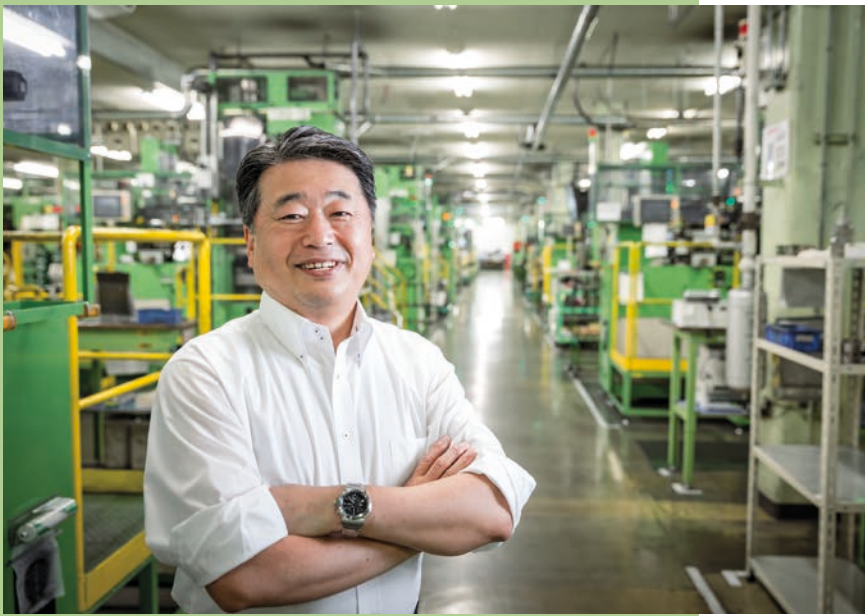
Mitsubishi Materials Craftsmanship Magazine

BM002E

YOUR GLOBAL CRAFTSMAN STUDIO

Road to Evolution

Generations of Technology



Listening to the voice of the customer

We are pleased to publish the second issue of our Craftsman Magazine that was first launched in April 2015.

As we and everything else around us is moving forward, we strive to continuously develop our technologies and evolve our company so that we contribute to the success of our customers' business activities. Our primary target is to be the reliable partner to whom customers can turn to for advice and whom they can trust for advanced solutions that go hand in hand with profitability and the highest quality.

This evolution naturally applies to tools and other technological advancements, but also to such aspects as the content and quality of services. Each and every employee must keep in mind that customers do not just benefit from a good product; they benefit from the right solution at the right time. To this end, it is vital to listen attentively to the customers' needs and respond with new initiatives and innovations.

Our will to "fulfill all customer needs" and "respond to every demand" forms our core identity as a Craftsman Studio that caters for each individual customer. Our customers' satisfaction and their positive feedback about Mitsubishi Materials' consultancy and technologies fuels our will.

Nothing would give us more pleasure than receiving a customer reaction that goes beyond simple satisfaction about a product or a solution. Such a reaction is seen when customers encounter something that surpasses what they originally envisaged. We will thus continue to respond by exceeding their expectations through harnessing all our strengths with a feeling of excitement when realising their goal, and when witnessing performance and quality that goes beyond their imagination. We invite you to look forward to the evolution of our studio as we aim to become an ever more professional tool manufacturer, capable of delivering results never before envisioned.

Dairiku Matsumo
Vice President / General Manager of Production Div.
Advanced Materials & Tools Company
Mitsubishi Materials Corporation

YOUR GLOBAL CRAFTSMAN STUDIO

Vol. 2 Stories

Photo: Mitsubishi Motors Corporation

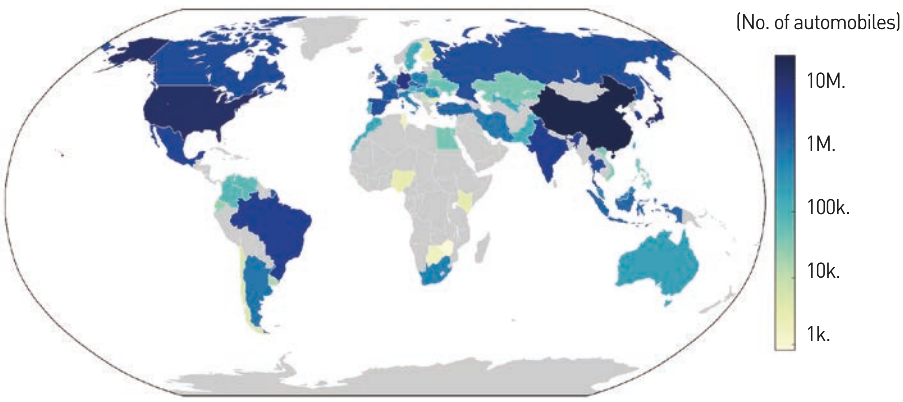
EYE on the MARKET AUTOMOTIVE INDUSTRY

Evolution of Fuel Efficiency and Machining Technologies

An era where almost one in every six people in the world owns a car

Automobiles fitted with a gasoline engine first appeared in Germany roughly 150 years ago. In 2013, the number of automobiles owned throughout the world surpassed 1.1 billion, which means that one in every 6.2 people in the world's total population of about 7.2 billion owns a car. In fiscal 2014, 89.75 million automobiles were manufactured globally and the numbers continue to grow in the huge Chinese and U.S. markets.

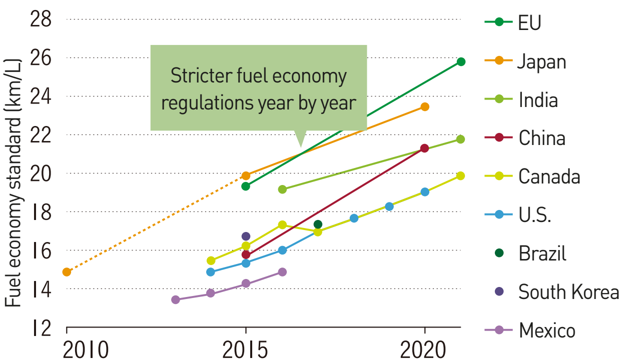
Automobile production by country



Motor vehicle produced by country in 2013
Source: Khassen Y., Wikipedia. Organisation Internationale des Constructeurs d'Automobiles (OICA). Material from the Japan Automobile Manufacturers Association, Inc.

Environmental issues caused by the explosive demand

Fuel economy standard in each country



The global spread of automobiles has totally surpassed the imagination of the early days and has given rise to new issues in the form of environmental concerns. In the 1960s, exhaust gas regulations were first established in California and Japan, and from this emerged the development of various environmental technologies by automobile manufacturers striving to satisfy these regulations. Today, automobile manufacturers are expected not only to make continuous efforts to eliminate harmful substances from exhaust gas in order to prevent air pollution, but to also minimize the emission of carbon dioxide, which is a principal greenhouse effect gas. These modern countermeasures have also had the effect of reducing fuel consumption and generating advantages for the consumer.

Source: The graph represents a simple conversion of the fuel standard in each country from the International Council on Clean Transportation. When a correction is applied by a simple calculation to account for a fuel consumption measurement mode, taking into account deregulation measures and differences in vehicle types, the fuel standard for the EU becomes 21.1 km/L (2021 reference value is calculated by METI), and for the U.S. it becomes 16.5 km/L (2020 reference value calculated by METI). The 2010-2015 values for Japan have been added by METI (they are reference values, as the measurement mode differs from 2015).

Photo provided by: Mitsubishi Motors Corporation

EYE on the MARKET AUTOMOTIVE INDUSTRY

Evolving fuel efficiency technologies

Some of today's representative fuel efficiency technologies for gasoline and diesel vehicles include the incorporation of a direct-fuel injection and a turbo charger to a downsized engine that discharges less exhaust gas than previous engines. Naturally aspirated gasoline engines with a compression ratio maximized to the utmost limit and hybrid systems that utilize both engine and electric motors are other examples. Low prices and running costs have also been strongly demanded by consumers of Japan's category of small vehicles called "kei cars". For this reason, all the latest available technologies have been applied to the development of fuel efficiency enhancement, with the result that kei cars now deliver greater fuel saving performance than regular passenger cars. In fact, models have emerged that deliver fuel efficiency that far exceeds 30 km/L*.

The emergence of electric vehicles

Electric vehicles, which do not consume gasoline have also begun to penetrate the market. These include electric vehicles that require charging, those that are equipped with fuel cells that generate electricity within the car (use hydrogen and oxygen to generate electricity and discharge water as a result), and those that are equipped with an engine that acts as a generator in addition to fuel cells. Engines for electricity generation are also called range extenders. Various types of range extenders, such as reciprocating engines, rotary engines and turbines are already commercially available or have been proposed. They are one of the most practical systems for the diffusion of electric vehicles as they utilize existing fuel infrastructures even though they are specifically designed to generate electricity. Some vehicles equipped with a range extender even deliver a fuel efficiency of more than 60 km/L*.

Various types of electric vehicles are emerging (the photo shows Mitsubishi Motors i-MiEV)

Diverse technologies that continue to evolve for environmental conservation

Energy diversification (independence from oil, resource conservation)

- Recycling technologies
- CNG technologies
- Utilization of bio-fuels (ethanol ratio)
- FCV
- HEV

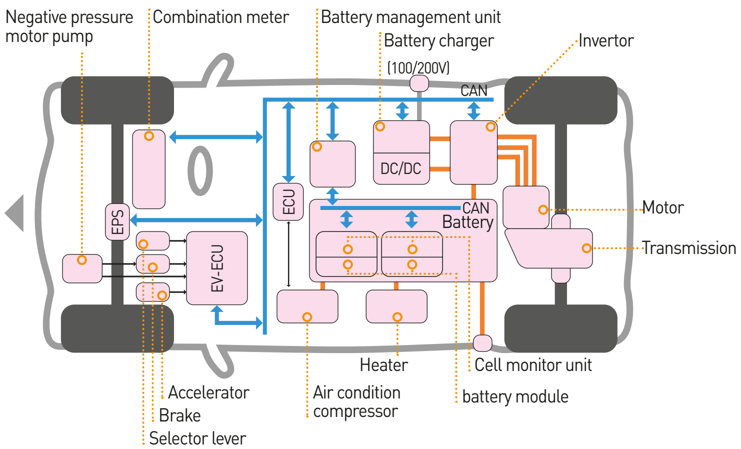
Prevention of global warming

- Variable displacement engines
- Clean diesel engines
- High-efficiency transmissions
- Variable valve system engines

Elimination of the use of organic substances (in advance of regulations and voluntary targets)

- Catalyst technologies
- Greater dissemination of low-emission vehicles
- Elimination of the use of organic substances (in advance of regulations and voluntary targets)

Key components of the i-MiEV (system configuration diagram)



