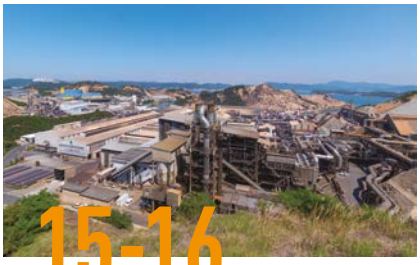
Mitsubishi Materials Craftsmanship Magazine

BM010E

YOUR GLOBAL CRAFTSMAN STUDIO

THE AUTOMOTIVE INDUSTRY

Vol. 10 Stories



Kazuo Ohara

President, Metalworking Solutions Company
Managing Executive Officer, Mitsubishi Materials Corporation

Opening the future of the automotive industry with the perspective of a tool provider

Ten years have passed since the first Your Global Craftsman Studio was issued in 2013. That first issue was two years after the Great East Japan Earthquake and record flooding in Thailand. These events interrupted our supply chain and caused significant inconvenience for customers, and we were eager to let them know that we had completely recovered. This was the main reason behind the start of Your Global Craftsman Studio. From that start, we have continued over the last ten years to highlight interesting and important topics in the manufacturing industry; and despite facing several obstacles that have interfered with the development of stories, obstacles such as the outbreak of COVID-19, which made customer visits difficult, we are pleased that we have made it to Volume 10, and I would like to express my deep appreciation to our readers for sticking with us through the difficulties we faced over these past ten years.

This feature focuses on current trends in the automotive industry during a time of a great change, as well as technological evolution and collaboration from the viewpoint of a tool manufacturer. We take a close look at changes in technological needs due to the sophistication and increased precision of parts and advancing EV conversion technology during this time of a great change.

We have also included articles on Mitsubishi Materials' focus as a tool manufacturer, the creation of new value through collaboration, the history of material technologies, development of smart factories for ultra-high-pressure tools, and ISO13399. I feel these articles provide important information and insights stemming from the knowledge and experience that Mitsubishi Materials employees have accumulated over their time in the industry.

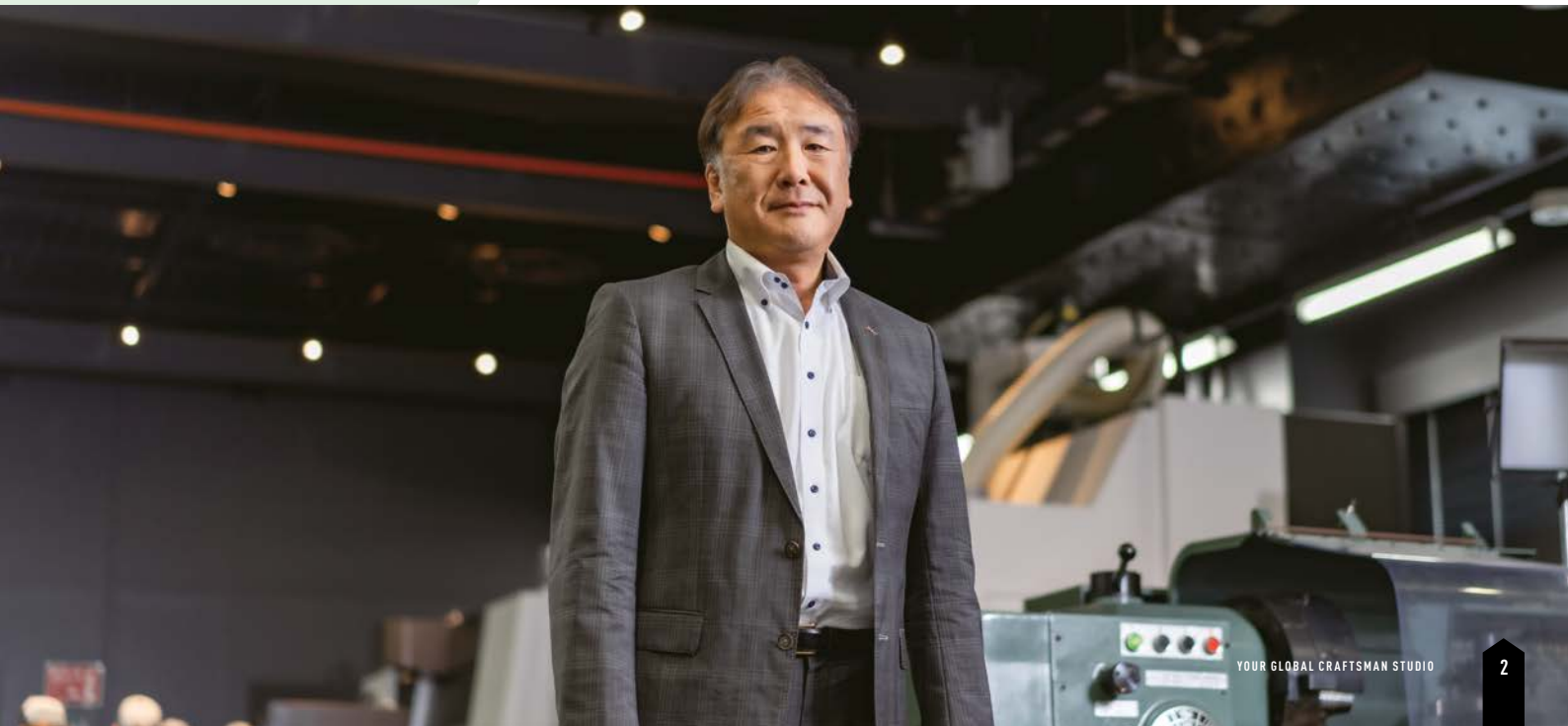
Your Global Craftsman Studio is a platform for sharing their most up-to-date knowledge and the experience we have accumulated as a global tool manufacturer with our global business partners.

Commemorating this 10th anniversary, we are also considering changes in the media through which we deliver content with plans to provide information in new ways. For the next 10 years, we will continue seeking the best topics and communication styles to ensure that Your Global Craftsman Studio realizes its full potential as a platform for the delivery of outstanding content.

I am very pleased that Your Global Craftsman Studio provides a wide range of information about the automotive industry. We continue with our commitment to display interesting and useful content, and I look forward to your continuing support as we move together into the future.

(to be continued to the next page)

YOUR GLOBAL CRAFTSMAN STUDIO



[Message to everyone at the Metalworking Solutions Company]

Reach Out!

Confident in our ability to contribute to customers successes

The Metalworking Solutions Company is committed to leveraging its experience and know-how as a craftsman studio to enhance customers successes.

Our mission priority is to help towards the success of our customers, and we are committed to exceeding their needs throughout the manufacturing process by ensuring high performance, stability and quality. To guarantee the productivity and quality essential for customer wins in a competitive market, we work closely together while always keeping in mind that the tools we provide are essential for success.

To achieve this requires the spirit of reaching out for something new towards others and towards customers. Society changes rapidly, and new problems and needs are generated throughout the manufacturing industry and the markets it serves. We must continue to pursue technological evolution to respond successfully to these changes. It is our mission as a tool manufacturer to advance new ideas and technologies in close cooperation with our collaborative partners without fear of failure to continue providing the products and services that satisfy customer needs. To ensure the fulfilment of the corporate philosophy, MMC Group circulates resources to create a sustainable future for people, society and the earth through the efforts of all employees throughout the Group; and I promise that this will continue to be our top priority.

The Metalworking Solutions Company strives to fulfil its potential as a tool manufacturer contributing to success and focuses all of its efforts on satisfying customer expectations.

I am confident that all employees are sincere in their efforts to ensure that Mitsubishi Materials products and services make meaningful contributions to the progress of industry and the society it serves. We enjoy working with customers to advance methods of manufacture, look forward to opening the future and continuing success together.

Kazuo Ohara
President, Metalworking Solutions Company
Managing Executive Officer,
Mitsubishi Materials Corporation

YOUR GLOBAL CRAFTSMAN STUDIO

AWARD for Supplier Day 2023

AWARD

NEWS
for Supplier Day 2023

Awards achieved by building trust
Closer relationships with leading global suppliers

Interviews with two representatives of Mitsubishi Materials overseas affiliate MMC Hartmetall GmbH about their award.

Mitsubishi Materials received an award at the Supplier Day Awards in 2023, for being an outstanding partner and supplier to the global automotive and industrial manufacturer, the Schaeffler Group. The Group has more than 80,000 employees working at 200 bases in 50 countries. Mitsubishi Materials was the only Japanese company to be recognized in 2023, and the first Japanese tool manufacturer to receive the award. Among a wide range of categories, including innovation, sustainability, and cost-performance, MMC Hartmetall GmbH received an award in the quality category.

Patrick Peter said, "I am delighted to receive this prestigious award, which marks the 15th anniversary of my appointment as Schaeffler Group Manager in 2008. This time we won the award in the quality category, but it is by no means just about the product. We have specific numerical targets and evaluation criteria for work efficiency, on-time delivery rates and support systems, which our teams have worked together to achieve over the past few years, and I am proud of the achievements the team has made."

Tetsuo Yamazumi, President of MMC Hartmetall, says he was more than happy when a representative of the Schaeffler Group told him, 'We have confidence in your company. I hope we can share this feeling of pride with everyone we have worked with,' he said, reflecting on the award ceremony. The Schaeffler Group is expanding its business not only in Europe but also in other parts of the world. We would like to use this award as an opportunity to build deeper relationships over a wider range of regions,' said Yamazumi, who also has high hopes for future global expansion.

