Mitsubishi Materials Craftsmanship Magazine

BM006E

YOUR GLOBAL CRAFTSMAN STUDIO

DRIVE TO THE FUTURE

Spirit and Technology Supporting the Automobile Industry

Vol. 6 Stories

MESSAGE

Shinichi Nakamura
Managing Executive Officer,
Mitsubishi Materials Corporation
President, Advanced Materials &
Tools Company

It's not too much to say that the history of the automobile industry and the history of cutting tools are one and the same. The automobile industry grew by predicting and satisfying market needs, but it is now undergoing significant reform. It is hard to predict what the market trends will be in 10 years and it has become increasingly difficult to achieve a unified vision of future trends even in individual countries.
Significant reform will also be the case for tool manufacturers because it is certain that the amount of machining per next-generation vehicle will decrease. This is the cold reality that tool manufacturers will soon face. However, I believe that we can identify significant business opportunities even under these circumstances. We need to show courage in selecting from among the options available to us to move forward into the future. We also need to think now about what we should do to prepare and pursue that course. Meanwhile, we must not forget to address the current issues. The issues currently facing the tool industry include the need to improve productivity by 5% and establish engine processing lines. While we prepare for the future, we also need to care for the present by providing goods and services with great value.
Mitsubishi Materials' Craftsman Studio is intended to be the place where innovators striving for significant advancements toward the future can feel free to boldly discuss the current and ideal states of machining with cutting tools.

A spirit of empathy for the customised designing of special tools

Thank you for reading YOUR GLOBAL CRAFTSMAN STUDIO vol. 6.

Volume 6 features the automobile industry. It is a fact that the growth of our Advanced Materials and Tools Business has been supported in no small part by the advancement of the automobile industry. Our customers in the automobile industry have taught us many important lessons, and I believe their support has been instrumental in helping us to expand our business.

There are five major parts to the automobile engine, the so-called 5C's; and most of the tools used to manufacture the 5C's are specialized. The manufacture of these special tools presents major challenges because of the need to incorporate a wide range of design perspectives while bringing to bear the most advanced know-how available to satisfy customer requirements. We sometimes, for example, re-grind inserts used in certain processes to intentionally reduce their size for further use on other applications. Designing tools for use across different processes requires us to be completely familiar with each of these processes and the quantity of inserts to be used in them. In addition, it is also important to design tools in such a way as to make it easier for the customer to conduct acceptance testing after delivery, to make it easier for the customer to sort for disposal, and also make it simpler for the customer's production & technology and procurement divisions to understand. With a spirit of empathy, we are responsible for making special tools for our customers.

YOUR GLOBAL CRAFTSMAN STUDIO is the brand message from the Advanced Materials and Tools Business. It expresses our desire to respond to the wide variety of customer requests to ensure that the tools we manufacture meet and exceed expectations. We rise to the challenge of manufacturing the finest specialized tools for the automobile industry. In addition to the wide application of special products, the use of standard products has increased. The telephone book-size catalogue contains more than 30,000 products and with such a vast array, it makes it a daunting task for customers to select the most appropriate tools and cutting conditions by themselves. Individual customer needs include the necessity to reduce processing costs, increase productivity, prioritize the finished surface, utilise a safe chip processing system and also to reduce vibration, noise and burrs. To meet these varying conditions, we must be increasingly prepared to provide comprehensive solutions. Such solutions include a wide variety of services such as seminars for young engineers, process testing in environments similar to those found at the customer's site, technical services such as on-site product line inspections and the proposal of new tools developed through CAE analysis.

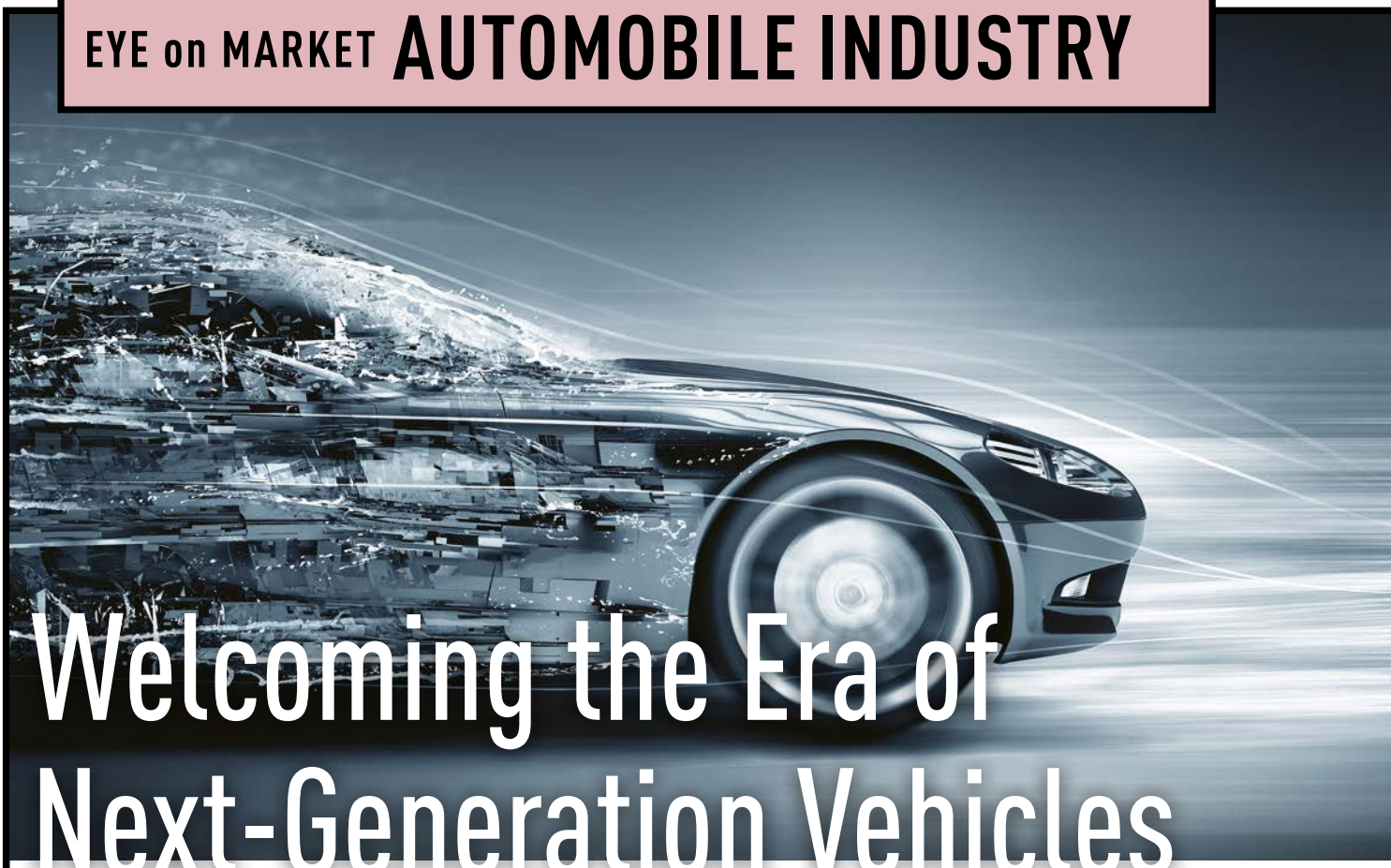
While our Research & Development Division continues to prioritize the performance of individual products, we also continue to provide customer-oriented consultation services.

In June 2017, we opened the Central Japan Technical Center adjacent to the Gifu Plant. We are looking forward to seeing automobile industry customers there to showcase our ability to provide the best engineering solutions. We will continue to innovate and improve our products and services to meet customer needs.

Koichi Ikenaga
General Manager
Research & Development Div.
Mitsubishi Materials Corporation
Advanced Materials & Tools Company

YOUR GLOBAL CRAFTSMAN STUDIO

EYE on MARKET AUTOMOBILE INDUSTRY



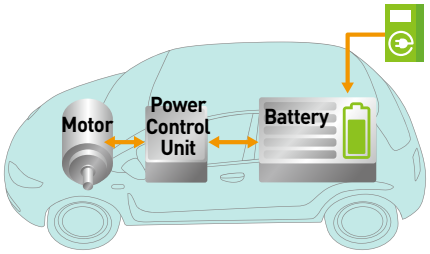
Welcoming the Era of Next-Generation Vehicles

Next-generation vehicle definitions and 4 major categories

Next-generation vehicles have attracted attention as a way to save energy and reduce the global environmental load. According to the Next-Generation Vehicle Guidebook 2016-2017 (published jointly by the Japanese Ministries of Environment, Economy, Trade and Industry, Land, Infrastructure and Transport), next-generation vehicles are defined as environmentally-friendly vehicles with high fuel performance and low or no emissions of air pollutants, including nitrogen oxides (NOx) and particulate matter (PM). The four major categories of next-generation vehicles are (1) electric, (2) hybrid, (3) plug-in hybrid and (4) fuel cell.

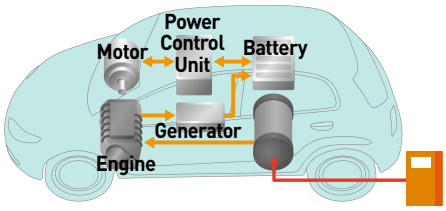
TYPE 1 EV : Electric Vehicles (EVs)

Electric vehicles (EVs) are powered by an electric motor charged by off-vehicle sources. They do not emit CO_2, and operational noise is reduced significantly. Compared with gasoline vehicles, EVs have a more simplified structure with fewer parts. The parts are also smaller, making it relatively easy to decrease the overall size and weight of the vehicle itself.



TYPE 2 HV : Hybrid Vehicles (HVs)

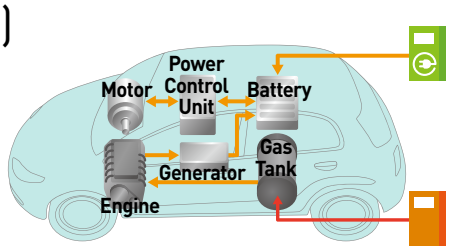
Hybrid vehicles (HVs) are powered by two or more distinct sources. The most common combination is a gasoline engine and an electric motor. The electric motor is used when starting and driving at low speeds while the gasoline engine is employed when accelerating. Utilizing the advantages of each power source, HVs realize low fuel consumption and reduced CO_2 emissions.



TYPE 3

PHV: Plug-in Hybrid Vehicles (PHVs) / Plug-in Hybrid Electric Vehicles (PHEVs)

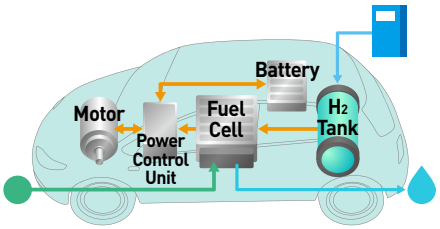
Plug-in hybrid vehicles (PHVs)/ plug-in hybrid electric vehicles (PHEVs) are powered by a gasoline engine used in combination with a battery and an electric motor charged by off-vehicle sources. PHVs/ PHEVs are powered by the electric motor whose charge is capable of powering the vehicle for a certain distance and discharges zero CO_2. When the battery charge drops, the gasoline engine is engaged to power the vehicle and recharge the battery, which enables it to travel longer distances.



