# Shorter Cycle Times for Carburizing: Dana Develops Atmosphere, Microwave-Based Process

Dana Corp. is developing a process that carburized a straight bevel gear to a carbon content of 0.8% in 60 fewer minutes than atmosphere carburizing did with an identical straight bevel.

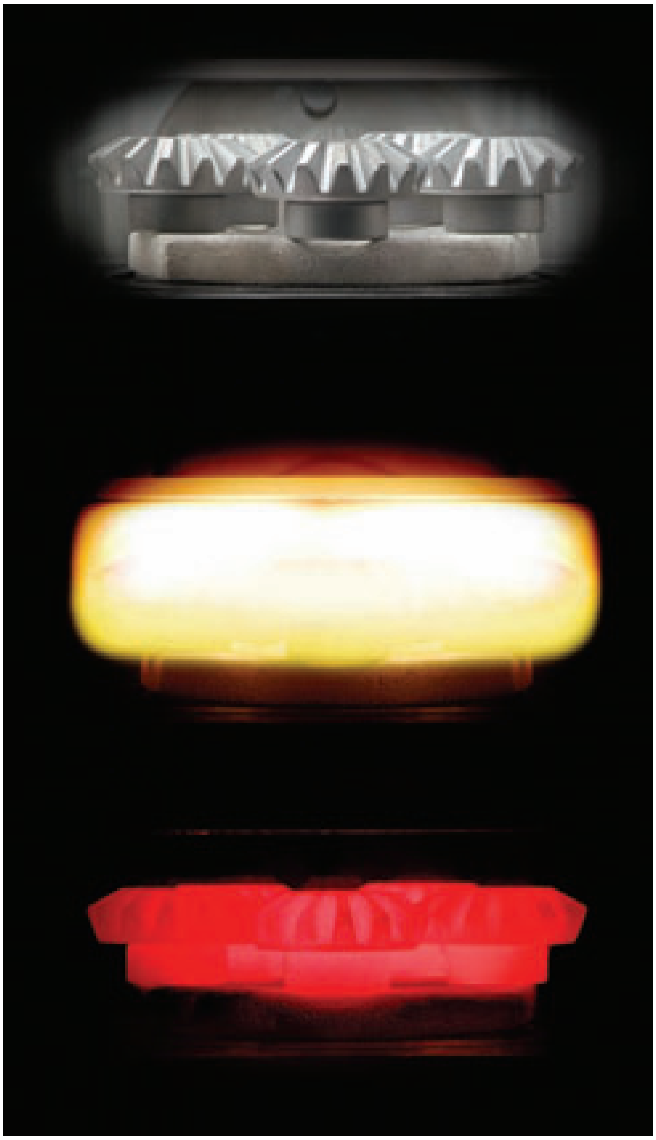
The Dana process, called AtmoPlas, uses plasma and microwaves to carburize workpieces at atmospheric pressure. Moreover, in the above test, the atmosphere carburized gear achieved a case depth of 0.035", the AtmoPlas processed gear: 0.045".

The test was one of many AtmoPlas trials being run by Dana with its lab research system to benchmark the carburizing of various single workpieces.

In trials, the microwave technology results in shorter cycle times than atmosphere carburizing, with time saved in the heat-up and carburizing parts of the cycle. "This would translate to overall lower gas consumption and lower power cost," says Kuruvilla Cherian, a Dana senior materials scientist and one of the developers of the AtmoPlas process.

In the above benchmark test, the straight bevels were differential side gears with outer diameters of 70 mm (about 2.76"). They were made of 8620 steel and had starting carbon contents of 0.2%. The AtmoPlas lab system was programmed to carburize its gear at 930°C. The other identical gear was atmosphere carburized at the same temperature.

Cherian provides the results for both treatments. The total time for the atmosphere carburizing was 272 minutes, and for the AtmoPlas processing: 212 minutes. The atmosphere carburizing time consisted of 142 minutes for the boost phase, 110 for the diffusion and 20 for the temperature-drop. The AtmoPlas time was 112 minutes for the boost phase, 80 for the diffusion, and 20 for the temperature-drop. Afterward, both gears were oil quenched.



