

FULL SPEED AHEAD

Indexable carbide insert (ICI) cutting tools continue to play a pivotal role in gear manufacturing.

By offering higher cutting speeds, reduced cycle times, enhanced coatings, custom configurations and a diverse range of sizes and capabilities, ICI tools have proven invaluable for finishing and pre-grind applications. They continue to expand their unique capabilities and worth in the cutting tool market.

Many of these technologies will be on display at the 29th edition of IMTS (September 10–15 in Chicago) where attendees will get a firsthand look at tooling advancements in machining centers, productivity gains utilizing two-start hobs and a wide variety of new coatings and materials that will lower manufacturing costs.

Cutting Tool Manufacturers Discuss Future of Indexable Carbide Inserts

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Associate Editor

For the production of large cylindrical gears, Gleason offers the Opti-Cut family, which provides users with all the performance benefits of the latest replaceable, indexable, carbide insert technology (courtesy of Gleason).

Gear Technology is getting a head start on IMTS by speaking with representatives from Ingersoll, Gleason, Sandvik, Seco Tools and Banyan Global Technologies on the future of indexable carbide inserts—a future that promises to keep high-speed steel (HSS) tools in check as reducing cycle times and cutting speeds remain a manufacturing priority.

Expanding Operations

While the normal range of indexable tools is from module 5–25 for quoting purposes, many cutting tool manufacturers are expanding to both larger and smaller sizes. Increasing the cutting tool production range is necessary in today’s manufacturing environment, thanks in part to the volatile market segments. Areas like energy, mining and heavy industry, for example, are in constant flux. Manufacturers are learning that in order to provide tooling/workholding systems to these markets, flexibility is a premium.

“We typically produce ICI hobs and gashers from module 6 on up,” says Frank Berardi, gear machining product manager at Ingersoll. “We can go smaller depending on the diameter of the gear and the cutting tool. There is almost no limit on the high end. We have built gashers, for example, up to 100 module for pinions used in offshore oil rigs.”

“Seco offers milling cutter roughing from module 1–30, milling cutter finishing from module 6–24 and gear hobbing from module 6–24,” says Alessandro Manta, international application expert, power transmission at Seco Tools AB, Sweden.

“While we have no set limits, we are constrained by the physical limitations to carbide insert and machine tool technology. For practical limits we can operate from module 1 to 50,” says Darryl Witte, vice president, sales at Banyan Global Technologies.

The Sandvik Coromant program for gear cutting has a full range of tools from module 4 to 40. “Within that range are three different programs,” says Kenneth Accavallo, industry and applications specialist at Sandvik Coromant. “Module 4–8, covered by our CoroMill 176 full profile hob; module 8–18, covered by our CoroMill 177 hob; module 8–40 covered by our disc cutters.”

“If the range is smaller or larger than module 5 to 25, then more investigation is required for the quote and design of the indexable tool,” says Michael Tennutti, senior project manager at Gleason Cutting Tools.

Small Module Gears. Ingersoll is currently developing a line of ICI hobs in the 4–6 module range with plans to go down to module 3. “We feel this is an important segment to address because of the large number of gears in this size range,” Berardi says. “Because of the small tooth profiles, the challenge is to produce a robust design that remains user-friendly. We have had good results with our initial prototype testing and expect to have products on the market in the near future.”

While indexable insert tooling is limited around module 3, Ingersoll offers other solutions for smaller sizes. “We have our ChipSurfer line of cutters with replaceable carbide heads

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that are ground to the finish spline involute size,” Berardi says. “These have been very successful for machining small splines down to 16/32 NDP and smaller.”

“Sandvik Coromant is planning on releasing module 3, module 9 and module 10 over the next year,” Accavallo says. “The full program will be between module 3–10. Also, with the innovation of the Invomilling method, which uses a five-axis machine to produce the gear form with standard tools, we will be able to offer a wider range of opportunities. It’s hard to get indexable tooling small enough to machine gears much smaller than 2.5 module or approximately 10 diametral pitch. Sandvik Coromant is working on a program that will be able to mill splines and racks smaller, but the current hob program is limited.”

Banyan is engaged in constant discussions relating to fine-pitch cutting.

“We have a solid solution for single- and multi-tooth spline milling, and are developing a revolutionary approach for fine-pitch indexable hobbing,” Witte says. “To date we have only provided tools for spline milling, and have not addressed indexable spline hobbing. In the coming years most every tooling provider will have some solution for gears 1 module and finer. The discussion is centered on tolerance and accuracy as finer gears have finer tolerances and indexable tools have the same repeatability and pocket tolerance limits regardless of tooth form.”

