

FORCE 10

IN WIND TURBINE GEARS

Belgium's Hansen Transmissions is gearing up to help meet the global wind industry's insatiable demand for bigger, quieter, more reliable wind turbines. Pay a visit to Hansen's new Lommel, Belgium facility and see the future of wind turbine gears take shape.

Hansen Transmissions' Georges Roobaert, Vice President, Manufacturing Technologies and Expansion Projects, is justifiably proud of the new Hansen factory that sprang up seemingly overnight in the fields outside Lommel, Belgium. After all, it took Mr. Roobaert and Hansen just 18 months to build what is arguably the most modern facility of its kind in the world for the production of wind turbine gear transmissions. And that's good news for the world's manufacturers of wind turbines, since some 50% are customers of Hansen Transmissions.

"Keeping pace with the remarkable growth in wind turbine production is our mission with the new Lommel factory," says Mr. Roobaert. "Our customers are seeking faster production of ever larger gear units, while at the same time raising the bar on reliability, noise levels, cost and delivery. Lommel is the answer."

Winds of change in energy production. The world's fastest growing energy source started from humble beginnings. Just 20 years ago, wind power was barely making a ripple in the world's energy supplies. The average wind turbine then produced just 25 kW of power, and annual worldwide wind power production was just a few hundred mW.

But today, economic and environmental forces have combined to make wind power the world's fastest growing source of energy. Wind power capacity over the past five years worldwide has expanded at an average rate of 32%. By the end of 2003, enough electricity was being produced to supply the electricity needs of 19 million European households. In fact, the European Wind Energy Association predicts that, within two decades, wind power could be supplying 12% of the world's electricity — and saving some 11 billion tons of CO₂ emissions from coal-fired power plants.

Making big gears better at Hansen. As demand has increased, so too has the average wind turbine's size and efficiency. In 2003 for example, the average capacity of new turbines installed in Germany (currently the world's largest wind power market) was 1.6 MW. Machines of this size are equipped with rotors some 90 to 100 meters in diameter, and are upwards of 100 times more powerful than the vintage 1980s machines. In fact, a single 1 MW turbine can produce enough electricity for the needs of some 650 households.

This trend towards bigger, better wind turbines has played right into Hansen's hands. Since the late 1970's, some 10,000 wind turbines, up to 3MW in size, have been equipped with Hansen gear units.

What is it about the Hansen gear units that customers like so much? They never have to think about them, says Hansen/Lommel Gear Department Manager Marc Hellinx. "Today's wind turbine gear units must run with extraordinary reliability, because they are often offshore or in other inaccessible areas operating in adverse conditions,

and the cost of repair is very high," says Mr. Hellinx. "Noise is a consideration too, since wind turbines are increasingly found in populated areas. And as demand has increased, so too has the pressure to produce these high quality gear boxes faster and more economically than ever before. Lommel is a showplace for how we've partnered with companies like Gleason to fulfill this mission."

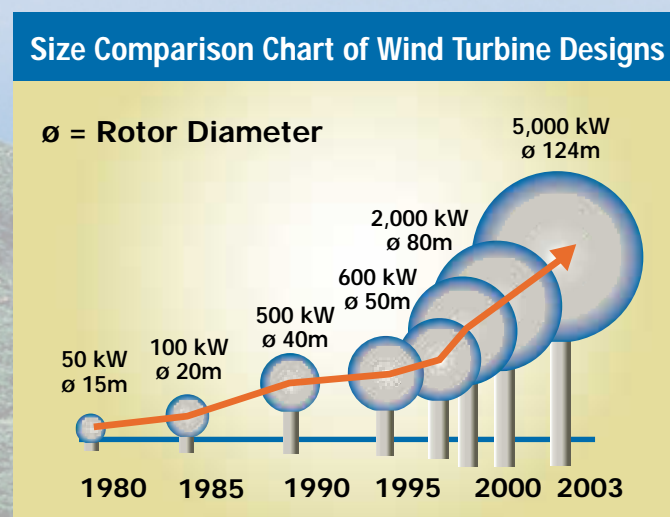
Entering new frontiers in profile grinding. The typical wind power gear box produced at Lommel will be a new-generation, direct-drive planetary system consisting of a ring gear as large as 3 meters, a sun gear up to 1600 mm and between three and five smaller planets. The critical external finish profile grinding of the sun and planet gears are done on six Gleason-Pfauter P1200G Profile Grinders; the internal gear grinding of the ring gear is performed by two Gleason-Pfauter P2400G Profile Grinders. Ultimately, these machines will help Lommel supply gearboxes for 2,000 MW a year — almost a quarter of the entire new wind turbine capacity installed worldwide in 2003.

