Contributing to the Environmental Performance and Safety Improvement, Nikon’s “Measurement” Technology Supports People’s Life “Create the Future with Optical Technology”
Gears are important components that transmit the power generated by the automobile’s engine to its wheels. In its development, not only its sufficient durability and efficient energy transmission, but also cutting down the noise of the gears grinding on each other is considered an important factor.

Automobiles are composed of tens of thousands of components. One of the most important of these is the gears that transmit the energy generated by the engine to the wheels, which greatly affects the safety of the automobile itself, and the stability of the run.

Toyota Motors, with their intention to Kaizen (continuous improvement) activities, has accumulated their efforts in diligently researching and developing the ideal gears.

“In recent years, with the popularization of quiet running automobiles such as hybrid cars and fuel cell cars, reducing the noise from the bad engagement of gears is becoming an increasingly important issue,” tells us Yoshikatsu Shibata, who manages the design/quality assurance of the gears and the development of testing equipment at Toyota Motors.

With the gears in smooth engagement, the uncomfortable noise will be reduced. But to realize this, extremely sophisticated measurement technologies will be required. “Although they may seem similar to the naked eye, the shape and posture of each single tooth flank differs by micrometers. To completely eliminate the cause of the noises, every tooth flank must be measured accurately,” (Mr. Shibata)

Toyota Motors conventionally performed these measurements using contact type metrology systems. With this method, each sample was literally directly contacted to measure its shape, length, height, etc.

However, this method had its difficulties. The tooth flanks are measured by equally spaced “points,” then connected with “lines,” and therefore if the distance between the lines is too wide, “measurement oversights” are more likely to occur. But then if the number of lines is increased to avoid oversights, the number of times of contact increases, and the time required for measurement becomes longer.

“It took us hours to complete the measurements at the precision required by our company. Just when we were thinking, couldn’t there be a way to complete the measurements at this precision within a shorter time, we met the “High-precision Non-contact Sensor 3D Metrology System.” (Mr. Shibata)

With this system, which can irradiate the laser from various angles without contacting the sample, the entire sample could be measured by “planes” instead of “points and lines,” and not only did measurement accuracy dramatically enhance, but measuring time was drastically reduced.

“We can understand the conditions of the tooth flank extremely precisely, so for some of the gears, we could omit the process of creating prototype gears to test the engagement. The fact that we were able to reduce not only job labor but also unnecessary materials is one of the big ever-bettering effects.” (Mr. Shibata)

Of course, the enhancement of the precision of the gear itself contributed to the manufacturing of safer and more fuel-efficient cars. Nikon’s “measuring” technology seems to be a strong advocate for Toyota cars, firmly supporting their reliance from the side.

Nikon’s Contribution
Enhanced measurement accuracy of the gears, reducing fuel efficiency loss and noise.

Factors that link to fuel efficiency loss: energy transmission efficiency, durability, and noise volume, are largely affected by the engagement of the gears. The “Non-contact Sensor 3D Metrology System” developed by Nikon dynamically increased precision using a technology that measures the tooth flank by the “plane” instead of “points and lines,” and realized optical engagement. Furthermore, measurements that required a long time with conventional technologies could be completed speedily.

Special Interview
The reason Toyota, continually making Kaizen (continuous improvement) activities, chose Nikon as their partner

The measurement time was drastically reduced
Even unnecessary materials were eliminated

“Nikon’s ‘Measuring’ Technology Contributes to Toyota’s Environment & Safety”
A 3D metrology system that acquires a large volume of surface point clouds by emitting laser scanner light instead of contacting the samples. General non-contact 3D metrology systems are limited to an accuracy of several hundred or several ten micrometers, but Nikon’s "High-precision Non-contact Sensor 3D Metrology System" is capable of high-precision 3D measurements of several micrometers. Measurement time is also short at almost several tenths of contact type systems.

