control.

Computer technology is a crucial foundation for forging advancements. Many applications are designed to predict die fill, load, energy, defect formation, grain flow and stresses that the device will encounter in actual use, while others are used to actively control manufacturing processes. Software such as Mega CAD, Think 3, Forge 3, Q Form and DeForm enables designers to analyze metal forming processes on the computer, rather than the shop floor, using trial and error, wasting time and money. Companies such as Tecomet, for example, use computer software to drive the entire production floor of its facilities, said Burtin.

Computer software also controls hammering equipment and is designed to give greater control of the blow pattern and the intensity of the blows that are required to manipulate the material through a series of impressions. As Kervick noted, "We make a hip in about 28 blows and about 40 seconds."

As applications advance and technology matures, computer simulation will continue to evolve into a daily production activity. But while software can control manufacturing processes and provide 3-D models, there really is no substitute for experience.

"Orchid Stealth recently purchased DeForm and is running some simulations to determine where we can best take advantage of this tool," said Van Note. "But in my opinion, no software can be substituted for practical experience. Unlike machining, the forging process is much more a mix of science, art and math all rolled into one."

Even off-site monitoring is proving beneficial, according to Martin Streng, manufacturing engineer at K-Medic Orthopedic Surgical Instruments in Tuttlingen, Germany, a division of Limerick, PA-based Teleflex Medical.

"Forging processes are monitored by employees who work from home, so the machinery can run 24 hours a day and on the weekend, if needed," Streng said.

Along with advances being made in operations and processes, materials and tolerances are also being improved.

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Materials and Tolerance

Historically, stainless steel, cobalt chrome and various grades of titanium have been used to forge orthopedics devices, with titanium becoming the stronger, more biocompatible material for cross-shaping hip components, according to Streng.

In the past five years, zirconium has emerged as another solution to the challenges set by complex designs of femoral and tibial components in which wear resistance is a major concern. Whereas titanium is in applications where a premium can be justified for high performance, such as prosthetic devices, zirconium is the second hardest material known, exceeded only by diamonds. The net effect is a femoral component that has the wear resistance of ceramics without the brittleness and eight times less friction, making a longer- lasting implant. But due to the complexities of forging these materials, not many companies can forge them easily.

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"Each material type has a different and specific set of processing parameters and most have been learned through many years of trial and error," said Van Note. "Thus, there are very few successful companies capable of forging these materials today."

Van Note also said that forgers generally do not develop new materials—medical companies and surgeons determine them.

Also difficult for forgers is maintaining the tight tolerance demands required by some OEMs.

Whereas the average tolerance for



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Orthopedic Consolidation Impacts Forging Industry

Even though forging companies create product for OEMs other than those in the orthopedic industry, consolidation in the medical field has become somewhat of a bane to the forging industry. As corporate giants such as Johnson & Johnson and Stryker acquire smaller companies, they invariably acquire forging facilities in the transactions and, therefore, no longer have the need to outsource forging needs.

Further, some of the larger OEMs prefer to handle the final machining or polishing, labeling and packaging themselves.

"If you're dealing with the Zimmers, the Strykers, and J&Js of the world, in many cases they handle most of the finishing internally," said Bob Kervick, CEO of Worcester, MA-based KomTeK Technologies. "The idea of vertical integration of casting and forging technologies originally began with many OEMs either creating or acquiring investment casting capabilities. Over the past decade or so, many have now acquired forging capabilities through consolidations and mergers."

Exacerbating the situation is the fact that the US forging industry has been in decline, with little or no capital reinvestment or expansion occurring. According to the US Department of Energy, the forging industry has shrunk approximately 10% per decade since World War II as consumers have moved toward products made from lightweight plastics. Further, according to The Forging Industry Association, US forging demands have decreased about 20% since the 1970s. To add fuel to the fire, China produces and consumes more than 25% of the world's steel output, and forgers feel it won't be long before China begins competing in the precision forging market.