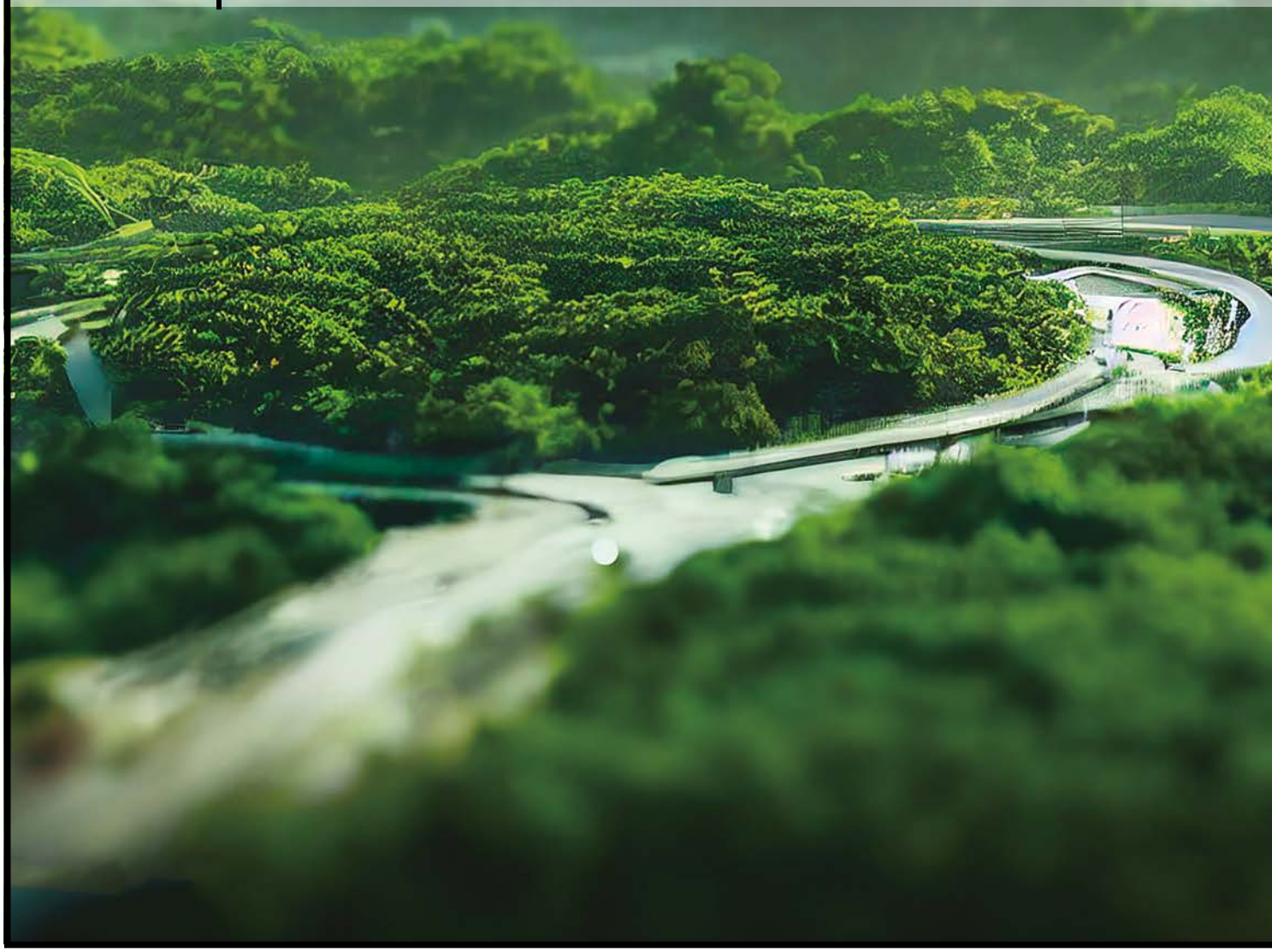
At the award ceremony held in Herzogenaurach in May 2023
(From the left) MC of the ceremony, Claus Rosenfeld (CEO, Schaeffler AG), Tetsuo Yamazumi (President, MMC Hartmetall GmbH), Patrick Peter (Manager in charge of the Schaeffler Group account for MMC Hartmetall GmbH), and Georg F.W. Schaeffler (Head of the Schaeffler AG Supervisory Board)

Conditions required for partnership

As a leading global supplier of bearings and other parts for automobiles and industrial machinery, the Schaeffler Group considers partner company relationships and trust as a very important function in global supply chains, which have encountered a wide range of issues. Partner relationships and trust are extremely important in ensuring improved processing efficiency and achieving numerical targets for economic efficiency. To achieve these targets, high-quality products supplied from Japan play an important role. Patrick Peter said, "I deeply appreciate Japanese engineers and also anticipate even greater quality improvement." The high evaluation given by the Schaeffler Group is shared by partner companies around the world, and it will have a significant influence on the global framework for delivering new solutions.

Turning Point for the Automotive Industry

Attention Must be Paid to Future European Standards



The shift to electric vehicles (EVs) is unchanging; however, movement varies

Changing trends in the EU
In July 2021, the EU announced its "Fit for 55" package of new proposals aimed at reducing 2030 CO2 emissions by at least 55 % from 2021 levels. In response to this new target, the EU proposed limiting sales of new vehicles in Europe to EVs and FCVs from 2035. With this proposal it was assumed that beginning in 2035, the sale of internal combustion engines (ICEs) would be prohibited.

However, resistance from Germany and other countries against the exclusion of e-fuel vehicles caused a compromise in the policy to allow the continuing sale of e-fuel vehicles beyond 2035. A synthetic combination of captured CO2 and hydrogen, e-fuel emits zero CO_2. In other words, e-fuel is carbon-neutral.

Behind the call for compromise was concern about power supply. An increase in EV production without an increase in the supply of electricity could lead to power shortages in Europe. This has raised expectations globally for fuel cell vehicles (FCVs), e-fuel vehicles (EFVs), and plug-in hybrid vehicles (PHVs).

On the other hand, China is experiencing rapid growth in EV production. Being unable to compete against ICE production in Japan, Europe and the United States, China looked to strengthen its EV industry. The government facilitated this policy by providing subsidies to EV businesses, which resulted in increased sales of EVs. The influence of this policy was made clear when demand for EVs dropped rapidly after the Chinese government announced the discontinuation of subsidies at the end of 2022. As a result, the policy was changed again to continue subsidies, and demand is currently recovering.

Indonesia is also promoting EVs on a national scale. The reason for this is to prevent air pollution, which is becoming an increasingly serious problem in the country, and the government is providing subsidies to promote the switch to EVs. As a result, the country has overtaken Thailand, which had been ahead of Indonesia in terms of EV sales.

Japan also considers employment in the automotive industry

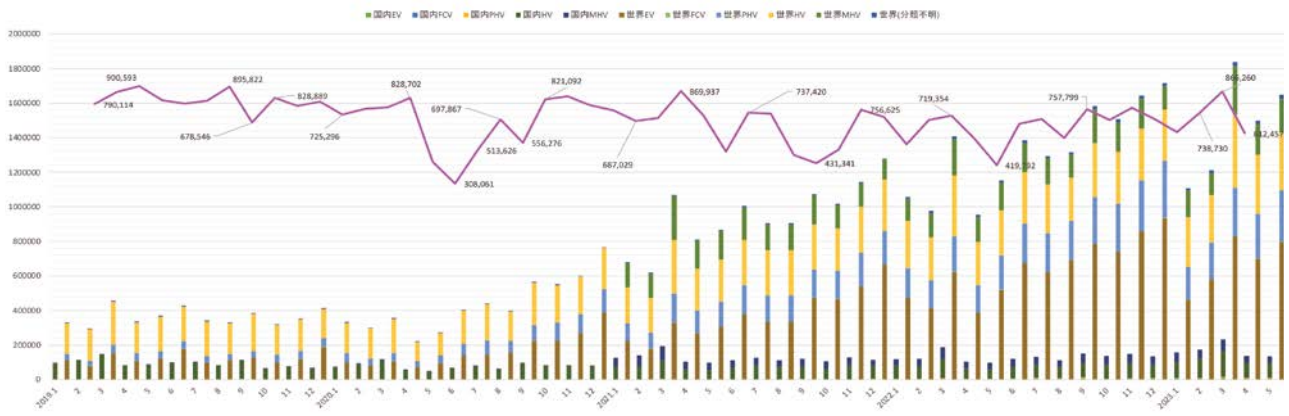
In Japan, Toyota has announced a plan to increase global EV sales to 1.5 million units per year by 2026 and to 3.5 million units by 2022, an extremely ambitious target given the company's current EV sales performance of around 24 000 units in FY2022. However, Toyota's basic strategy is considered to be an all-round strategy that includes not only EVs but also hydrogen engines.

Japan's electricity situation is similar to Europe, in that if all Japanese cars were to be replaced by EVs, the amount of electricity equivalent to the output of several new nuclear power plants would be required. There is also an undeniable risk of a shortage of rare metals for batteries.

The supply of rare metals is a global problem, and in June 2023 the EU adopted a draft regulation requiring the recycling of batteries used in EVs and other vehicles in the region. This stipulates that 50 % of lithium, the main material, must be recycled by 2027 and 80 % by 2031.

There is also concern that the rapid transition to EVs may have a significant impact on the domestic labour market in Japan. Since the transition from ICE vehicles to EVs significantly reduces the number of parts used, it is estimated that of the approximately 5.5 million employees currently engaged in the automotive industry, from 700,000 to 1 million people may lose their jobs. Considering the industry's position as a major employment market in Japan, manufacturers will be searching hard for ways to protect their employees.

Looking at the global trend as a whole, the move toward a complete transition to EVs in Europe seems to be slowing slightly; however, China continues its bid to be the world's leader in the transition to EVs while Japan is exploring a variety of options, including PHVs, because of concerns about employment. Under these circumstances, it remains a challenge to predict whether all the countries around the globe will start moving in the same direction. However, from the viewpoint of carbon neutrality, it is clear that the manufacture of ICE vehicles will be reduced in the future.



EYE on MARKET Turning Point in the Automotive Industry

Carbon neutrality is a global goal

Carbon neutrality is not just a priority in the automotive industry. It has become a global pursuit. In its 6th Assessment Report issued in 2023, the Intergovernmental Panel on Climate Change (IPCC) emphasized the need for a rapid reduction in greenhouse gas emissions. In response, UN Secretary General Antonio Guterres called on member nations to move the schedule forward to achieve reduced emission targets.