There have not been many requests for the smaller range of modules at Gleason. “The current size range for the



Photo courtesy of Banyan

inserts for the smaller modules is limited by the size of the insert and the hole required to lock and position the insert. Many requests have gone from an indexable request to a solid design tool,” Tennutti says. “There are smaller tools available in the marketplace today which can take insert carbide forms which screw into a body adaptor that can be used for thread milling and producing involute splines.”

“Small module (less than 6) normally needs direct finishing with a high quality that is difficult to obtain using indexable tools,” Manta says. “We’ll always have an open question regarding quality, but it’s really hard to do better



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than solid tools and due to small dimensions they are cost effective.”

Large Module Gears. “Large gears have always been a major focus in the development of our indexable gear tooling lines,” Berardi says. “Primarily because large gear tools more readily lend themselves to the application of indexable tooling. For large gears, solid carbide, if feasible, is usually cost prohibitive, leaving indexable carbide as the obvious solution. The productivity gains can be very dramatic when applying indexable carbide tooling over HSS on large gears.”

In one case study on a very large diameter Module 20 gear with 181 teeth, the customer was finishing with a HSS hob in 2 passes, which required 70 hours to machine, according to Berardi. “The Ingersoll ICI Finish Hob completed the 2-pass finish operation in just six hours... a whopping 64 hour time savings, and AGMA 10 quality which was as good as or better than HSS.” Ingersoll continues to see strong growth in mining and heavy construction, shipping, rail, and oil & gas. “We have a long history in providing tools for the wind industry, and although growth has slowed in recent years, it continues to be a very important customer segment,” Berardi adds.

“It is no secret that production tax credits from state and federal programs push the wind energy market in and out of growth modes. Mining, agriculture and other energy producing sectors have played an important part in our business growth, and continue to be a focus for us in 2012 and 2013,” Witte at Banyan adds.

Coating/Materials Technology

In addition to the developing size range, cutting tool technology is advancing in new coatings and materials—which in turn is reducing manufacturing production and costs. Sandvik is developing optimized grades for gear milling applications. “The objective is to find substrates and coatings that allow higher cutting speed and/or longer tool life, which will in the end bring benefits to the end-user in terms of reducing manufacturing costs,” Accavallo says.

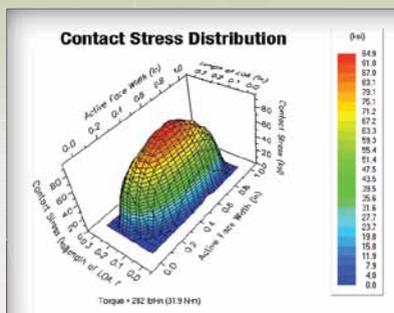
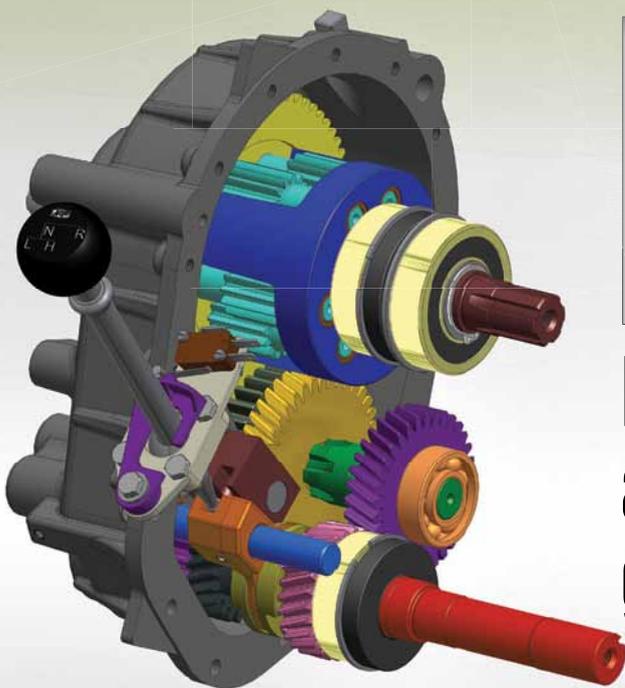
Tennutti at Gleason agrees, “The coatings used on these inserts yield more pieces per index. The better these coatings are able to endure the heat when operating at higher speeds, the better the life the inserts will have. Currently, the more advanced coatings, i.e. AlCroNite, are being used. Future coatings will enhance the performance of these inserts.”

“For Seco Tools, coating is one of the main investments, and Duratomic coating is one of our best achievements. Duratomic is already changing the market, and its development will go even further,” Manta adds.