- **The drive battery and other key components for electrification are installed under the floor.**
  - Offers the same in-car space and luggage space as the base car.
  - The passenger space is separated from high-voltage wires to ensure safety.
  - The lower gravity centre of the body contributes to excellent handling.
- **A compact, high-efficiency motor is adopted and installed in the rear (same rear-wheel drive as the base car).**
- **A large-volume drive battery is installed to realize sufficient cruising distance for the daily use for a kei car.**

* Measurement based on the JC08 mode fuel economy test cycle

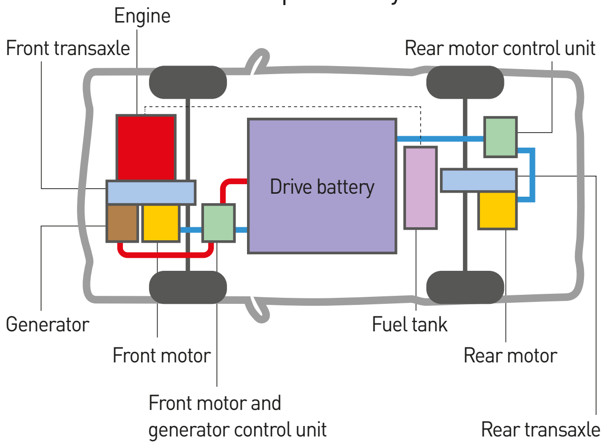
COLUMN PHEV Technology

Mechanism of the plug-in Hybrid EV System

Self-generating electric vehicles that maintain optimal driving mode in various driving situations

The Plug-in Hybrid EV System (PHEV) was developed independently by Mitsubishi Motors as a new derivative electric vehicle. When driving at low to medium speeds through residential areas, PHEV switches to EV Driving Mode that mainly uses electricity from the drive battery. When the drive battery runs low or powerful acceleration is needed, it switches to Series Driving Mode so that the engine automatically begins to generate electricity and supplies power to the motors and battery. When driving at higher speeds it switches to Parallel Driving Mode to convey the high-rpm, high-efficiency driving power of the engine directly to the transmission and to also assist the motors. Furthermore, when decelerating the motors act as a generator to regenerate the deceleration energy and recharge the drive batteries.

Component layout



Outlander PHEV (Mitsubishi Motors)

EV-based plug-in hybrid EV system

- A large-volume battery is installed under the floor in the centre to ensure a sufficient cruising distance.
- Twin motor 4WD is adopted with a drive motor in both the rear and front.
- An engine for power generation and drive is installed in the front.
- The driving force of the motor and engine can be switched using the front transaxle.

Drive system	Twin motor 4WD	
Motor (front/rear)	Type	Permanent magnet synchronous motors
	Max. output	60 kW
Drive battery	Lithium ion battery	
Engine	2.0l four-cylinder MIVEC	

Fuel efficiency and machining technologies

FMAX face milling cutter for high-efficiency finish machining

The advancement of production technologies is essential to the realization of fuel efficiency. This is also true in the metal cutting industry. The turbo charger is not new technology, but the production of efficient turbos was made possible by the advancement of cutting tools capable of high-efficiency, prolonged machining of materials that can withstand high-temperature exhaust gases, the source of power for turbines. Additionally, lower production costs have become possible, for example by the high efficiency machining of cylinder blocks and heads previously made of cast iron but that are now made mainly from aluminium. Mitsubishi Materials' cutting tool business has worked closely with automobile manufacturers both in Japan and overseas and has engaged in the advancement of machining technologies throughout its 80-year history.

Thus far technologies that support improved fuel efficiency of automobiles, with the main focus on the motor have been introduced. However, in reality the foundation of such technologies is extremely wide and includes transmissions that are used in combination with the motor, drive systems and lightweight bodies and even extends to motor oil, low-resistance tyres and improvement of the fuel itself. Nevertheless, motors, transmissions, drive systems and bodies to which these components are assembled and mounted to are mostly made of metal. Automobiles may someday be made solely of plastic and electric parts, but that day is probably still far in the future. Mitsubishi Materials' cutting tools will therefore continue to realize machining processes that contribute to the further growth of the automotive industry.

Photo provided by: Mitsubishi Motors Corporation

FOCUS on PERFORMANCE

MITSUBISHI MOTORS

A manufacturing bond that has produced continuing technical innovation

Part1
Mitsubishi Motors and Mitsubishi Materials

Mitsubishi Motors evolving while expanding global sales

Japan's ancient capital of Kyoto remains a rich treasure trove of history and culture, and is known as a popular tourist destination. Within this quaint capital, just 15 minutes by car from Kyoto Station sprawls a vast manufacturing plant. It is the Mitsubishi Motors Powertrain Plant. Mitsubishi Motors started production of the Mitsubishi A type in 1917 and continued manufacturing automobiles that are popular throughout the world such as the PAJERO and LANCER EVOLUTION. Mitsubishi's "Drive@earth" project aims to deliver an enjoyable driving experience for the global market with an emphasis on coexisting with nature through the development, production and sales of electric vehicles (EV) and plug-in hybrid vehicles (PHEV). Such leading-edge innovation has provided the foundation for manufacturing technology throughout Japan's automobile industry. The development of technology at Mitsubishi Motors has been promoted by the "Tool Technology Council," a group of process technology specialists.

Established nearly 50 years ago in 1966, the Council comprises of engineers selected from departments and divisions at Mitsubishi Motors group companies and Mitsubishi Materials to develop innovative technologies for the automotive industry. Under the concept of "Creating Dreams in Manufacturing," Council members are selected each year to attend technical exchange meetings. They also come together once a year to share the progress they have made in their processing technology improvement activities. The purpose of these meetings is to exchange technical information beyond company boundaries. In addition to the regular members, young engineers are invited to participate in these activities to cultivate next-generation engineers. Approximately 420 engineers have participated in Council activities over the half century since it was established and hundreds of presentations covering a wide range of technologies have been given. These activities provide opportunities for interaction among engineers, users and manufacturers and have resulted in new tools that have supported Mitsubishi Motors through the development of highly advanced production lines. We asked Mitsubishi Motors and Mitsubishi Materials Tool Technology Council members to tell us about the history and achievements of the Council.

Tool Technology Council's support for production lines

Shimizu (Mitsubishi Motors): It has been about 40 years since I became involved with the Tool Technology Council, which I guess, makes me one of the oldest members. I was working in engine production for Mitsubishi Jeep when I was asked to join the Council. Looking back on its history, I remember most our work on low-fuel consumption vehicles. That was a time when automobile manufacturers were under pressure to reduce both weight and cost.

Ogino (Mitsubishi Motors): That's true. Engine improvements required the development and application of stronger materials which were difficult to cut. Of course, this meant that we needed to adapt tools capable of machining these new materials. I look back and feel like it was a time of competitive evolution between materials and tools. A new tool that had low cost-performance that but hard to pre-set, or difficult to adjust was no good to us.

(Left) Hiroshi Shimizu: Production Engineering Group, Powertrain Production Engineering Department, Mitsubishi Motors (a pioneer at the Tool Technology Council)
(Middle) Takashi Ogino: Powertrain Production Engineering Expert, Production Engineering Division, Mitsubishi Motors (in charge of machine technology)
(Right) Makoto Nishida: Chief of the Powertrain Production Engineering Department Group, Mitsubishi Motors (chief)

Japanese industry has taken its lead from the automobile industry, which continues to show growth driven by demand in emerging markets. Technical innovation such as the production of electric vehicles has also accelerated and Mitsubishi Motors has continued to innovate and produce even better products. Mitsubishi Motors 50-year collaboration with Mitsubishi Materials has supported this history of innovation. In this feature, we visit Mitsubishi Motors Powertrain Plant in Kyoto to ask about the collaboration between both companies in the development of process technology, global expansion and the contributions made by Mitsubishi Materials.

The Tool Technology Council benefits from a history where engineers from different areas had discussions and ideas to ensure that quality wasn't compromised. Despite the difficulties, ultimately, solutions were always found The Tool Technology Council has also focused on the cultivation of young engineers, serving as an opportunity for them to objectively examine their technical capability. Mid-level engineers are also involved in Council activities, constantly challenging one another to improve.

Shimizu (Mitsubishi Motors): The opportunity to share the most advanced information that individual members had was quite meaningful, and it served to vitalize technology. That is how new ideas and opinions were generated. The Tool Technology Council is an organisation where core elements of automobile manufacturing are brought together in the search for future directions.

Ogino (Mitsubishi Motors): The Mitsubishi Powertrain Plant (Kyoto) is a major production facility for the engines used by Mitsubishi Motors. At its peak, some 5,000 employees operated world-class production lines twenty-four hours a day. To support this operation, Tool Technology Council members were required to have the highest level of knowledge and skill and it was quite an honour for young engineers to be selected as members.

Takiguchi (Mitsubishi Materials): Only about 5 employees from Mitsubishi Materials are selected to join the Council each year. New members are selected as the Council evolves and adapts along with the trends in industry. To date, it has accumulated know-how and experience over 50 years.

Uno (Mitsubishi Motors): Yes. For the young engineers, it is a big honour to be involved with the Tool Technology Council. The technology that has been developed and passed down by the Council has contributed to growth over the past 50 years.

Nishida (Mitsubishi Motors): I am currently the Mass Production Team leader at the Council and I feel that employees from both companies bring needs and seeds to the same table, set common goals and discuss issues together. The Council has become an excellent place for technical exchanges. Mitsubishi Materials used to dispatch personnel to Mitsubishi Motors but then stopped 25 years ago. Just this year though, Mitsubishi Materials rejoined the Council and sent Mr. Uno to join. The Tool Technology Council really is an outstanding venue for human resource exchanges.

Producing excellent tools to support the busiest production lines in the world

Takiguchi (Mitsubishi Materials): I was on the production line in 1987 when Mitsubishi started producing the V6 engine.

Kitamura (Mitsubishi Materials): The V6 was being supplied to Chrysler at that time. We produced 50,000 vehicles per month. I think then it was the busiest production line in the world.

Takiguhi (Mitsubishi Materials): Yes, it was 50,000 vehicles per month, right? Under such tough conditions, Mitsubishi Materials tools had their job cut out for them. We were always aware that even the tiniest of problems could stop a production line so we were always thinking of ways to process high efficiency tools. The know-how accumulated through the Tool Technology Council was very useful.

Kitamura (Mitsubishi Materials): We needed to continually produce faster, so we also had to reduce the time it took for tool replacement.