Corporations have advanced their approaches to reducing emissions. America's Apple Inc. has asked its global supply chains to achieve carbon neutrality by 2030, and the same trend is being seen in the automotive industry. In fact, one European automobile manufacturer has asked its suppliers in Japan to achieve the CO_2 emission targets it has set and has hinted strongly that suppliers who fail to meet them would be dropped as partners.

In the past, safety standards in machine tools were established on the basis of EU standards. Similarly, standards in the automotive industry are essentially set by Europe. It is quite likely that European car manufacturers will require carbon neutrality in the supply chain in the future, and parts manufacturers will need to prepare accordingly.

Accelerated transition to aluminium parts

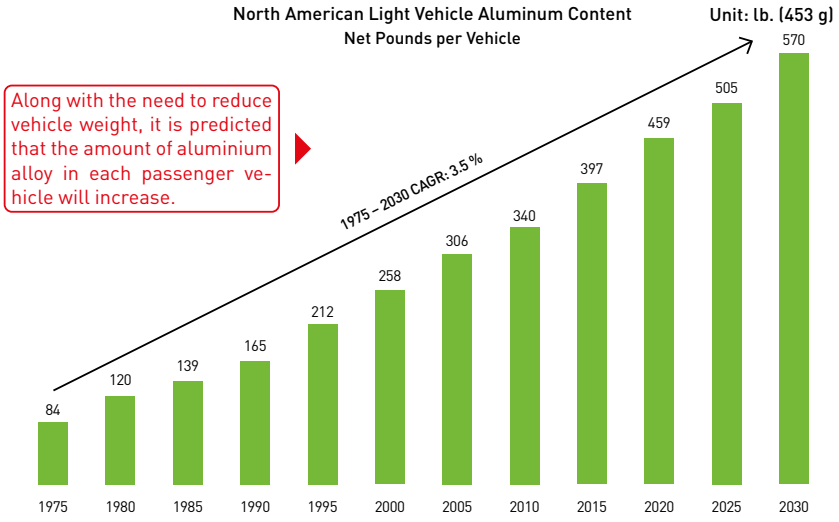
The transition from ICE vehicles to EVs means the phasing out of traditional engines and transmissions. A prime example of this transition is the e-Axle, a traction unit for EVs that includes a motor, speed reducer and an inverter package. The e-Axle, a core EV component, will become increasingly compact, and some 30 % of the approximately 30,000 parts that go into the manufacture of ICE vehicles are expected to become unnecessary. On the other hand, new types of components for the e-Axle and other units will be required.

EVs are equipped with high-capacity lithium-ion batteries, which makes the vehicle heavier than ICEs of the same size. Therefore, a shift to aluminium materials is expected in order to reduce weight, and some are seeking to substitute metals with plastic resin. According to data from the US market, the average annual growth rate of aluminium alloys used in passenger cars is expected to be 3.5 %; by 2030, and the aluminium alloy used per passenger car is expected to be about 260 kg, equivalent to about 15 % of the total weight of a passenger car. This shift to increase aluminium components will create new demand for the tools needed for aluminium machining.

Considering the popularization of European standards, approaches to carbon neutrality in component production has also started. This is seen for example in the movement to downsize conventional production lines. In response to this, the shift of the reduction of spindle size from BT40 to BT30 has also moved forward.

Average Annual Growth Rate

According to the data from American markets, the CAGR (compound annual growth rate) of aluminium alloy will grow 3.5 % per year. The amount of aluminium alloy per vehicle by 2030 is predicted to be approximately 258 kg (570 lb), or about 15 % of the total weight of components used per passenger vehicle.



Source: Duckerfrontier Corporate Report
http://1pp2jy1h0dtm6dg8i11qjfb1-wpengine.netdna-ssl.com/wp-content/uploads/2020/08/DuckerFrontier-Aluminum-Association-2020-Content-Study-Summary-Report-FINAL.pdf

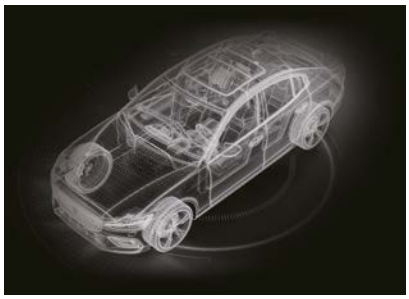
Helping to reduce CO_2 emissions utilizing highly accurate simulation

Keeping pace with the shift to EVs, Mitsubishi Materials Corporation is developing a wide range of tools for machining aluminium and downsized production lines. Furthermore, we are also reinforcing our digital solutions to support the move toward carbon neutrality.

We consider these movements to be a shift from selling things to selling concepts. We utilize the results of CO_2 reduction from individual customers that have different goals to create customer-specific simulations based on facility size, type of work, drawing data, machining programs, etc. to visualize cutting resistance during machining. This allows us to accurately judge in advance whether we can truly achieve the desired CO_2 emission reduction goals.

These simulations make it possible to conduct assessments at Mitsubishi Materials Technical Centres using actual machines, this helps customers reduce their workload in the test phase. We are able to provide highly accurate simulations because of our impressive store of Big Data and extensive know-how based on our long-term experience with the data. Our simulation services have provided about 800 analyses over the past five years.

Mitsubishi Materials has already advanced initiatives for carbon neutrality, even raising our greenhouse gas emission reduction targets in February 2023 following a review of our progress. At the same time, we have been collecting our used cemented carbide tools for reuse as raw material. Through such initiatives, we are also supporting customer approaches to carbon neutrality.



FOCUS on PERFORMANCE

Brother Industries, Ltd.

(Nagoya City, Aichi Prefecture)

Constantly enhancing productivity with small-size machine tools Pioneering a new field with the SPEEDIO Series

Machine tools and cutting tools are always closely associated. Given this, it is surprising that Brother Industries, Ltd., a well-known leader in machine tools, and Mitsubishi Materials Corporation, a specialist in cutting tools, have not worked together before despite both companies having more than 100 years in the industry. This has changed, though, as the two companies have now teamed up to start a joint project for the creation of an integrated holder, closely collaborating on development, joint promotion and expansion into new fields and evolve together. We invited people involved in this collaboration from both companies to a roundtable.

Mitsubishi Materials Corporation

More than a century of experience / Outstanding small-scale machines for 60 years

Brother Industries, Ltd. opened for business as a sewing machine repair shop in 1908. In the one hundred years since then, the company has captured the top market share for both home-use and industrial sewing machines. It also leads the industry in printers and multi-functional peripherals.

In 1962, Brother Industries leveraged its leading-edge technology to introduce tapping machines for threaded hole processing. In 1985, it launched the CNC Tapping Centre an outstanding advancement in the industry that brought increased accuracy and productivity. Since then, it has continued to develop equipment and control devices as a major core strength.

"It's because engineers involved in the development of the NC (numerical controller) device are deeply familiar with the mechanics of the machine, we were successful in reducing wasted movement to maximize efficiency. Our primary focus from the beginning with the BT30 spindle for small-size machine tools was on boosting productivity by increasing the speed at which materials could be cut," said Nagoya Sales Office's Kenta Shimodaira. He explained that they repeated a process of trial and error not only to increase cutting speed, but also to process larger materials and materials with a higher tool load than what was possible with a conventional BT30 spindle.

The initial CNC Tapping Centre design eliminated functions, in spite of the trend for multi-functional machine tools, to focus on machining productivity. Keeping pace with market demand, milling and fine boring functions were added. With the popularization of personal computers and mobile phones, the CNC Tapping Centre gradually established itself as a small-size machine tool in both Japan and China.

Development of the SPEEDIO brand and collaboration with Mitsubishi Materials

Launch of the compact SPEEDIO machining centre brand in 2013 was a major turning point in Brother Industries' machinery business. After successfully launching the S Series, which focused on the BT30's high productivity, Brother introduced the M Series, which incorporated lathe functions, the R Series, which incorporated a high-speed double surface pallet changer, and the W Series, which has the largest processing area for the BT30 class. The success of these products has solidified the brand's standing in the machinery business.

"The most notable characteristic of the BT30 is high productivity. Since the launch of SPEEDIO, which has been very well received, market share has been growing steadily with upgrades being introduced every year to keep pace with the need for new machining trends, technology and increased productivity. Such progress in machine tools requires ongoing evolution in tools for machining," said Yunosuke Hirose of Development Group 1. He continued, "Even before the launch of SPEEDIO, the quality of milling cutters produced by Mitsubishi Materials was well known in the company. Surprisingly, however, there were no joint projects with them despite the fact that Brother had prioritized relationships with tool manufacturers."

Atsuhi Kitamura, Tooling Management Section, Technical Sales Dept., Mitsubishi Materials Corporation, said, "We did not understand the BT30's potential until a few years ago. We all thought BT30 was inappropriate for difficult-to-cut materials. We now know differently."

SPEEDIO S SERIES

S300Xd1 / S500Xd1 /S700Xd1

Launched in 2013, the SPEEDIO S Series has become the best seller.

In 2022, the first model change in three years improved the intuitive operability with the newest CNC device and a large touch panel. The maximum weight of the tools allowed increased significantly to 4 kg. Broadening the range of more usable tools gained high praise from customers engaged in the machining of components for automobiles and IT devices.

Kenta Shimodaira
Nagoya Sales Office, Domestic Sales Dept., Industrial Equipment Sales Div., Machinery Business, Brother Industries, Ltd.

Yunosuke Hirose
Development Group 1, Industrial Equipment Development Dept., Machinery Business, Brother Industries, Ltd.

Atsushi Kitamura
Tooling Management Section, Technical Sales Dept., Sales Div., Mitsubishi Materials Corporation

Strengthening the business collaboration structure through the development of the iMX BT30-Integrated Holder

Brother Industries and Mitsubishi Materials did not have a business collaboration structure in place when Mr. Hirose and Mr. Kitamura met in 2019. It was then that Mr. Hirose first asked Mr. Kitamura, about the possibility of developing a new, integrated BT30 holder that connects the head of the iMX end mill series to SPEEDIO without the need for a separate tool holder.