TYPE 4

FCV : Fuel Cell Vehicles (FCVs)

Fuel cell vehicles (FCVs) are powered by an electric motor whose energy is produced by the chemical reaction of oxygen and hydrogen in the fuel cell. Because the electric power is generated by this chemical reaction, only water is discharged in the process. These have attracted global attention as extremely eco-friendly vehicles.



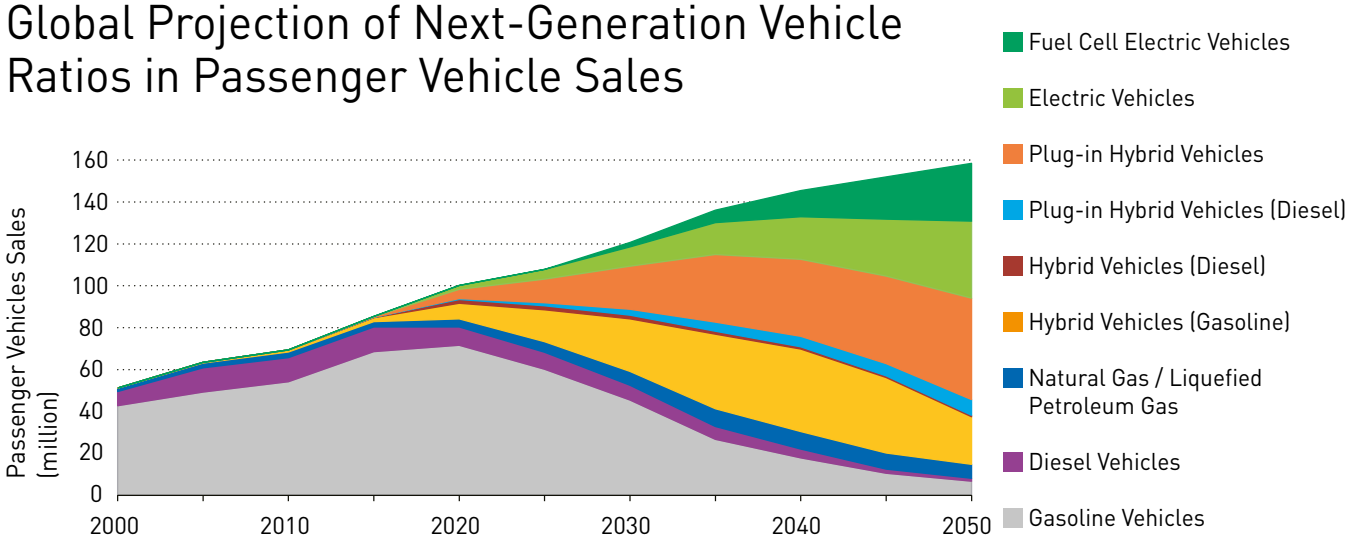
The market share of EVs and FCVs will grow after 2040

While next-generation vehicles are thought of as the wave of the future, they first appeared back in 1873, way before gasoline-powered vehicles. Automobile production in the United States around 1900 was approximately 4,000 units, 40% of which was EVs. The rapid improvement of gasoline vehicle performance and their lower prices, meant that EVs disappeared from the market around 1920. It wasn't until the 1970s that interest in EVs reemerged against the background of increasingly serious air pollution and concerns about dwindling oil resources. Japan took the initiative in the research and development of EVs; however, poor battery performance and improved exhaust purification technology for gasoline vehicles dampened enthusiasm.

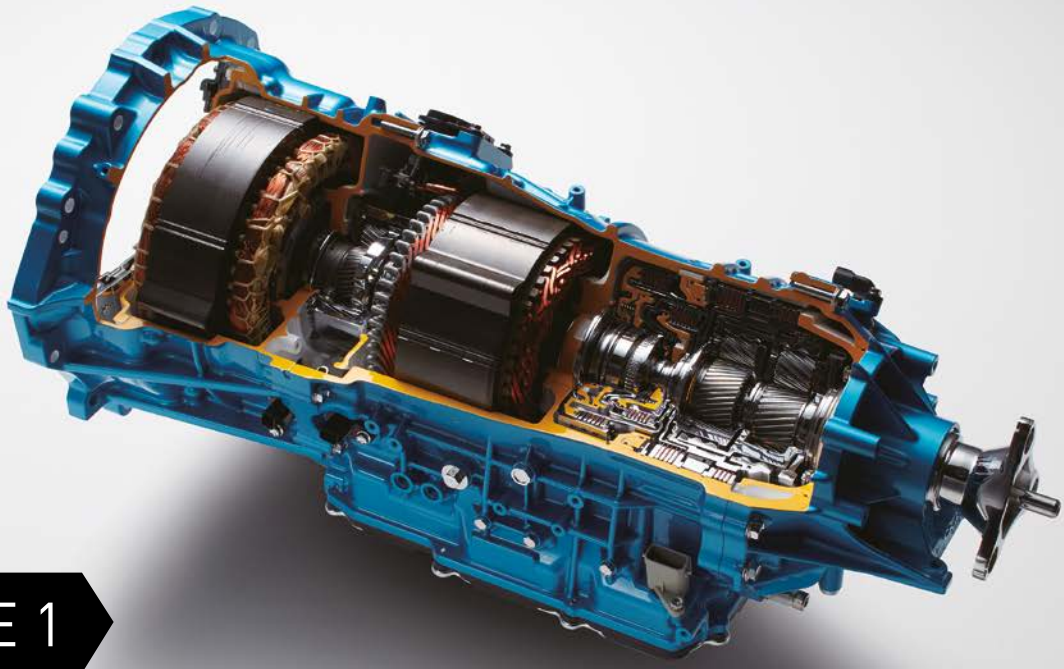
This started to change in the 1990s when the State of California enacted its Zero-Emission Vehicle (ZEV) Programme. This prompted major automobile manufacturers around the world to initiate full-scale development of EVs. In 1997, Toyota was the first automobile manufacturer in the world to announce production of a hybrid vehicle and other manufacturers are now accelerating the development and spread of EVs, HVs, PHVs/PHEVs, and FCVs.

According to the International Energy Agency (IEA), sales of gasoline and diesel-powered vehicles will peak in 2020, after which HVs and PHVs/PHEVs are expected to take the lead in the automobile market. After 2040, it is predicted that the number of vehicles with internal combustion engines will steadily decrease as the number of EVs and FCVs grows.

Global Projection of Next-Generation Vehicle Ratios in Passenger Vehicle Sales



Source: IEA Energy Technology Perspectives 2015



CASE 1

AISIN AW CO., LTD.
Technical Centre

Joint development of innovative helical broaches

Aisin AW Co., Ltd. holds the world's top share of the automatic transmission (AT) market. The company's work on advancing processing technology utilizing large-diameter helical broaches has drastically improved AT production efficiency. In this feature, we focus on a new project between Aisin AW and Mitsubishi Materials.

Technical Centre built in 2011 for the development of next-generation technology

Committed to maintaining its position as the world's No.1 automatic transmission manufacturer and to lead future automotive development

Founded in 1969 as an automatic transmission manufacturer, Aisin AW Co., Ltd. is a subsidiary of Aisin Seiki Co., Ltd. and one of the Aisin Group's six major companies. Since the development of the 3-speed AT with the front-engine, rear-wheel-drive (FR) layout in 1972, Aisin AW has continued developing products that anticipate market trends. It followed up commercialization of the world's first FR type 8-speed automatic transmission in 2006 with the world's first front-engine, front-wheel-drive (FF) layout 8-speed AT in 2012 to help maintain its lead in the industry as the world's No.1 AT manufacturer.

FY 2016 sales reached 1.2 trillion yen, AT being responsible for 90% of that number. Approximately 38% of the AT units made by Aisin AW go to Toyota Group, and the rest are delivered to more than 50 automobile manufacturers across 15 different countries. In 2012, cumulative production of AT units exceeded 100 million. As the leading global supplier of AT, Aisin AW keeps an eye on next-generation mobility and advances the development of electronics. This effort resulted in the successful mass production of a hybrid system in 2004 ahead of other manufacturers. "We would like to create a vehicle that we can operate almost intuitively and one that inspires the driver." With such commitment, Aisin AW continues to lead the development of AT to meet and exceed market expectations.

Aisin AW Technical Centre continues developing new-generation technology

The Aisin AW Technical Centre features an innovative manufacturing system that enables smooth information sharing and cooperation among departments in both the Engineering and Manufacturing Engineering Divisions. This new Technical Centre was built in 2011 to integrate all departments engaged in technical development for the commercialization of AT, continuously variable transmissions (CVT) and hybrid transmission units manufactured at different locations. The Centre has approximately 3,000 employees that are committed to increasing technical development capacity through the application of an innovative system that comprehensively integrates all phases of new-product development, from planning through to manufacture. Serving as a facility where Aisin AW can pass its DNA to the next generation of innovators, the Centre sets the goal of maintaining a lively human network for the continued development of new products. The Aisin AW Technical Centre is well prepared for the development of electric vehicles (EVs). According to Shinya Sugiura, General Manager of the Manufacturing Engineering Division's Tool Engineering Department, "The use of EVs is predicted to grow and countries are preparing for the implementation of tightening regulations around 2020. As a leading automotive parts manufacturer, we are also preparing for this." Aisin AW has started development of new systems to ensure that it is ready for the emerging era of the EV.

Parts manufacturing sites have as much drama as there are parts

While Aisin AW supplies parts to manufacturers across the globe, the company's largest single customer is Toyota Group, which accounts for around 40% of total sales. Aisin AW was established as a joint venture between Aisin Seiki and the American automotive parts manufacturer Borg Warner, which is where the "W" in Aisin AW comes from, and the American culture is deeply rooted in the company. Harumichi Nakagawa, Group Manager of Tool Engineering Group 1 in the Manufacturing Engineering Division's Tool Engineering Department says, "I can still find sizes written in inches in old drawings."

While the AT is generally unseen by car owners, it is every bit as important as the engine and just as complicated because of the planetary gears that make its smooth operation possible.The three major materials used in the manufacture transmissions are aluminum for the casing, steel for the gears and shafts and cast iron for the oil pump and differential cases. Each has unique characteristics and presents different challenges in manufacturing. Thousands of parts go into each AT unit, and each one is essential in enabling a vehicle to run smoothly and quietly. In the process of manufacturing AT units with such a large number of parts, the highly skilled engineers involved in the design and development of each part find it hard to avoid generating problems for each other from time to time, but it's the creative energy they have that results in the best product possible. Step-by-step, each AT unit takes form through a painstaking process of production, and there are as many stories that come from the process of development as there are parts developed.

According to Shogo Itoh of the Subsidiary Material Purchasing Group, Material and Equipment Purchasing Department, Purchasing Division, "After the engine, the most expensive part of any car is the transmission. Its function is to connect the engine and the driver; and the more luxurious the vehicle, the more important a quiet ride becomes. AT's from 20 years ago were a simple 3-speed unit, but now they include up to 8 and even 10 speeds. To fit the gears necessary for this degree of performance in a limited space requires a much higher level of processing accuracy for each part than ever before, and such accuracy requires cutting tools that deliver the highest possible performance and quality."