Shimizu (Mitsubishi Motors): It was in 1897 that we developed a system that allowed replacement of tools with the click of a button. We developed this system in collaboration with machine design engineers, but the sharing of a wide range of knowledge through

(Left) Taizo Uno: Powertrain Production Engineering Group, Powertrain Production Engineering Department, Mitsubishi Motors
(Middle) Atsushi Kitamura: Manager at the Sales Department, Osaka Office, Global Key Accounts Department, Sales Division, Mitsubishi Materials
(Right) Masaharu Takiguchi: Machining Technology Center, Research & Development Division, Advanced Materials and Tools Company, Mitsubishi Materials

the Tool Technology Council had a significant impact. One of the concepts for technical improvement at that time was the "Constant Search for Quick Change." The development of spring clamps for face milling cutters and the hydraulic clamping mechanism reduced tool replacement time to less than one minute, and eliminated the need for wrenches and other tools.

All: Yes, those are great memories!

Takiguchi (Mitsubishi Materials): There were no machining centres at that time and it was impossible to exchange tools automatically; but we had already developed a system very close to the automatic replacement type you see today. I can tell you that the Tool Technology Council played no small role in making it possible to produce a large number of engines, very quickly.

Ogino (Mitsubishi Motors): It is really great to get together with the major players that were on the Council at that time to share memories.

Shimizu (Mitsubishi Motors): Our proposals for technical improvements are summarised in this edition of "THE TOOLING." The colour on the front page is one of the PAJERO colours, which we decided to use to show our spirit.

Kitamura (Mitsubishi Materials): There was no other production line in the world that was as complex as ours. Our achievement was outstanding and it made us proud that our tools were used on one of the busiest and toughest production lines in the world.

Shimizu (Mitsubishi Motors): We did have some troubles though. Line maintenance required a serious effort. The lines only stopped for a short time during summer and at year end. During these times we analysed and accumulated data about the products we developed. We also inspected deterioration of cutter reference planes and worked in cooperation with the tooling centre to examine changes in runout. We worked constantly to monitor machined surface accuracy over the years.

Kitamura (Mitsubishi Materials): We worked hard on maintenance. All through our 20s, we spent our summer and New Year holidays ensuring that the lines would keep running.

Shimizu (Mitsubishi Motors): For solutions to problems, the initial design can achieve up to 70 percent of the improvement but the other 30 percent must be found in manufacturing techniques. Employees devote themselves to improvement and that has not changed.

Takiguchi (Mitsubishi Materials): Experience in manufacturing can be applied to design.

Kitamura (Mitsubishi Materials): The origin of all tools sold by Mitsubishi Materials to automotive industries around the world can be found in the history of the Tool Technology Council. Everyone knows that a defect in a tool can cause the stoppage of a production line that produces 50,000 vehicles per month, and that would be a serious problem.

Uno (Mitsubishi Motors): We will continue recording the problems that come up in production lines and reflect them in improvement proposals. The importance of sharing problems and solutions has been passed down from past members and we want to continue this great tradition through Tool Technology Council activities to ensure a level of quality that leads the automobile industry.



(Left/ Right in the photo) Tadashi Terasaka: Powertrain Production Engineering Group, Powertrain Production Engineering Department, Mitsubishi Motors
(Left/ Left in the photo) Hajime Goto: Powertrain Production Engineering Department (in charge of machine technology), Production Engineering Division, Mitsubishi Motors
(Middle/ Right in the photo) Hiroyasu Furubayashi: Keiji Office, Osaka Branch, Advanced Materials & Tools Company, Mitsubishi Materials
(Right) Motoki Yamada, Global Key Accounts Department, Sales Division, Advanced Materials & Tools Company, Mitsubishi Materials

The Tool Technology Council is a generator of wide ranging achievements

The Tool Technology Council expanded its activities in 1993 by adding mass production and metal mould processing teams. Cutting tools have improved significantly over the past 50 years and the Council has been a key factor in development each step of the way. It produced tools utilizing the UTi20T grade, as well as multi-layer chemical vapor deposition (CVD) coatings and cubic boron nitride (CBN) materials. Simultaneously, we set new themes for further technical developments. These included lowering tool costs, increasing productivity, better chip control as well as improving tools for mass production and mould machining. The technology accumulated here supports the production lines at Mitsubishi Motors and technical research conducted at user sites has become know-how that Mitsubishi Materials uses for proposals over a wide range of industries.


Part 2 - Development of next-generation tools through partnerships

Updating processing methods for core vehicle parts

Machine processing relates directly to vehicle performance and it has improved on a daily basis along with automobile development. The cylinder, the heart of the engine, plays an important role in translating explosive power into movement and the parts that convert this explosive power to inter-connected energy requires materials that exhibit excellent strength. High-strength cylinders are made of difficult to cut materials and machining these is the challenge. What type of processing method is required to create high-quality, high-performance and low-cost tools? Mitsubishi Motors and Mitsubishi Materials are on top of the challenge. Their solution is the development of next-generation tools that enable cylinder machining without a semi-finishing process. We asked Mr. Goto (Mitsubishi Motors), Mr. Terasaka (Mitsubishi Motors Engineering), and Furubayashi, Sakuyama and Yamada (Mitsubishi Materials) about the background of development and methods

Making cylinder processing possible without a semi-finishing

Terasaka (Mitsubishi Motors): In automobile parts processing, we constantly encounter many high demands. Of particular concern in our recent challenge was the cost of machining a high-precision cylinder. The cutting tool for this one step accounts for the lion's share of the cost of tools used in cylinder block processing. Thus, with an eye to reducing this cost, it was first sought to clarify the potential within the production lines.

Furubayashi (Mitsubishi Materials): That was about four years ago, right? After looking at Mitsubishi Motors' approach, we let them know at a Tool Technology Council meeting that we could help them make improvements and cut costs.

Goto (Mitsubishi Motors): Cylinders currently undergo three boring process steps, rough, semi-finishing and finishing. Our plan was to reduce this to two steps by alleviating the semi-finishing process. In order to do so, however, we had to figure out how to improve rough boring quality.

Sakuyama (Mitsubishi Materials): We proposed a wiper geometry to improve the surface quality of rough boring and we were quite confident that this would be effective when used on a rough boring tool.

Terasaka (Mitsubishi Motors): The wiper geometry requires significant power; but because the machine tool that performs the rough boring application had twice the power of a general machining centre, I was confident that it would be powerful enough to allow us to get the most out of the wiper geometry.

Furubayashi (Mitsubishi Materials): After six months of preparation, I was confident that we would be able to do this. I was very excited to know that we would achieve our goal.

Ideas are connected and shaped

Sakuyama (Mitsubishi Materials): We put maximum effort into satisfying all needs, such as achieving high-quality, high-efficiency and low cost, shortening work processes. We examined a wide range of wiper geometries to find one that would achieve surface quality equivalent to semi-finishing boring. The result was a new insert that applied a double-positive breaker to reduce cutting resistance. We also developed a rough boring tool whose inserts and layout angles were arranged to achieve a stable process.

Yamada (Mitsubishi Materials): The larger the rake angle, the sharper the insert becomes. However, the sharper the tool the more breakable the cutting edge becomes. To prevent breakage and achieve a rigid high feed cutting action, we modified the geometry to achieve more rigidity. Additionally, the original insert was square and only provided the use of four corners; but the new insert is hexagonal, allowing six corners to be used, thereby lowering the cost.

Goto (Mitsubishi Motors): For rough boring, where cutting is more difficult than the existing process, the set-up of stock removal and the optimum machining conditions was the most difficult. Taking account of the facility's capability, we accumulated data on location accuracy to set the amount of stock removal. Previously, we had set processing conditions along the lines of two-dimensional thinking, of feed and depth of cut, this time however, we increased efficiency by simultaneously optimizing 3 parameters, feed, depth of cut and speed. During testing we found the optimum parameters that gave us higher-quality, higher efficiencies and lower costs.

Furubayashi (Mitsubishi Materials): We processed approximately 20,000 holes

(Left) Toru Sakuyama: Insert Tool Development Center, Development Department, Advanced Materials & Tools Company, Mitsubishi Materials

to assess performance. The new tool life increased by six fold and processing efficiency jumped by 10%. This is why we have great confidence in our new product.
Terasaka (Mitsubishi Motors): The processing efficiency of the machines increased more than 10%. You may think 10% isn't much, but that 10% improvement has the effect of eliminating the need for an entire machine that costs tens of millions of yen.
Yamada (Mitsubishi Materials): We spent four years improving this tool; but this is now an outstanding development that represents a new era in tool technology.
Sakuyama (Mitsubishi Materials): Yes, it was a great chance for me to really see how the tools we develop are used by Mitsubishi Motors. As a developer it was my pleasure to know how satisfied both users and manufactures were with products that employed our tools. Although we are working in different places, we are connected; and such bonds can achieve outstanding results.
Goto (Mitsubishi Motors): I want to further advance the technology and methods we have developed. There are unlimited possibilities for added value in cutting tools, unlimited potential for cost reduction and the development of tools that can control chips and alleviate burrs.
Terasaka (Mitsubishi Motors): We always look to develop the best in high-performance cutting tools. However, it is also important to optimize the principal three factors of high-quality, high-efficiency and low-cost. Mitsubishi Materials spared no effort to help us develop new ideas and realize production and was largely instrumental in producing the excellent achievements we attained. The high-performance tools developed here will also contribute to other industries.

Part 3 - Cooperation with Mitsubishi Materials for global Expansion

Establishing a new plant in Thailand

Mitsubishi Motors is currently focusing on expanding production capacity in Asia. Mitsubishi Motors Thailand Co., Ltd. built an engine plant in 2008. Building a new production line overseas was more difficult than building one in Japan. Mr. Masago, Mitsubishi Motors Kyoto Engineering Department, who was involved in the establishment of the production line said, "I was involved in the engine processing line project in 2012. The engine was used for the MIRAGE, which was produced entirely in Thailand. These days, it is easy to procure everything we need in Thailand; but it was not that easy back in 2012. Of course, it was not Japan, so everything was different, including the way orders were placed." We need to develop production lines that are suitable for each country and culture but changing processing methods carries the risk of impacting on quality. Mr. Oka, Mitsubishi Motors Production Engineering Department, who was also involved in the establishment of the production line, wanted to install the exact same production line we had at the Mitsubishi Motors Powertrain Engineering Plant in Kyoto. He felt that having the same production line would make it possible to reduce risks in applying new processing methods and that implementing the most advanced production line, one whose quality had already been proven in Japan, would ensure the best performance.

