

Arrow Gear Expansion

SUPPORTS AEROSPACE PROJECTS

Presented with an opportunity from Sikorsky to supply several gears for a Blackhawk helicopter project, Arrow Gear did not have the required equipment capable of accommodating the large Sikorsky internal ring gear. At that point, Arrow's maximum capacity for spur gears was 22" and the Sikorsky parts would require up to a 36" capacity. If the company was interested in taking on the project, it would require a multi-million dollar expansion.

Around this time, another opportunity for Arrow presented itself in the form of the CH-53 Super Stallion, also produced by Sikorsky. The new "K" version of the CH-53 had been developed, in part, for military operations in the mountainous regions of Afghanistan. The previous version was unable to carry a full payload over the tops of the Afghan mountains.

The new "K" version is a significant improvement to this supply and transport aircraft. Equipped with the latest technology, the "K" version can fly three times higher and three times farther without refueling. This enhanced ability provides numerous strategic benefits to military personnel operating in this part of the world and will help to save lives of U.S. war fighters.

Arrow was approached by Sikorsky to produce prototype bevel gear sets to be used in the Super Stallion's three gearboxes. Notably, this project called into play Arrow's



Arrow Gear is supplying gears for the CH-53 Super Stallion (courtesy of Air Force Master Sgt. Dawn M. Price).



A gunner aboard the CH-53 Super Stallion watches another helicopter take off (courtesy of Air Force Master Sgt. Dawn M. Price).

advanced gear design technology. Using tooth contact analysis (TCA) and finite element analysis (FEA), Arrow was able to work with Sikorsky on refining the development of the gear tooth design and predicting tooth contact performance under load. But again, the issue of size capacity to actually manufacture all the gears remained a problem.

"In the face of these opportunities, Arrow's chairman and CEO, James J. Cervinka, made the difficult decision

to borrow the money required for the upgrade to accommodate larger gears for the Blackhawk and Super Stallion programs," says Joseph L. Arvin, president of Arrow Gear, adding, "an investment that came to approximately \$4.5 million."

Key components of the expansion included the purchase of a Höfler Helix 800 spur and helical grinder, a Gleason Phoenix II # 600 spiral bevel grinder, a Gleason Phoenix II # 275

continued

spiral bevel grinder, two Gleason # 450 HC Phoenix gear cutters, a 36" CNC Doosan vertical turning lathe, a 36" CNC vertical surface and OD/ID grinder, a 36" DixiTech CNC quench press with specialty tooling, a Zeiss 36" x 70" CMM inspection machine, a large Magnaflux machine and a substantial expense for the tooling required for machining and inspecting the workpieces.

The last of these new additions were recently implemented. As a result, Arrow Gear will be producing gears for the Blackhawk and CH-53K projects. "In the end, this investment allowed Arrow to substantially increase production capability," Arvin adds, "Now, instead of 22" (558.8 mm) parts, Arrow can produce parts up to 36" (914.4 mm).

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MAG

Demonstrates Five-Axis Machining Center at imX



MAG's modular HMC 1250/1600 Series will be demonstrated at the Interactive Manufacturing Experience (imX) show with cryogenic tool cooling technology and a new cryogenic-equipped A-axis tilt-spindle for five-axis horizontal machining on large parts. The imX demo, which supports MAG's Learning Lab on cryogenic machining, will feature parts of titanium, compacted-graphite iron (CGI) and composites. The imX takes place September 12–14 at the Las Vegas Convention Center.

The HMC1250/1600 Series is engineered for high-precision, high-productivity machining of large aerospace, power generation, pump, valve and off-road equipment parts. It now includes six spindle options to suit special-purpose or general machining requirements. The new 6,000 and 8,000 rpm/46-kW (61.6 hp) tilt-spindle—with + 90/–120 degree A-axis travel—joins an all-around 10,000