The most difficult aspect of AT manufacture is ensuring that all gear teeth meet the strict tolerances determined by the design. To ensure success, AT manufacturers and tool suppliers like Mitsubishi Materials work closely to create new machining methods and develop new cutting tools.

Shinya Sugiura
General Manager
Tool Engineering Department,
Manufacturing Engineering Div.

Harumichi Nakagawa
Group Manager
Tool Engineering Dept., Group 1,
Manufacturing Engineering Div.

Naoto Hattori
Team Leader
Tool Engineering Dept., Group 1,
Manufacturing Engineering Div.

Shogo Itoh
Subsidiary Material Purchasing Group,
Material and Equipment Purchasing Dept.
Purchasing Div.

Machining is the final process, and it has a significant influence on fuel efficiency and quietness

There are many processes in the manufacture of AT units. Shinya Sugiura says, "The machining process is the key because the accuracy of the gear, the heart of the AT, is determined by the cutting process." If the part is not cut correctly, then the AT fails to achieve its potential. It's not too much to say that cutting process technology is what makes the manufacture of ATs with new added value possible. "AT performance is determined by the accuracy of the overall machining, and the outcome of this process has significant influence on fuel consumption and quietness," said Noto Hattori, Team Leader of Tool Engineering Group 1.

Depending on the quality of work materials and the machining required determines the type of tool, heat processing method and type of coating that are to be used. The combinations are infinite. "I feel great pleasure when I find the best combination, and that includes details such as finding the optimum cutting oil. It is often the case that solving just one problem in the machining process increases the overall efficiency of production. There is no doubt that highly advanced machining technology has supported Aisin's technical development and has maintained the high quality of our products. Advanced machining technology is one of our fundamental assets," said Shogo Ito.

Large-diameter helical broaches are precision tools often used in AT gear processing. The number of teeth on one broach can number more than a few thousand, but if a defect is found on only one tooth, the product is considered scrap. Hattori says, "When we see a problem, it is absolutely essential to find the cause of the defect." Nakagawa says, "Being involved in gear cutting, has changed my outlook significantly. I have come to consider the mechanisms behind the phenomena I see in daily life, and this has changed the way I live my life. One of my coworkers liked to collect mini-cars. He carefully observed the size and locations of the engines and transmissions, and considered how he could apply his observations to automotive technology, weight balance and turning performance. It surprised me to see his interest in toys, but it made me realize the importance of considering the reasons for and causes of even a very tiny phenomenon."

Developing a new large-diameter helical broach with Mitsubishi Materials

The trend of planetary ring processing has been shifting recently from the helical broach method to skiving. Aisin AW did not want to stand idly by and watch their superior processing methods it had developed to become outdated, so it initiated a project in conjunction with Mitsubishi Materials to develop a new type of helical broach. This project sought to drastically improve productivity and reduce costs in ways that could not be achieved by skiving.

Sugiura explains why they chose Mitsubishi Materials as a partner, "Their attitude toward product development was very forward thinking and they were clearly motivated to take part in the development of a new tool. We were very proud to have been a pioneer in the implementation of the American broach in Japan. We felt that developing a new future in cutting utilizing broaches was our mission and that Mitsubishi Materials' great attitude and quick response would make it the best partner for joint development."

The joint project for development of the new large-diameter "Innovative Helical Broach" started in 2013. "Mitsubishi Materials let us see details of broach manufacturing that are usually not shared outside the company. We shared information on design and the fundamentals of manufacturing to advance the joint project. We worked hand-in-hand with staff at the Mitsubishi

(Left) **Tatsuya Nagaoka**, Development & Design Section,
Gear Cutting Tools Manufacturing, Akashi Plant, Mitsubishi Materials Corporation
(Right) **Manabu Kimura,** Tool Engineering Group 1, Tool Engineering, Aisin AW Co., Ltd.

Materials Akashi Plant to reach our goal of finding innovative ways to reduce the cost of AT manufacture. I really appreciated their cooperation and hospitality. "Engineers from both companies had serious discussions at the Akashi Plant looking over full-scale drawings that measured as much as 2 meters long, and there were times when those discussions became heated debates. In fact, there were disagreements about the best way to proceed from the beginning of the joint project.

"For this project, we used the simultaneous engineering method that we have employed at Aisin AW. We brought in staff who would normally become involved only after the design phase has been completed to participate. It is extremely rare, however, that we employ this method with an external partner. We were hoping that Mitsubishi Materials would work with us on this project like comrades in arms fighting for victory," said Sugiura. He continued, "The key to achieving high precision was the establishment of measurement technology. We had to surpass the level other manufacturers were capable of achieving and because the relationship between precision and cost involves trade-offs, friction between the parties involved was hard to totally avoid. However, both Mitsubishi Materials and Aisin AW kept at it until they achieved high levels of both."

Development of the helical broach, an innovation that achieves approximately five-fold greater performance than the existing broach

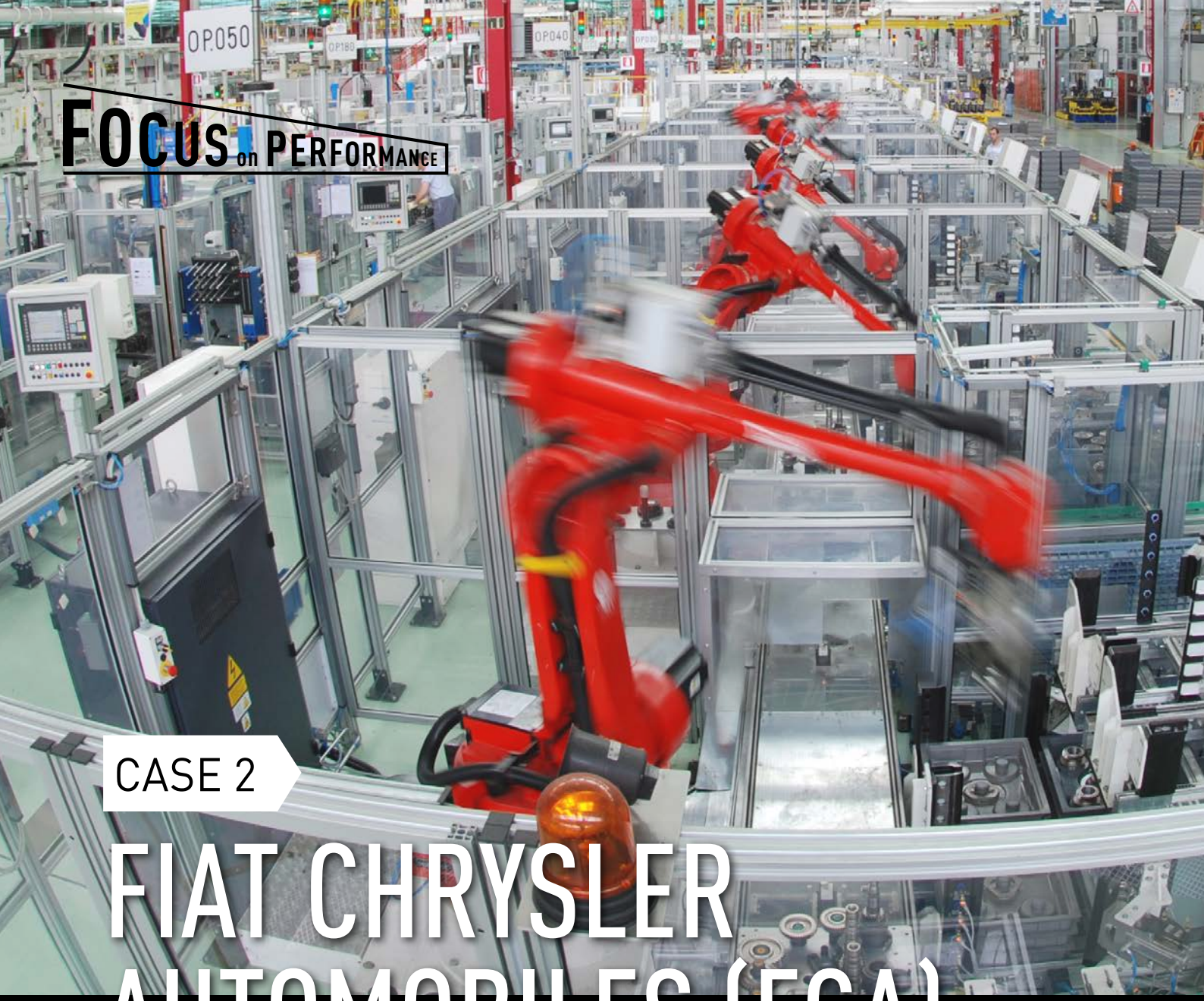
Innovative design, polishing and other concepts were implemented in the development of the new helical broach. The original design concept increases tool life, the polishing concept stabilizes the re-manufacturing process, and the innovative machining technique enhances processing precision. These three concepts resulted in a truly ground-breaking helical broach.

"Although the existing broach only needed to be replaced once a day, this new helical broach lasts for five days. The time and manpower it takes to replace a broach is significant, and meant stopping the production line for around one and a half hours every day. Reducing the frequency of replacement to once every five days improved productivity significantly. It has been said that technical development for skiving has been delayed because of our focus on this innovative helical broach, but I disagree. If the limit of broaching were to remain unchanged, we would not need to set a high goal for skiving. However, because broaching productivity has reached an incredibly high level, we now need to reconsider skiving from the beginning to match the new standard. Helical broach development has had a good influence on in-house operations like this, in fact, it was recognized with the Manufacturing Improvement Award, which is a highly coveted in-house award at Aisin AW," said Sugiura.

Nakagawa looked back on the process and achievements of helical broach development and said, "Mitsubishi Materials was quick to respond to our requests and questions and welcomed us with open arms at the plant. They were like comrades in our fight to develop leading-edge technology and this gave us a shared a commitment and goal that led to success."

(Left) Component before broaching
(Right) Component after broaching

Both companies learned from each other, reviewed results, supported each other and worked hard together step by step to overcome challenges along the way. Mitsubishi Materials will continue to partner with Aisin AW to support its leading position in the automotive industry and the future of automotive development.



CASE 2

FIAT CHRYSLER AUTOMOBILES (FCA)

FCA Verrone Plant

Partnership between FCA Group and Mitsubishi Materials

Mitsubishi Materials Corporation (MMC) has built a firm partnership with Fiat Chrysler Automobiles (FCA) Group, one of the long-established automobile manufacturers in Europe, through the provision of a wide range of thoroughly-customized solutions.

(Left) **Leonardo Rossi,** FCA Verrone Plant Chief
(Right) **Marco Rimoldi**, General Manager of MMC Italia

FCA Verrone Plant manufacturing products for all FCA Group brands

FCA Verrone Plant is the production base for FCA Group. Located in Verrone, Piedmont, Northern Italy, the plant is surrounded by forests and rice fields. This large plant measures 60,000m², including a 3,000m² warehouse and produces manual (MT) and dual dry clutch transmissions (DDCT) for both gasoline and diesel vehicles across all FCA Group brands (Fiat, Alfa Romeo, Jeep, Chrysler, and Dodge).