Specialist support for overseas expansion

At the same time, Mitsubishi Materials predicted expanding demand for cemented carbide tools in Thailand, which had become a base for automobile parts production in Southeast Asia. Kitamura from Mitsubishi Materials said, "Since there was a need to set up a fine-tuned customer service system in Thailand, we planned to establish this and focus on major countries from the perspective of demand". Mitsubishi Materials promotes the expansion of accumulated technology, experience and human resources on a global level, not only to provide products, but also to respond to expanding global markets. In 2013, Mitsubishi Materials established the Global Key Accounts Department, a specialist group to support overseas business expansion, to help achieve this goal. Kitamura said, "The Global Key Accounts Department provides support to help our customers enter overseas markets. We provide them with the best solutions and services and promote the enhancement and optimization of their production system with a focus on a new framework that allows each customer to create new values and bolster competitiveness." When Mitsubishi Motors was planning its engine plant in Thailand, our Global Key Accounts Department was involved in the project. "When we launched the plant project, we were constantly aware that we had to come up with quick solutions to problems that were encountered. Mitsubishi Materials staff always helped us check production lines and conditions. We placed priorities to on-site work, on-site production and I really appreciate the cooperation we received from Mitsubishi Materials staff. It was instrumental in helping us maintain our priorities," said Mr. Oka.

(Left) Mr. Furubayashi, Mr. Kitamura, and Mr. Yamada (Mitsubishi Materials) from the left
(Middle) Yoshiki Oka: Powertrain Production Engineering Expert, Production Engineering Division, Mitsubishi Motors (in charge of machine technology)
(Right) Toshio Masago: Engine Department 1, Kyoto Engineering Department, Powertrain Production Plant, Mitsubishi Motors

Need to work together to solve difficult problems

Installing a production line where no line previously existed requires manpower. Therefore, there was an urgent need to cultivate human resources capable of operating cutting tools. In particular, meticulous cost calculation is an integral part of processing in Japan, but it was a challenge for the original project members to establish the importance of this system and way of thinking among the local staff. Mr. Masago said, "Quality comes first. People who had worked in completely different areas needed to be trained in production line skills. This required thorough instruction and monitoring to ensure that everyone understood the work. We exchanged information with Mitsubishi Materials staff and obtained knowledge and information regarding processing. It was very helpful." Mr. Yamada from Mitsubishi Materials said, "We placed great emphasis on matters that are highly regarded in Japan, such as communication with overseas workers about products and sharing information on processes with our customers. We worked hard to build cooperative relationships at home and abroad to ensure a prompt response to customer needs." Mr. Furubayashi from Mitsubishi Materials added, "We worked hard to perceive and accommodate customer needs. The most important thing for us is the willingness to work together with customers to overcome difficulties." Both companies have the same desire to work with customers to improve our products and services and this strengthens the relationship between us. During the interviews, they expressed an attitude of seeking the best process as professionals in manufacturing. Mitsubishi Materials continues to provide the best to each of its customers around the globe by delivering the most advanced process technology, technology that can only be provided by a company that is intimately familiar with the characteristics of each product.

HISTORY OF MITSUBISHI

Vol. 2

Japan's treasure trove, boasting the largest-ever production of gold

Sado Gold Mine

One of Mitsubishi Materials' roots goes back to Sado City, Niigata Prefecture. Sado appears in Konjaku Monogatari Shu (The Tale of Times Now Past), written toward the end of the Heian Period and in Zeami's Kintosho (The Book of Golden Island) and has been known since ancient times as the "island of gold." The Sado mine, which belonged to the Imperial family was sold to Mitsubishi Goshi Kaisha in 1896 and thereafter supported the growth of Japan's industries with the largest-ever production of gold in Japan. This article introduces the history of Sado Gold Mine and the development of mining technology.


Power lines installed inside the tunnel to increase production (1939)


Switching yard in the former Ohdate shaft hoisting house (made of wood)


The Kitazawa flotation mill (rear centre) during the Meiji Period

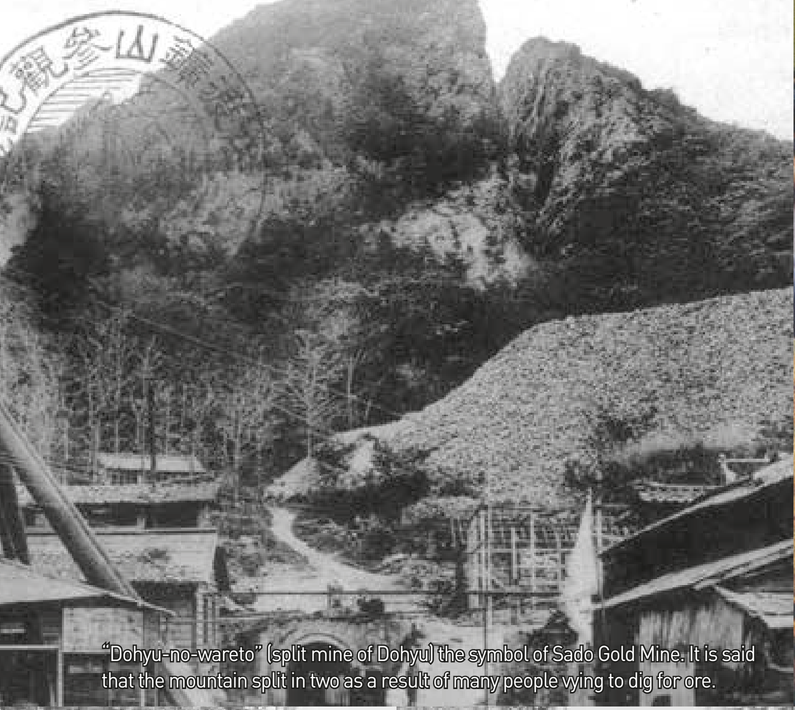

"Sado Mine Open House," held since the Taisho Period

Gold Rush in Modern Japan

The Historical Site of Sado Gold Mine is roughly four hours from Tokyo by Shinkansen and jet foil (high-speed passenger boat). Found on Sado Island, located in the western part of Niigata Prefecture, the mine has some 400km of tunnels (same distance as that between Sado and Tokyo) and is known as the largest gold and silver mine in Japan. The vast site includes various mining facilities that are designated a National Important Cultural Property, Historical Site or Heritage of Industrial Modernization. It is said that the history of Sado Gold Mine began in 1601 when three speculators who were mining for silver in the Tsurushi Silver Mine in Aikawa discovered a new vein of gold amongst the silver. In 1603, Shogun Tokugawa Ieyasu placed Sado under his direct control immediately after winning the Battle of Sekigahara. The Shogun immediately appointed Okubo Nagayasu as its administrator because Okubo was originally from Kai and had knowledge of gold mining. Under Okubo, the Sado mine was exploited, beginning with the largest Aoban vein, followed by the open-pit Dohyu vein, the Ohkiri vein and then the Torigoe vein. At its peak in the first half of the 1600s, the mine produced more than 400kg of gold and 40 tons of silver per year. The Sado mine suddenly became Japan's largest gold and silver mine and precipitated a gold rush. Over a period of approximately 270 years thereafter until the end of the Edo Period, a total of 41000kg of gold were mined and supported the Tokugawa Shogunate financially.

Rapid Growth Owing to the Development of the Mining Technology and Transfer of the Mine to Mitsubishi

The Sado mine became famous as a gold mine, but its production declined from around the middle of the Edo Period prompting the Meiji government to send a Western engineer to the mine in 1869 to deal with the situation. As a result, in 1877 an ore mill was built using Western technologies and the Ohdate shaft, the first Western-style shaft to be used in a metal mine in Japan was opened. With the


"Dohyu-no-wareto" (split mine of Dohyu) the symbol of Sado Gold Mine. It is said that the mountain split in two as a result of many people vying to dig for ore.


The Sado Koban coin foundry in the Edo Period (reproduction)


Mining inside the Sohdayu shaft during the Edo Period (reproduction)


Shotoku Sado Koban coin

Mitsubishi Material gold bar

Ohdate shaft


Dohyu-no-wareto (site of gold ore mining by hand)


The Kitazawa flotation mill, the largest flotation mill built in the Showa Period in Asia

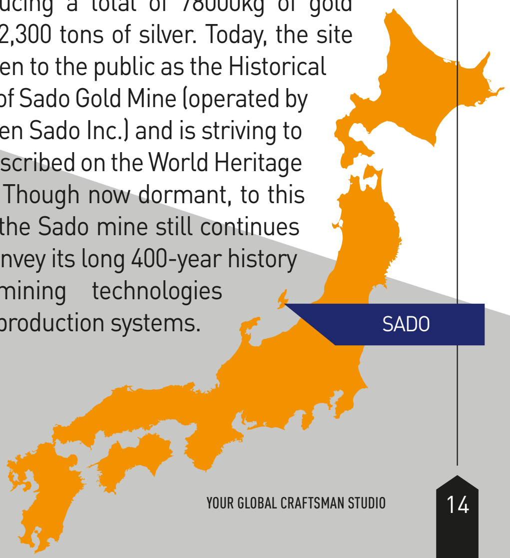

The former Ohdate shaft hoisting house, built using Western technologies in the early Meiji Period and the Ohdate mill, built in the latter Meiji Period (front)

addition of these facilities, the government aimed to acquire foreign currency with an eye toward modernization and also to acquire monetary benefits. Furthermore in 1885, the new Meiji government attempted to increase production at the Sado mine in preparation for shifting to a modern monetary system based on a gold standard. Oshima Takato, upon being appointed director of the Sado mine, subsequently opened several new facilities including the Takato shaft, the Kitazawa flotation mill using new German technology and also developed the Oma Harbor. In 1890, a mining school was also opened to promote the domestic production of mining technology and important policies were implemented in regard to mining education in Japan.

Thereafter in 1896 the Sado mine was sold to Mitsubishi Goshi Kaisha (predecessor of Mitsubishi) and along with the Ikuno mine achieved rapid growth. By promoting mechanization such as through the automation of power systems, Mitsubishi succeeded in returning the mine's momentum back to the level of production it achieved at its peak during the Edo Period. New production levels helped it to achieve far more than the 400kg of gold it produced annually during the latter half of the Meiji Period. During its 93 years of operation, Mitsubishi produced approximately 33000kg of gold, and it was Mitsubishi's modern mining and ore processing technologies that made a significant contribution to the increase in gold production.

Long-lasting History of Sado Gold Mine

Sado Gold Mine's history as Japan's largest gold mine ended when operations were closed down in 1989, after producing a total of 78000kg of gold and 2,300 tons of silver. Today, the site is open to the public as the Historical Site of Sado Gold Mine (operated by Golden Sado Inc.) and is striving to be inscribed on the World Heritage List. Though now dormant, to this day, the Sado mine still continues to convey its long 400-year history of mining technologies and production systems.



Craftsman Story

Vol. 3

Kiyoshi Okada
Manufacturing staff /
Joined in 1985

Toshiaki Kubota
Manufacturing staff /
Joined in 1989

Kenji Yumoto
Development staff /
Joined in 2006

Makoto Yasuda
Development staff /
Joined in1983

Toshiyuki Kodera
Manufacturing staff /
Joined in1989

Takuya Maekawa
Development staff /
Joined in 2007

Coated CBN material for high-hardened steel turning

BC81 SERIES

The challenge of the CBN/PCD team in developing high-performance, long-life CBN materials

The team embarked on the development of the BC81 Series (BC8110, BC8120) in 2011. To develop a new CBN series for high-hardened steel that would outstrip other companies, a completely new technology needed to be developed. Below is an interview with six development and manufacturing members who tackled this goal.