To explore the request, Mr. Kitamura and the team started working on the new holder concept. It took approximately two years, but in 2021, a prototype of the iMX BT30-integrated holder with a unique fastening mechanism was ready.

Mr. Hirose told us that he initially wondered if they could produce anything that would be significantly different from what other manufacturers had on the market; but as the team progressed, it became clear that they could significantly suppress tool vibration and increase accuracy. This also reduced noise to increase operator comfort during machining. "I could see the process up close, so I saw how motivated Mr. Kitamura and the team were to develop the tool."

The iMX exchangeable end mill head series achieves high rigidity with a double-face contact system of taper and end face and utilizes a unique technology that enables the attachment of special steel to screws. The two companies successfully collaborated to develop a holder that connects the head directly to the SPEEDIO unit that enabled an improvement in stability even under high cutting loads. This would be a bridge that connects Mitsubishi Materials and Brother Industries.

Approaches to processing difficult-to-cut materials using advanced technology gained through the joint development of the new holder

The power of the SPEEDIO series has improved each year, and it is now able to process materials at the same level as BT40 spindles can. The F series in particular has astounding rigidity, the highest among BT30 spindles. However, even if the machine tool can deliver extremely high power, capacity is ultimately determined by the rigidity of the tools and holders. Therefore, using the know-how and relationships built up through the development of the iMX BT30-integrated holder, Brother Industries and Mitsubishi Materials started a new joint promotion project.

Looking back on the experience, Mitsubishi Materials' Soshi Washimi said that they first recommended customers to use the SMART MIRACLE end mill series, which is excellent for machining difficult-to-cut materials. They demonstrated this by machining some stainless steel and other difficult materials. When customers had the chance to observe this machining, they could see that the speed was significantly higher than with BT40 series machines and they were clearly impressed with how much faster it was than conventional equipment. The Technical Sales Department's Tooling Management Section worked together to deliver a comprehensive range of support, not only for tool selection, but also for operating conditions and machining methods.

According to Masato Yukitoki, who was involved in the promotion, it was their first experience in an undeveloped field and to make videos of actual processing that would later be uploaded to their website. It was a great opportunity for them to move toward the next generation.

SPEEDIO F SERIES

F600X1

The F series is designed for high rigidity with outstanding machining capabilities added to its superior conventional productivity. It is suitable for difficult-to-cut materials such as stainless steel, titanium alloys and pre-hardened steels.

Products exhibited at the Brother Technology Centre

MS Plus Series
Superior cost-performance, general-purpose solid end mill series incorporating MS plus coating developed by Mitsubishi Materials.

FMAX
Feed maximum (FMAX) face-milling cutter featuring a light-weight and high-rigidity body. Precise runout adjustment of the cutting edge enables highly efficient machining of aluminium alloy and other non-ferrous metals.

Solid Carbide End mills
Suitable for aluminium alloys. This three-flute series achieves high-efficiency and precision machining. A wide-ranging product lineup of various geometries and also includes high-welding-resistant, DLC coating types that are also suitable for machining resin.

SMART MIRACLE End Mills
SMART MIRACLE coating enables high-efficiency and long tool life to deliver a revolutionary performance when machining difficult-to-cut materials such as stainless steels and titanium alloys.

iMX End Mills
The iMX series is a system combining the advantages of solid carbide and indexable cutting tools. Rigidity close to that of a solid-type end mills and a wide range of geometries ensures high-precision and versatility.

SPEEDIO M SERIES

M200Xd1 / M200Xd1-5AX

SPEEDIO M are multi-tasking machine tools capable of performing a wide range of applications such as milling and turning on one machine. The M200Xd1 was launched in 2022 to handle not only complex work, but also simultaneous five-axis cutting to machine more complex geometries.

Medical-Use Components Utilizing the Simultaneous Five-Axis Machining Function

While the SPEEDIO Series is used for a wide range of applications in the automotive industry, the unpredictability of the industry as it shifts to EV production has prompted Brother Industries to explore new areas. One of these key areas is the machining of components used in the medical industry.

Yasuhiro Itsubo told us that the new direction presented a challenge for him and the other members of the Promotion Team, but they eagerly brought themselves up to speed with this market segment and identified the best point of entry. "We received a tremendous boost when a specialist from Mitsubishi Materials stepped in to help us familiarize ourselves with a variety of highly regarded products that were used in health care throughout the United States and Europe."

"We discussed these at length and settled on artificial knee joints for patients suffering from rheumatoid arthritis and similar diseases that affect an estimated 10 to 30 million people in Japan alone. As society ages, the number of surgeries for knee-joint replacement will continue to increase, and this will create a demand for increased productivity. The SPEEDIO M Series, with its simultaneous five-axis machining function seemed the ideal solution to meet these demands. Producing the components for artificial knee joints requires extremely complicated multi-facet machining. The long-term use of these parts in the human body means that safety and precision are extremely important. The SMART MIRACLE end mill series from Mitsubishi Materials because of their high rigidity, performance and long tool life was selected to machine the knee replacement components made from titanium alloy."

SPEEDIO and Automotive Industry Moving into the Future

While moving forward with medical components, the automotive industry still remains SPEEDIO's major market. With the industry shifting to EVs, aluminium components will become larger and more complicated, which will increase the need of multi-facet machining centres.

The SPEEDIO U Series was launched in 2022 to meet these needs. The U series incorporates a large tilting rotary table with an expanded jig area of 500 mm in diameter with a BT30 spindle as standard equipment. The first model, the U500Fd1, maintains the same compactness and productivity as con-

Masato Yukitoki
Marketing Team, Solution Group, Industrial Equipment Development Dept., Machinery Business, Brother Industries, Ltd.

Yasuhiro Itsubo
Promotion Team, Solution Group, Industrial Equipment Development Dept., Machinery Business, Brother Industries, Ltd.

ventional BT30 tools, but is capable of five-axis machining, which allows the production of small-size motor cases, battery cases, gear case covers, bearing shields, pumps, housings, inverter cases and many other EV components.

It is still early days for EV production and many changes in machining specifications can be expected. But while changing specifications during three-axis machining forces a complete reprograming of the unit, five-axis machining allows a great deal of flexibility.

There was also a focus on the increased number of tools used for machining these complex geometries, which meant increasing the tool magazine for the U500Xd1 from 14 and 21 to 28 places. The Tooling Management Section's Mr. Kitamura told us that they did not have enough tools for demonstrations that they conducted with Brother Industries. "This wasn't a problem for the machining, but there was the danger of overloading the tools when multiple processes were assigned to each tool. With a 28-tool capacity, it is possible to have spare tools available in the magazine, which can prevent problems. On the other hand," he continued, "the more tools incorporated into the magazine, the larger the total weight becomes. We worked on reducing the weight of each tool." He told us that this is something they'll have to incorporate into development along with advancements in small-size machine tools.

SPEEDIO has been improved by reducing waste in terms of power consumption, air flow and coolant. Compared with large machine tools and machining centres with BT30 spindles produced by other manufacturers, SPEEDIO's energy saving tops the industry. The shift to EVs began with carbon neutrality initiatives aiming to reduce environmental load. During the transition period, SPEEDIO's market reach will continue to expand.

SPEEDIO U SERIES

U500Xd1

This universal model enables five-axis machining while requiring less space and maintaining high productivity, and also includes other specifications that are standard in conventional models. The U Series features a tilting rotary table with maximum jig area as standard equipment.

Continuing to evolve together

In 2023, Brother Industries launched the SPEEDIO H Series, the first horizontal machining centre with a BT30 spindle. This unique BT30 model maintains the same machine width as conventional models while achieving a maximum jig area of 800 mm diameter by alleviating interference.

Mr. Hirose said, "This new machining centre enables the machining of large and long workpieces that aren't possible for conventional units. The application of BT30 spindles will continue to expand in the future; and to realize the full range of capabilities, we want to deepen our partnership with Mitsubishi Materials. As we look to gain experience in unexplored fields such as the aerospace industry, we are counting on support from Mitsubishi Materials; and we are confident that the good partnership we're building will allow both companies to continue evolving."

Hiroto Murakami from the Anjo Sales Office feels that Mitsubishi Materials still has much more to offer to Brother Industries. "Our FMAX high-efficiency face-milling cutter, which features light weight and high rigidity, will be a great asset when processing aluminium alloys for the aerospace industry as well as for the machining of EV components. FMAX was developed with a focus on high machining speed, so synergetic effects with SPEEDIO can be expected. We'll bring new tools based on FMAX to Brother Industries that I'm confident will make a very positive impression."

Looking back on their relationship, Mr. Yukitoki closed the roundtable discussion by commenting on the comprehensive support provided by Mitsubishi Materials. "When I was in Thailand a few years ago, we always received excellent support from on-site staff and others via web conference. We also received outstanding support that enabled us to respond very effectively to customers in India and Vietnam, and they provided comprehensive layout ideas at demonstrations held in Japan. This level of support is invaluable and provides us with a great sense of security."

SPEEDIO H SERIES

H550Xd1

This compact machining centre processes large and long workpieces with a horizontal main axis. It enables high productivity, which allows multi-face and large component machining with a BT30 spindle.

Soshi Washimi
Tooling Management Section, Technical Sales Dept., Sales Div., Mitsubishi Materials Corporation

Hiroto Murakami
Anjo Sales office, Tokai Region, Domestic Sales Dept. Sales Div., Mitsubishi Materials Corporation

HISTORY OF MITSUBISHI

Vol. 10

Supporting Japanese growth through a century of copper refining
Developing a bright future through recycling at an urban mine

Mitsubishi Materials Corporation Naoshima Smelter & Refinery

Mitsubishi Material Naoshima Smelter & Refinery is located on the coast of the Inland Sea (Setonaikai). Naoshima is known both in Japan and overseas as an island of modern art. However, the plant here smelts copper as well as other non-ferrous metals such as gold and silver. Copper is an essential material for the development of civilization. Even today, it supports a wide range of industries, from electric wires to home appliances and IT materials. The smelter began operating in 1917 (Taisho 6). At the time, Japan was dominated by Yamamoto smelters attached to mines but there was need for a more efficient copper smelter.