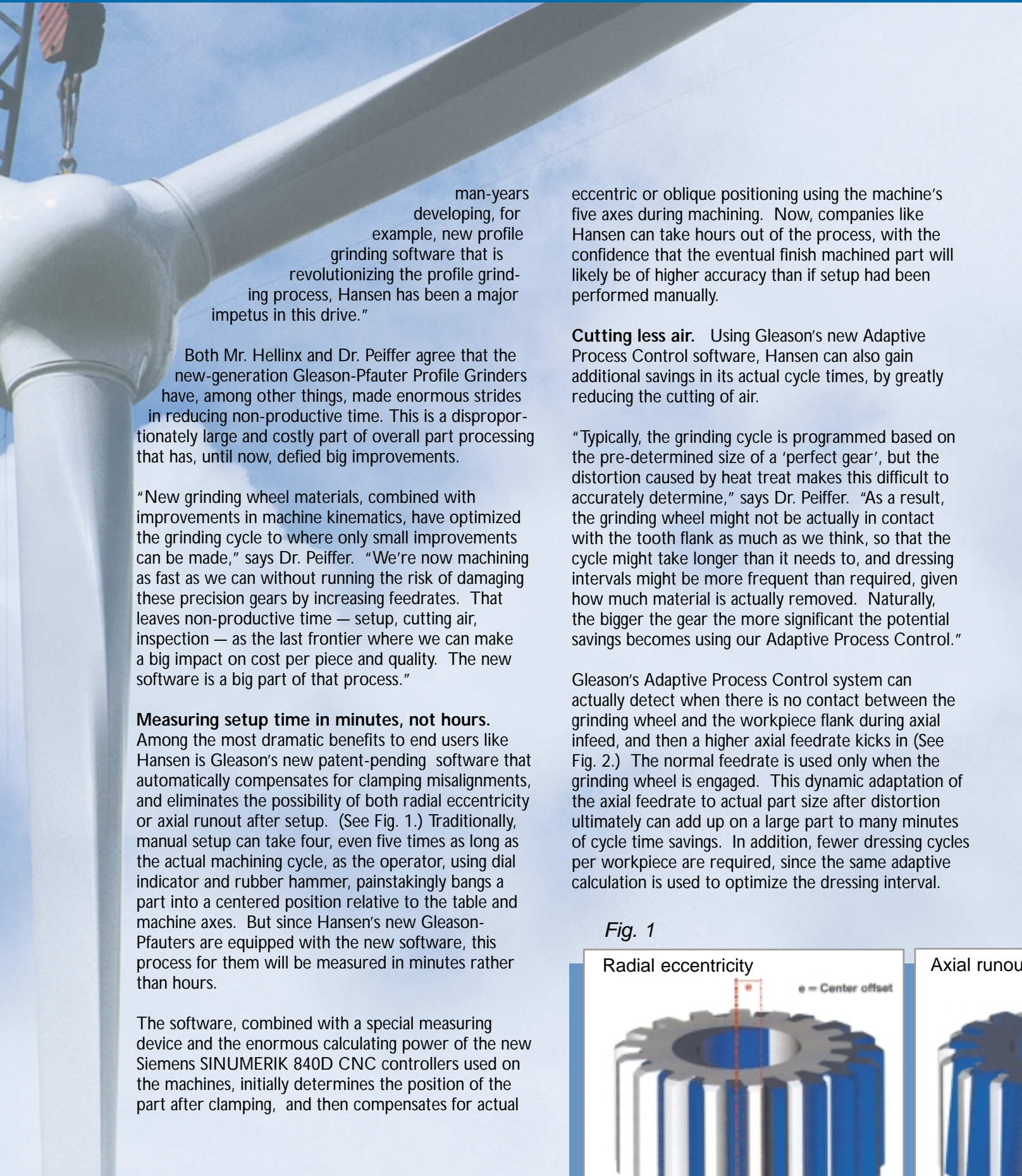
"The productivity and quality Hansen can achieve at Lommel would not be possible without these Gleason-Pfauter machines," says Mr. Hellinx.

