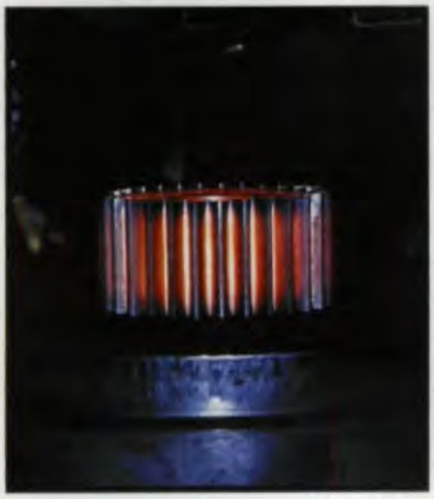
Better Quality, Lower Cost Forged Gears

Today, near-net shape forged gears are produced with better quality than just a few years ago. Requiring only minimum finishing to meet specific tolerances, these gears can also be produced at significantly lower total costs than gears manufactured using other traditional techniques.

Near-net gears come from the forging press in almost the exact shape of the finished gear, with straight-from-the-die quality ratings as high as AGMA 6–7. Gear teeth are forged with an envelope of excess steel around the tooth profile, which is removed by either a single-pass grinding or hobbing operation. While only a handful of companies produce gears with this method, its popularity is growing, says Chris Carman, president and chief operating officer of Presrite Corporation, Cleveland, Ohio, which produces straight bevel, spiral bevel, helical and spur near-net gears in diameters up to 17" with stock allowances ranging from 0.1 mm to 1.5 mm.

Forging Near-Net Gears. The manufacturing process, which can take from 6 to 14 weeks depending on materials and design complexity, begins with steel bar stock that is usually turned and polished to improve the surface and then cut to the exact weight. This is critical since the steel must completely fill the die to complete the gear profile.



A near-net shape forged gear hot off the press. Courtesy of Presrite Corp.

Prior to forging, billets are heated in an electrical induction furnace, then, in a single stroke, mechanical forging presses, ranging from 1,600- to 6,000-ton, form near-net shape gears with the complete allowable material envelope, or stock allowance.

Finishing. After the raw forged gear is ejected from the die, it is allowed to atmospherically cool to ambient temperature. The gear is then ready for turning and a light-finish hob cut. If grinding is the final operation, a complete and consistent lower material envelope of grinding stock (0.1 mm to 0.3 mm per flank) is ensured by cold drawing the forged near-net gear through a finish sizing die. This operation is also capable of providing a finished protuberance and root configuration to the geometry supplied by customers, thereby eliminating requirements of grinding the root area. The cold drawing process is sometimes capable of producing a net tooth geometry, which eliminates gear finishing altogether.

Quality Control. A dedicated, climate-controlled gear lab, with responsibility for quality audits of the gears and dies, is essential to both the die design and the gear production process. Presrite recently improved its CMM capabilities with the addition of a new Mitutoyo Bright 910, running the latest proprietary gear software, to provide dimensional analysis of forged dies and gears. Dies are checked before and after press runs, and gears are checked during press runs to ensure quality.

"All of the machining equipment we've invested in is allowing us to produce near-net gears with lower profile stock allowances that are ready for our customers' final finishing processes," says Norman Fisher, Presrite's director of international sales. "Ultimately, we are helping our customers avoid capital equipment expenses, and at the same time we are providing them with higher quality parts."

Investing in Technology. Presrite has recently invested more than $30 million in technology for its near-net gear production process. This includes another state-of-the-art Solid Works 3-D CAD/CAM system to assist in precision tool design, and five CNC wire EDM machines to tighten repeatable die tolerances and reduce tooling costs.

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Enhancements in equipment and tooling development have greatly reduced die set-up times, and advanced die materials now yield less forging scrap and greater production. Forging scrap rates have decreased from 20% to a current rate of less than 0.2%. "The changes we made to our die material and die design have resulted in extended die life, enabling us to produce more pieces per die," says Dale Debeljak, Presrite's technical services director. "And, in certain cases we've been able to cut die costs by as much as 50%."

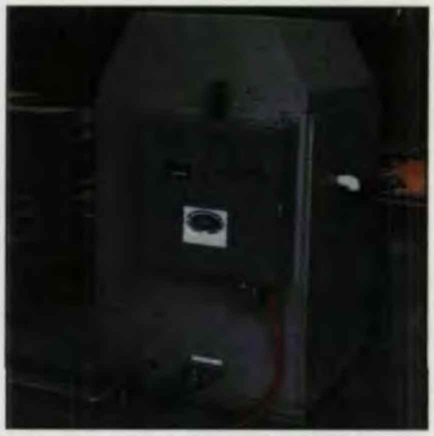
Manufacturers Benefit. Manufacturers wishing to minimize capital expenditures and utilize their gear finishing areas for other manufacturing functions can benefit from using near-net shape forged gears. These gears exhibit less stress and last longer because of the consistent, unfractured grain structure of the integrally forged teeth. Near-net shaped forged gears can also cost less. Many manufacturers are eliminating rough hobbing, focusing instead on high-speed hobbing because of the benefits of working with near-net shape forged gears including increased productivity, reduced work-in-process, reduced expendable tooling costs and reductions in scrap rates.

According to Fisher, "We've had manufacturers tell us that they have experienced savings of up to 65% of hobbing time in certain conditions when working from a near-net shape configuration rather than a blank."