Q: Tell us how the BC81 Series came to be developed.

Yumoto: In recent years, the automotive and machine industries have entered a growth trend and there has been an increase in demand for CBN (cubic boron nitride) tools that could be used for machining high-hardened steel parts. Mitsubishi Materials launched BC8020, a coated CBN material for general cutting of high-hardened steel in 2010, but in some cases it lagged behind the products of our competitors. Taking this disappointment to heart, we drew fully upon the strengths of new technologies and developed the BC81 Series coated CBN material for machining high-hardened steel.

Q: Tell us about the development of BC8110.

Yumoto: BC8110 was developed as a coated CBN material for continuous cutting of high-hardened steel. In our development process, we committed ourselves particularly to pursuing "what customers seek." By having our entire team focus on user-oriented product development rather than on technology-driven development, we were able to proceed towards the same goal without going off track.

Maekawa: When starting our development we exhaustively investigated "what needs to be improved" in comparison with competitors' products. The result pointed to an improvement of wear and chipping resistance, so we set our eyes on developing as our main concept "a CBN base material with excellent chipping resistance and a coating with superior wear resistance."

Q: How was the development actually carried out?

Yumoto: First of all, to develop "a CBN base material with excellent chipping resistance," we single-mindedly worked to improve the toughness of the CBN base material. However, all sintered CBN materials, including those of our competitors, had the same type of composition, so it was evident that CBN base material produced in the ordinary way would only provide the same level of performance in the final analysis. Therefore, to achieve a toughness that outstrips our competitors, we invented the new "ultrafine binder" technology. Owing to this technology, we were able to make the BC8110 binder much finer than our previous and competitors' products and succeeded in developing a ceramic binder with improved toughness. We were thus able to achieve extremely good resistance to chipping.

Maekawa: Following the development of the base material, we embarked on the development of "a coating with superior wear resistance." Generally speaking, coatings do not adhere as easily to CBN tool material compared to other carbide tool materials. So what needed to be done to achieve both adhesive strength and wear resistance? As a result of examining the issue in various ways, we decided to modify our company's unique Miracle coating technology so that it could be applied to CBN. This involved what seemed to be an endless series of trials and errors to find the appropriate conditions, this was because carbide tools and CBN tools differ completely in the way a coating adheres to them. We also introduced new facilities to the manufacturing stage and added a new process after coating. There were bound to be disadvantages to increasing the number of work processes, but a comprehensive review needed to be performed, beginning with the manufacturing stage in order to achieve the performance we desired.

Okada: Frankly, as a member in charge of manufacturing, I doubted whether increasing the number of work processes would make any difference. However, seeing one of our members passionately explain the need to increase the number of processes to achieve the goal, I had to believe in him. In the end it led to good results, although there is still more room for improvement.

Yasuda: In the product testing stage, we performed repeated field tests with the cooperation of our customers. By proposing a new perspective to the customer at this stage, they came to value our product more than our competitors, especially as we ultimately succeeded in extending tool life.

Maekawa: Customers who cooperated in the testing requested to buy the product before its release, even if it was a special-purpose product. Receiving such high commendation before a product's release has left a very strong impression on us.

Q: Tell us about the development of BC8120.

Yumoto: BC8120 is a successor of the BC8020 coated CBN grade for general cutting of high-hardened steel, which was released in 2010. Some application problems arose with BC8020, such as degradation in dimensional precision due to delamination of the coating and also when chipping occurred during continuous cutting. When developing BC8120, we therefore aimed to resolve these problems and to develop a material that delivers greater intermittent performance compared to competitors' products.

Yasuda: BC8020 lagged behind our competitors' products in some areas, so we knew that we would fall further behind if we were to spend four to five years developing something new. For this reason, it was essential to develop our next product in a short period of time. As a matter of fact, it took us only a year or so to further improve our CBN base materials and coatings.

Yumoto: It was necessary to increase the chipping resistance of the CBN base material. We initially thought we could enhance toughness to a certain degree by applying the ultrafine binder technology to BC8120 that had been developed for the CBN base material, but this was no easy task. Due to limited time, we even worked over the weekends making sample after sample and ultimately succeeded in applying the ultrafine binder to develop a dedicated CBN base material for BC8120.

Maekawa: For the coating our main objective was to control delamination. We began by considering film compositions and applied a new technology that would control residual stress in order to enhance adherence strength. As a result, we achieved greater adherence strength than ever before.

Q: Were any special efforts made in manufacturing the BC81 series?

Kodera: Because the BC81 series is a new type of material, we began searching for processing methods only after gaining a thorough understanding of the material. It was a tremendous challenge to produce samples in a short time without any disruption to regular production.

Yumoto: Mr. Kodera is a specialist, so he would make a sample three times faster than other people. That is why we always ended up asking him to make a sample (laughs). Having someone like Mr. Kodera on the manufacturing staff is an enormous support to production development.

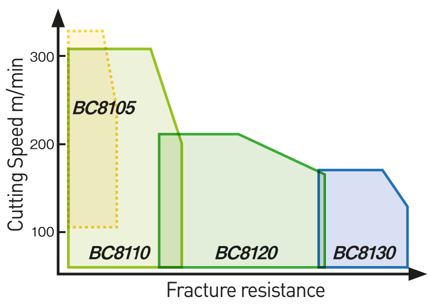
Kodera: The result was achieved not only by me, but by the cooperation of the manufacturing staff. The members of the CBN/PCD team are extremely cohesive and tend to want to help whenever someone needs it (laughs).

Kubota: On the production floor, we hear our customers' appreciation and words that they are awaiting our product and this motivates us to make greater efforts. In hindsight, I think that our wish to "make outstanding CBN/PCD products" created a solidarity beyond the bounds of departments and roles. This is because we had a relationship of mutual trust that we were able to realize our product goals.

Q: Please say a few words to your customers.

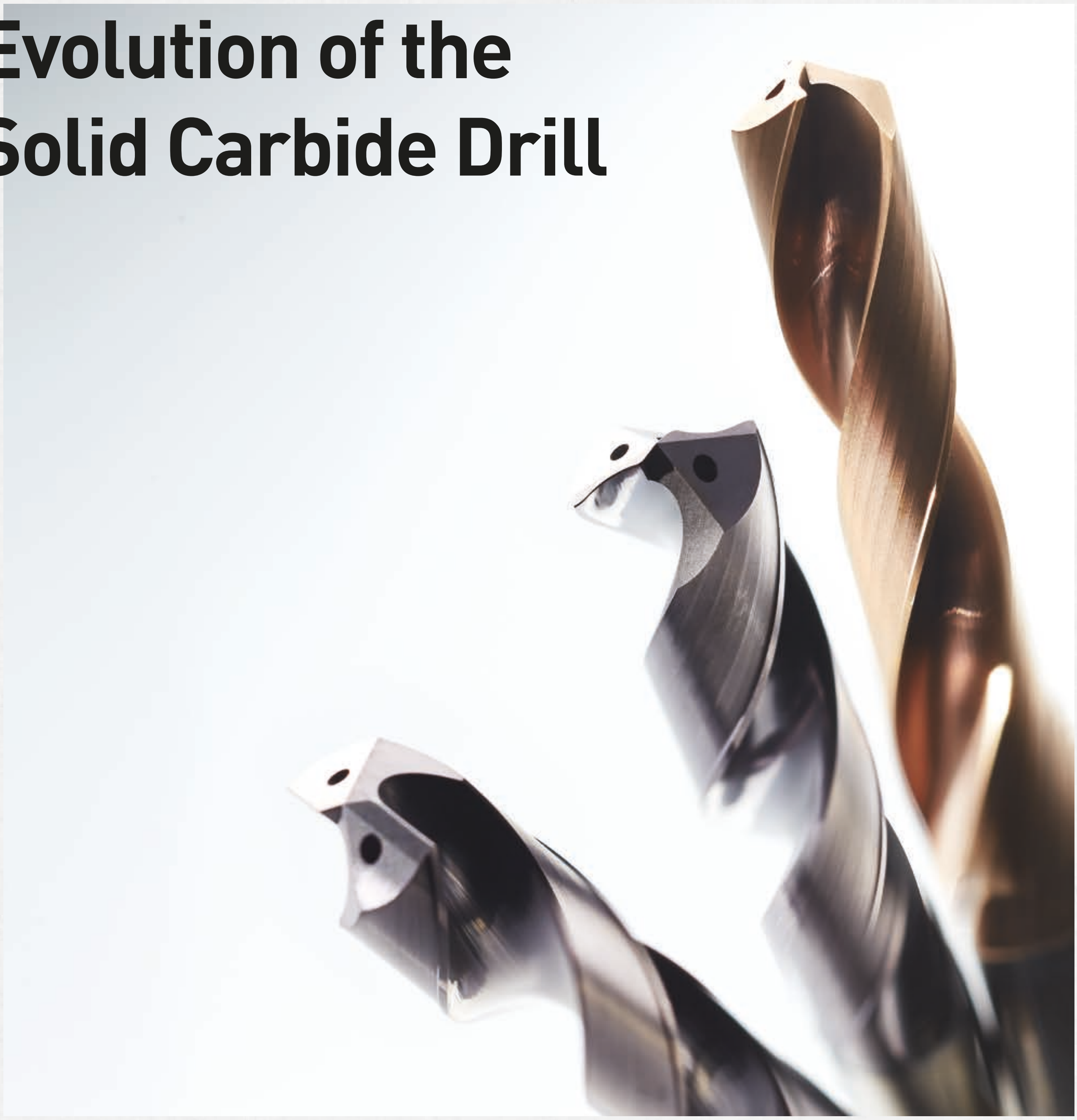
Yumoto: We have absolute confidence in the BC81 series, particularly considering all the struggles we have gone through. We will actively engage in cutting tests and PR activities and hope customers will try our products.

Maekawa: This fiscal year, BC8105 coated CBN material for finishing high-hardened steel and the BC8130 coated CBN material for continuous cutting of high-hardened steel are scheduled to be released. However, we will also focus our efforts on further developments, so please look forward to our future lineup of products.



TECHNOLOGY ARCHIVE

History of the Evolution of the Solid Carbide Drill



Hidden within the design lies the history of a challenge that became a breakthrough in drilling technology

The ZET1 drill appeared in the latter half of the 1980s as the first solid carbide drill in the industry. Its genes have been inherited by the WSTAR drill, the current core drill product of Mitsubishi Materials. In this issue, we trace the evolution of the solid carbide drill.