An agreement between Naoshima Town and Mitsubishi Goshi Kaisha in 1916

Taisho Period (1912 – 1926)

Placing a priority on the environment from the start as a central refinery that meets demand

The increasing demand for copper along with the development of heavy industry during the Taisho Period (1912-1926) created an urgent need for a central refinery that could process ore brought in from mines around the nation. The coastal area of the Inland Sea, where many copper mines were located, satisfied the environmental requirements for refineries. Noshima Town in particular was enthusiastic about hosting this fundamental industry, but a major priority for the town was employing cutting-edge technology to prevent smoke and other environmental pollution. Thus began the history of environmentally friendly refineries developed under the leadership of Mitsubishi's 4th president, Koyata Iwasaki.

Major products in 1940. The company name was Mitsubishi Mining Company, Ltd.

Early Showa Period (1926 – 1989)

Supplying materials that supported Japan through hardships to achieve high economic growth

Naoshima Smelter & Refinery produced a wide range of products, including crude copper, crude lead, sulfuric acid, electrolytic zinc, cadmium and germanium until the early Showa Period. In 1939, the refinery's reverberatory furnace was upgraded to increase the production of crude copper from 300 to 1,000 tons per month. Operation ceased with the end of the war in 1945, but raw copper production restarted two years later. By 1952, the production of copper recovered to 1,000 tons, and reached 3,000 tons within five years.

In 1969, President Mitsuo Aikyo lit the newly built 2nd reverberatory furnace.

In the 1960's

Making the bold decision to invest in a new copper smelter under difficult circumstances, including the closure of copper mines

Since the high economic growth in Japan had cooled and domestic mines had been closing one after another, the copper refinery business found itself under pressure. It was against this background that Mitsubishi Mining Company Ltd. built a new copper smelter in 1969. The smelter had the 2nd reverberatory furnace with an electrolytic copper production capacity of 7,500 tons, a copper electrolysis plant, a sulfuric acid plant, a general office and a transformer substation (present-day Chugoku Electric Power Co., Inc.) comprising the foundation of the facility that has continued operating to the present day. Through large-scale investment in facilities and equipment, crude copper production more than tripled from the 54,000 tons that had been produced the year before.

Naoshima Smelter & Refinery around 1932, immediately after starting operation

The metal division is separated from the Mitsubishi Mining Co., Ltd. to establish Taihei Mining Co., Ltd.

View of the completed copper refinery in 1969, including the new copper smelting plant

The second copper electrolysis plant started operation in 1974.

In the 70s

Established the world's first continuous copper production method in spite of an oil crisis

It had been the dream of engineers to combine a series of processes into an integrated system, from the preparation of raw materials to the production of copper, since the time of King Solomon, the Biblical ruler who oversaw the birth of copper refining about 3,000 years ago. In 1974, Mitsubishi was the first in the world to introduce a continuous copper production method with an integrated refining system into practical operation. Takeshi Nagano, who would later become the first Chairman of Mitsubishi Materials Corporation, took the initiative in establishing the method. Having overcome difficulties brought on by an oil crisis, which caused delays in plant construction, they succeeded in establishing a world-class pollution-free and highly efficient method of copper production.

View of the completed precious metal plant in 1989

In the Heisei Period

While establishing a product lineup that has continued to the present, a serious problem arose on a neighbouring island

In 1989, a precious metal plant with the largest capacity for gold production in the Orient was built. This made possible the integrated production of not only for copper, but also for precious metals. In 1991, a new, highly productive continuous copper refining furnace integrating a continuous copper refining furnace and a reverberatory furnace was built. The plant established the production methods for the company's current major products – electrolytic copper, precious metals, sulfuric acid, plaster and crude nickel sulphate. During the Heisei Period, however, it was discovered that large amounts of industrial waste had been illegally dumped by a disposal company on Toyoshima, an island neighbouring Noashima.

A valuable metal recycling facility in 2003. Operation started a year later in 2004

Present

Aiming for further growth of the recycling business to realize a sustainable society

The amount of industrial waste, totalling more than 900,000 tons, was dumped illegally by the disposal company over a period of 16 years. The Naoshima Smelter & Refinery decided to give its full cooperation to Kagawa Prefecture to facilitate the intermediate processing of the waste. At the same time, Mitsubishi Materials started its waste recycling business to process materials such as shredder dust. At present, the processing capacity for scrap such as circuit board waste containing valuable metals (E-Scrap) is among the world's highest. Not only is the facility a major source of income within the metal business, but it is also an important step that Mitsubishi Materials has taken toward creating a sustainable society.

The third Lurgi-type sulfuric acid plant built in 1974

Lighting ceremony for the copper smelting plant held in 1992

Group-wide E-Scrap processing capacity target by 2030 will be 200,000 tons annually.

CRAFTSMAN STORY

Vol.11

Tomomasa Niizuma
Cutting Technology Section,
End Mill Development
Dept., Akashi Plant
Joined in 2006

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Yuji Takagi
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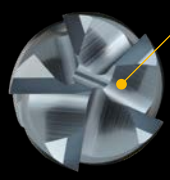
Five-Flute, Smart Miracle Coated, Vibration Control End Mills with Chip Breaker Function

「VQJCS/VQLCS」

The geometry breaks up and expels chips, improving machining efficiency and extending tool life

Demand for trochoidal milling has been increasing in the aircraft, automobile and other industries. Trochoidal milling combines a circular orbital and a linear motion, which reduces load when deep groove and pocket machining. However, there are certain issues. One of these is the large amount of chips generated. To address this, Mitsubishi Materials developed a unique method that uses the edge geometry of the end mill to break chips. When development started in response to a request from customers in Europe, many competitors had already launched products. Since the competitors had a head start, the Mitsubishi team had to focus on delivering higher performance.

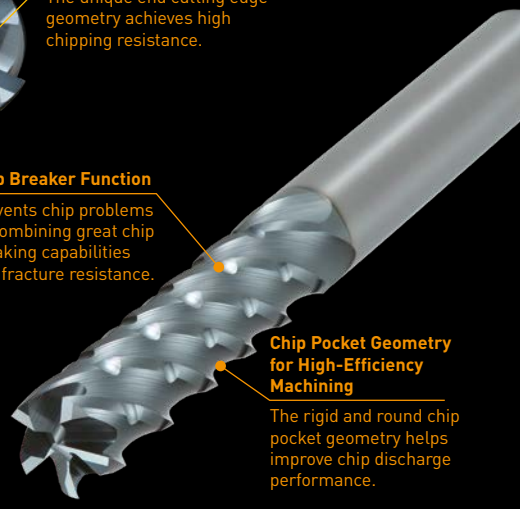


Unique End Cutting Edge Geometry

The unique end cutting edge geometry achieves high chipping resistance.

Irregular Pitch Flutes and Micro Clearance Angle of the Peripheral Cutting Edge

Due to its excellent vibration damping properties, chatter and vibration are suppressed making stable machining possible.



Chip Breaker Function

Prevents chip problems by combining great chip breaking capabilities and fracture resistance.

Chip Pocket Geometry for High-Efficiency Machining

The rigid and round chip pocket geometry helps improve chip discharge performance.

Exciting trials and significant pressure

- Would you please tell us your thoughts when you were first asked to develop a unique end mill?

Shikata It wasn't included in the lineup of conventional products, so I felt at first that it would be an exciting challenge. I started out by checking competitor's products and found that a few already had similar end mills. This increased the pressure because we had to develop a product that would be superior to the competition, while being very careful not to violate their patents. The Smart Miracle end mill series has superior base materials and coatings, so that was no problem; however, the geometry would be a key challenge. We revolved around a number of ideas based the roughing end mills whose structure is very similar to chip breaker types, and then we asked Niizuma develop 10 prototypes.

Niizuma Shikata always insists on the best results, so I knew from the start that expectations were high. It was a challenge to develop the optimal geometry, but we had the knowledge of the base materials and coatings that we had accumulated through the Smart Miracle End Mill Series, so making samples was not a problem. I wanted to give us enough time for in-house evaluation for the prototypes and worked hard to finish them well before the deadlines.

- How was the performance of the first prototype?

Shikata After looking at competitor products, I saw that they had achieved higher performance than I had expected. For the first prototype, I focused on vibration resistance, but I fell short on just about every specification. Having five flutes to improve machining efficiency made it difficult to suppress chatter. Besides the chatter, we also had to improve chip breaking capability, chip discharge and achieve rigidity. The pressure was really overwhelming.

Nagaoka We tested about 10 prototypes for a week to evaluate them. During that time, I could sense Shikata's disappointment. After repeating three or four evaluation cycles, though, we could see improvement in product quality that was clearly surpassing the competitor's products already on the market. I was continually surprised at the difference in performance we were achieving with only slight changes in form.

Shikata We intentionally applied an irregular pitch flute and minimized the clearance angle of the peripheral cutting edge, which helped produce well-balanced performance. Then, we experimented with different groove patterns to identify the most suitable for high-efficiency machining with an eye on a round form with high chip-discharge performance. In the end, high rigidity was also achieved. To break chips, end mills need some notches; however, the smoothness of the finished surface is almost the same as the smoothness produced by square end mills.

Ensuring high usability by maximizing performance

- You continued with development even after exceeding the performance of competitor products.

Shikata Both Managers of the Tool Development and Cutting Technology Sections provided an ideal environment, giving us a free hand and plenty of time to work with. This made it possible to achieve maximum performance within the range of prototype development.

Nagaoka From that stage, it was my turn to face the challenges. One example is that the prototypes had become more durable, which meant that we had trouble producing defects to evaluate the breakage limit even with very heavy loads. This added significantly to the time required for testing. In addition, during the tests, Shikata, who was always standing behind me, kept thinking of new ideas. He'd take a prototype that we had chosen carefully from all the protypes and come up with more changes that he wanted to try out.

Niizuma Development had kicked off with a request from a customer in Europe. We had originally focused on machining deep grooves in stainless steel. However, Shikata wanted the end mill to have different capabilities and for wider range of purposes. After we succeeded in developing a prototype with specifications that readily exceeded the competition's products, we began competing with ourselves, trying to surpass our results.