**Microwave-Based Carburizing—Dana Corp. has developed a process, AtmoPlas, that uses microwaves and plasma at atmospheric pressure to carburize gears. Differential side gears are shown (from top) before carburizing; during heat-up, while plasma absorbs microwave energy; and right after the microwaves are discontinued.**

Cherian and application engineer John Hudson, another AtmoPlas developer, were also using the test to achieve a target effective case depth: 0.035". The atmosphere carburized gears achieved that depth after 272 minutes. In 212 minutes, the AtmoPlas processed gears had 0.010" of additional case depth.

Having surpassed the target, Cherian and Hudson have to run further tests to find the right time and temperature combination to get the 0.035" depth. The combination will likely be even less than 212 minutes.

The heat treatments were designed to harden the gears to greater than 57 HRc. Cherian says the atmosphere carburized and AtmoPlas processed gears reached the target hardness and were comparable to each other.

Also, Cherian points out that AtmoPlas results in smaller grains. In trials with coupons, he and Hudson were able to compare AtmoPlas processing to atmosphere and vacuum carburizing. In the cases, grains were 15.9–22.5 microns for the vacuum carburized coupon, 11.2–22.5 microns for the atmosphere carburized, and 5.6–11.2 for the AtmoPlas processed. Smaller grains mean: "Higher strength properties in the gears," Hudson says.

However, Cherian says microwaves' effects on crystal growth aren't fully known at present, so AtmoPlas' effects on grain size would require more research.

AtmoPlas heat treats workpieces at atmospheric pressure using plasma heated by microwave energy. The system consists of two chambers, an outer one and an inner one. Workpieces are placed inside the inner chamber. A mixture of three gases—argon, hydrogen and nitrogen—is injected into the chamber, which is insulated with ceramic walls.

In the outer chamber, magnetrons are activated to generate microwaves. The microwaves pass through the inner chamber's walls, which are transparent to them. The microwaves convert the gases into plasma. The plasma absorbs the microwave energy, heating rapidly. Acetylene is introduced as the enriching gas, the carbon source. The heat and carbon are then absorbed by the workpieces. The plasma uses about 95% of the microwave energy for its carburizing.

Acetylene makes up a small amount of the total volume of gases—"The acetylene is typically less than 5%," Cherian says. Still, it is one of the more expensive gases, so Cherian and Hudson are looking into using methane as the enriching gas for the next round of benchmark tests with single workpieces.

The inner chamber's atmosphere doesn't include oxygen, so the system doesn't create intergranular oxidation in its workpieces. By avoiding IGO, the AtmoPlas processed gears would avoid the possibility of their ultimate strength being reduced.

According to Hudson, AtmoPlas' power consumption is comparable to an atmosphere carburizing furnace—when both are heat treating parts. Between jobs, AtmoPlas can be turned off. Unlike atmosphere carburizing, there's no need to keep the AtmoPlas system running between gear jobs, to keep it at temperature and maintain its atmosphere.

"We can establish our atmosphere very quickly with a minimal amount of gas," Hudson says. "We have no reason to keep the module running when empty."

"It's basically a switch-on, switch-off system," Cherian says.

Besides differential side gears, AtmoPlas has carburized crown gears with 8" diameters, as well as 7" long spiral bevel pinions. The system's gear trials have mostly consisted of gears made of 8620 alloys, but AtmoPlas has also been used to carburize gears made of manganese-chromium alloys. Cherian and Hudson plan additional trials of the Mn-Cr gears in conjunction with high pressure gas quenching.

**Next Step: A Production-Scale Machine—Development of the AtmoPlas process has progressed to trials using the above lab pilot system, the MD-800. Dana's next step is to create a pilot production-scale machine for further trials.**

AtmoPlas needs the trials in part to catch up with atmosphere and vacuum carburizing. Those processes have known time-temperature profiles. Heat treaters with gears of a certain type and size and with a certain target case depth and hardness, know or can easily figure the needed time-temperature profile for existing commercial processes. AtmoPlas, still in development, doesn't have established profiles yet.

"We're in the stage of developing the time-temperature profiles for AtmoPlas," Hudson says. He adds that AtmoPlas' carburizing profile can be changed like vacuum carburizing's profiles, so the microwave technology can achieve desired case depth and percent carbon.