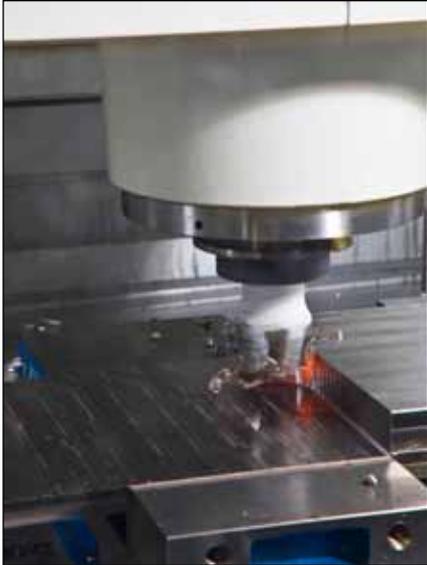
rpm/56-kW (75 hp) spindle, high-speed 24,000 rpm spindle, high-torque 2,600 Nm/80-kW (1,918 ft-lb) spindle and two live spindles (110 or 130 mm diameter). The high-torque spindle is especially suited for hard-metal cutting, while the live spindles extend W-axis reach by up to 800 mm (31.5 in), enabling deep cavity milling to high precision with shorter, more rigid tool lengths. Standard on the live spindle, MAG's exclusive Z-axis thermal compensation software dynamically offsets spindle growth to maintain tight tolerances.

Designed for extreme application flexibility, the HMC 1250/1600 offers maximum 3,000 mm (118 in) work-zone swing, 2,500 mm (98.4 in) work-height capacity and 15,000 kg (33,000 lb) pallet load capacity. Major machine components, including the X-bed, Z-bed and column, are cast ductile iron, with pallets up to 1,600 x 2,000 mm, headstock and rotary table hous-

ings of gray cast iron. Modular design provides a range of machine travels, 60- to 300-tool magazines and two control choices.

Powerful and agile, the new HMC offers 56 to 80 kW (75 to 107 hp) spindle power, 35 kN (7,870 lb) Z-axis thrust, and super-rigid, full-contouring hydrostatic rotary table. The 360,000-position contouring table provides a rigid work platform, while a rugged worm gear drive with clamp securely holds axis position. Rotary table positioning accuracy is 10 arc seconds, repeatable to five arc seconds. Positioning accuracy of the tilt-spindle is 4 arc seconds, repeatable to two arc seconds.

Meeting industry needs for tighter part tolerances and greater machining accuracies, the HMC Series comes standard with linear scale feedback in X, Y and Z axes, providing 8 micron (0.0003 in) positioning accuracy and five micron (0.0002 in) repeatabili-



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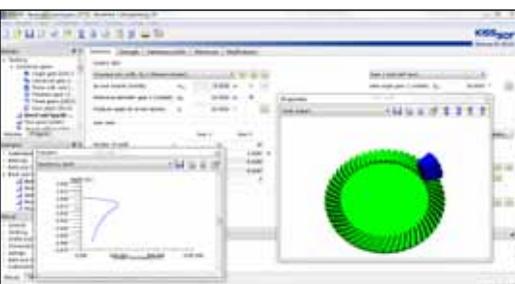
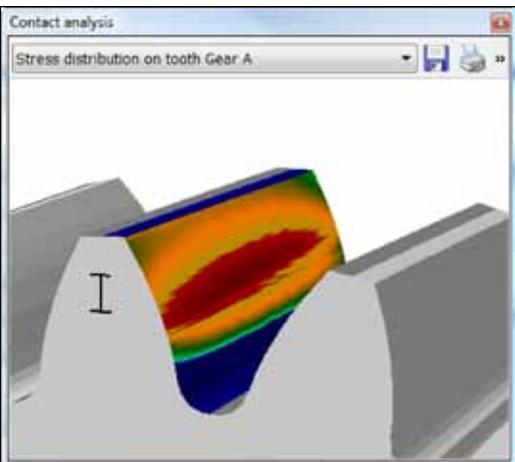