FCA Verrone Plant awarded World Class Manufacturing's (WCM) Gold Level in 2015

FCA Verrone Plant's extremely high production efficiency was recognized with the Automotive Lean Production Award, a coveted award for automotive products, as well as the WCM Gold Level award in 2015. The basis of these awards was FCA Group improvement plans for plants that manufacture Fiat, Chrysler, CNH, and Iveco. WCM excels in total productive maintenance methodology (TPM), lean manufacturing and total quality management (TQM) based on 10 managerial and 10 technical pillars. The 10 technical pillars are safety, cost deployment, focus improvement, autonomous maintenance and workplace organization, professional maintenance, quality control, logistic/ customer services, early equipment management, early product management, energy and environment, and people development. The most important of these is cost deployment, which involves the identification of loss and waste in the production process. Designed to achieve zero occupational and environmental accidents, zero quality defects, zero waste and zero loss by taking economic impact into account, it resulted in the reduction of costs across all plants. "We are very proud of the WCM award. The validation of the success of our efforts to achieve maximum efficiency throughout management increases our motivation to continue striving to improve all plant functions and enhances human resource cultivation. Receiving the Gold Level means the improvement that we have been committed to achieve has met the standard of WCM," said Leonardo Rossi, FCA Verrone Plant Chief.

FCA Verrone Plant has also achieved both an environmental-friendly manufacturing system along with its high productivity. In fact, the plant is located in the Baragge national nature reserve in Ticino.

Reasons why FCA Group selected MMC (Mitsubishi Materials)

FCA Group chose Mitsubishi Materials because of its great teamwork and cutting technology know-how that has achieved high production efficiency. Mitsubishi's technology was essential in helping FCA Group to achieve the WCM Gold Level. MMC Italia General Manager Marco Rimoldi and FCA Verrone Plant Chief Leonardo Rossi discussed and agreed upon the roles each company would play, as provider and user of the tools for future manufacturing respectively. "Solutions provided by Mitsubishi were practical and easy to adjust to achieve the desired results. As for the maximization of machinery capability, the tools were highly effective not only in reducing purchasing costs, but also in optimizing profitability throughout the entire production system," said Rossi.

The partnership between FCA Group and Mitsubishi is not limited to the development of technical solutions and the provision of advanced tools, but includes training for FCA Group staff. The unique training programs are customized for individual plants to achieve FCA Group goals as if they were tailor-made suits. Through the joint efforts of Daniele Rametta (Key Account Manager, MMC Italia),

FCA Verrone

Training program provided by MMC Italia (**Marco Giannini**, Technical Support and **Daniele Rametta**, Key Account Manager)

Marco Giannini (Technical Support, MMC Italia), Gabriele Raiano (FCA Verrone Process Improvement Manager) and Mauro Beltrame (FCA Verrone Know-how Engineer), the first FCA Verrone training program was implemented in May 2017 and was well received by the 40 employees that participated. "This program focused on FCA Verrone's steel, its most common material to be machined, and cutting technology know-how for turning," said Giannini, MMC Italia Technical Support. They worked to bring participants of differing ages, degrees of experience and knowledge to a standard level to ensure a solid understanding of the technology. The main contents vary from basic to advanced, with basic knowledge including turning insert machining methods and the meaning of tool names, all in accordance with ISO codes, basic knowledge required for the selection of the correct tool, plus an advanced knowledge including insert grades used for general steel and for turning of harder heat-treated steels.

The standard training given to specific groups achieved impressive results. The most effective was personal training tailored to individual participants. "Outstanding collaboration enabled us to create programs that matched individual skill levels, and participants were very satisfied with the content. We are currently planning to provide programs for more advanced skills. This approach has been working smoothly," said engineer Beltrame. Plant Chief Rossi added, "We pay special attention to the performance of the tools. Great performance leads not only to reduced costs, but also to improved process efficiencies. Elongating tool life and stabilizing tool performance can help us to achieve higher goals."

Results that FCA Verrone could obtain through the collaboration with MMC

The major advantages of the collaboration between FCA Verrone and MMC are the ability to have continual discussions among engineers and other key personnel from both companies, and the shared checking of production lines to identify problems and establish solutions.

"We met the Key Account Manager at MMC Italia and asked him to extend the life of tools used in turning by 30%. We considered solutions involving improvement of boring bars, and they were ready to proceed within one week. Results of the tests showed that we could successfully increase tool life by more than 50%. This is a huge difference," said Manager Raiano with a smile. "I also participated in the tool testing to confirm performance and reliability," said Patrizio Lalà, Tool Specialist at FCA Verrone. "Flexible customized training, products and technical services that achieve high productivity are keywords at MMC," said the Plant Chief Rossi. The greatest strength of collaboration between FCA Verrone and MMC is the ability to identify problems and find the best solutions based on logical approaches.

"It is essential for us to improve processing efficiency and speed", Rossi confirms. When we encounter a problem, we require measures that produce solutions in a timely manner. We also know that standard measures cannot solve problems promptly. Our joint project with MMC proved this."

(From the left) **Mauro Beltrame** (FCA Verrone Know-how Engineer), **Gabriele Raiano** (FCA Verrone Process Improvement Manager), **Patrizio Lalà** (FCA Verrone Tool Specialist), **Daniele Rametta** (MMC Italia Key Account Manager)

Special training for team speakers

The training programs that MMC provides to FCA Verrone prioritize the cultivation of personnel that play key roles at production sites. FCA Verrone Plant has invested a large amount in the cultivation of team speakers.

"The team speaker position was implemented by FCA Verrone and has been expanded to other plants. The title differentiates the position from team leaders at plants producing automobile bodies and emphasizes their different specialties. The most qualified person among the workers at the cutting processing sites is selected to be a mediator between the production site manager and machine operator. Team speakers are required to participate in a wide range of training programs to gain sufficient know-how of basic tools and machining processes and to improve their communication ability. MMC Programs have been very useful because they provided the best training programs to the most suitable personnel. WCM requires the categorization of human resources according to capability and specialization, which allows us to select the employees with the necessary abilities for each project. We have our specialists with higher skills handle relatively difficult problems, and we ask on-site workers to handle the more routine problems directly at site," said Rossi.

"We have asked MMC to create new training programs that enable higher quantity and quality. In regard to quantity, we would like to improve the efficiency of basic programs to qualify as many employees as possible; and in regard to quality, we would like to provide more specific, highly-specialized programs that deliver practical and applicable content. Our final goal is to increase the overall specialization of the whole workforce. We would like to establish a system in which all our employees can accurately perceive situations, analyze them to the degree possible at the site, and understand the processes and parameters that influence them, as well as master the technical terms required to exchange information with tool manufacturers," said Raiano.

What FCA Verrone expects from MMC

The services that MMC provides to FCA Verrone are thoroughly customized. "MMC reports are extremely useful in sharing information at the plant," said Beltrame. MMC Italia Key Account Manager Rametta added, "We determined the format of the report together because communication is the most important product." The sharing of information is essential to improving speed and efficiency; the strengths of the plant. FCA is also working on the development of a software application that allows users to check the state of all manufacturing processes from their smart phones.
The collaboration between MMC Italia and FCA Verrone, as a tool supplier and user, is projected towards a bright future. "I expect that MMC will keep sharing with us their know-how related to technological development, and that it will provide us with solutions, and not only products, with the same determination and results, as well as help us in basic and advanced training", continues Director Rossi.

Process Improvement Manager Raiano added at the end of the interview, "We've known MMC for a long time and have worked together in the past outside Italy and I really have a good impression of them. The advantages of MMC in Italy are the quality of its services, the speed of its response and its enthusiasm regarding tests at the plant. Even when we require solutions to issues that may be outside the range that MMC would usually be expected to handle, MMC staff work hard to provide results. It's this attitude that puts MMC in a category of its own."

HISTORY OF MITSUBISHI

Vol. 6

Supporting the growth of the Mitsubishi Group

Mitsubishi Materials

On April 1, 2017, Mitsubishi Materials introduced a new company logo featuring three red diamonds. This logo represents the Mitsubishi Materials Group's emphasis on expanding overseas markets with its technological capabilities and facilitating further global business expansion. This feature focuses on the history of Mitsubishi Materials Corporation, a history of support for Mitsubishi Group business expansion.

Yataro Iwasaki, Founder of Tsukumo Shokai, predecessor of the Mitsubishi Group

A water bucket made by Tsukumo Shokai (Made in November 1872). The three-diamond mark was already in use.

Coal and mineral mining business in the 1880s expanded into the major business of Mitsubishi Group (The photo is Takashima Mine).

The Imperial estate Sado Mine sold to Mitsubishi Goshi Kaisha by the government.

Mitsubishi's corporate logo and the roots of Mitsubishi Materials Corporation

In 1870, Yataro Iwasaki, an official of the Tosa Domain, established Tsukumo Shokai, a shipping company approved by the domain. This was the beginning of Mitsubishi. In 1873, the company name was changed to Mitsubishi Shokai. Yataro wrote a letter to his brother Yanosuuke telling him, "I changed the name of the company from Tsukumo Shokai to Mitsubishi Shokai. The company logo is ⅄." This was the beginning of the logo that has become synonymous with reliability. The root of this logo was three diamonds adorning the flag flown on Tsukumo Shokai ships. It is believed that this logo integrated the three layers of diamonds on the Iwasaki Family crest, and the three oak leaves of the crest of the Yamauchi Family, whose head was lord of the Tosa Domain.

In the same year, Yataro expanded the mining business, purchased Yoshioka Mine and started a metal refining business. Thus, as well as its original shipping business, coal and mineral mining became a major pillar of the business. These would become the foundation of Mitsubishi Materials Corporation.

Mitsubishi Mining Co., Ltd. is established to handle Mitsubishi mining assets

In 1908, Mitsubishi Shokai implemented a divisional system for its mining, banking and shipbuilding businesses in which each business employed an independent, self-supporting accounting system. The implementation of this system for individual businesses managed by a head office was a very advanced approach in the Meiji Period (1868-1912). In addition, Mitsubishi established subsidiaries to enter a wide range of business fields. These became independent in the Taisho Period (1912-1926) and went on to be major members of Mitsubishi Kinyokai's group of 28 companies.

In line with these developments, Mitsubishi Mining Co., Ltd. was established in 1918 to take over the Coal and Mineral Mining Division from Mitsubishi and the assets of the Mining Research Institute, which handled the mining business. This new company was the predecessor of Mitsubishi Materials Corporation. Mitsubishi Mining entered the cutting tool business in 1942 and in 1944, it started the mass production of powdered metallurgy products. Additionally in 1945 it started production of special copper alloys. These aggressive business expansions became the foundation for the current Mitsubishi Materials.

Mitsubishi Mining Co., Ltd. Coal and Metal Divisions were separated in accordance with the Excessive Economic Power Deconcentration Act

Hashima Colliery became famous as Gunkanjima.

Mining Research Institute (Around 1920)/ Mass production of powdered metallurgy products started in 1944.

Naoshima Smelter & Refinery established as the central smelter and refinery of Mitsubishi.