Also, the process hasn't been tested in a production-scale system yet. Hudson says the pilot production system is scheduled for installation this year, in the fourth quarter, in a production, vacuum carburizing line with a gas quenching system. The pilot system would be built with a work area 24" wide, 36" deep and 24 or 30" high, with a rated gross load of 500 kilograms. Once installed, the system would undergo three to six months of testing via production work. Then Cherian and Hudson would be able to compare its power consumption with those of production-scale atmosphere and vacuum carburizing.

Also, after the testing, Dana would be able to decide when AtmoPlas will become commercially available. The technology would be licensed to equipment manufacturing companies. In fact, Dana has already announced joint development agreements with ALD Vacuum Technologies GmbH of Hanau, Germany, and Rübig GmbH & Co. KG of Wels, Austria.

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## Gleason's New Hobbing Machine Can Cut Cycle Time Down to a Second

The Genesis 130H CNC vertical hobbing machine from Gleason features a new design that optimizes dry machining, reduces floor space requirements and improves cycle times.

This machine is the first in the new Genesis family of gear production equipment. Genesis machines all include a single-piece frame cast from an advanced polymer composite material that ensures a small, compact machine footprint and enables the user to install and relocate the machine with no special lifting equipment or foundations.

Jim Gnadt, manager of product development for Gleason, says, "One unique feature is that the base unit is not cast iron. We're able to offer much more thermal stability and vibration absorption by using a polymer-graphite combination."

The hobber can accommodate wet cutting processes but is better suited for dry machining. The work area is completely isolated from the machine frame to minimize thermal expansion from contact with hot chips, and a stainless steel cutting chamber with steep inclination ensures that chips fall clear of the work area.

Another feature is the hobber's new mechanical, cam-driven, double gripper loader that is fully integrated into the machine. This cuts non-productive time down to a minimum and significantly reduces part load/unload times.

"It's a cam-operated, high-speed device, and it's now possible to achieve cycle times as low as one second. One of our most popular machine applications is the 125GH, and it usually takes 4–5 seconds for loading and unloading. Now we've got it down to 2 or 2.5 seconds tops," says Gnadt.

The D-Drive system enables the spindle to transmit more torque with less runout and also accommodate the use of larger diameter hobs for greater performance and longer tool life. Also, direct-drive spindle motors reduce setup and machining times by eliminating the need for mechanical adjustments and change gears. Higher acceleration/deceleration rates and increased torque, combined with faster axis motions, reduce non-cutting time between cycles.

Other features include an easy-access service module that consolidates hydraulics, lubrication and pneumatics into one location, optional on-board chamfering and deburring, availability of the latest Siemens or Fanuc controls and Gleason software running in a Windows environment, and a chip conveyor that can be located from either side or the rear of he machine to meet any cell/system arrangement.

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## Mahr's Air Gage Uses Single- or Dual Master Air Tooling

The Universal Dimensionair line of air gages from Mahr Federal combines the performance of a single-master air gage system with the ability to use two-master air gage tooling.

In single-master systems, the gage is calibrated to zero or a reference measurement, and users rely on the gage system accuracy to determine tolerance limits. Dual-master systems use two masters to calibrate maximum and minimum. For go/no-go applications, the air gage is usually calibrated with both masters or setting gages set for both tolerances.

Built-in magnification and zeroing controls allow the product to act as a dual-master air gage comparator. By selecting the appropriate dial configuration, users can adjust the gage for dual-master air tooling or span master tooling, according to the company's press release.

The user sets system sensitivity (scale factor) by adjusting the air comparator span to correspond to the difference between minimum and maximum setting masters, thus setting the sensitivity of all the components of the gaging system. A zeroing control brings the span to a balanced position on the dial.

The Universal Dimensionair is available with a range of interchangeable dials for selecting magnifications from 1,250:1 to 10,000:1 in inch or metric scales. Dials are quickly exchanged by a snap-off bezel that allows for changing while protecting the gage against contamination from the shop environment. An analog dial provides fast visual representation of size and degree of good/bad or approaching readings.