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KISSsoft Updates

INCLUDE CONTACT ANALYSIS, SINTERED MATERIALS AND FLANK BREAKAGE

KISSsoft has continued releasing updates to its 03/2011 software release including new material on contact analysis, sintered materials and flank breakage. In the contact analysis of *KISSsoft*, the effects of shaft deformations may now be precisely evaluated (module ZA30). The results of shaft calculations can also be directly imported to the contact analysis. Bending and torsion of shafts are furthermore calculated load-dependent



and considered in the tooth contact. In the *KISSsys* calculation, the shaft classification is done automatically. Additionally, the face load factor $KH\beta$ is calculated according to ISO 6336-1, Annex E. Another new feature is to combine the profile and lead correction factor within defined areas. Thus all variants are automatically analyzed in respect of the load distribution, transmission error, safety against micropitting, wear and flash temperature and the stress curve (module ZA33). The pressure curve and root stresses are currently shown on the flank of the gears as well, allowing a direct comparison with the contact pattern on the gear during the assembly, operating process and test rig. All these features constitute a huge improvement of the gear calculation under load for planetary gears and cylindrical gear pairs.

The Swedish company Högånäs AB provided the *KISSsoft* calculation program with SN-curves for tooth bending of sintered material Distaloy AE. Two different conditions were

measured: The case hardened (0.2 percent C and 0.8 percent C-potential) and the through hardened (0.6 percent C) ones. The fatigue data was extrapolated to one percent risk of damage as requested by ISO 6336 standard. There is no information in ISO 6336 or DIN 3990 for the calculation of sintered

materials. But as Högånäs provided complete Woehler-line data, which can be read and used by *KISSsoft*, the life factor YNT for bending is calculated based on the real SN-curve. Therefore bending strength calculation according to ISO 6336 is possible. The Distaloy

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materials will be fully integrated in the gear material database of the 2012 release. For the *KISSsoft Release 03/2011*, the data is now available on request.

The flank breakage of gears is a failure mode that is separate from the damage forms such as root breaking or

pitting. Consequently, it adds a further risk factor for gearbox failure. To be able to calculate this damage form in advance, extensive studies were performed on spiral bevel gears by Dr. Annast at the FZG Munich. On the basis of this analysis, the flank breakage calculation for bevel gears, and



additionally for cylindrical gears, was implemented in the current *KISSsoft Release 03/2011 (module ZZ4)*. Thus, a reliable risk assessment of flank breakage and its calculation is now available for the user.

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Nikon Metrology introduces the HN-6060, a next-generation non-contact inspection system providing the latest in metrology capabilities. With advanced laser scanning, five-axis synchronized hardware control, ultra-stiff design and powerful processing software, the HN-6060 allows for fast, ultra-precise inspection of complex shapes. This includes gear teeth, turbine blades, appliance housings and much more.

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design was taken from the industry favored Lapointe Broach Machine engineering. The leveraging of the Lapointe designed style index tables and cradles with today's technology creates the next generation of turbine disc broaching machines. The design stage was an onerous 12 months.

The team used solid modeling to test and retest the designs for deflection, rigidity, accuracy & reliability. Manufacturing did not begin until all industry criteria were completely satisfied.

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tem builds upon the Nikon Metrology portfolio of vision systems and 3-D solutions,” says Myles Richard, managing director of Americas for Nikon Metrology. “It addresses the need for fast, high-accuracy 3-D inspection of complex shapes by combining innovative optical technology with the highest precision measurement hardware.” The newly designed laser scanning sensor extracts the surface form and waviness data in one scan. Previously, tactile gear-inspection tools needed to rely on 2-D sections of data. This new advancement provides better inspection possibilities, revealing all shape and waviness information in one simple measurement.

“What the HN-6060 provides is a much easier, quicker and more precise method of 3-D data capture than metrology systems have demonstrated before,” says Robert Wasilesky, senior vice president of sales for Nikon Metrology. “The demand for high-accuracy 3-D surface metrology systems continues to increase as the automotive, aerospace and appliances industries also implement higher precision.”

The metrology system’s laser scanner and SFF (shape from focus) sensor use active texture projection to per-

form high-precision measurement of shapes even with glossy surfaces or no surface texture. Touch probes and optical heads with built-in TTL laser AF complete the multi-sensor system. This allows it to perform shape measurements of parts such as complex

automotive and machined components, molded parts, and medical devices.

