A REVOLUTION IN HOBBING TECHNOLOGIES

KNOWN FOR ITS COMMITMENT TO INNOVATIVE TECHNOLOGIES, LMT-FETTE, INC., ANNOUNCES ENHANCEMENTS TO ITS PRODUCTS, SERVICES, AND PHYSICAL FOOTPRINT IN THE UNITED STATES.

By Darryl Witte
In a market that has not seen any truly revolutionary changes in decades, LMT-Fette is pushing the long overdue evolution of hobbing. LMT demonstrates their North American commitments with facility improvements, including the new LMT Detroit Automotive Technical Center and the start up of U.S. hob production. These commitments allow LMT to provide their automotive engineering expertise and guarantee rapid delivery. LMT-Fette is committed to providing the latest technology to the U.S. gear cutting market to assist in combating intense offshore competition. Innovative technology has long been understood to be a critical part of maintaining a competitive edge in a hostile global manufacturing market. In light of this, LMT-Fette is launching new technologies into the gear manufacturing market. With cost saving tool offerings to improve high production gearing, as well as a continued focus on LMT’s strength in coarse pitch gear tools, it is an exciting time for LMT-Fette—and even more so, for their customers.

While management at LMT-Fette has been busy with the strategic investment in U.S. production and support network, the backbone of the Fette hobbing business—their core engineering staff—have been working on a few items of their own. These innovations include LMT’s new ICE hob, Twist Free hob, and Chamfer Cut system.

ICE Hob

With patents applied for, Fette is now introducing to the world the idea of internally cooled gear hobs. The ICE hob can be used for either wet or dry cutting, but looks to be most promising in dry applications. Although this tool is currently under study, there are enough benefits to introduce the product and concept to the market. Take a look at the 3D computer image in figure 1.

The concept is quite simple; having coolant orifices projected at each cutting tooth with a central coolant line to keep the core temperature constant. The tool can operate in severe applications with outstanding results. One early test has shown a 40-percent increase in tool life on a test gear, as noted in figure 2, which shows the tool at wear point having less material to be removed with double the output of gears cut. This is quite an exciting result, but the true savings will be in the elimination of chip welding to the part. This issue is familiar to anyone who has been involved with dry hobbing, and it is known to be caused by the recutting chips that land on top of the hob and are then brought back into cut. As chips are recut, there is always a chance of excessive wear or breakage to hob teeth within the generating zone, in addition to the poor surface quality or smearing of the gear. By introducing coolant holes in front of every cutting tooth, chips are no longer a problem. Instead of being recut, chips are constantly blown away with air or coolant as supplied from within the hob. Both problems to tool and gear are resolved.

The ICE technology is not without some small hurdles. As seen in the 1980s with the introduction of the coolant fed drill, tools are now capable of slightly more than the machine tool counterpart. As the tool plays leapfrog with the machine tool regarding technology, customer ingenuity will reign supreme in finding a solution to fit the needs and take advantage of this groundbreaking advancement. In the case of the study application cited above, a simple fitting has been applied to replace the jackscrew in the end support of the hob arbor, and air is easily introduced to the tool. Additional work is still required to adapt this technology to manual machines, wet applications, and arbors where the coolant manifold will need to route via an inducer ring to the shoulder of the hob. The benefits, however, do outweigh the limitations at this point. With the ICE hob design, a safety measure is now in place to ensure that hobs can be used to the projected end of life, without scrapping tools and/or parts due to breakage. Air nozzles—long a frustrating variable of how successful a dry hobbing application might be—can tend to be repositioned in error. In the best condition, the nozzles are blowing the problematic chips directly back into the hob, in exactly the wrong direction. The ICE hob can make way for consistent cooling, and great savings are made a reality. Elimination of chip welding will ensure better surface quality and allow dry hobbing to continue its advance in replacing alternate gear finishing methods. Longer up time will contribute to lower cost per part calculations, and the use of air, oil, or coolant will allow customers to continue to use the same medium currently in place to cool existing hobbing operations. The ICE technology is ideal for any shop considering MQL technology as well.

![FIGURE 1: CAD image of the internally cooled ICE gear hob](image1)

![FIGURE 2: Test study cutting parameters and results](image2)
This ICE technology can also be used with indexable gear gashing processes. Gashing technology is rapidly being accepted as the most optimal process for producing low and medium quantities of coarse pitch gears. Gashing has also been put on ICE. By adding coolant holes aimed directly at the cutting edge, the steel milling body can now be pushed even harder with minimal erosion of the tool body from hot chips. This is the most common limitation regarding the productivity of a coarse pitch gashing cutter, and with minimal engineering a common rotary union can be employed at the end of the arbor to allow air through these tools as well. Due to the potential for thermal cracking of carbide inserts used for milling applications, coolant is not recommended. Gashing designs with duplex and triplex installations used to machine two and three gear tooth spaces at a time are also available. The LMT-Fette studies have yet to qualify the improvements of insert life in using the technology, but as the tool has minimal cost difference in relation to solid tools of yesterday, the ICE gashing cutter will be a tool of choice for years to come. With optimized German designs for placement of smaller overlapping inserts, now LMT-Fette gashers, common to reduce pounding and machine loads, can make you sweat a little less over high heat applications (see figure 3).