Circle 250

Recycling Comes to Abrasive Waterjet Operations

Abrasive waterjet, an alternative cutting process that utilizes abrasive particles in a highly directed, extremely high-pressure stream of water to cut metal and other materials without some of the drawbacks associated with other processes, has traditionally had some high waste and disposal costs associated with it. In fact, according to Richard Ward, president of EasiJet, Inc., of Tallmadge, OH, abrasive is the single largest consumable cost borne by all abrasive waterjet cutting customers. However, Ward and the folks at EasiJet think they have come up with an answer to those costs: their Waterjet Abrasive Recycling Dispenser, the WARD 24.



The Ward 24 Waterjet abrasive recycling system. Courtesy of Easijet, Inc.

How It Works. The WARD 24 removes waste product from the tank in an abrasive waterjet cutting system. It separates the poor product into a container for removal and then washes and dries the remaining abrasive particles so they can be used again. The abrasive is removed from the tank using patented nozzles that have no moving parts. Even if they have been buried under the abrasive for several days, the nozzles can be activated to begin delivering the sludge to the WARD. The sludge is sent to the top of a series of vibrating screens where usable abrasive is separated. This recovered abrasive is then dried and readied for reuse. This results in two products: waste and recycled abrasive.

The waste is made up of sludge and fine particles. These waste products are typically well compacted and have very little water in them since the water used for washing the abrasive is returned to the tank. The recycled abrasive is washed and dried. It is then ready to be reused.

Maintenance Issues. In general, all alloys, steels and harder materials work well without clogging the machine. Test cutting of several plastics has also proven to work well. Small particles that found their way into the dryer were bonded, melted together with a grain of abrasive and removed during the final screening. This is not to say that clogging cannot happen. If materials being cut break down into frayed particles, these could cause screen clogging, which is easily fixed by removing and cleaning the clogged screen.

Clogging is not the only potential problem associated with the WARD. A number of parts on the machine—all parts in contact with the abrasive—are considered consumables and need to be watched and replaced as needed.

Recovery Rates. A number of variables need to be taken into account when considering recovery rates of recycled abrasive. These variables include the material being cut by the waterjet, the speed and quality of the cut specified (this determines the amount of abrasive contacting the abrasive stream's cutting face), the type and mesh size of the abrasive used, the placement of the abrasive removal nozzles in the tank, and the amount of operator attention given to the machine. Given these variables, field tests have achieved recovery rates of up to 70% in a general job shop environment. This reduces costs associated with waste removal and hauling, saving users up to 40% of the cost normally associated with abrasive waterjet.

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Ford's Outstanding Young Manufacturing Engineer

Jose R. Ruiz Ayala, a manufacturing/process engineer who contributed to the implementation of the helical gear honing process at Ford Motor Company's Automatic Transmission Organization, was named as one of six recipients of the John T. Parsons Outstanding Young Manufacturing Engineers award by the Society of Manufacturing Engineers. The honor is conferred on individuals 35 years of age or younger who demonstrate outstanding leadership and achievement in the field of manufacturing engineering.

Ayala is researching the honing process as the benchmark in gear noise. "We're using honing to control the frequencies of the gear noise," says Ayala. "Right now, we're applying it only at the Sharonville plant, but other units within the company are looking at it." Ayala also reduced tooling changeover time on two gear production lines through the redesign of tooling and equipment. According to Ayala, the original design of the machine, manufactured by Federal Broach, required the complete removal of six, 6-inch bolts to change two collets.

"This removal had to be done blind," Ayala says, "as did the reinstallation. We worked with Federal Broach to redesign the tools and the machine so that the collets could be removed by only loosening the bolts. This saved a great deal of time." Ayala's redesign reduced changeover time from 90 minutes to 15 minutes. He is now working to change the tooling at hard turning operations from diamond coated inserts to ceramic inserts, which cut tooling costs by half and extend the useful life of the tool. "With the diamond-coated inserts, which have two corners, tool life was 250 parts per insert," he says. "With the ceramic inserts, which have 4 corners and slightly longer life per corner, we can get approximately 720 parts per insert."

After earning a masters degree in mechanical engineering from the University of Michigan, Ayala, a former Exxon Scholar, joined Ford, participating in the Ford College Graduate Program. As a member of Ford's South American Ranger launch team at the Ford Pacheco plant in Buenos Aires, Argentina, he was able to work closely with vendors to address issues and was the liaison between the Pacheco launch team and the launch team at Dearborn, MI.

In addition to his work at Ford, Ayala is a member of the Society of Hispanic Engineers (SHPE) and has also worked with the Young Engineers and Scientists (YES) program, guiding students through presentations ranging from electricity and chemistry to resume writing.

Each year, the Outstanding Young Manufacturing Engineer Award is named after an SME member who is considered a role model for young engineers. This year's choice, John T. Parsons, is the retired founder and president of the John T. Parsons Company of Traverse City, MI. He has a 70-year history in manufacturing with contributions to the automotive and aerospace industries that include the development of Numerical Control (NC), which he worked on with a partner.

The awards were presented in May at the North American Manufacturing Research Conference (NAMRC), an international forum for the presentation and critical discussion of the results of basic and applied research in material forming, material removal, manufacturing systems and manufacturing controls. The other recipients were Matthew Davies, Ph.D., a mechanical engineer at the National Institute of Standards and Technology in Gaithersburg, MD; Hugh Jack, Ph.D., an assistant professor at the Padnos School of Engineering, Grand Valley State University, Grand Rapids, MI; Paul Schiebel, assembly engineering manager at Hutchinson Technology, Inc., Eau Claire, WI; Steven Schmid, Ph.D., CmfgE, PE, a professor and researcher at the University of Notre Dame, South Bend, IN; and W.R. Winfough, Ph.D., senior staff engineer at Ingersoll Milling Machine, Rockford, IL.

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