TECHNOLOGY ARCHIVE

Part 1 1987 ~

The ZET1 drill that rewrote the book on drilling performance

In the latter half of the 1980s, when brazed and high-speed steel drills were the mainstream product used across various industries, Mitsubishi Materials embarked on the development of the solid carbide drill. Brazed carbide drills already existed in the market, but due to technical reasons they were only available in large diameters. Nevertheless, Mitsubishi Materials anticipated that there would surely be a time when small diameter solid carbide drills would be in demand and began development in a small corner of a factory. However, during the 1980s, computing technology was in its infancy and all calculations and design was done manually. Days upon days were spent designing the ideal flute and cutting edge geometry through simple trial and error. It was a time when products were developed based on engineers' experience and sense, rather than on the basis of data and simulation that have become the standard today. After several years of development, the ZET1 solid carbide drill finally came into existence in 1987 as the first solid carbide drill in the industry.

At the time, high-speed steel drills had approximately a 70% share of the market, so we were very confident of the ZET1's performance as a solid carbide drill. It delivered five times greater drilling efficiency, ten times longer tool life, steady discharge of chips and an overall higher drilling performance. In other words, it represented a dramatic evolution. However, contrary to expectations, it did not sell well. The first reason was its price. Compared to high-speed steel drills, the carbide type was around 30 times more expensive. This meant that what customers used to buy for 500 yen would become 15,000 yen. In the final analysis, one hole would cost less and production efficiency would increase, but it was difficult to set a precedent in the market so that it would open up to the overall advantages of the solid carbide drill in terms of cost. Another reason was that initially there was little knowledge about how to handle and operate solid carbide drills and we needed to begin by teaching customers how to use the drill correctly. Solid carbide drills perform best when using what is known as peck or step drilling cycles, and at that time many customers only used conventional machines and methods that were not suited to the peck or step drilling processes. Therefore, we offered trainings in cooperation with machine tool manufacturers, and provided information to customers so that they knew of the correct methods to gain the most efficiency from the new drills. Furthermore, since many customers were not familiar with the need for accurate resharpening of solid carbide drills in order to maintain the drills' performance levels, we also disseminated knowledge of how to care for them. These efforts, made in conjunction with marketing activities required a large amount of time, but owing to their steady influence the ZET1 drill eventually came to be accepted, primarily by the automobile industry. In hindsight, the sense of accomplishment we experienced after overcoming the hardships and receiving customers' understanding of the advantages of the product, plus their words of praise, remain strong in our minds.

HISTORY Evolution of the solid carbide drill

1973 Gifu Plant is established. The manufacture of cutting tools begins.

1987 The ZET1 drill is released.

1995 The Super Burnishing - brazed drill is released (receives an award from the Japan Cemented Carbide Tool Manufacturers' Association).

2002 The WSTAR drill is released.

2004 The MiniSTAR drill is released.

2006 The WSTAR Super-long drill for deep-hole machining is released.

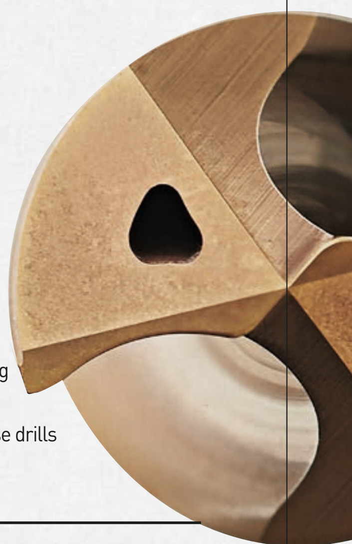
2007 The MNS drill for aluminium alloy machining is released. The MGS solid gun drill is released.

2008 The MHS drill for die machining is released.

2010 The MMS drill for stainless steel machining is released.

2011 The MQS drill for steel and cast iron machining is released. The MCS drill for CFRP machining is released.

2013 The small-diameter MHS drill for die machining is released. The MVE/MVS new-generation general-purpose drills are released.



Part 2 2002 ~

Beyond the ZET1 drill, the origin of the WSTAR series

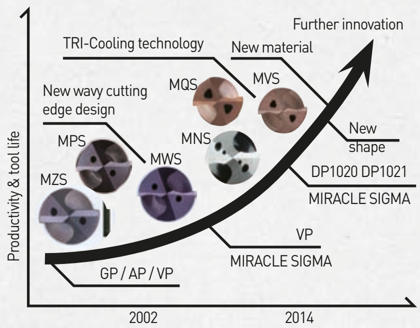
Roughly ten years after the ZET1 drill was born, the solid carbide drill had become widespread across the industry, and various products including those of other companies had appeared in the market. New developments were also demanded of the ZET1 and the development team had run up against a wall as to what types of improvement should be made. It was then that the general manager of development gave the following advice: "Go and hand cut holes in bars of soap until you find an answer." We spent several days thereafter, using both Mitsubishi and competitors' drills, single-mindedly drilling a huge amount holes in soap by manually rotating them. As a result, we discovered many things through the sensations we felt in our hands, such as where the point of resistance begins and how chips are discharged. This led to a shift in concept from the ZET1 drill's linear cutting edge to a curved type. We thus explored how to realize a wavy type cutting edge that no one had ever seen before. The inspiration for this curved shape came suddenly from a moment while cooking when using a food processor to chop ingredients. Inspired by the bold curves on the blades of the food processor and after much trial and error, we ultimately came up with the WSTAR solid carbide drill with its unique wavy cutting edge.

Through the wavy edge and new flute geometry we succeeded in minimizing the size of chips and this enabled a more efficient discharge. In addition a newly developed point shape ensured excellent concentricity and positional accuracy of holes. Furthermore, we were able to extend tool life by adopting VP15TF Miracle coating. These features ensured that the WSTAR drill series, launched in 2002, became recognised for its accuracy and long tool life and has become a product that is still favoured by many customers today.

Part 3 2006 ~

The ongoing evolution of the WSTAR drill series

The WSTAR drill has further evolved since 2006 in response to the needs of the market. The series of drills has expanded and now includes the general-purpose MWE/MWS drills designed primarily for carbon and alloy steels. In addition, the MNS, MHS, MMS and MCS drills that are designed specifically for machining aluminium alloy, high-hardened steel, stainless steel and CFRP materials respectively, have also been launched. Amongst the highlights that are available today are also the super-long type drills for machining deep holes with an aspect ratio of up to L/D = 30. Each of these products embodies technologies, originality and ingenuity that only Mitsubishi Materials could achieve. An example of this originality is the MNS drill that was developed for machining aluminium alloys. To lubricate the precise spot near the centre of the drill where chips tend to adhere, further improvement of the coolant flow was required. Straying beyond the conventional two-hole drill, we collaborated with the manufacturing technology group and created a drill with four coolant holes, the first drill of its kind in the world. Then, taking this technology further, we developed and released the MVE/MVS general-purpose solid carbide drill series in 2013 by employing TRI-Cooling technology to create an originally shaped coolant hole that requires extremely high precision. By taking an innovative approach to increasing the flow rate, we succeeded in enhancing cooling performance, lubricity, discharge of chips and the overall performance of the drill itself just because of the design of the coolant hole. Long tool life against a wide range of work materials was also realised by applying a PVD coating (DP1020) that was designed specifically for drills. WSTAR is indeed the perfect solid carbide drill series for the new generation of engineering needs.



History of the solid carbide drill (standard size)

CLOSE UP

Manufacturing technology for tools with coolant holes: The results of Mitsubishi Materials' technology and persistence

Mitsubishi Materials began manufacturing tools with coolant holes in 1988. For 27 years thereafter, coolant holes continued to evolve, supported by production technology. Below, we introduce the work processes involved in manufacturing tools with coolant holes.

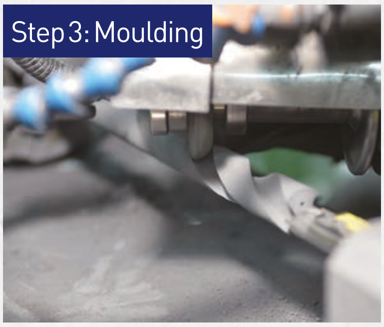
Step 1: Raw material

Tungsten is mainly used to make carbide products. It is an extremely heavy substance, but it has fine particles that flow like liquid.

Step 2: Extrusion press

Raw material in powder form is fed into a press and extruded. The finished product simply appears like a twisted rod, but spiral coolant holes are already inside at this stage. The key here is the accuracy of the position of the holes. The holes are spiral in shape, but are positioned so that the same thickness is maintained from the outside at any point along the drill. Production technology born from long years of trial and error is at work here in stabilizing the lead length while the raw material is pliable.

Step 3: Moulding



After pre-sintering the drill so that it is as strong as chalk, spiral flutes are cut in the drill. This is done without reaching the coolant holes inside, using an advanced technology that ensures the holes are in line with these spiral flutes.

Step 4: Sintering

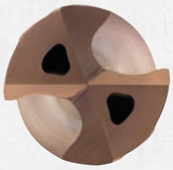
The drill is sintered at high temperature so that its volume is roughly halved but the density greatly increases. This means the coolant holes are made in a size and position that takes into account the shrinkage factor from the beginning.

Step 5: Final inspection

All drills are not only inspected for flaws, but also checked whether the coolant holes are made as specified even after shrinkage during sintering has occurred. Only materials that pass strict inspection procedures are approved and made into a product.

Round hole (2002 —)

Four holes (2007 —)



Triangular holes (2009 —)

The demand for drills with smaller diameters and longer lengths in recent years has meant increasing difficulties when manufacturing tools with coolant holes. For example, in ultra-small diameter drills, the product itself is thin and the flutes are extremely narrow, so even greater hole positioning precision and pitch precision is required. Similarly, with longer drills, it has become even more important to ensure the lead of the helix remains constant, and production technologies continue to evolve daily toward that end. Additionally, tools with coolant holes generally have round coolant holes, but Mitsubishi Materials develops and manufactures tools with coolant holes that differ from the conventional two round holes—such as four holes and triangle holes—to increase drill performance. Only Mitsubishi Materials uses coolant holes of differing shapes according to the work material. The various coolant hole shapes are able to be produced precisely because the drill and materials plants are located on the same site, and are the product of strong cooperation and hard work among members of both plants. The three types of coolant holes embody Mitsubishi Materials' technologies and pride as a company that manufactures products from its own raw materials.

Unraveling the history of the solid drill

The ZET1 drill appeared 30 years ago. As I look back at the history of the solid carbide drill thus far, I realise it is precisely because we are a manufacturer capable of developing and producing a whole gamut of items, that we are able to continually produce new drills that the market requires. This process is a direct result of our interlinked work processes and through the concerted efforts of the entire development team. Going forward, we will continue with a flexible outlook to produce new materials and shapes in order to pursue further innovations.