Shikata The three of us worked well together, and this is why we continued developing even better products. During the seventh evaluation cycle, data from the 10 prototypes developed by Niizuma finally showed no significant variation, so I left the final decision to Nagaoka to choose the final product.

Nagaoka During development, I saw myself as the first user of the product. I focused on tiny differences that I picked up on during the repeated evaluations, things such as difference in sound and usability, and evaluated these from the end user's point of view.

Aiming to expand end mills as a new series

- How did customers react to the completed product?

Shikata One comment in particular sticks in my mind: "This is the best tool on the planet right now." I was also pleased to receive high evaluations when we conducted field tests in Europe during the three or four months before we launched the end mill. Besides the trochoidal milling, they examined shoulder machining, for which data had not yet been acquired. This really demonstrated the product's great versatility. I deeply appreciated the on-site staff in charge of marketing in Europe for the work they did building good relationships with engineers across a broad range of markets such as the aerospace, plastic mould and semiconductor-related businesses.

Nagaoka Looking at the flagship products that the competition had on the market and comparing the data that we had acquired, showed that the threshold feed rate of our end mill was about two times greater, efficiency was about 1.5 times higher and tool life was about 1.2 times longer. With this in mind, I was confident that customers would be satisfied with our end mills. This turned out to be the case, and it was this that gave me great satisfaction.

Niizuma When we started development of the end mill, there was a mountain of problems to be solved. Therefore, we started on a small scale, developing only two types of end mills. However, since these products have been highly regarded as general-purpose tools, and customers in Europe have made additional requests, we are looking to increase the number of different types. We have already been working on larger diameter and longer end mills and would like to develop a corner radius-type to add to our conventional square-types.

TEHCNOLOGY ARCHIVE

The Strength of CBN Tools Built on the Firm Foundation of Experience and Technology Accumulated Throughout Our History

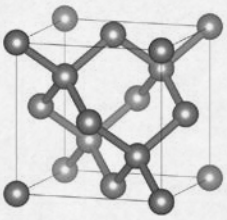
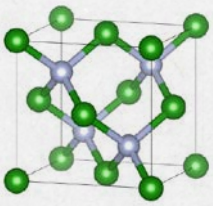
Artificial materials that are nearly as hard as diamond for cast iron machining

Machining tools have evolved through the development of new materials and looking at a history of machining tools wouldn't be complete without talking about CBN (cubic Boron Nitride). CBN is the second hardest material on earth after diamond and having lower affinity to iron (Fe) than diamond makes it highly suitable for machining difficult-to-cut materials used in the automotive and other industries. For this reason, tool manufacturers around the world have competed with one another to be the first and best. How has Mitsubishi Materials maintained its position at the forefront of the industry? Let's look at the early history of CBN and the search for next-generation solutions.

CLOSE UP

What is CBN (cubic Boron Nitride)?

CBN does not exist in nature. It is artificially synthesized under high temperatures and pressure in the same way artificial diamond is manufactured. The crystal structure of CBN is similar to diamond, making it extremely hard and heat resistant.

	Diamond	CBN
Crystal structure		
Material	A natural mineral composed entirely of carbon	A chemical compound composed of boric acid and nitrogen
Vickers hardness	>9000 Hv	>4500 Hv
Thermal conductivity	Approx. 2000 W/m·k	Approx. 1300 W/m·k
Characteristics	Affinity to iron (Fe) High	Affinity to iron (Fe) Low

K.Momma and F.Izumi,"VESTA 3 for three-dimensional visualization of crystal,volumetric and morphology data,"J.Appl.Crystallogr.,44,1272-1276(2011).

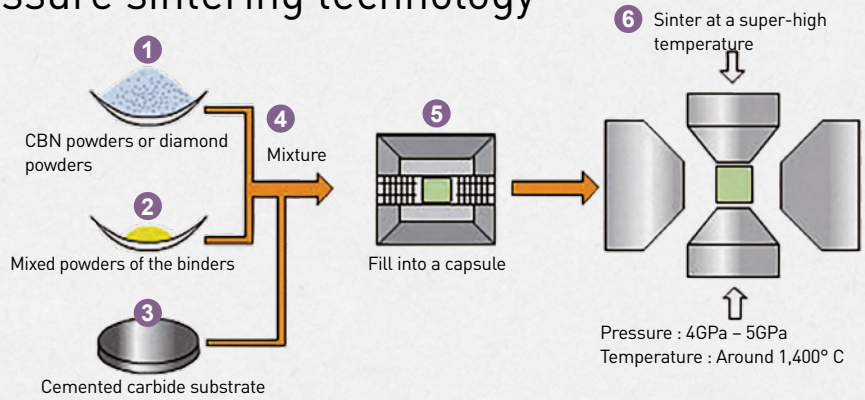
1 Early Period

Succeeding in manufacturing a material that does not exist in nature through ultra-high pressure sintering technology

The development of CBN tools was closely tied to artificial diamond. As is well known, diamond is the hardest material in nature. Beyond its value as a precious stone, its characteristic properties make it an excellent material for tools such as grindstones, dies and drills.

Natural diamond powder was already being used as a polishing agent as far back as 700 B.C. in ancient India. Polishers using diamond powder were being used in Belgium in the 1400s, and diamond dies were developed in England in the 1800s for use in the manufacture of piano wire.

Full-scale research on the syntheses of diamond using ultra-high-pressure sintering began in the 1950s. It was thought that sintering artificial diamond powder to produce a sintered body would make it possible to develop tools in a wide range of forms. In 1955, the world's first artificial synthesis of diamond was accomplished by an American company founded by Thomas Edison. In 1957, using ultra-high-temperature and pressure technology established for the artificial synthesis of diamond, the first CBN was synthesized. In 1969, CBN sintered body was commercialized.



Taking advantage of this cutting-edge technology, the Mitsubishi Material Central Research Centre (present-day Innovation Centre) started research and development of CBN tools in 1979. In 1982, Mitsubishi Materials succeeded in the development of a CBN sintered body and transferred the production line to its Gifu Plant. In 1983, MB10 and MB20 were launched. In the 1990s, MB810, MB820 and MB825 were launched to good market reviews. Compared to the standard inserts at that time however, these were expensive, which meant limited sales.

2 2000 ~ Development of New-Generation CBN Tools Using a Particle-Activated Sintering Method Developed by Mitsubishi Materials

In the late 1990s, when competitors were launching general-purpose CBN tools, the Gifu Plant initiated the development of new materials that would be superior to others. The development team focused on the interfacial reaction layer between ceramic binder and CBN particles used for a sintered body. The challenge they faced was an uneven reaction layer that prevented them from increasing the strength of the CBN body. The unevenness caused wear and other damage to the tools.

In 2000 after much trial and error, Mitsubishi materials developed a unique technology called particle-activated sintering. With this they succeeded in producing an even interfacial reaction layer and achieved both reduced wear and damage. Until then, improvement of one feature was usually at the sacrifice of the other.

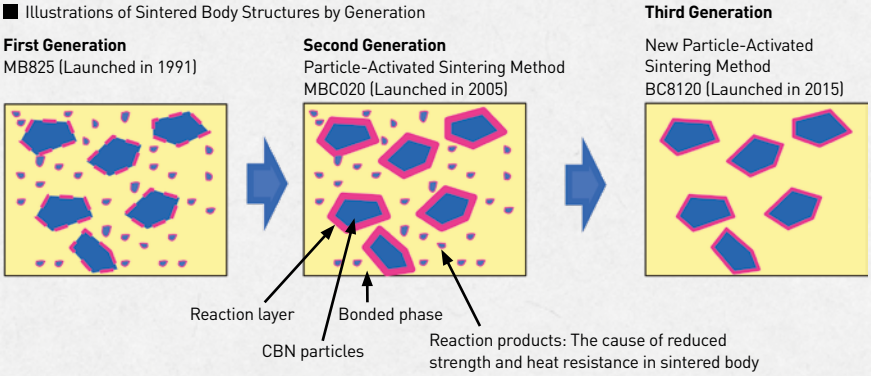
On November 5, 2003, Mitsubishi Materials launched a tool made using the MB8025 type of CBN, a general-purpose model based on the particle-activated sintering method. This was the beginning of second-generation CBN tools, which became the technological foundation for CBN tools that has lasted until today.

At the same time, in the early 2000s, PVD (physical vaper deposition) coating technology was applied to CBN tools by both Mitsubishi Materials and competitor companies. The Gifu Plant applied Miracle Coating technology based on titanium aluminium nitride. Coating with ceramic, which has high thermal stability, achieved significantly longer tool life compared with non-coated products. In 2005, Mitsubishi Materials launched two coated CBN tools, the MBC010, suitable for continuous machining, and the MBC020, suitable for general-purpose machining.

To enhance the superiority of CBN tools used for finishing, in addition to CBN sintered body and PVD coating, honing shapes (edge treatment) must continue to evolve. There were only three types of conventional honing, F (continuous cutting), G (light interrupted cutting), and T (interrupted cutting). However, Mitsubishi Materials combined these with A (conventional type), S (restraining chatter and burrs type;), and N (restraining wear on the cutting face) types to produce nine variations.

The Gifu Plant also hosted seminars such as the CBN College for distributers to popularize CBN tools made by Mitsubishi Materials. Combining technical innovation and sales expansion projects, Mitsubishi Materials strived to prevail over its competitors in product development.