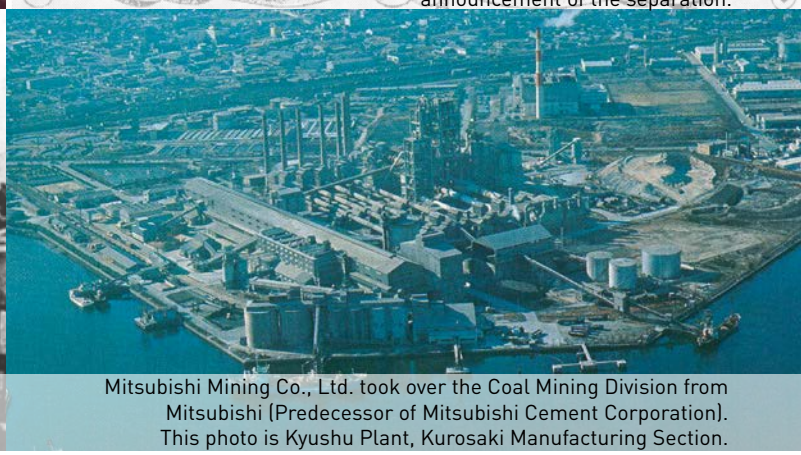
御挨拶

三菱鑛業株式會社

太平鑛業株式會社

In 1950, the Metal Division separated from Mitsubishi Mining Co., Ltd. to establish Taihei Mining Co., Ltd. This photo is the newspaper announcement of the separation.

Osaka Smelter in 1906.



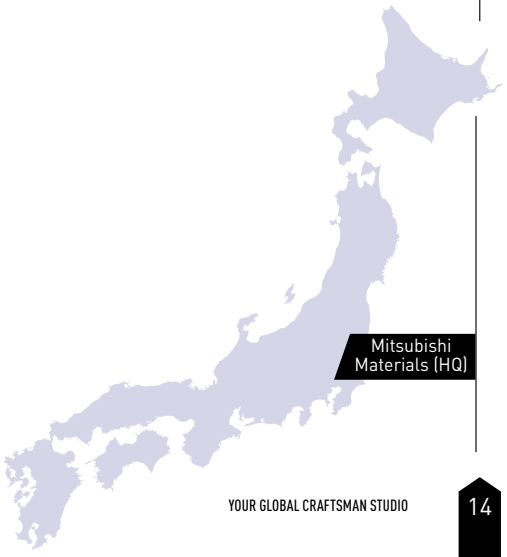
Mitsubishi Mining Co., Ltd. took over the Coal Mining Division from Mitsubishi (Predecessor of Mitsubishi Cement Corporation). This photo is Kyushu Plant, Kurosaki Manufacturing Section.

Mitsubishi Mining Co., Ltd. encountered hardship in 1947, two years after the end of the World War II. Under the influence of the American occupation policy, the Excessive Economic Power Deconcentration Act was established to dissolve large financial combines and Mitsubishi Mining became a target. Mitsubishi Mining at that time had capital funds of 407.4 million yen and annual sales of 4,400 million yen across 46 facilities, including 17 coal mines, 20 metal mines, and 9 other facilities such as smelters, and 69,672 employees.

On April 1, 1950, the Mitsubishi Mining Metal Division separated to establish Taihei Mining Co., Ltd. It was a painful division for the company; however, both Mitsubishi Mining and Taihei Mining continued growing under independent management. Mitsubishi Mining merged with Mitsubishi Cement Corporation and Hokoku Cement to establish Mitsubishi Mining & Cement Co., Ltd. in 1973. Taihei Mining's name was changed to Mitsubishi Metal Mining Co., Ltd. in 1952, and changed again to Mitsubishi Metal Corporation in 1973 to start the new phase of its business.

Establishment of Mitsubishi Materials Corporation

On December 1, 1990, Mitsubishi Metal and Mitsubishi Mining & Cement merged into Mitsubishi Materials Corporation. Forty years after Mitsubishi Mining's Coal and Metal Divisions were separated in 1950, the companies merged into one company. This merger resulted in the solid establishment of Mitsubishi Materials' position as a comprehensive material manufacturer holding technology and products in a wide range of fields, including smelting, cement, cutting tools, alloys, ceramics, chemicals, silicon, fuels, building materials and nuclear power.
Inheriting the assets, technology and spirit of mining, Mitsubishi's major business, Mitsubishi Materials has expanded its business aggressively. With its corporate philosophy "For People, Society and the Earth," Mitsubishi Materials continues to protect its assets and traditions, creating new materials for people, society and the Earth with its unique technology and aims to be a leader in the establishment of a sound material-cycle society.



Craftsman Story

Vol.7

Makoto Nishida:
Coating Technology Group, Material & Coating Development Centre, Research & Development Div.
(Joined the company in 2000)

Tetsuhiko Honma:
Designing & Manufacture Engineering Group, Insert Production Dept., Tsukuba Plant
(Joined the company in 1997)

Hisashi Hara:
Production Engineering Group, Production Engineering Dept., Tsukuba Plant
(Joined the company in 2002)

For Turning Processing: CVD Coating Material Super-Diamond Coating

UC51 Series

Commitment to high performance surpassed the conventional wisdom of the industry

Immediately after the UC51 series was introduced to the market in 2005, monthly sales topped 1 million. Dropping the function of identifying used corners, an innovative idea at the time, the staff sought to prioritize ultimate performance. The all-black body has achieved performance that silenced those who had insisted on using the identifying function. We took a look at the backstories of the all-black super-even coating development.

UC5105/5115

MC5005/5015

How much could we smoothen the surface?

– Would you please give us a little background on the development of the UC51 series?

Hara: The UC51 series was launched in 2005. Similar products by different manufacturers whose cutting surface was smoothened (in black) had a known market share. To exceed that share, we needed to offer performance that was significantly better. We considered smoothening the entire surface of the insert because it was obvious that focusing on the cutting face alone would not maximize performance.

Nishida: Our competitors also realized that at the time. However, improvements in the smoothening process would increase insert production efficiency and allow the identification of worn corners. Considering production costs and ease of use as well as performance, however, they may have hesitated to focus on the entire surface.

Honma: Significant extension of tool life can be achieved through the improvement of both wear and chipping resistance. The key to achieving both was the integration of surface and coating technologies. We examined a wide range of approaches for surface processing before deciding upon the wet-blasting method. We were lucky to have a wet-blasting device on hand. We could readily verify a wide range of factors and this helped us during the different phases, something that led to a significant breakthrough.

Hara: Removing the gold coating on the surface of the inserts completely to make them all black meant sacrificing the ability to identify worn corners. At the beginning of development, the majority of our sales staff was against the idea and this made it difficult to move forward with development.

Nishida: Indeed, identifying worn corners is very important. However, I believed that offering outstanding performance could help our customers more. When we realized that the establishment of new surface processing and coating technologies would enhance performance more than expected, the negative opinions about an all-black insert gradually subsided.

Honma: When we received feedback from pre-sales field testing, we felt that our decision had been justified. Our customers reported that it was a challenge to identify worn corners but as compensation, they were very satisfied with the cutting performance.

Hara: Domestic tests showed a three-fold improvement in performance over existing products. We sought and achieved the best performance in the industry, and this gave us confidence to initiate sales of the all-black super-even coating.

– What challenges did you encounter during development?

Honma: When we were discussing ideas at the beginning of development, my supervisor asked me to produce mellow, springy materials. I remember clearly wondering what he was talking about.

Hara: Yes, we all wondered what was up. We were discussing a cutting tool, but we were asked to think of the development in something of a mellow and springy way rather than a hard task.

Nishida: But, when we checked the quality and texture of the tool, it is indeed metaphorically mellow and springy in comparison with other grades, or, technically speaking it is durable and versatile.

Outstanding performance gained tremendous popularity

– Did you expect this grade to be such a big hit?

Hara: We were certainly confident about the quality, but we didn't expect that it would be so popular.

Nishida: Tool sales were supported by the rapidly growing Chinese cast iron machining market. Word-of-mouth is a major factor in the Chinese market; and once a customer takes to a product, its good reputation spreads quickly.

Honma: Since we only had one wet-blasting device, it was impossible to keep up with demand. Of course, we wanted to increase production to meet demand, but we were also quite pleased with what we had achieved.

Nishida: The key to success was having surface-processing technology based on the wet-blasting method, and having coating technology capable of enhancing that surface-processing technology to the maximum extent. It was a big surprise to see that the integration of two different technologies could bring such a significant achievement. That experience was extremely valuable for me.

– Following this, the MC50 series was launched as the replacement for the UC50 series.

Nishida: Of course our competitors' progress was a significant factor in the development of the MC50 series, but we also wanted to develop tools for ductile cast iron, which has higher hardness than standard cast iron, and we wanted to offer cemented carbide CVD coated inserts for customers that machine cast iron using ceramic inserts.

Honma: The performance of the MC50 series for machining FCD700 is exceptional.

Nishida: MC5015's middle-layer coating has been improved significantly to maintain performance during interrupted cutting and tool life is 2 to 3 times higher than the existing product. We also applied our patented TOUGH-Grip technology (toughening technology for coating) to the MC50 series for the first time.

– Do you have anything you'd like to say to our readers?

Hara: When I joined the UC51 series development team, it was only my second year at Mitsubishi Materials. While we had to work on a wide range of properties, we maintained our focus on performance. I would like to tell young developers not to give up. That's the ticket to success.