Kazuya Yanagida
Leader, Drill, CBN & PCD Products Development Centre

About Us

Thailand Engineering Center

Thailand Engineering Center
Centre of Technical Support in Southeast Asia

For the automotive and other industries that are looking to expand their facilities and build plants overseas, Thailand is a popular choice. This article introduces the Thailand Engineering Center that was established to provide speedy, high-quality technical services.

"We aim to provide the same quality of technical services as in Japan."

An interview with Takayoshi Saito
MMC Hardmetal (Thailand) Co., Ltd.
Technical Director / GM Engineering Center

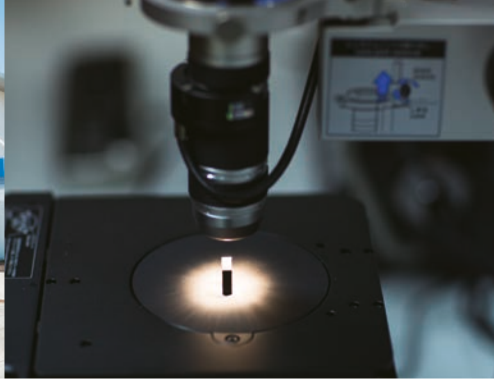
Advanced services in the industrial heart of Thailand

Mitsubishi Materials Advanced Materials & Tools Company promotes the localization of technical services to provide prompt support to customers throughout the world. Therefore in early 2014, the Thailand Engineering Center was planned. When opened, it was to be available as a source of technical solutions to customers in countries throughout the neighboring Oceania region. After roughly a year of intense preparation to ensure the strongest and most reliable services possible, the official opening came in January 2015. The Center now provides diverse services ranging from standard machining tests through to workshops on machining technologies, product workshops and studies related to machining, plus other surveys and reports. The Center is located in the Amata Nakorn Industrial Estate, considered as the geographical hub of the Thai automotive industry. It is the largest industrial estate in Thailand and is open to all customers, both large and small. This location is advantageous because customers can call in at any time to consult about technical matters and in turn allows us to provide speedy support. Today, a year after commencing operations, we already provide technical support to approximately 84 companies.

Comprehensive support to customers as their partner by offering learning programs and other diverse solutions

We offer learning programs on machining technologies in both English and Thai languages. Through regular courses and new product demonstrations we actively provide information that lets customers gain an understanding of our products and enables them to utilize the product's features to the fullest. There is extremely strong demand for such learning and there have been cases where our customers have incorporated our machining technology programs into their own in-house training.

With continued focus on providing high quality technical services at the same standard as found in Japan, we aim for further growth and cooperation as an engineering centre that our customers can always rely on.



An employee's view:
I wish to provide close support to our customers' production sites

My name is Napatpol Artharamas, my nick name is Phyte. I studied Electronics and Communications Engineering in Thammasart University after which I joined MMC Hardmetal (Thailand) in May 2014. I spent 6 weeks training based around the Tooling Technology packages 1 and 2, then I had the chance to spend 7 weeks of study and hands on training at the Omiya Technical Center, Japan. Whilst there, I learnt several new skills and had many new experiences. On reflection, it was the most influential period of my career so far.

When I arrived back in Thailand I was transferred to Amata Nakorn, where the construction of MTEC had already been started. Amata Nakorn is one of Thailand's largest Industrial Estates and is an excellent location in which to establish the MTEC Technical Center.

I helped set up the equipment and facilities along with other colleagues by using the knowledge I gained during my time in Japan. After MTEC was officially opened I was given a number of roles to carry out. I was given responsibility as the main operator for the CNC lathe and also as a sub-operator for the machining centre. I conduct seminars, training and machining demonstrations when MTEC has visitors from Thailand or abroad. Another important role I am involved with is to assist our local Thai sales staff in areas such as troubleshooting as well as carrying out machining tests and writing of technical reports.

Even though I have only been a member of the technical team for a short time, the experiences I have everyday help me to continuously improve my knowledge and understanding of metal cutting processes. I do believe that we as a team, will develop and look forward to furthering and deepening our relationship with other global technical centres, ensuring that we offer current and potential customers a higher standard of services and solutions.

"Our engineering team works as one to provide a high standard of services and solutions."

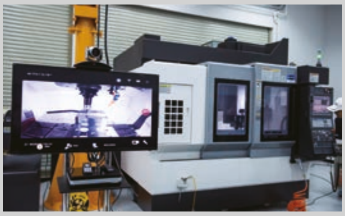
Napatpol Artharamas
MMC Hardmetal (Thailand) Co., Ltd.
Technical Engineer

Thailand Engineering Center's solutions services

1 Demonstrations using actual machines and a rich seminar curriculum

We provide lectures on the basics of metal machining technologies, such as milling, turning and drilling using materials published in Thai, Japanese and English languages. We also give active demonstrations using the latest CNC lathes and machining centres in the engineering machine room.

2 System for live streaming of demonstrations



We have established a ubiquitous training system equipped with an internet-based live streaming system showing demonstrations for remote customers. This enables them to "attend" our programs and seminars at their convenience.

3 R&D collaboration between industry and academia

We cooperate in research and development projects based on new business models. The ASEAN market promises future expansion, therefore to strengthen responses we are also exploring the possibility of a joint development with major universities and research institutions in Thailand.

CUTTING EDGE

Vol. 2

Tomoyoshi Sakamoto (left), Yuji Takaki (centre), Wataru Takahashi (right)
Advanced Technology Team, Development Division Processing Technology Center

Seamless and self-turning

A rotating tool developed for the market 20 years ago

It all started with a customer's request. They wanted to reduce the number of insert corner changes on a mass production machining line. They also wanted to make complete use of the insert's peripheral edge. There was a definite need for imagination in order to meet this seemingly impossible request. That's when we came up with the idea to rotate the insert itself: and invented the rotary holder. The insert had to be rotated, therefore in the early stages of development we experimented with a sliding and other types of bearings (oil retaining, solid lubricant, carbide + DLC coating). However, these types could not successfully overcome the problem of the insert rotation stopping under certain cutting conditions. After finding that mechanism using sliding type bearings made it difficult to reliably rotate the insert, we replaced the slide bearing with a needle roller type. This solved the rotation issue, but new problems arose. There were side effects from the cutting temperature, it was difficult to improve lubrication and also to prevent shavings from penetrating the bearing housing. Downsizing was also challenge. We cleared each problem step by step, by using different seals and so on until the tool could finally withstand practical use. When put into actual use, it was found that it was possible to use the entire periphery of the insert, but it was also evident that the effects of lowered relative velocity with the workpiece also contributed to improved wear resistance.

1996年(平成8年)11月12日 火曜日

丸形超硬チップが回転

新発想の旋削工具 摩耗を大幅減少

三菱マテ

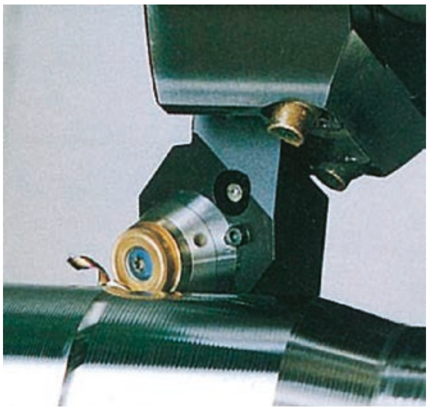
Newspaper article about the development
(Nikkan Kogyo Shimbun November 12, 1996)

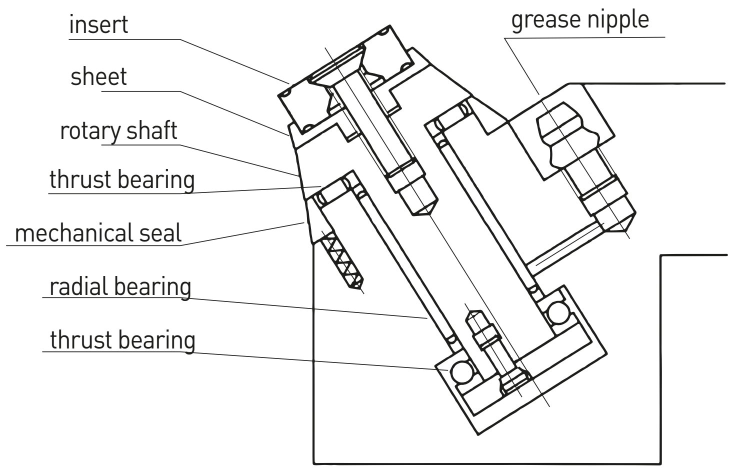
Reducing abnormal damage with an ingenious rotating tool

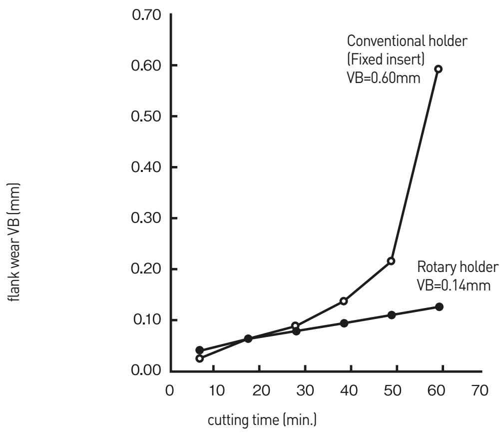
Mitsubishi Materials developed the rotary holder, a turning tool designed so that the cutting forces caused the round carbide insert to rotate automatically; it achieved the following benefits:

1. Unified wear eliminated the need for insert positional changes until the insert was spent.
2. The constantly moving cutting point meant no boundary wear (see column below) to the cutting edge.
3. Non-concentrated cutting heat reduced insert wear.

As shown in the graph below, these three advantages made it possible to create a stable, long-life when compared to a fixed insert tool. If the workpiece is manufactured from a tough material, abnormal damage can occur due to high temperatures when cutting, or the workpiece can be easily work-hardened. For a standard tool, lowering cutting conditions helps to prevent abnormal damage, however, this also reduces efficiency. The rotary tool negates the need to reduce cutting conditions by rotating the edge of the tool during cutting, thereby improving machining efficiency and extending tool life.