Another core element of the HN-6060 is its five axes of synchronized hardware control. This allows optimum part orientation to the sensor and can measure the part from dif-

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ferent angles. The HN-6060 software integrates with the measurement hardware and is designed for user operability and safety. It features macro-based teach in, simulation for collision avoidance, easy acquisition of point clouds from 2-D and 3-D shapes, and insightful part-to-CAD comparison.

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For the first time, a complete line of standard tools for high pressure coolant (HPC) turning puts more efficient turning of titanium, Inconel and stainless steel within easy reach of any shop. Previously, HPC tooling was available only as a special. Manufacturers can now get the same quick delivery and security of supply for HPC tools as for any standard tool. In combination with optional standard high pressure plumbing readily available on virtually all mainstream turning machines, Iscar JETHP (jet high pressure) tools bring three key benefits on these problematic metals— they consistently end chip jamming, and improve tool life more than 10 to 1, while doubling removal rates.

HPC turning has been proven effective for decades as a stable, safe process, especially on titanium. The obstacle has been that it required custom coolant plumbing and special tools. More recently, most machine builders have made high-pressure coolant plumbing capability a standard option. Iscar has completed the HPC chain by standardizing the tooling as well and making it as easy to use as regular tooling. The Iscar JETHP

family covers the full range of turning, grooving and parting tools and includes HPC versions of the company's Isoturn, Heliturn, Tang-Grip, Pentacut and Cut-Grip tools, in both standard and interchangeable-tool Camfix styles. Their design derives from more than a decade of Iscar experience in supplying special HPC tooling to hundreds of manufacturers, mostly titanium fabricators.

All styles feature internal coolant paths compatible with through-spindle plumbing in the machine. The JETHP line also includes all connection accessories as standard. HPC turning works by aiming a high pressure "hydraulic wedge" of liquid coolant precisely into the cutting zone, shattering chips into uniformly small, classic C-shapes and ejecting them completely. In addition, because it remains liquid at such high pressures and flow rates, it lubricates and cools the cutting area more effectively. Between 40 and 400 bars pressure, the higher the pressure, the smaller the chip in titanium, Inconel and long-chipping stainless steels.

In the Iscar Isoturn line, two separate streams simultaneously deliver coolant to the top rake and bottom flank of the tool. The nozzle for the top stream can be aimed and is easy to move out of the way for convenient insert indexing and replacement. It automatically snaps back into place when coolant is turned back on. The bottom stream can be turned on to enhance the cooling effect. Other models in the line have discharge points, always targeting the cutting zone.

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size are often too light or too flimsy to turn the larger bearings found in typical live centers. This is a common problem, resulting in galling or excessive wear on the tip of the live center and/or damage to the part when the center fails to turn with the part. The Extra-Light live centers can turn parts

at speeds up to 8,000 rpm while holding concentricity of $\pm .00005"$. This is achieved by using miniature precision angular contact bearings graded and matched at the factory to obtain the proper fit necessary to hold concentricity in high rpm applications. The small bearing head diameter and long



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With technology developed in collaboration with some of the world's leading engine manufacturers, the new Kistler Type 5630M Series was developed to include all processes that a customer would need for long-term viewing. By assigning a unique part or serial number to each data file, a user can quickly search, locate and view all historical process data. The part search screen, or dashboard, can be user-cus-



tomized to display an image of the component, allowing for a clear visual representation of the process, as well as the interactive capability for the user to select the area or process portion that the engineer wishes to view. The Type 5630M Series also offers a statistical process analysis module, which allows the user to select a specific manufacturing application, along with an associated date range, to display various statistics, including mean values, standard deviations, six-sigma statistical measurements of Cp and Cpk, and others, within a single screen view.

Kistler Type 5630M Series software is designed for compatibility with most Microsoft Windows operating systems to allow easy connectivity to IT infrastructure, with the added capability to back up data and ensure compliance with various IT software requirements. The unit is placed on an industry-proven industrial PC and can be ordered with a free-standing NEMA 12 enclosure. A standard 115 V power supply source is required for operation.

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