Lastly, tooling can be mounted directly on the front of the unit. This lets the Universal Dimensionair act as a bench gage where the parts are brought to the air tooling. When the parts are too large for a bench-mounted gage, a hose and handle assembly provide portable measurement on the part.

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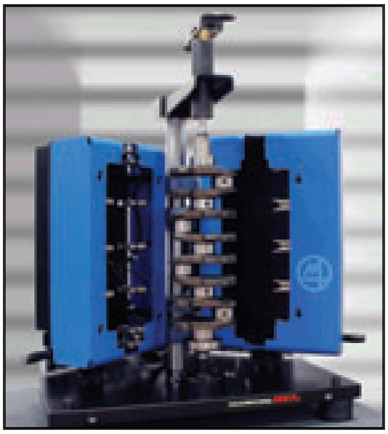
## Marposs' Vertical Solution Provides a Smaller Footprint

The M57V bench from Marposs provides a smaller footprint that occupies less surface space than the company's horizontal solution, according to its press release.

Vertical loading of the workpiece eliminates part and structural deformation as well as bending in the reference centers and helps part dragging in dynamic applications. The bench is engineered for





crankshafts weighing more than 6 kg, can also check camshafts, gear shafts, rotors and axle shafts and can be configured as a single or double gage station.

The bench gage is dedicated to the interoperational inspection of a single part type (or when no retooling is required) after end face milling, turning, pin bearing milling and grinding.

The workpiece is loaded manually or by a manual gantry between centers in the vertical position. Centers are fixed (static measurement) or motorized (dynamic measurement) and the measuring stations are brought onto the part by manual pivoting arms.

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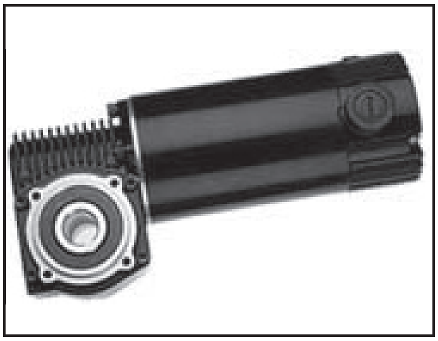
## Bison Gear's Hollow Shaft Gearmotor Doubles Continuous Torque Ratings

Bison Gear's new 562 series hollow shaft gearmotor offers increased low speed center distance coupled with greater clearance for wider faced gears.

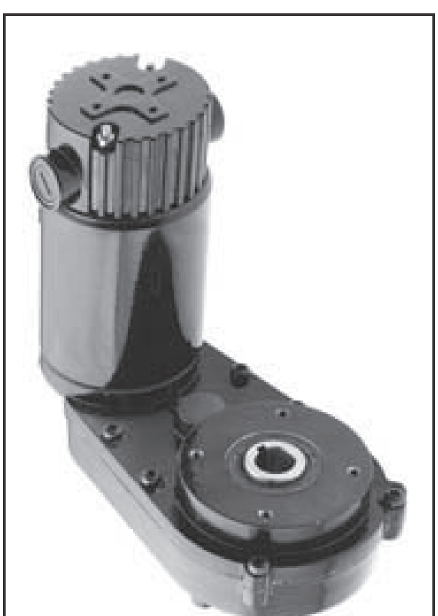
According to the company's press release, the gearmotor allows for up to 1,100 in.-lbs. continuous torque—twice



traditional continuous torque ratings. An optional fourth stage of gear reduction is possible as well, providing ratios up to 2,200:1 in the same envelope, allowing for a smaller input motor without sacrificing output torque.

Additional features include hollow shaft options with multiple configurations and various AC and DC input motors, including three-phase and inverter duty. A hollow bore diameter of 3/4" allows for interchangeable shaft designs.

Bison Gear also introduced low voltage additions to its 750 series right-angle gearmotor design. New additions consist of two input motor options rated at 1/8 hp, 12 VDC, and 1/8 hp, 24 VDC. Gear ratios will be 5, 10, 13, 20, 30, 45 and 60 to 1 and available from stock with a 3/4" diameter hollow shaft with face mount or a 5/8" diameter solid shaft insert with steel footplate. These options allow uses of battery power and other low voltage applications.