<test conditions>

Sample:	rotary insert (AP20M)
Comparative samples:	fixed insert (UC6010)
	RCMX2006M0
	insert / RCMX2006M0
	PRGCL3232P20
	holder / PRGCL3232P20
Workpiece:	SNCM439 (270HB)
Cutting conditions:	vc: 200m/min
	f: 0.30mm/rev
	ap: 1.5mm dry cutting

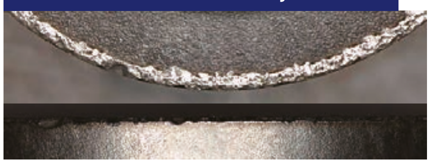
The rotary holder went on sale roughly 20 years ago and was well received by customers because of its novel mechanism and cutting performance. Unfortunately however, it is now no longer a stocked standard tool because of later improvements to cost and performance of conventional tool holders. However, it remains very effective in suppressing abnormal damage and its value is once again being reviewed because more components are being manufactured from difficult-to-cut materials. By passing down the know-how regarding rotary tools from the developing team 20 years ago to today's young tool development engineers, a next-generation rotary tool, in tune with the workpieces and machinery of today, is currently under development at Mitsubishi Materials. Stay tuned!

Boundary wear

Standard tools often suffer from damage called boundary wear or notching when the cutting edge is affected by the work-hardened layer of the workpiece, casting or forged surface (see diagram below). Work-hardening of the material occurs where cutting has caused plastic deformation. Extra boundary wear or notching occurs at the point where the insert contacts the work hardened layer. Likewise, cast and forged surfaces have tough surfaces that contribute to notch damage. Compared with other workpieces, INCONEL®718 and stainless steels are particularly vulnerable to work-hardening, which means notch boundary damage is likely to occur.

Boundary or notch damage

Insert wear from rotary tool cut



Sumo

"Hakkeyoi, nokotta!" The Gyoji clad in his beautiful costume signals the start of a powerful bout between two sumo wrestlers. The setting is perfectly set, with the suspended roof over the dohyo and ready to show the distinguished rituals of the ring entering ceremony and the bow dance. When you go to a Honbasho to watch sumo, there is far more to enjoy than simply the "match".

Known as Japan's national sport, sumo dates back to the age of mythology. The word sumo originally comes from the ancient noun sumahi meaning "battle". The word sumahi can be found in Kojiki (Records of Ancient Matters) and Nihon Shoki (Chronicles of Japan) written in around 720 A.D., to describe contests of strength between the gods.

During the Heian Period (794~), messengers were sent around the country to gather sumahi people (sumo wrestlers) to entertain nobility and the emperor. After the bouts, grand banquets were held. Sumahi continued as a court event for 400 years, while slowly developing into the form we know today as sumo.

In the days of the samurai from the Kamakura Period (1185~) through the Azuchi-Momoyama Period (1573~), shoguns and feudal lords began to take an interest in sumo wrestling and they too, gathered wrestlers to watch. Warring Lord Oda Nobunaga had a special preference for sumo, inviting wrestlers from all over Japan to the Azuchi Castle in Omi to perform. It is well known that he welcomed the strongest into the castle as retainers.

Sumo started to become a form of box office entertainment when collecting entrance charges from the public started during the Muromachi Period (1336~). By around the middle of the Edo Period (18th century) different sumo groups that had independently been holding performances, gathered together. This gathering created the basic structure of what would later become professional sumo wrestling, with six scheduled Honbasho tournaments per year. Sumo's popularity grew quickly with the rise of great wrestlers such as Onogawa Kisaburo and Tanikaze Kajinosuk, one of the first Yokozuna's. Along with kabuki, it became established as the people's entertainment of the Edo Period.

Throughout its long history, sumo gradually took shape as a sport and became a traditional culture unique to Japan. Today, while balancing tradition with innovation, sumo still continues to fascinate fans from across Japan and all over the world.

Ryogoku Kokugikan

(Our editorial team is located in Ryogoku, the Sumo town)

The heartland of Sumo

Six sumo tournaments called Honbasho are held each year. Three of them (the January, May, and September Basho) are held in Tokyo, at the Ryogoku Kokugikan just north of JR Ryogoku Station. Colorful banners with names of sumo wrestlers written on them line the streets during the tournament, adding a true ambience to the sumo town. The first thing that makes visiting Ryogoku Kokugikan especially exciting is approaching the stadium gate. There's a good chance of meeting stable masters, who were once famous wrestlers because they stand there as ticket collectors. Once inside the hall, you are enveloped in the sumo world with 20 information booths side-by-side and the area is usually bustling with ushers dressed in hakama and ladies dressed in kimono. There is a sumo museum on the first floor of the Kokugikan where you will find an abundant collection of sumo artifacts such as woodblock prints, banzuke (rank charts), and keshomawashi (ornamental aprons worn by Yokozuna).

Sumo basics

Sumo rules are simple. The Gyoji is the referee and two men wearing sumo belts wrestle until one wins by knocking the other down or pushing him out of the ring. If one commits a foul such as intentionally pulling the opponent's hair or by grabbing him, he automatically loses. Tournaments called Honbasho are held six times a year and each lasts for 15 days. The wrestlers engage in one bout a day and the wrestler with the most wins is the champion. The official list showing the wrestlers' rankings is called the banzuke. There are ten ranks, from Jyonokuchi at the bottom through to Yokozuna at the top. In Japanese sumo wrestling, the banzuke means everything. The ranking represents the size of each wrestler's salary and the level of privileges they are entitled to. Only wrestlers who have reached Sandanme (third stage) are allowed to wear leather-soled sandals and only Juryo and above can wear the formal attire, haori hakama.The promotion and demotion in ranks is determined at the banzuke ranking conference held after each tournament. Essentially, the rank of a wrestler goes up when he wins eight or more bouts during a tournament and goes down with eight or more losses. Traditionally there are no bouts held between members of the same stable or between brothers. This is based on the deep-rooted hidden samurai compassion that would pity both parties confronted in such a situation.

There are 82 winning moves in Sumo

A winning move in sumo wrestling is called a kimarite, of which there are currently 82. Of these, the most commonly used is yorikiri, followed by oshidashi. Nearly half of the kimarite used in post-intermission bouts during the 2015 Hatsu Basho (January tournament) were yorikiri and oshidashi, which are classified as basic kimarite skills. Other skills include sokubi otoshi where an opponent is struck downs from above the neck and tsumadori where the opponent's foot is pulled back in order to make him fall.

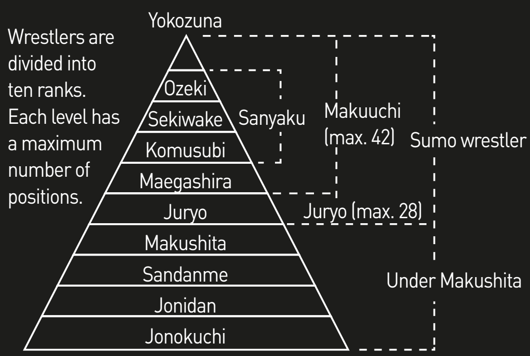
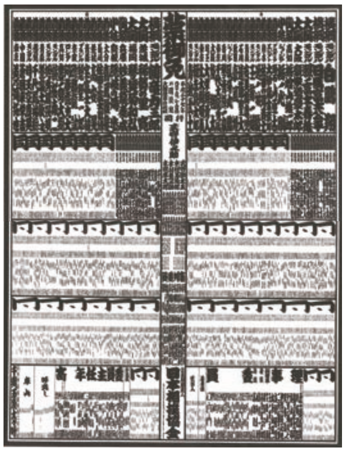


Fig. Rank and number of wrestlers



Sumo wrestler names are larger and thicker as the rank rises

Oshidashi (frontal push-out)

Strike the opponent's side or chest to push him out of the ring.

Yorikiri (frontal force-out)

Push the opponent out of the ring by attacking the torso and moving him backwards or sideways.

Uwatenage (overarm throw)

To grab the mawashi (belt) from over the opponent's extended hand and throw him.

Kinjite (forbidden)

Dangerous and dirty moves such as grabbing hair, striking with a closed fist or slapping both ears at once with open hands are forbidden.

Sumo Trivia

1. Only men can become sumo wrestlers. Women are not allowed.

To become a sumo wrestler, you need to clear three conditions to pass as a new apprentice, known as a Shin-deshi 1) You are a male, under 23 years of age and have completed compulsory education. 2) You are at least 173cm tall. 3) You weigh at least 75kg. It is documented in the sumo rules that "wrestlers are limited to the male gender".

2. The "Splits" are an important part of the training to become a strong wrestler.

The most important thing for a sumo wrestler is to train his body to be flexible so that he doesn't get injured. As part of this routine they practice the "splits", stretching their legs to the left and right. Wrestlers who have completed training must be able to spread their legs 180 degrees while touching their torso and chin flat on the floor. New wrestlers practice in the sumo training room in the Kokugikan for six months to learn the basics, including the splits.

3. Ryogoku is filled with restaurants that specialize in chanko nabe, a sumo wrestlers cuisine.

Chanko nabe is known as standard sumo wrestler food. It is a huge hot pot with stewed seasonal vegetables, fish and chicken, eaten with a dipping sauce or ponzu vinegar. Many specialty restaurants line the streets Ryogoku, home of the Ryogoku Kokugikan where chanko nabe originated.

4. Throwing salt before a bout is to cleanse impurities.

Before a bout sumo wrestlers sometimes throw salt. This custom began as a ritual to cleanse the dohyo, which is considered a sacred place. During the Honbasho, about 45 kilograms of salt is used a day. This adds up to more than 650kg for the duration of the tournament. Wrestlers are only permitted to throw the salt after they reach Makushita status, and only when time allows.

5. Like businessmen, sumo wrestlers are paid salaries.

Sumo wrestlers are paid on a salary system, but salaries are paid only to wrestlers who are at Juryo ranking or higher. The Makushita and lower ranks are paid an allowance for each Basho. A Yokozuna's basic salary is 2.82 million yen per month and a Makushita's allowance is 150,000 yen per Basho. There is also prize money and the more a wrestler wins, the more money he can earn.

6. The Man-in Onrei (full house) banner is displayed in accordance with ticket sales

The banner over the suspended roof reads "Man-in Onrei" and means that it is a full house (see upper photo on previous page). This banner is lowered after the Juryo bouts are finished at the moment the "ki" (wooden clappers) start to signal the beginning of the Makuuchi bouts. It is said that the banner is only shown if at least 80% of the admission tickets for that day are sold by 3:00 p.m.

Source of Emotions

"I hope to pass on this cultivated technology." "Drill a hole by hand through soap and feel with all of your senses." "Daily repetition makes people strong."
Even in interviews that start off on a nervous note, after several carefully chosen questions there usually comes a time when even experienced interviewee's let their guard down and open up their inner thoughts. It is at this moment that the really pertinent points can be expressed freely and openly and a genuine article can be written from those reactions.
Pure emotions make people try harder and they follow their heart, wherever it leads. Their strong desires push them along and these repeated efforts can create a breakthrough. People are attracted to their crystal clear source of emotions, as these are the efforts that make them real.

"Your Global Craftsman Studio"
Chief Editor; Hideyuki Ozawa
(Business Development and Planning Department)

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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.

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