■ Illustrations of Sintered Body Structures by Generation



3 2010 ~ Against a Background of Fierce Competition, Reviewing Manufacturing Processes to Develop the Third-Generation Tools

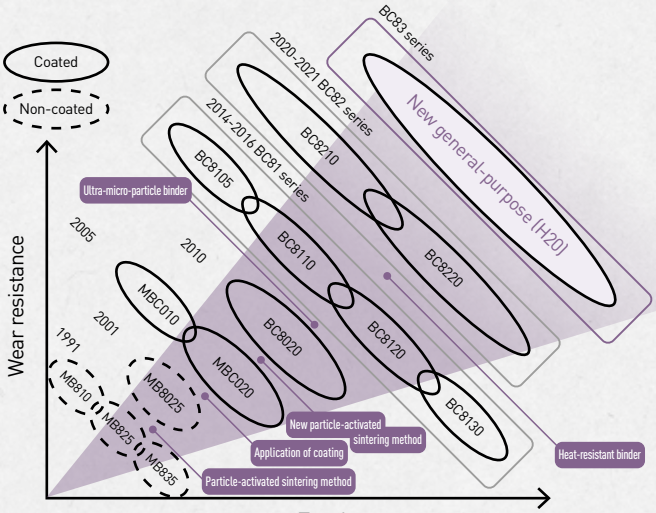
The BC8020 marked the beginning of the third-generation tools. The BC8020 was a coated CBN tool for general-purpose machining launched in April 2010. Manufacture applied the new particle-activated sintering method developed by Mitsubishi Materials to thoroughly remove impurities that interfere with the sintering reactions of CBN sintered body and minimize excessive reaction products. It optimized the thickness of the interfacial reaction layer with CBN particles while removing impurities inside the ceramic binder to improve both wear and damage resistance.

The new particle-activated sintering method improved wear resistance beyond that offered by competitor products; however, damage resistance was less satisfactory. Seeking to improve damage resistance without sacrificing wear resistance, Mitsubishi Materials turned to ultra-micro-particle binders. The application of these ceramic binders composed of finer particles than conventional types succeeded in increasing particle interface, thereby reducing crack propagation to significantly improve damage resistance.

The BC8100 that resulted from this also applied special PVD ceramic coating developed exclusively for CBN tools. From 2015 to 2016, Mitsubishi Materials launched different BC types. These included BC8110 to offer even greater wear and chipping resistance as well as adhesive strength, and the BC8120 type to offer stability over a broader range of machining. Additionally, the BC8105 offered excellent component finished surfaces, and the BC8130 type that was resistant to damage.

In addition to meeting the market demand for improved machining efficiency, Mitsubishi Materials developed more honing geometries. The GH type for preventing damage during light interrupted cutting, and TH type for resistance to damage during medium to heavy interrupted cutting were also added. In 2017, WL wiper inserts with a small wiper type edge were also launched. These achieved excellent results in component surface finishes through the reduction of chatter and cutting resistance. Research based on user comments and requests led to great achievements and an expansion of the product lineup.

TEHCNOLOGY ARCHIVE



1979: CBN development starts.
1983: NB10 is launched.

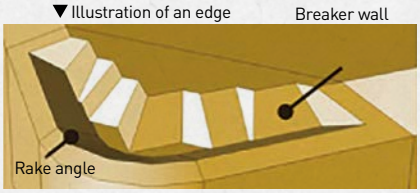
	Particle-activated sintering method	Coated	New particle-activated sintering method	Ultra-micro-particle binder	Heat-resistant binder
MB800 series					
MB8025	●				
MBC series	●	●			
BC8000 series		●	●		
BC8100 series		●	●	●	
BC8200 series		●	●	●	●

4 2020 ~ Knowledge and Technology from Development Passed Down to the Next-Generation

CBN tool development at the Gifu Plant is constantly being passed down to the next generation. In April 2019, a new material development project was initiated with a focus on involving newer employees. They attempted a wide range of approaches from different perspectives not only to improve tool life, which is a constantly ongoing theme, but also to expand the areas of machining that will meet the demands of the modern metal cutting market.

■ BR Breaker

▼ Illustration of an edge



▼ Sectional view of an edge

Such approaches helped to develop new technology, such as ultra-micro-particle and heat-resistant binders. Maintaining the strength of the ultra-micro-particle binder to reduce cracks improved heat resistance to reduce crater wear. Application of ultra-multi-layer coatings also led to improved chipping and fracture resistance. In 2020, Mitsubishi Materials launched the BC8200 series for high-speed machining while achieving improved efficiency. Tool life of the BC8210 continuous cutting tool, improved to 1.4 times that of conventional products at 200m/min or greater. The tool life of the general purpose BC8220 improved to more than 1.6 times that of conventional products under high-speed machining, including interrupted cutting.

With an eye toward reducing problems while enhancing high-depth cutting and automated production, Mitsubishi Materials developed its first 3D-structure, the BR breaker. The BR breaker achieved not only ideal chip control during high depths of cut, but also responded to a broad range of cutting angles, which made possible the integration of multiple processes.

The shift to EVs and carbon neutrality in the automotive industry will no doubt include significant future changes in the requirements for CBN tools. It is difficult to predict what might happen from day to day and what the future holds is still unknown. However, the technology, knowledge and experience Mitsubishi Materials has accumulated is being passed down to prepare the next generation of engineers; and the new ideas they develop through trial and error will help Mitsubishi Materials respond effectively to the unexpected.

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ABOUT US

Gifu Plant

Delivering High Productivity and Advanced Automation That Improves Product Quality

Cutting-edge technology is essential in producing solutions to the wide range of problems that society encounters over time. Automation and manpower saving in particular will be key factors at production sites in the future. The Gifu Plant succeeded in establishing a model line capable of long-term unmanned production. We interviewed the General Manager, Nariyoshi Fukushima about frontline approaches and future targets at the Gifu Plant.

Interviewed
Nariyoshi Fukushima,

General Manager of the Production Engineering Dept.

Beginning with manual machinery, solid drill production has now evolved into a sophisticated cutting-edge technology requiring no specific location or manpower

Automation aiming to improve all factors

When I joined Mitsubishi Materials and began working at the Gifu Plant in 1989, brazed-type drills were the main trend and solid drills were still under development. Most of the manufacturing processes at the plant were performed by manual machinery. For 10 to 20 years, we focused on facility investment to increase production and expand product lines. Now, solid drills have become the major product manufactured at the plant.

When the advanced automated model line project started in 2018, solid drills were the goal. The Production Technology Dept. was assigned to the project with the task of achieving improvements in manpower saving, productivity and process capabilities. Although the department was manned by a small staff, the members were highly capable.

I personally feel that three out of four major technologies - automatic measurement, automatic set-up change and automatic transfer - have already been established. Operations that had interrupted long-term continuous machining during the grinding and the sharpening processes were optimized through the introduction of unmanned operations. The only exception to this was operations required for quality assurance. This led to even greater quality stability than we had expected. What we developed at the Gifu Plant was a broadly applicable technology that could be used at any location by anyone. Therefore, we are thinking about expanding the system not only inside Japan, but also to overseas bases.

What we need to focus on now is the effective utilization of data to achieve smart operations. We have visualized the whole operation and work rates, and we are now evaluating the best way to analyse data and prevent problems. We have also started work on advanced automation lines for small-diameter solid drills, CBN tools and metal products. Another task is to prepare supervisors for future overseas expansion.

In FY2023, the Gifu Plant celebrates its 50th anniversary. I am extremely impressed with the progress that has been made over the past 30 years or so, outstanding results that were achieved through the tireless commitment of the skilled people at the Gifu Plant. We are now setting our sights on achieving our next goal, drastically improving the rate of automation at the Gifu Plant by 2030.

Fixed-type six-axis robot

Automated machine for measurement and correction

AMR (autonomous mobile robot) is in operation.

Two-story stocker (storage for palettes)

6-axis robot arm and palette with RFID (radio frequency identification)

AMR (autonomous mobile robot) conducting an inspection.

In-house development of the advanced NC program

For our automatic measurement system, sensors and CCD cameras are incorporated inside machinery to send data for automatic adjustment of the next tool. There were many problems to be resolved and we needed to determine the range away from median value for adjustment, and we needed to strategize our response to failed measurements. However, although we were extremely busy, we didn't want to outsource the work because we had strived for years to build know-how, and therefore wanted to handle it ourselves. We engaged in trial and error for about a year to develop a program to establish median value adjustment technology for size. For our automatic set-up change, an NC-controlled rest is incorporated into the grinding machine. Applying our accumulated know-how to development made automation relatively smooth.

Product lines combining multiple robots

For automatic transfer, we established an integrated system that manages the schedules for different machines by providing instructions to a palette with RFID (radio frequency identification) that has a non-contact telecommunication function. Utilizing fixed-type 6-axis robot arms connecting the AMR (autonomous mobile robot) and machines achieved automatic transfer of work material between processes. We resolved issues regarding wireless telecommunication and control methods and battery life before beginning full operation in the summer of 2021. Even after that, we continued working to improve the system. In FY2022, we developed an unmanned product line that could operate for an extended period by replacing a 2-axis conveyor on the AMR with 6-axis robot arms that have a higher degree of freedom of motion.

Achieving unified cloud management

We also developed a unified cloud management system for data collected from machining devices, and we are trying the establish a learning system to the machine that uses data to predict how environmental changes will influence machining results as we promote our smart factory project. Currently, automation is only applied to the grinding and honing processes. We would like to apply the advance automation system to a broad range of machining processes and establish a product line that can unitarily manage productivity improvement, budget control for production, quality improvement and predictive maintenance via the cloud.