Twist Free Hobbing
LMT-Fette has also dedicated a large investment of engineering to the new technology introduced as “twist free hobbing.” With three separate benefits, the twist free hob—developed in unison with Liebherr GmBH—can eliminate the known convexity errors from a helical gear with crowning. Commonly a limitation in the use of hobbing as a finishing solution for these helical gears, the bias caused by the hobbing process can now be removed with the twist free hob. In addition, the tool can be used without the twist free hob profile and offer substantial tool life improvements in spur gears or pre-grind applications. Lastly, the addition of LMT-Fette’s chamfer cut technology can allow for gears of any helix angle to be chamfered and de-burred at the hobbing machine with a consistent form along the involute and through the root of the gear.

The development of the twist free hobbing solution (see figure 4) starts with analyzing the gear to determine the width of convexity, or amount of bias. Commonly known as twist, and assumed to be removed by alternate finishing methods or overlooked altogether, this error can be measured by performing a few simple checks. By measuring the lead of a single tooth at the SAP, the pitch diameter, and the tip, it is found that the theoretical lead is not the same on single tooth with conventional hobbing on helical gears with crowning. Similarly, by checking the profile at the top, middle, and bottom of the gear, the involute form is notably in error. The severity of the crowning impacts the amount of this complex twist to the gear tooth (see figures 5, 6). In coming to a solution to this hobbing-related phenomenon, it was noted as used by Liebherr worm grinding theory, that by changing the pressure angle at the point of generation across the face of the part, this twist could be minimized. LMT-Fette has managed the most difficult task of blending a gradient change to the pressure angle of the finishing hob. This hob has a corrected pressure angle similar to figure 7, with the corrected tooth profile for the bottom of the gear separated from the corrected tooth profile for the top of the gear. As the finish hob is in cut, a diagonal feed process can be employed with today’s state of the art machinery. With the diagonal hobbing, the twist found in crowned helical gears cut by conventional hobbing has been eliminated. This technology which can reach to DIN 5 quality for common automotive pinions can now change process theory to allow for finish hobbing to be considered for parts that until now would require additional finishing processes. The concept of replacing a finishing process, typically either grinding or shaving, with finish hobbing must consider distortion at heat treatment and should be evaluated on a part by part basis. If applicable, the savings can be more than significant when considering the cost of machine tools, cutting tools, and labor eliminated. The LMT-Fette twist free concept adds little to no extra cycle time to an existing two-pass hobbing application.
Regarding tool life, a simple detail relating to two-cut hobbing processes has also been realized. As the primary cause for tool change in production hobbing, hobs are generally changed due to loss of part quality rather than attainable wear points. In addition, the highest quality finishing hobs are routinely being called on to rough out the tooth form as current hobbing equipment does not allow for automatic tool changing. As a solution to both problems, a two-hob tool system has been utilized to optimize tool life for each process. This concept has two benefits of its own. First, by separating the roughing from the finishing, the roughing tool is allowed to cut to the normal point of wear. The finishing tool can now run five times the volume of parts, as this tool is not subjected to the wear from the roughing process. As a second benefit to the two-hob solution, each hob can be designed to optimize the process it is intended for. Each tool can have a different number of starts, a different number of gashes, and even a different tooth profile. The profile change from rougher to finisher can now account for even more life to the finishing hob as well. As there is generally three times the amount of material in the root of the gear in comparison to the flank stock left for a finish pass with a conventional single tool using a two-pass process, the LMT-Fette tool system solution has corrected that condition by an addendum modification to the roughing tool. In application study, the finishing hob has dramatically reduced wear on the tips of the hob teeth, where the most common wear would normally occur. LMT-Fette is referring to this two-hob solution as a “tool system” and does require higher volume production to justify the investment in tooling optimized for a given part. It is ideal for any gear manufacturer with stable part designs and regular production quantities.

**Chamfer Cut System**

The Fette chamfer cut introduces another technology improvement that produces better quality and productivity (see figures 8, 9).
Adding little additional cycle time, the chamfer cut tools use a set of two identical cutting tools that are specific to an individual gear. The tool acts to mill away the material at the end of the gear tooth by always cutting towards the center of the gear. The first tool will rotate clockwise and feed into the top of the part and the second cutter will rotate counter clockwise and feed up from the bottom of the gear. Each tooth on the chamfer cut tool feeds into a single tooth gap on the gear. Short feed lengths and an accelerated tool to part speed ratio make this a very fast process.

Along with the latest technology in hobbing, LMT-Fette also continues to make conventional hobs designed with intelligent engineering and regularly optimizing hob design as needed for cost per piece, quality.
and required cycle time reductions. All three considerations are evaluated with every tool LMT makes.

**Additional Innovations**

With a strong commitment and dedication to the U.S. market, LMT-Fette is making large capital investments and engineering unique new technology. This new technology pushes the envelope of hobbing to a new level and demonstrates LMT’s leadership in the gear cutting industry.

With a new 13,000 square-foot Automotive Technical Center in Auburn Hills, Michigan, to be opened this summer, LMT-Fette will now service and support automotive tooling with the highest efficiency. Customer training and demonstrations are also planned for the new location. The highlight of the new commitment is the addition of U.S. hob production at Onsrud Cutter, a sister company in the LMT group. Located in Libertyville, Illinois, just north of Chicago, Onsrud has started with production of gear hobs focused at what made Fette famous: high quality hobs, ground with premium tool steels and the best modern coatings for the application. Fully functional at the present time, LMT-Fette can now offer ground gear hobs with rapid delivery, and no loss of the quality that has always been synonymous with Fette.

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**Figure 8:** Gear with burrs

**Figure 9:** Gear without burrs after using LMT-Fette’s Chamfer Cut

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