Conversely, Gleason's Dr. Klaus Peiffer is quick to point out that Hansen has played a major role in the development of some of the most important new features found on these machines. "Hansen's openness to new ideas and their drive to make every process better has made them a great and very productive partner over the past 12 or 13 years," Dr. Peiffer says. "While we have spent some 36

Growth in size of commercial wind turbine designs (right)...

...has created demand for the larger gearboxes produced at Lommel (far right).





man-years developing, for example, new profile grinding software that is revolutionizing the profile grinding process, Hansen has been a major impetus in this drive."

Both Mr. Hellinx and Dr. Peiffer agree that the new-generation Gleason-Pfauter Profile Grinders have, among other things, made enormous strides in reducing non-productive time. This is a disproportionately large and costly part of overall part processing that has, until now, defied big improvements.

"New grinding wheel materials, combined with improvements in machine kinematics, have optimized the grinding cycle to where only small improvements can be made," says Dr. Peiffer. "We're now machining as fast as we can without running the risk of damaging these precision gears by increasing feedrates. That leaves non-productive time — setup, cutting air, inspection — as the last frontier where we can make a big impact on cost per piece and quality. The new software is a big part of that process."

Measuring setup time in minutes, not hours.

Among the most dramatic benefits to end users like Hansen is Gleason's new patent-pending software that automatically compensates for clamping misalignments, and eliminates the possibility of both radial eccentricity or axial runout after setup. (See Fig. 1.) Traditionally, manual setup can take four, even five times as long as the actual machining cycle, as the operator, using dial indicator and rubber hammer, painstakingly bangs a part into a centered position relative to the table and machine axes. But since Hansen's new Gleason-Pfauters are equipped with the new software, this process for them will be measured in minutes rather than hours.

The software, combined with a special measuring device and the enormous calculating power of the new Siemens SINUMERIK 840D CNC controllers used on the machines, initially determines the position of the part after clamping, and then compensates for actual

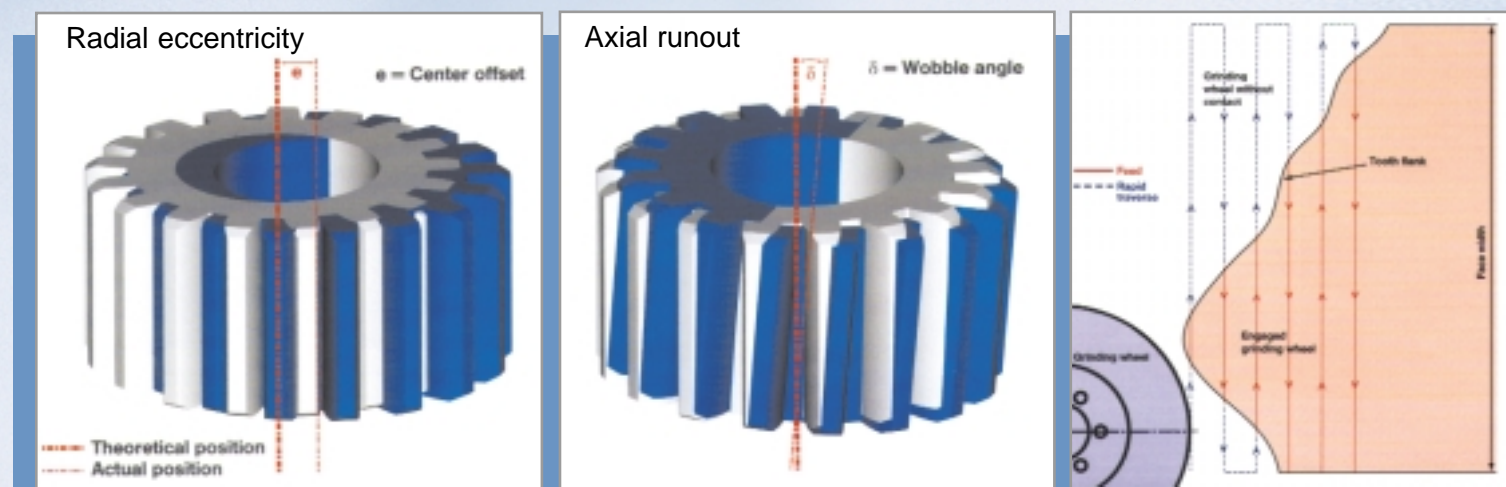
eccentric or oblique positioning using the machine's five axes during machining. Now, companies like Hansen can take hours out of the process, with the confidence that the eventual finish machined part will likely be of higher accuracy than if setup had been performed manually.