“Coating technology is a constant evolution and does not look to cease evolving for many decades, if ever. The most interesting technology looks to be improved coating adhesion via new PVD machine technology,” Witte says.

“With oxide coatings by the PVD process, we are applying coatings that have similar resistance to abrasive wear, heat, and chemical attack that have so far only been possible through the higher temperature CVD processes,” Berardi at Ingersoll says. “By using the lower temperature PVD pro-

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Photo courtesy of Sandvik

history we have produced many insert design innovations including the tangential mounted insert that made indexable carbide insert gear tooling possible in the first place. We continue to place as much emphasis on geometries as we do with grade development. We feel they are equally important in the performance of the insert and the entire tool in terms of part quality and tool life.”

“The profile on the inserts can be compared to any form that is being used on the current solid hobs or milling centers. The features such as protuberance, full tip radius, semi-topping, or curved profile can be achieved using inserts,” Tennutti says. “There appears to be no limit on the current applications compared to the current HSS cutting tools. This being the case, the biggest advantage when using carbide inserts is the higher speeds that can be achieved, which will reduce the cutting cycle time.”

“Modern insert manufacturing technology and the tool manufacturing process allows Sandvik to be able to manufacture and measure gear tooling to a close tolerance. This allows higher cutting speed and feed rates while maintaining gear wheel quality. This also allows closer tolerances to allow less grind stock to increase productivity while reducing overall production cost,” Sandvik’s Accavallo says.

“Custom machines and tooling have always dominated the calculation for process improvements,” says Banyan’s Witte. “Many tooling manufacturers are pressing to enter the stable gear market while the balance of manufacturing is in flux, there are a select few that have the gear background to

cess, the end result is an insert that has a higher toughness and higher wear resistance. Additionally, surface treatments for both before and after coatings are showing significant improvements in tool performance. Whether by improving the adhesion of the coating, reducing crack initiation sites, lowering frictional forces, or smoothing the finish left on the work piece, the advantages of the various surface treatments contribute to productivity gains.”

Custom Insert Configurations

While standard cutting tools provide capable results, many companies come up with innovative custom tooling solutions that outshine their counterparts. “Custom insert configuration has always been the hallmark of Ingersoll engineering,” Berardi at Ingersoll says. “Over the course of our long

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Touting the Technology

IMTS will likely shed some light on the future of indexable carbide insert cutting tools. Tooling/workholding systems will once again play a large role in the Chicago exhibition and all participants in this article plan on bringing their latest products/equipment to the show floor.

“The future of indexable tools may go from a single form indexable insert to a multiple form insert. These inserts may have several forms on the inserts and have the capability of one index. This would be an advantage when producing finer module rack type milling and finer pitch module hobs,” Tennutti at Gleason says.

“Due to the large interest in the large module gears with a high number of teeth being hobbled, multiple thread hobs have their advantage. Multiple thread indexable hobs have a place in this industry today. We expect to see more interest in these hobs and will have a two-start hob on display at IMTS for review and discussion,” he adds.

Invomilling and uP-Gear Technology will take gear production to new levels as these methods offer manufacturers savings in both time and money, according to Sandvik. “With uP-Gear Technology the machine cost is no higher than a traditional five-axis machine and the tool cost is considerably lower than by using dedicated bevel gear tools. On top of this, the machining time is very short compared to an end mill process. Similarly, the Invomilling method offers high machining flexibility at high productivity levels and at low costs, using standard or standard-like tooling. These methods offer alternatives to existing solutions, so it will be

interesting to see how this will influence the future of indexable cutting tools,” Accavallo says.

“At IMTS, Sandvik will showcase a new product, CoroMill 172 for machining of gears and splines in multitask machines, machining centers and turning centers,” Accavallo adds. “In the Sandvik Coromant Smart Hub at IMTS it will be possible to see the full line of products for hobbing machines, for example hobs, roughing disc cutters, semi-finishing disc cutters and finishing disc cutters.”

“We are currently developing our indexable hob line. Early concepts are planned for IMTS release,” Witte says. “The Banyan Indexable hob will be like no other and developed by gear engineers for production gear applications. We are also seeing great push for ganged tool assemblies (duplex and triplex) and will show our latest technology for those medium-pitch components as well.”

“We will be exhibiting our expanded line of hobs, gashers and shapers and to be sure there will be some interesting new concepts on display,” Berardi at Ingersoll says.

Seco will also be showing its first two-start hob at IMTS, according to Manta. IMTS will also give the company a chance to highlight its entire range of new and established cutting tool solutions. “Indexable carbide solutions continue to gain ground in this market. In the future, we’ll have more requests in the highly specialized cutting tool industry, allowing our customers to be more competitive.” 

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