**Uncovering issues unseen with conventional metrology systems, using non-contact systems**

**High-precision Non-contact Sensor 3D Metrology System**

It was back in 2008 when Nikon started developing their "High-precision Non-contact Sensor 3D Metrology System." "Until then, our company had an arrangement of appropriate lineups of two dimensional metrology systems, including the measuring microscope used for measuring electronic components. So, we decided to apply these know-hows and technologies to the three dimensional area, and develop an unprecedented 3D metrology system. That is how it all started," tells us Mr. Kenta Kanto, from Nikon Industrial Metrology Business Unit.

Back then, the mainstream of metrology systems used for dimensional measurements of mechanical components was contact type 3D metrology systems. Insisting on non-contact type systems, and freely using Nikon’s optical technology, precision technology, and high-speed image processing technology, they invented this 3D metrology system.

Not only is this system equipped with high-precision sensors, it realized a five-axis automatic control that moves the sensors left-right, forward-back, up-down, tilts the sensor itself, and furthermore rotates the sample, allowing the laser to reach blind spots created by the concaves and convexes of it. This allows complex shaped samples such as gears to be thoroughly measured. Also, "Because it is a non-contact type system, it has a merit of being able to measure components of various materials, such as rubber parts that sink when touched," explains Mr. Kanto.

Soon after starting the development, Mr. Shibata of Toyota Motors delivered a comment of high assessment, saying that he "sees in it a potential" as a system for measuring gears, and repetitive improvements were made to the system according to their demands. "They tell us that, measured by the ‘plane,’ subtle concaves and convexes on the surface that could not be seen with conventional systems can be confirmed, so ‘we can discover more issues to Kaizen (continually improvement).’ We will continue to further improve this system to realize even higher-precision, to provide technicians with more ‘discoveries.’" (Mr. Kanto)

**Answering to compelling needs to secure safety and environmental response with non-destructive systems**

**Non-destructive X-ray and CT Inspection Systems**

Nikon’s "High-precision Non-contact Sensor 3D Metrology System" is used for the measurement of various automobile components including gears, compressor wheels of turbo chargers which have a very complex shape, eddy current test that prevent oil leakage from the engine, and more. Meanwhile, "Non-destructive X-ray and CT Inspection Systems" are not only used to inspect automobile components, but to inspect turbine blades, a main component of jet engines of airplanes, and more. Optimization of the blade shape based on the inspection results brings merits such as improved fuel efficiency.

Not only has Nikon contributed to the improvement of safety and fuel efficiency of Toyota automobiles by enhancing the measurement precision of the gears, Nikon also supports safer and more environment-friendly car manufacturing with a distinguished system called "Non-destructive X-ray and CT Inspection Systems" for engines, the "heart" of automobiles.

This system allows inspection of internal conditions of various industrial products or components without destroying or deforming the sample, by penetrating X-rays like medical X-rays or CT scanners. This system is used in a wide range of inspections within automobile manufacturing, but for engines, it serves the purpose of detecting ‘voids’ inside cast components.

"In recent years, to improve fuel efficiency, automobile engines have become more miniaturized, and down-sheet metal gauging of cast components have proceeded. However, if ‘voids’ exist within these thin castings, depending on their positions, they may possibly become the cause of engine failures. The importance of accurately inspecting the state of ‘voids’ before embedding the engine into the automobile is rising," tells us Mr. Naoshi Sakaguchi of Nikon Industrial Metrology Business Unit.

Conventionally, destructive inspections, where part of the manufactured engines were picked out and severed for internal inspection was typically used, but "It was a wasteful inspection method in that even after confirming that the engine had no problems, the severed engine could no longer be returned to the manufacturing line." (Mr. Sakaguchi)

Non-destructive inspections generate no waste, making it an environment-friendly inspection method.

The strong point of Nikon’s "Non-destructive X-ray and CT Inspection Systems" is, "That the internal conditions of large sized samples can be confirmed in detail with its overwhelmingly high technology. Also, the system can be customized flexibly according to the requests of the client," says Mr. Sakaguchi. Nikon continues to answer to compelling needs shared by various industries, securing safety and environmental response, with their advanced technology.
Large Volume Non-contact Inspection System: Laser Radar

Automobiles are "running precision machines." Automobiles consist of tens of thousands of components, but a subtle offset of one single component may cause a drastic harmful effect on its running performance and safety.