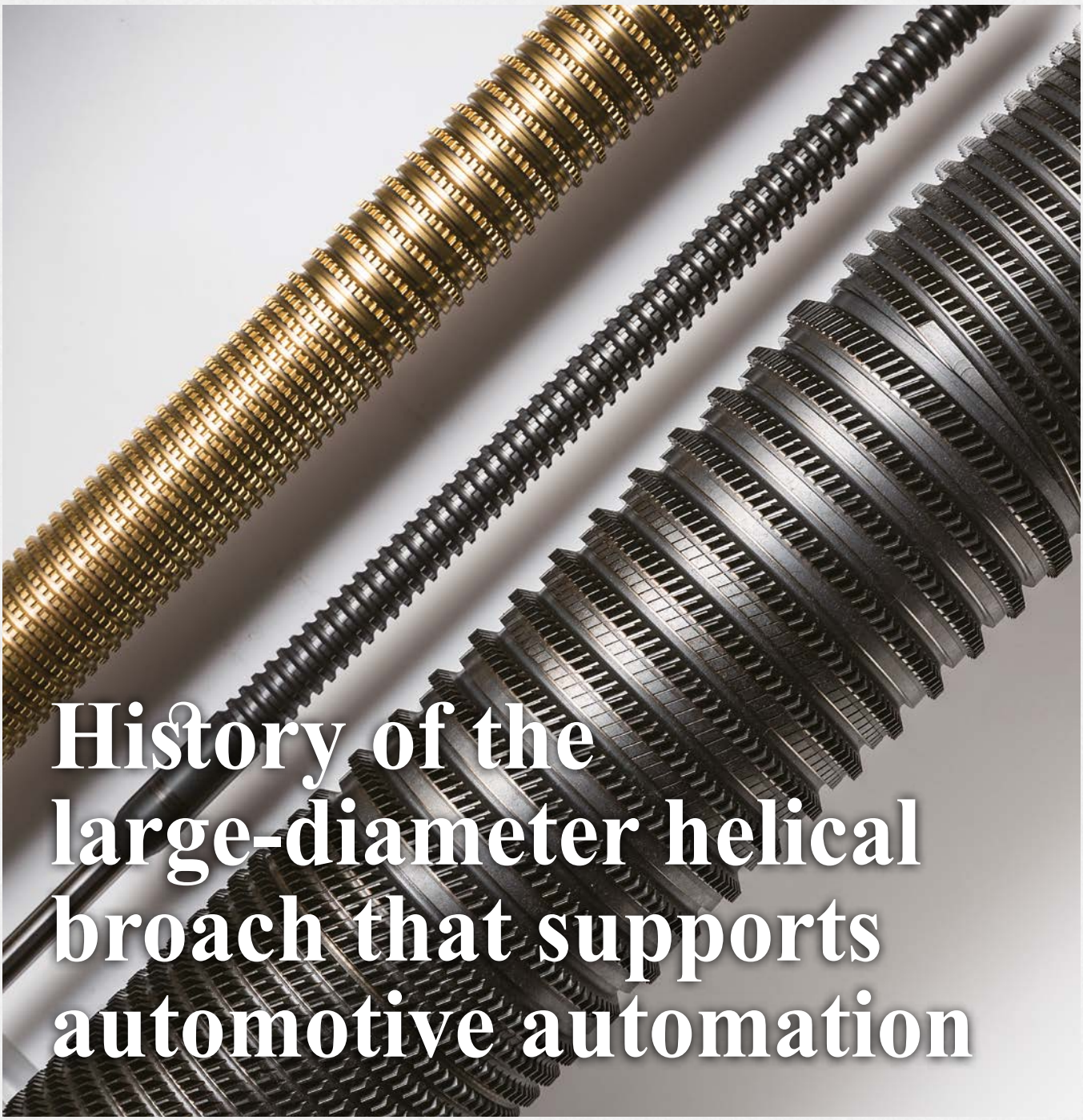
Nishida: As a developer, it is necessary to discover the rules and principles for each phenomenon. If we understand these, we can apply them to the development of subsequent products.

Hara: Analysis at that time was at the micron level while it's now on a Nano scale. Enthusiasm is important in the drive for top performance in the industry and a cool head is required for logical analysis.

Nishida: We developed this tool with a focus on cutting performance. From the viewpoint of ease of use, we considered the corner identification function as an important performance metric. From now, we will develop products not only with a focus on cutting performance, but also ease of use.

Honma: We would like to expand the surface processing technology we have accumulated through development of the UC51 series and apply it to applications over a wide range of products.

TECHNOLOGY ARCHIVE



History of the large-diameter helical broach that supports automotive automation

Large-scale tools that support the automotive industry

Planetary gears are a key component in automatic transmissions (AT). The shift from manual to automatic transmission required improvements in the production of these essential gears, and the large-diameter helical broach was developed to meet this need. The helical broach ensures the consistent machining required throughout the process, from roughing to finishing. We interviewed staff at the Gear Cutting Tools Manufacturing Department about the history of its broach development, including innovative products developed ahead of the global competition.

TECHNOLOGY ARCHIVE

CLOSE UP

What is broaching?

Broaching is a method of processing designed to enable the creation of special forms on the interior surface of the cylindrical bore, forms such as splines and key grooves. The edge of a broach is similar to the round-hole on the material. The teeth are gradually formed as it proceeds toward the centre. And finally formed into their completed geometry by the time the broach is pulled all the way through. Thus the entire gear forming process, from roughing to finishing, is performed in a single process.

Creating the best cutting conditions for the individual processes required to cut the high-precision gears used in automatic transmissions - the roughing, semi-finishing, and finishing - all three steps in one process, significantly increases productivity.

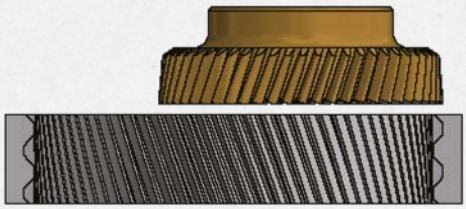
Characteristics of Broaching

Capable of forming precision interior gears on workpieces

Broaches with many teeth whose forms gradually change from roughing to finishing profiles have the following features:

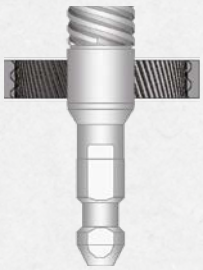
- Ease of the procedure to pull the broach through a workpiece on a broaching machine shortens the time required for processing.
- The sharpness of the broach and precision of the edge are directly reflected on the workpiece. The higher the broach performance is, the higher the quality of the surface and dimensional accuracy of the finished product becomes.
- It is possible to process complex axial gears such as those with helix angles.
- Since the amount of cut per edge and total amount of cutting can be set in advance when designing the broach, operators do not require special skills to pull the broach through a workpiece.
- Since the pressure created during cutting works towards clamping the workpiece, it is not necessary to have special jigs to clamp it.

Machining with a Gear Shaver



- Processing requires more time.
- Difficult to process bores with specific shapes

Broaching



- High-precision machining possible within an extremely short time
- Easy to process holes with complex shapes
- Easy operation that does not require technical skill
- Favorable surface and dimensional accuracy possible
- Processing time is short, which is advantageous for mass production

Part 1 1962 ~

Akashi Plant started its operation

After 1955, the rapid growth of the Japanese manufacturing industry spurred demand for cutting tools. To meet this demand, Mitsubishi Materials opened its Akashi Plant in 1962. The Akashi Plant had a wide range of leading-edge equipment for specific processes such as polishing, quenching. As well as the inspection facilities to aid manufacture of various cutting tools, including drills, end mills, reamers, and broaches. Broaches in particular were expected to offer significant merits for customers since gears could be processed with accuracy and efficiently with them. Therefore, Mitsubishi Materials started working on the development of broaches early on.

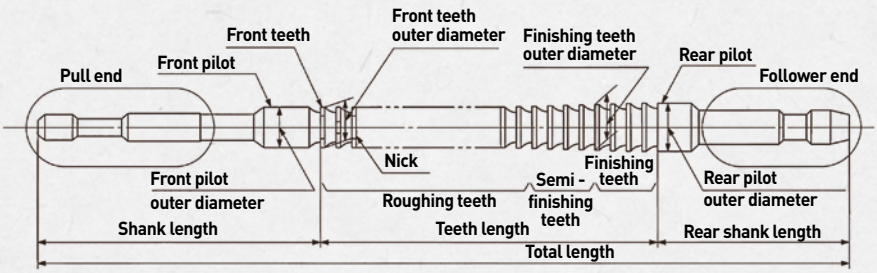


Fig. 1 Inner Surface Broaching Tool Part Names

TECHNOLOGY ARCHIVE

2 1990 ~ Rapid implementation of automatic transmissions increased the demand for broaching

As the implementation of automatic transmission accelerated in the 1990s, production efficiency of planetary gears that have relatively large diameters had to be improved. Before the development of broaches, gears were cut with gear cutters. Gear cutting required three processes, roughing, semi-finishing and finishing that required approximately 2 to 3 minutes per gear. Broaching required 30 seconds or less for each gear, which meant a 4- to 6-fold improvement in productivity. In addition, broaching achieves much better precision than gear cutting and it only requires the simple operation of the broach being pulled through a workpiece on the broaching machine.

To take full advantage of these benefits, Mitsubishi Materials started development of a large-diameter helical broach, an advanced model of the existing spline broach. The first prototype was an assembly of the roughing gear (main body) comprising a cutting blade for the outer periphery and a finishing gear (shell), which was a cutting blade with thick teeth. Due to the large size, a big enough precision measurement device at that time was unavailable, meaning it was necessary to separate the prototype into the main body and the shell. The form of the broach end is directly transferred to the workpiece. It was difficult to achieve the required precision with the assembly-type broach. Several prototypes were provided to automatic transmission manufacturers; however, most of them were returned due to their poor precision. For the assembly type, the performance of the blade in the shell part affects the precision of the gear teeth. This required making micron-level adjustments to the form of the blade in the shell. Mitsubishi engaged in a process of trial and error to improve the blade until a stable level of precision was achieved in 1995.

3 2000 ~ Development of an innovative measurement device contributed to the world's first one-piece broach

Mitsubishi Materials started mass production of assembly type broaches in the 1990s and also began development of a new type of broach. The work started on the development of an one-piece broach that combined the main body and the shell part. Due to not having a device to measure the precision of the teeth on an one-piece broach, it was impossible to grind the teeth with high precision. The large-diameter helical broach used to manufacture planetary gears for automatic transmissions would have an outer diameter of ø100 – 180 and a total length of 1,500 – 2,000 mm. This necessitated the adoption of an assembled type of broach that separated the shell part, whose teeth had to be very precise, but due to the smaller, size precise measurement was possible with a gear measurement device. However, precise measurement of a large one-piece broach demanded development of a new measurement device. A Mitsubishi Materials engineer succeeded in creating an innovative on-board measurement device for the tooth form. This was the first attempt in the world, and Mitsubishi Materials' achievement was recognized with the Japan Society of Mechanical Engineer Encouragement Prize. The engineer received his doctorate in engineering at Osaka University Graduate School of Engineering. A summary of his study was as follows: "Precise grinding of the form of the teeth used for spur and helical gears requires measurement of grinding errors caused by grindstone and tooth formation, analysis of the data, creation of an automatic error correction program, and immediate feedback to the grinding machine. Combining these systems together can secure the required precision in gear grinding."

The use of this new on-board measurement device for tooth form on the CNC grinding machine, made it possible for the one-piece broach to have the tooth form to be ground with high precision. This led to the successful development of the world's first large-diameter helical broach. The one-piece helical broach can significantly reduce manufacturing costs through one step manufacturing of both body and shell and realize high-precision gear machining. In addition, the cutting load on each blade can be optimized, which reduces abrasion on the entire broach and increases the tool life thereby extending the time before regrinding is required. Furthermore, the disassembly, reassembly and phase adjustment of the shell required for regrinding on the assembly-type broach are unnecessary with a one-piece broach, which also reduces costs. These merits pleased our customers and the reduction of work for regrinding in particular is highly regarded by overseas automatic transmission manufacturers.

4 2010 ~

Setting further goals

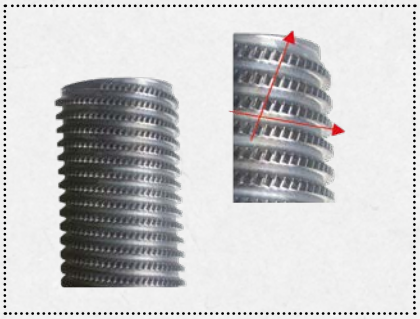
While promoting the development of the one-piece broach, Mitsubishi Materials has also worked to improve the assembly-type broach. Groove types include a ring groove (right angle to the axis) and a helix type (off-normal). The ring groove type causes a significant change in cutting load compared with the helix type, causing shorter tool life. The helix type causes less change in cutting load, which improves both the precision of the tooth form and increases tool life; however, it requires special equipment for regrinding.