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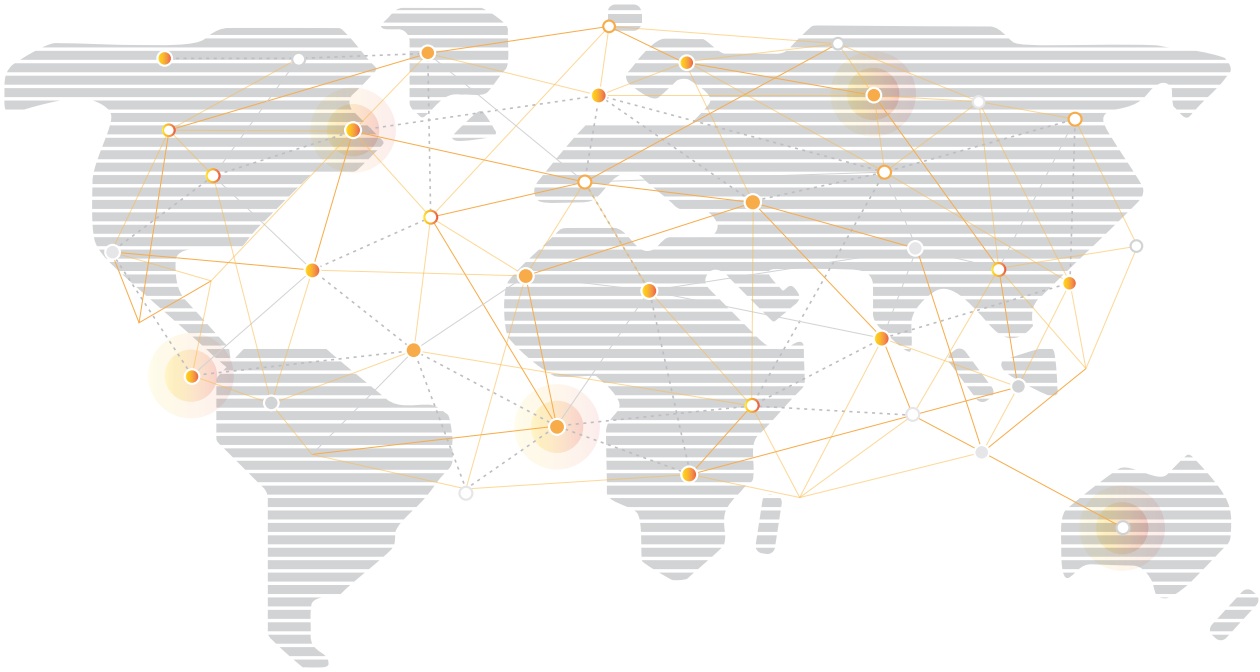
CUTTING EDGE

Vol. 10

What is the Merit of ISO13399 Certification, International Standards for Cutting-Tool Data Representation and Exchange Essential for Digital Strategies in Global Markets?

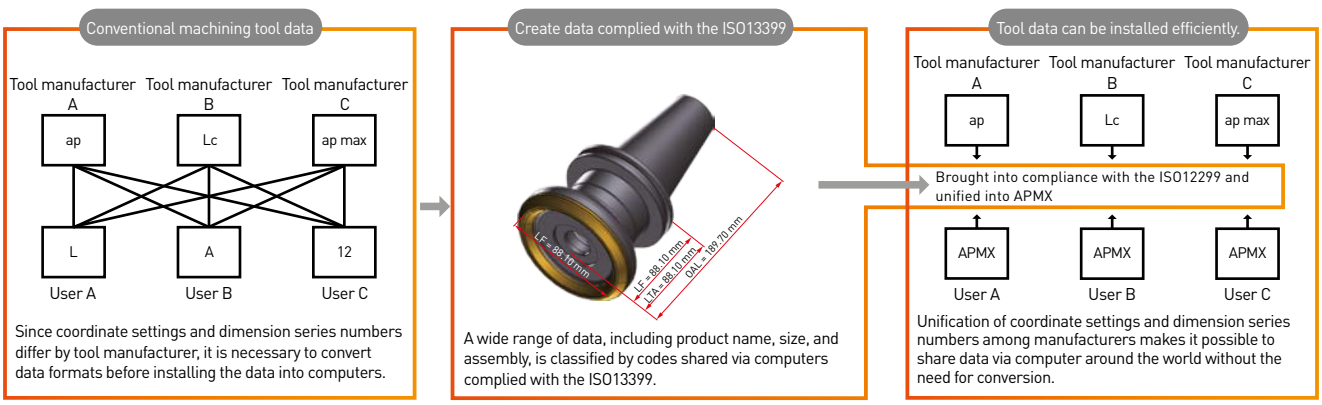


ISO13399, international standards for the installation of tool data into computers

ISO13399 is an international technical standard established by the ISO (the International Organization for Standardization, whose head office is in Geneva, Switzerland.) in 2006. ISO13399 defines terms and symbols for tools to promote common understanding beyond the boundaries of countries and manufacturers.

The biggest advantage of ISO13399-compliant tool data is that it allows users to directly implement and share product databases for cutting tools without changing the format of data files. This allows users to manage CAM, CNC simulation, PLM, tool management systems and other software more efficiently.

These international rules are based on DIN4000 standards developed by tool and software manufacturers in Germany in the 1980s as domestic standards. DIN4000 came to be adopted by European countries, and finally the German Government announced its industrial measure, Industry 4.0 (The Fourth Industrial Revolution: 4IR). Since then, manufacturers around the world started working towards compliance with the standards. When Mitsubishi Materials acquired ISO13399 about 10 years ago, manufacturers in European countries had already been applying this standard for 30 years.



How have user workflows been changing?

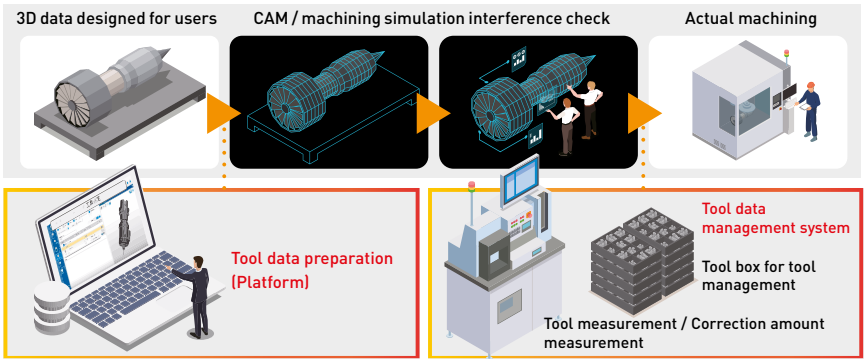
Along with progress in hardware, software, and the cloud environment, it has become possible to examine in advance what tools will be used and how materials will be processed based on an image of the finished product and 3D-CAD data in a process called "digital preparation."

In the past, we used paper-based catalogues to look up data on tools, holders and arbors. With digital preparation, when we bring up the tools that customers will be using, the holders and arbors are listed automatically on the screen, which significantly increases efficiency.

What's more, with digital preparation, we can confirm the results of interference simulations, etc. before moving toward actual operation; and this shortens the process of validation, which conventionally requires several repetitions. This serves to improve quality and efficiency while reducing costs.

Adopting such innovative workflows guarantees the selection of ISO13399-compliant tools from the online database.

Changes in Customer Workflows



Platform essential for tool data

Many customers use what are known as platform providers to compare tools made by different manufacturers. Platforms are internet tool search services operated by a wide range of tool manufacturers. MachiningCloud is a major company in the United States, which provides ISO13399-compliant tool data registered by 30 companies*.

The German service, ToolsUnited, has expanded its coverage in Europe, China and India. One of the world's largest, it provides ISO13399- and DIN4000-compliant tool data registered by 36 companies*.

In addition to the catalogues on our official website, Mitsubishi Materials provides tool data to MachiningCloud and ToolsUnited to expand the provision of tool data to users.

*Data provided as of the end of November 2022

Europe and the United States focusing on labour reduction as Japan prioritizes the spirit of artisans

Japan trailed significantly behind Europe in the utilization of ISO13999. The Japanese manufacturing industry originally focused on education to cultivate employees with advanced skills. This made high-quality manufacturing possible without adopting innovative workflows. On the other hand, turnover was so high overseas that they prioritized a system that enabled materials to be processed at a certain level of quality regardless of individual employee skills. Such efficient workflows have been broadly accepted by countries in Europe and elsewhere.

Japan will also accelerate the westernization of its workflow due to the decrease in the number of people entering the labour force and a rethinking of attitudes about work-life balance. The digitalisation of tool data promotes positive cost performance in the long term, and this means that the use of ISO13399-compliant data can be expected to also gain popularity in Japan.

Supporting the creation of a 40,000-item database utilizing unified standards to keep pace with the international trend

Around 10 years ago Mitsubishi Materials started to create its ISO13399-compliant tool database. It took nearly five years to accomplish this enormous task for its approx. 40,000 conventional products.

Also, because the quality of our data was inferior to what was being provided by European manufacturers, who had 30 years' worth of accumulated know-how on data creation, we spent another three years fixing bugs before we were satisfied that what we had was equal to European standards.

For the last four years, we have dispatched staff to the International Organization for Standardization (ISO) to participate in the development of ISO13399, and our contribution has effectively supported significant improvements in machining, quality, efficiency and a cost reduction for users.

International standards for machining conditions, etc. are essential for automation and saving manpower.

Along with the rapid progress of AI, advanced technology beyond automatic tool selection, simulation and CAM software will be essential. Even with highly advanced technology, however, accurate operations will be impossible without a high-quality database serving as a foundation. In Japan too, ISO13399-compliant tool data will be essential in satisfying the requirements for automation and manpower saving.

ISO13399 essentially defines tool form. Users all around the world are now requiring tool data such as form, operation and recommended machining conditions. Tool use has not yet been standardised internationally, although there is clear movement in this direction. To effectively identify its role in leading this movement, Mitsubishi Materials must leverage the experience it gained during the 10 years it used to successfully close the 30-year gap between Japan and Europe.

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Announcing DIAEDGE, our new brand of tools,
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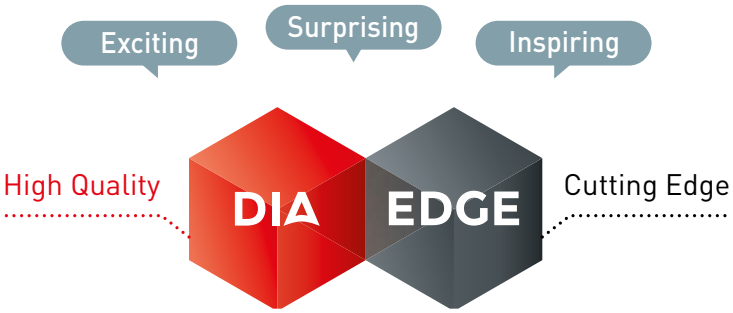
Our aim is not only to offer value with our tools,
but to think together with our customers, share inspiration with them,
and continue to take on new challenges.



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for mutual understanding and growth.

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