To combat this slide, forgers believe that modernization is the key. According to a survey conducted by the US Bureau of Industry and Security, many forging companies are starting to use modern practices and technologies such as Total Quality Management, Concurrent Engineering, Statistical Process Control and CAD/CAM technologies. Many already are using Near-Net shape forging, faster die changing, robotics, non-destructive testing and flexible cell manufacturing. And companies not already implementing changes are in the process of investigating the possibilities of modernizing.

Forgers also believe that this downward trend is now starting to reverse itself as the baby boomer generation comes of age and the average lifespan increases. While the forging industry might be losing ground in the aerospace and automotive markets, it is making strong gains in the orthopedic industry with high-tech, precision implants.

the past 20 years has been in the range of +/- .015, tolerances of +/- .005 have been achieved and maintained.

According to Kervick, the secret to maintaining tolerance consistently is controlling tooling and constantly measuring the parts as they come off the production line.

"Every hour we'll take a sample of parts and do a layout on a CMM [coordinate measuring machine], and we also do scans as well," said Kervick.

Further, according to Burtin, aesthetic qualities often are a consideration.

"Orthopedic forging requires very tight dimensional tolerances, very demanding mechanical properties and very smooth surfaces capable of achieving high visual standards," said Burtin.

Visual standards are becoming increasingly more important as many products now produced use the forged surface of the component as the final implant surface, Van Note explained. As a result, large amounts of costly machining operations are eliminated, producing substantial cost savings.

Net and Near-Net Shape Forging

A relatively recent development in the conventional impression die forging process is Net and Near-Net shape forging, processes that offer the benefits of fewer machining operations, reduced weight and lower costs for raw materials and energy. Net and Near-Net shape forgings are distinguished by geometric features that are thinner and more detailed, varying parting line locations, virtual elimination of draft, closer dimensional tolerances and many as-forged surfaces. In fact, the orthopedic industry alone can be considered the key driver in the technology, since implants demand precise anatomical design shaping and tolerances.

"Some people like to look at it as a cost savings because they're not going to have to do as much machining or finishing on the part," said Kervick. "It's how people are set up and what they want, what their capabilities are, what their competencies are and how much value-add they prefer to have outsourced versus doing it internally."

Net and Near-Net shape forging, however, invariably mean higher costs, since dies are custom made to

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meet the particular requirements of an orthopedic part.

"The processes are quite expensive in terms of the tooling and capital expenditure required," said Streng. The processes only can be justified for current processes that are very wasteful where the material savings will pay for the significant increase in tooling costs."

Shape of Things to Come

Most forgers agree that staggering changes are not forecast in the forging industry for the next five to 10 years. They do, however, believe that to stay competitive in the changing global market, forgers must continue to automate their processes as much as possible, employ well-trained people who understand the process requirements and employ a very controlled and monitored manufacturing system.

Other forgers believe that the development of consistent pre-formed parts remains a challenge, because parts must be shaped from flat or round bar stock into a close approximation of the finished part before the forging process can begin. With a preformed piece of raw stock, forgers can save time and energy.

Finally, many forgers believe that increasing lifespans and new technologies such as advances in hip replacement surgery will keep the industry healthy for the foreseeable future.

"A lot of the technology that exists today will continue to be used because it's relatively cost effective," said Miclot. "And many of the newer materials initially are going to be more expensive. With cost containment being a major driver at hospitals, I don't see one thing replacing everything all at once. There will always be cobalt chrome and titanium forgings being used as implants 10 years from now."

With new forging equipment and process controls being developed, Net-shaped forgings are becoming more common and tolerances that were previously unattainable are now routinely held throughout the forging process. Few companies can forge Net-shape orthopedic components and fewer still are able to forge alloys of titanium and zirconium. With these advances and challenges combined, the forging industry still has room to grow and become even more of a "precision" industry. ❖

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