There are three assembly-type broaches. One is a combination of both main body and shell at a right angle to the axis. The second is a combination of the main body at a right angle to the axis while the shell is an off-normal type. The third is a combination of both main body and shell that are off-normal types. The number of grooves also varies. For example, the teeth on the main body are reduced to from 4 to 6 while those on the shell are increased to from 8 to 10, which improves sharpness.

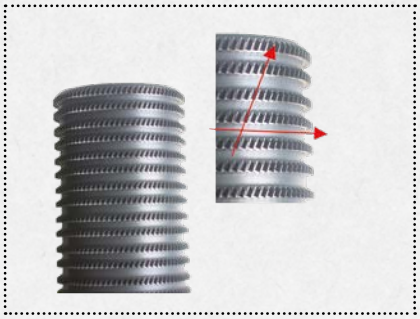
The one-piece broach also has the same three types of teeth, and a one-piece broach whose teeth are changed on the main body and shell has been under development.

The manufacture of high-precision broaches requires the strict control of temperature during grinding. Since the grinding requires a significant amount of time, the temperature needs to be maintained within a narrow range to prevent the grinding machine from expanding and contracting that could cause variations which would influence pitch accuracy in the final product. Mitsubishi Materials continues its search for ways to manufacture even higher quality and higher precision broaches while reducing even slight changes in temperature.

Twisted Groove Type (Off-normal)



Ring Groove Type (Right angle against the axis)



Looking back on the history of helical broaches

Nishikawa: The Gear Cutting Tools Manufacturing Department, which manufactures broaches is in close contact with our customers. Since the cutting tools are made to be used by our customers, their feedback after use and problems they have are very important to us. Sometimes they have complaints, which we take very seriously; but in addition to addressing any issues they may have, it is important to develop tools that are even more useful for them. The repetition of this cycle has provided the foundation for our growth.

Kohno: Precision tool manufacturing does not always follow theoretical expectations. This is perhaps the most enjoyable part of manufacturing broaches. We have developed large-diameter helical broaches, and some of these exceed 2 meters in length. Only a small difference in the blades of a broach has a big influence on tooth precision in the final product. For example, the very slight honing of the cutting edges by hand, sometimes improves precision. This cannot be explained by theory, and cannot be done by just anyone. This is why it is important, that such precision tools can be adjusted in such an analogue way.

(Left) **Mitsuo Nishikawa**, General Manager, Gear Cutting Tools Manufacturing Department

(Right) **Kensuke Kohno**, Manager, Gear Cutting Tools Manufacturing Department, Development & Design Section

A logistics network that supports manufacturing sites throughout the world

ABOUT US

Logistics Division

Ask the Manager!

Eiji Koga
General Manager, Logistics Division

We are now setting the goal of delivering products to all customers around the world within 24 hours

Mitsubishi Materials promptly and efficiently delivers more than 40,000 products to customers all around the world from five global logistics centres.

Unification of inventory management through a global network

Mitsubishi Materials sells products around the world, which makes it important for us to have logistic strategies that allow prompt delivery of our products at the lowest possible cost.

The work of the Logistics Division is classified into two major roles. One is "Design and Management," which involves creating and executing customer-oriented strategies. The other is "System Development," which is supporting the execution of these strategies.

In regard to design and management, we have established logistics centres at five locations around the world to realize an ideal product supply system. Specifically, in addition to the Global Distribution Centre (Narita, Japan), we have established the European Distribution Centre (The Netherlands), the North American Distribution Centre (Los Angeles, U.S.A.), the Asian Distribution Centre (Singapore) and the China Distribution Centre (Shanghai, China). In regard to system development, we implemented our Zero Stockout Project in 2000, and have initiated a unique inventory system. The Logistics Division currently provides unified inventory management for individual logistics centres around the world to maintain the optimal balance of supply and demand.

We continue enhancing such approaches to seek an ever more efficient logistics system to satisfy our customers with prompt delivery. We also continue to optimize customer services through the use of different packaging for different regions, labeling and special product marking according to the needs of individual customers.

Building a supply chain that satisfies customer expectations

We are currently working on improving the efficiency and lowering the cost of the current logistics system, and developing our ability to predict changes in the environment regarding logistics services through oversight of the entire supply chain. We share, for example, real-time data among our five logistic centres to ensure the smoothest transfer of products and prevent long-



term storage. In addition, we also strive to realize the most strategic supply chain possible through the efficient application of the Free Trade Agreement (FTA). It is important for us to not only manage the logistics of products manufactured and sold in individual regions, but also to respond effectively to the FTA, Trans-Pacific Strategic Economic Partnership Agreement (TPP), and Regional Comprehensive Economic Partnership (RCEP) to ensure the efficient transfer of inventories between neighboring countries. Furthermore, meeting customer needs requires that we effectively handle the number and management of customer lots as we reduce the time required for distribution. We need, therefore, to fully utilize cutting-edge IT. A great deal of information on orders, deliveries, and logistics, results in digitalized and accumulated data; however, the system is not yet perfect. We continue to work on establishing the ultimate supply chain system, a system that enables us to respond to the full range of changes through the visualization of necessary information in real-time.

Striving for customer-oriented logistics

While we prioritize quick delivery, we also focus on improving the entire supply chain through the implementation of the most advanced IT based on our desire to achieve the highest degree of customer satisfaction. Our goal is to realize an environment that enables the delivery of products to customers anytime, anywhere. Delivering better services to our customers requires that we gather information on a continuing basis. The key to the improvement of our services is sometimes hidden in our daily lives outside the industry. We look for hints, implement them without hesitation, and strive to accumulate experience that ensures future improvement make the system even more efficient.

We work in a great environment that allows us to use highly-advanced internet resources. Taking advantage of this, we focus on identifying information with the potential to drive service improvement, and establishing an optimal global network capable of delivering products to customers within 24 hours. This will make DIAEDGE the tool-of-choice for our customers.

Global Network

Netherlands
(European Distribution Centre: EDC)

Narita
(Global Distribution Centre: GDC)

Singapore
(Asian Distribution Centre: ADC)

Shanghai
(China Distribution Centre: CDC)

Los Angeles (North American Distribution Centre: NADC)

CUTTING EDGE Vol. 6

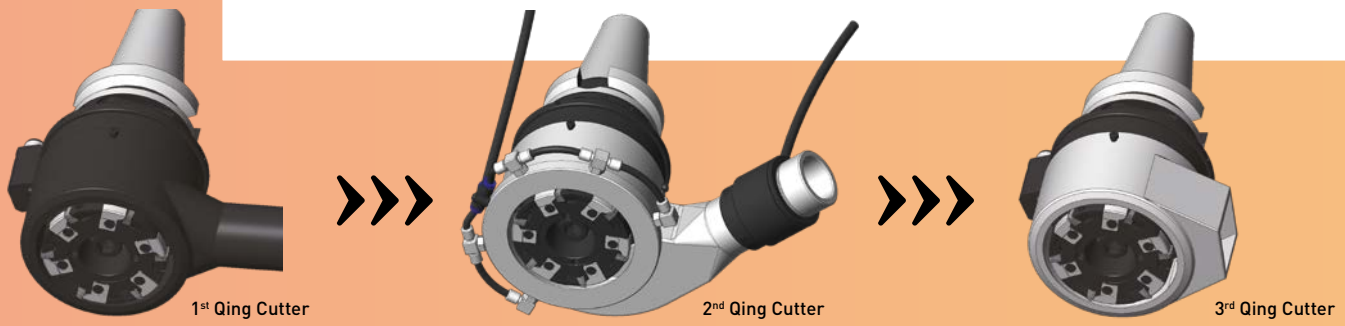
Tools that collect chips Qing NEO

Chip collection tools were introduced 30 years ago

Chip collection is an eternal theme in metal cutting. The improper handling of chips can lead to a wide range of problems, including compromised quality of the machined surface and damage to the cutting edge. Generally speaking, the focus of improvement has traditionally been on chip breakers and coolants. However, around 30 years ago Mitsubishi Materials approached this problem from a completely different perspective. Suction, like using a vacuum cleaner during cutting, was applied. In 1986, this idea was incorporated into Qing cutters. This special tool was designed to improve chip collection during face milling for automotive engine cylinder blocks. Not only do chips have the potential to damage the interior surface of the cylinder block, they also need to be removed, which significantly affects both the quality and efficiency of processing. In order to address these issues, it was proposed to collect the chips during cutting. This is the history of Mitsubishi's chip-collection tools.

Evolving Qing cutters

The first Qing cutter (QSV type) was introduced in 1986. It adopted a dust-collector system which lifts chips with a guide plate and then vacuums them through a casing with a collector. While the chip collection capability is highly stable, it requires hoses and a collector that are relatively expensive. To improve convenience, a second Qing cutter was developed (QWA type) at the beginning of the 1990s that applied a double-air system. It works by pumping air into the case to create a cyclone to blow the chips, and then collects them with an air-amplifier. This was very effective in processing cast iron and aluminium and was adopted by many customers. The third type of Qing cutter was developed in the late 1990s. Returning to the basic concept of chips not being collected, but instead being discharged away from the workpiece. This was achieved using by centrifugal force to automatically direct the chips toward a conveyor and thereby alleviate the need for both the dust collector and air. In addition, it allows a design with a very simple structure, which helps to keep the price of the tool relatively low and enables the use of automatic tool changers on machining centres. Following the introduction of these innovative developments, a wide range of chip collection tools were developed and sold by many other manufacturers. However, the support and maintenance for these are costly. In addition, cellular manufacturing has advanced as a part of chip prevention and this has caused a gradual decline in the demand for chip collecting tools. This prompted many tool manufacturers to withdraw from the manufacture of them; however, Mitsubishi Materials has continued manufacture to meet the existing demand.



1st Qing Cutter

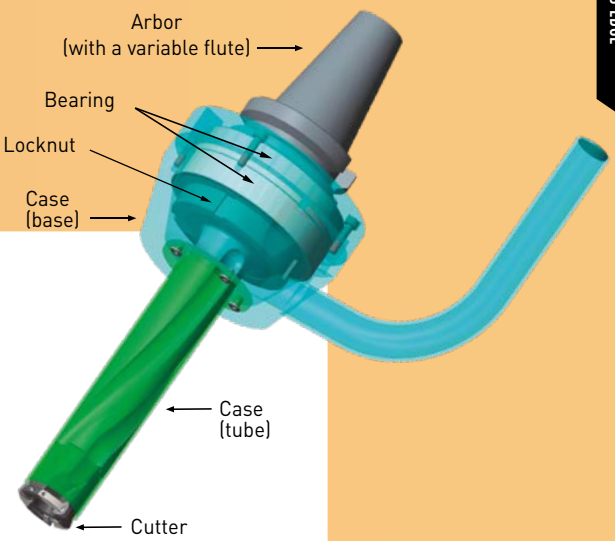
2nd Qing Cutter

3rd Qing Cutter

The establishment of the most advanced Qing NEO

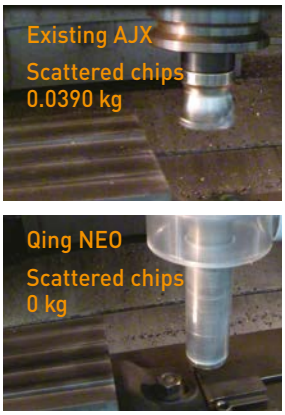
In 2015, Mitsubishi Materials started on the development of the 4th Qing cutter, the Qing NEO, upon request from Toyota Auto Body Co., Ltd. Qing NEO comprises an arbor, a bearing, a locknut and a case that covers the cutter. This collects chips generated around the edge of the tool and discharges them from the base of the arbor to an external collector, it is an effective design that exerts a high chip-collection rate. While only face milling cutters were mounted on the 1st to 3rd Qing cutters; which limited the variations, Qing NEO is capable of using a wide range of tools, including face milling, profile milling and deep hole cutters. The airflow speed around the edge of the tool blade is 10,000 – 40,000 mm/s, which sufficient to collect chips and they are forced into the channel installed in the arbor, and then into the case via centrifugal force generated by the airflow and the tool rotation. Currently, advancement of the development of Qing NEO is underway for an automatic tool change type and also under consideration is the application of Qing NEO to turning tools.