Cutting less air. Using Gleason's new Adaptive Process Control software, Hansen can also gain additional savings in its actual cycle times, by greatly reducing the cutting of air.

"Typically, the grinding cycle is programmed based on the pre-determined size of a 'perfect gear', but the distortion caused by heat treat makes this difficult to accurately determine," says Dr. Peiffer. "As a result, the grinding wheel might not be actually in contact with the tooth flank as much as we think, so that the cycle might take longer than it needs to, and dressing intervals might be more frequent than required, given how much material is actually removed. Naturally, the bigger the gear the more significant the potential savings becomes using our Adaptive Process Control."

Gleason's Adaptive Process Control system can actually detect when there is no contact between the grinding wheel and the workpiece flank during axial infeed, and then a higher axial feedrate kicks in (See Fig. 2.) The normal feedrate is used only when the grinding wheel is engaged. This dynamic adaptation of the axial feedrate to actual part size after distortion ultimately can add up on a large part to many minutes of cycle time savings. In addition, fewer dressing cycles per workpiece are required, since the same adaptive calculation is used to optimize the dressing interval.

Fig. 1



Brains — and brawn. The new profile grinding software is only part of the total array of performance-enhancing features Hansen now can employ as it seeks to take time and money out of big gear production. Other key features include:

- A special design Internal Grinding Adapter, used on the Gleason-Pfauter P2400Gs for the internal grinding of the ring gears (shown above), enables Hansen to accommodate large face widths and high helix angles.
- An integrated Windows® based user interface with a Gleason-Pfauter dialogue program that provides for quick, simple and operator-friendly programming.
- Fully automatic determination, via on-machine inspection, and optimum distribution of stock allowance (stock division) of the workpiece in relation to the grinding wheel before machining.
- On-machine dressing that integrates the dressing unit with the grinding head to ensure the highest level of repeatability. Compensation for wheel wear between dresses is automatic.

- A grinding technology database that recommends and optimizes the "perfect production" methodology.
- K-Chart inspection that allows specific input for both profile and lead modifications.

Big gears, bright future. All told, Lommel is home to some 18 of the latest Gleason-Pfauter CNC machines for hobbing, shaping, internal milling and, of course, finish grinding. Hansen's Georges Roobaert sums it up this way.

"Wind energy is by far the most challenging application for a gear unit due to the high and dynamic loads. The performance and reliability of a gear unit is determined both by the design and the ability to manufacture the gears and other components to very high quality levels far above those required in other applications," Mr. Roobaert says. "By putting our faith in Gleason-Pfauter technology, we have been able to take on the challenges of ever-larger gear units that would be difficult, if not impossible, otherwise. We've challenged Gleason to meet our demands for high quality and more productivity, and the results are evident."