"The structure (the pre-coating body) which is the skeleton of the automobile, has countless numbers of holes for building-in these components and building up the structure itself. Accurately measuring the position of these holes is essential for manufacturing safe automobiles," explains Mr. Takashi Tanemura, from Nikon Industrial Metrology Business Unit. One big characteristic of their company’s "Large Volume Non-contact Inspection System: Laser Radar" is that it can accomplish dimension measurements of such shapes accurately at a high speed.

Conventionally, many automobile manufacturers had measured the length of the structure and position of the holes using contact type systems, but it had problems such as being time-consuming, and requiring a large sized metrology system. In that sense, because lasers use the reflection of lights, it can measure by scanning the laser beam directly at the sample from a distance, without setting a target. They have achieved 7 - 8 times the speed of contact type metrology systems.

"It was originally developed for measuring airplanes, but its merit of being able to measure samples accurately and speedily from a distance is useful for a wide range of industrial fields." (Mr. Tanemura)

The optical technology and control technology that Nikon has long nurtured. Their fields of application are infinitely expanding beyond consumer products.

Nikon’s "Measuring" Technology

Supports the Safety of Large Airplanes and Automobiles

Special Interview

The mission of Nikon Industrial Metrology Business Unit is to resolve clients' issues

The name Nikon recalls images of consumer products such as cameras, optical lenses, and sport optics, but actually they also specialize in the research and development of various industrial equipments such as "Laser Radars."

Nikon positions this area of business as one of the "growth engines" of the next generation, and launched Nikon Industrial Metrology Business Unit in 2014. Since then, they have introduced to the world many unique metrology systems distinctive of Nikon, including the "High-precision Non-contact Sensor 3D Inspection System" and "Non-destructive X-ray and CT Inspection System" introduced in the previous article.

"Applying our long cultivated optical and control technologies, our metrology systems are characteristic in that they possess both 'speed' and 'accuracy' that were difficult to achieve with conventional systems, together with 'convenience,'" explains Mr. Masao Nakajima, Senior Vice President, General Manager of Industrial Metrology Business Unit of Nikon.

Their products share a common concept, "using light to measure materials."

Although the source differs from laser to X-ray, "What makes possible the detailed measurement of the sample to its internal structures without contacting or destructing it, is light. It is already being used in various industries including automobile, airplane and space industries, but it seems that clients highly assess our systems for overturning the common recognition in the development/manufacturing scenes that samples had to be physically touched to be measured, and realizing dramatic reduction of inspection time, or decrease of loss from destructive inspections," tells Mr. Nakajima.

With this technology, Nikon enhanced the safety and environmental performance of the inspected products, therefore contributing to the safety/assurance of people's lives and sustainability of the global environment.

For example, if measurement time is accelerated, products that were conventionally only able to be inspected by randomly extracting samples could be inspected thoroughly. Thus, manufacturers that use Nikon's metrology systems can widely distribute products more safely.

Nikon, with their extraordinary optical/control technology, not only produces cameras, but provides to a wide range of industries, metrology systems that accurately "measure" industrial products. Their technology contributes greatly to the safety and environmental performance of the products they measure. A close-up of Nikon's technologies that support worldwide manufacturing from the side.

Exploring the possibilities extensively without limiting industries

"Optical technology could possibly be applied to a wide range of industries, not only automobiles and aerospace. As for our company, we would like to proactively propose new solutions to various clients without being adhered to conventional frames or stereotypes. What's important is, at all times, not the products, but the needs of the client and the market. And we should not define these frameworks by ourselves. We think that by confronting the issues we are required to, we can open up new possibilities." (Mr. Nakajima)
NIKON CORPORATION
Industrial Metrology Business Unit

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