Body structure



Chip collection effect

vc=130m/min, fz=1,3mm/tooth ap=1mm, ae=35mm, L200m
Machining the L200m block (1pass)



Cutter structure

Looking back on development

Horiike: I was involved in the development of the 2nd and 3rd Qing cutters. Although customers had already asked us to develop a Qing cutter to machine metal moulds, we did not have three-dimensional CAD or the technology required to analyze fluid phenomena such as sucking chips and our manufacturing technology was not sufficiently advanced for the development of such a product. However, recent progress in a wide variety of technologies has allowed us to design mechanisms that could not have been thought of in the past. We hope this new Qing cutter will be as popular with customers as the previous versions have been.

Sato: Qing NEO was successfully manufactured because we could imagine the final output at the initial stage of design. I gained knowledge about chip collection tools and related technology, including chip collectors, hoses and bearings, that are not related to the usual tool development and this broadened my horizons as an engineer. I would like to focus on the reduction of costs to increase customer satisfaction and expand the lineup of the cutters to broaden the range of use.

(Left) **Nobukazu Horiike** Industrial Tools Group, Indexable Tools Development Centre, R & D Division (Joined the company in 1988)
(Right) **Takahiro Sato** Advance & Creation Tools Group, Machining Technology Centre, R & D Division (Joined the company in 1987)

CUTTING EDGE

Special Talk: Toyota Auto Body Co., Ltd.

Ideal teamwork could develop Qing NEO

Toyota Auto Body Co., Ltd., with which we jointly developed Qing NEO, was established in 1945 as a truck body manufacturer in Toyota Group. It has expanded business to include commercial vehicles, mini-vans and SUVs. Through a consistent domestic development and production system, its products have effectively responded to market needs. Furthermore, the company has also engaged in the design and development of a wider range of products. These include welfare vehicles and devices that support elderly and disabled transport, as well as micro-electric vehicles that are slated to become the next generation in personal mobility. In this feature, we ask Mitsumasa Okuda, Akihiro Idota, and Satonori Matsumoto of Toyota Auto Body to give us the backstory of the development of Qing NEO with Mitsubishi Materials.

Automation of metal mold processing

– How did the joint development of Qing NEO come about?

Okuda: The Metal Mould Section manufactures press molds for body panels and because the press moulds for commercial vehicles, mini-vans and SUVs are large, means they generate a large amount of chips during machining. Currently, dealing with the chips requires that machining be brought to a halt, taking valuable time away from production. Since the automation of processing is essential for reducing costs and increasing productivity, chip removal is an important issue. We knew that there was a tool designed for chip collection during machining and we thought that using this might be the right approach to realizing more effective automation.

– When did you start working on the automation of press mould manufacturing?

Okuda: We decided to change the fundamental method of metal mould manufacturing in 2012. As an important part of this we discussed the reduction of waste during individual manufacturing processes. It was at that point that we considered the benefit of developing a dedicated tool for chip collection.

Sato: Our first meeting was in June 2015.

Idota: We first drew rough pictures to illustrate our concept and paid a visit to the Mitsubishi Materials Tsukuba Plant. At first we weren't sure if Mitsubishi Materials would accept such a complicated request, however, the staff there were eager to become involved.

Okuda: Although Mitsubishi Materials had manufactured the Qing cutter, we wanted a cutter designed specifically for mould machining, which meant Mitsubishi Materials would have to start from scratch. However, their enthusiasm to work with us on this was clear from the start, which pleased us greatly.

Sato: Thank you so much for your kind words. When I heard their request for the first time, I was a little worried about whether or not we could meet their needs. What they needed would require us to defy gravity to collect the chips and we had to give it a great deal of thought. My experience in developing drills helped me to conceptualize a new shape and when this concept began to evolve in my mind I felt we would probably be able to succeed.

Matsumoto: Although we had difficult requests every time we talked, they quickly found solutions that met our needs. Prototype improvement after each inspection was also very quick, which made me feel very confident about their work.

Idota: We presented our request in June and by the mid-September, Mitsubishi Materials had completed a prototype; including the main body and the case, and not just a design model.

Sato: When we carried out the in-house inspection in September, we confirmed that there was no abnormality in machining; including chatter marks, and the chip collection rate exceeded 90%,

(From left) **Takahiro Sato** (Mitsubishi Materials), **Akihiro Idota** and **Satonori Matsumoto** (Toyota Auto Body), **Yoshiyuki Sugiura** (Mikawa Office, Sales Division, Mitsubishi Materials), **Mitusmasa Okuda** (Toyota Auto Body)

Mitsumasa Okuda: General Manager, Machinery Engineering Division, Machinery and Tool Dept.

Akihiro Idota: Project Manager, Machinery Engineering Division, Machinery and Tool Dept.

Satonori Matsumoto: Metal Mold Group, Machinery Engineering Div., Machinery and Tool Dept.

which met our target. We felt that we had succeeded.

Partnership seeks magical machining

Okuda: When I saw the machining test, I was amazed. Since having chips during machining was natural for me, it was incredible to see that they were automatically disposed of.

Sato: We were very happy that everyone was amazed to see no chips during machining. That motivated us to strive for even greater customer satisfaction. It was exhilarating to impress customers by delivering performance that surpassed their expectations.

Idota: Mr. Sato was very helpful and responded quickly to meet our expectations. He always found solutions to issues we brought up at meetings and included them in the next prototype.

Sato: Everyone was very happy to be able to solve the problems we encountered. It was my first experience discussing problems and solutions with customers in joint development, and we took our time and discussed all issues until we were satisfied that we had come up with the best solution. I enjoyed working with Toyota Auto Body staff.

Idota: In November of each year, we present technical improvements that we have been working on. One presentation I gave was on Qing NEO using a prototype that I had asked Mitsubishi Materials to have ready for me on a short deadline. I showed the chip removal operation and everyone in attendance was impressed with its effectiveness.

– Did the development go smoothly?

Idota: The shape of the workpiece and style of machining sometimes created problems such as interference between the case and arbor or a reduced chip collection rate. However, we worked diligently to identify the cause and create a solution for each problem that we encountered.

Sato: During machining on a 75-degree angle, we still have a lot of uncollected chips. This is an issue we need to focus on from now.

Okuda: When we changed the entire design to eliminate the interference between the case and arbor, the chip collection rate was already at about 96% to 97%, and more than 90% on slopes. We were satisfied with the results, but Mr. Sato worked to make those results even better. A major goal, using Qing NEO with an ATC, should be attainable and we are still looking to identify ways to reduce manufacturing costs.

Idota: The relationship we developed during this joint development allowed us to feel comfortable about exchanging opinions freely and honestly; and this led to success. We continue working together with the hope of bringing manufacturers of peripheral equipment and processors into future projects.

– Before we finish, I would like to ask you what it is about metal cutting work that interests you.

Sato: At first glance, metal cutting looks very simple; but in fact, it is very complicated. Each customer has unique goals, such as chip removal, the elongation of tool life and achieving a good finished surface, and there are many different ways to approach these. As we achieve each goal, I feel the satisfaction of seeing that we are moving closer to the ideal.

Matsumoto: For me, it is that the value of what we have planned and carried out can be quantified. For example, chip cleanup has been reduced from one hour to just a few minutes, meaning overall machining time has been halved. Our achievements are clearly visible and it brings me great satisfaction when everyone else involved is satisfied.

Okuda: While value has been shifting from products to services, the desire to create equipment capable of increasing quality and reducing costs will continue. I am proud that the machining of metal moulds are a part of what creates value in products.

Idota: There are still many undeveloped fields, and Qing NEO was one of these. Additionally, materials that are hard to cut with existing technology are constantly being developed, meaning there is always a great potential for the creation of innovative metal cutting technologies.

Okuda: Toyota Auto Body has often customized existing tools; however, we rarely develop tools from scratch jointly like this with another company. I would like to find more business partners that are willing and able to work like this with end users. I am confident that despite the challenge it presents, halving the current machining time will be possible. I would like to realize the ideal machining method for press moulds.

Mitsubishi Materials is not just a tool manufacturer

We are committed to responding promptly to customers' challenges and to actively contribute to their success with the dedication of a professional craftsman.

We will strive to become the only tool manufacturer globally offering "your personal craftsman studio", a unique service for our customers.

It is the place where you can:
Find state-of-the-art technologies and products.
Find solutions, anytime, from anywhere in the world.
Share our excitement about the latest technology trends and product innovation.

It is the studio where we think, share, create and develop together with our customers, exciting solutions to meet their specific needs.

YOUR GLOBAL CRAFTSMAN STUDIO
MITSUBISHI MATERIALS

YOUR GLOBAL CRAFTSMAN STUDIO

The meaning of our logo
Our logo shows people, standing on a circle, holding hands. The circle represents the earth. Holding hands reflect our commitment to grow and succeed "hand in hand" with our customers and closely work with them to improve performance across the globe. The shape of the logo embodies a variety of ideas. It captures the image of "cutting tools" combined with the dominant letter "M" of the Mitsubishi Materials brand name. It also depicts a flame that symbolises our passion for craftsmanship.

MITSUBISHI MATERIALS CORPORATION

Editorial Note

The publication of the MMC Magazine Vol. 6 was made possible through the cooperation of many talented and dedicated people, and I would like to express my deep appreciation to those who accepted our requests for cooperation.
This issue focuses on the automobile industry as a continuation of Vol. 2. We featured the future trend of next-generation automobiles. Market trend predictions can change significantly within a period of just a few months, and this means that even the most experienced minds in the industry can have wildly differing opinions.
It is not too much to say that the history of automobiles is also closely linked with the history of cutting tools. Tool manufacturers tend to perceive the shift to next-generation automobiles pessimistically. In fact, the need for machining has decreased in absolute terms and competition in the industry will become increasingly fierce. However, the reduction in demand does not signal the end of the industry. It is the birth of a new business opportunity.
I hope the cutting tool industry continues to serve as a valuable partner for the automobile industry, an industry that students in science and engineering are looking to as a future career.

Yutaka Nada
Chief Editor

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