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## Marposs' Inspection Software Cuts Production Time

The new 3-D Shape Inspector software from Marposs performs on-machine measurement. When used with Mida touch probes, the software enables high precision measurement to be accomplished on the same machine used for cutting parts.

According to Marposs, the software checks the part shape and dimensions. Furthermore, the program generates geometric dimensioning & tolerancing (GD&T) reports and allows for immediate reworking of out-of-tolerance measurements without time lost by sending the part for measuring on a CMM and then refixturing and setting up the part after inspection. The program can be used as a direct TCP/IP or DMC interface on a CNC-integrated PC or offline by creating probing programs on an external PC.

Michael Sterioff, a product manager, says this product will be displayed in the Marposs booth at Westec, but won't be officially introduced to the manufacturing community until IMTS in September.

Currently, the shape inspector software is used on Fanuc and Fanuc-compatible controlled machines, typically horizontal or vertical machine tools. Marposs will demonstrate the software capabilities on a Haas machine at Westec. Sterioff says that the software will be compatible with Siemens, Heidenhain and Selca controls by early May. When it's officially released in September, the software will also be compatible with Okuma controls. Looking to the future, Marposs would like to expand its uses into lathe applications.

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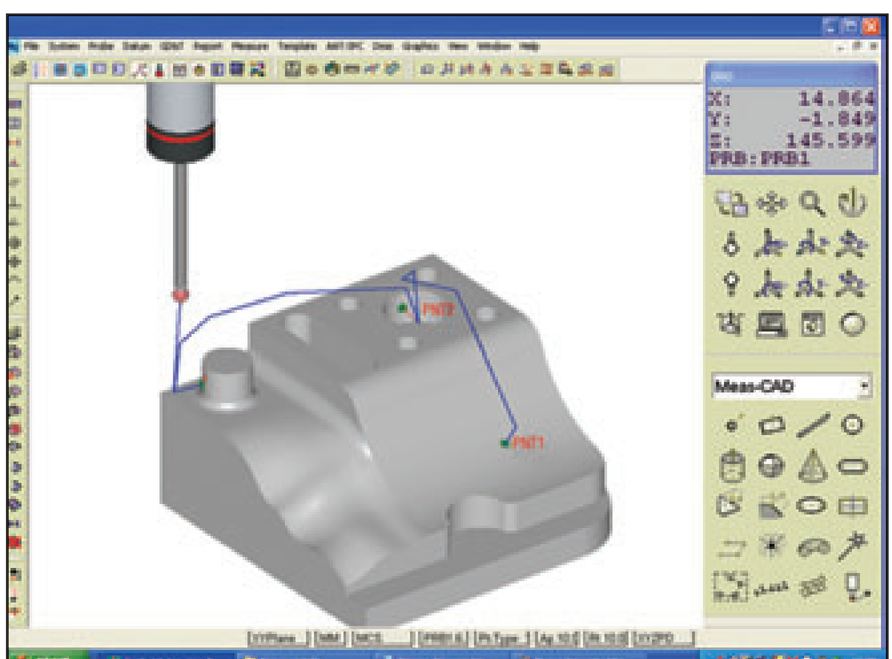
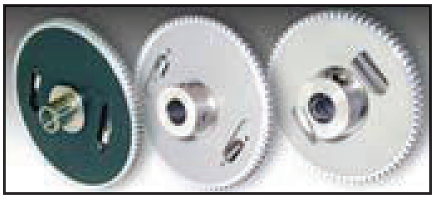


## Sterling Instruments' Anti-Backlash Gears Eliminate Marred Shafts



A new series of 1158 anti-backlash gears manufactured by Sterling Instruments features the Fairloc integral hub fastening system, which eliminates marred shafts.

According to the company's press release, the fastening system helps adjustment, timing and frequent removal problems with full component support along the entire hub system. In addition, the self-contained gears offer a small gear hub envelope.

Each gear comprises a set of two gear halves that give the appearance of a split gear. Built-in springs, mounted around the hub, force the two gear halves to turn in opposing directions relative to one another until the tooth space between the inner and outer mating gear is filled. This technique is applied to gears with diameters down to 0.642" to eliminate backlash in gear trains.

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