Mitsubishi Materials Craftsmanship Magazine

BM008E

YOUR GLOBAL CRAFTSMAN STUDIO

FLY HIGH IN THE SKY

AEROSPACE INDUSTRY

Vol. 8 Stories

Supporting Manufacturing in Turbulent Times

Thank you for reading the MMC Magazine Vol.8. In 2020, COVID-19 spread throughout the world and significantly slowed the global economy. It caused us to limit our movement and significantly impacted our work and lifestyles.

Innovation had been rapidly advancing in a great number of important fields over the past few years and from a historical perspective, 2021 will be a turning point in increasing our momentum. With "For People, Society and the Earth" as its corporate philosophy, Mitsubishi Materials Corporation promotes business activities along with our vision to become the leading business group committed to creating a sustainable world through materials innovation by leveraging our unique technologies. With regard to the 3-year mid-term management strategy from 2020 in particular, we have established the goal to contribute to the realization of a prosperous, recycling-oriented and decarbonized society.

With a focus on cemented carbide products, the Metalworking Solutions Business Company aims to be an ideal partner by serving as a global craftsman studio offering outstanding solutions and services to individual customers as it contributes to building an even more affluent society through every aspect of our business activities. Furthermore, we promote the recycling of cemented carbide products and advance the establishment of a recycling-oriented society through the effective use of rare metal tungsten resources. As an essential aspect of our participation in creating a decarbonized society, we aggressively strive to manufacture products without discharging carbon dioxide.

In 2018, Mitsubishi Materials established its new DIAEDGE brand. DIAEDGE is a combination of two words, DIA, meaning high quality, and EDGE, meaning sophisticated performance. We produce high quality products that deliver sophisticated performance that excites customers as we expand the DIAEDGE brand through high-quality and sophisticated business and services.
We have also shifted our business style to ensure that our products are not only high quality, but also highly customer oriented. To accomplish this, we have accelerated digitalization at all customer contact points and in addition, we will place a particular focus on utilizing a wide variety of diagnostic and simulation technologies to provide solutions that increase productivity.

Meeting the challenge of continuing to provide the highest quality during turbulent times, Mitsubishi Materials strives to deliver solutions and services that meet and exceed individual customer expectations through the unified effort of all departments and divisions. We are proud to provide products and services that contribute to our customers' success.

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

YOUR GLOBAL CRAFTSMAN STUDIO

EYE on MARKET AEROSPACE INDUSTRY

Manufacturing for Flight
-Quicker, Faster, and Stronger-

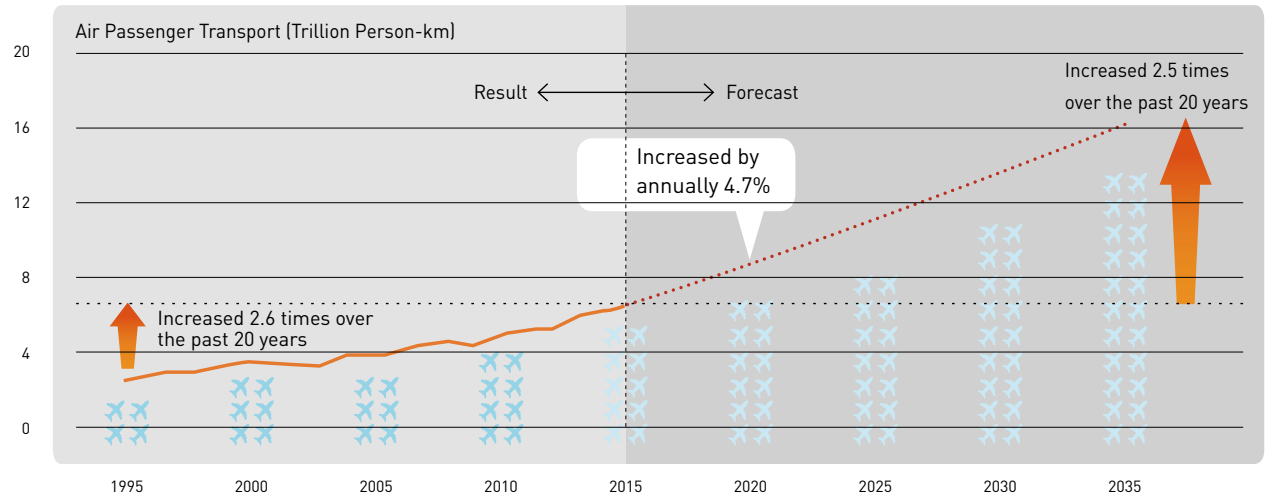
Productivity with a Focus on Promptness

Changes in the markets around the world due to COVID-19 have also had a significant influence on the aircraft industry. Up to FY2019, demand from the aircraft industry was expected to increase by 4 to 5% annually. This was based mainly on increase in demand for short-distance transfer by LCC (Low Cost Carrier) , which meant delivery of more than 40,000 aircraft over the 20 years following FY2019. This expectation was bolstered by the fact that the world's major manufacturers such as Airbus and Boeing had already received 7 to 10 years' worth of orders. In addition, China has also given significant support for the development of domestic aircraft.

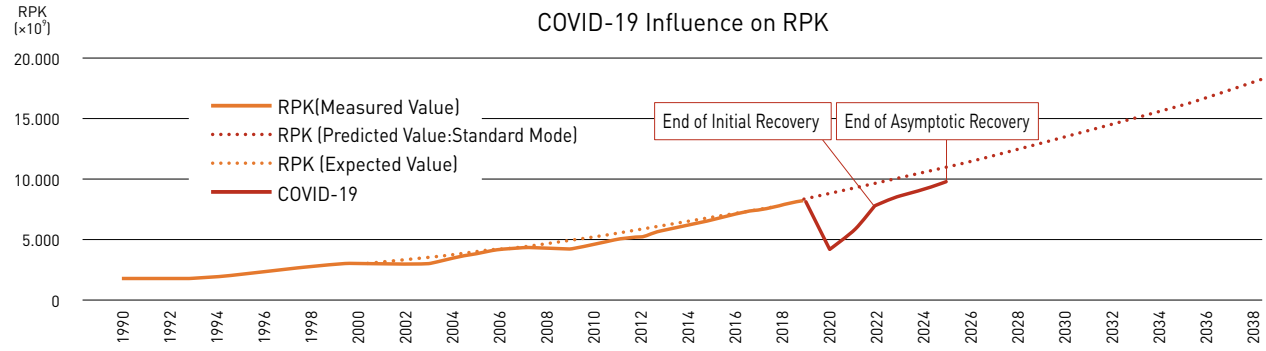
Although the pace of development and problems requiring adjustments may influence the type and number of aircraft delivered to airlines, demand, especially demand driven by expansion of the middle class in China and other Asian countries, will not change. Based on these facts, we predict that the required number of aircraft for domestic short and mid-distance transportation will not drop significantly.

In fact, according to the 20-year forecast issued by Boeing each year, demand is predicted to be 43,000, slightly below the 44,000 forecast issued before COVID-19. However, no significant decrease is expected in the number of narrow-body aircraft. On the other hand, the recovery of numbers of aircraft passengers will take until 2024, meaning that demand may easily change in the short term.
Aircraft are such large, highly complex machines that even major aircraft manufacturers cannot handle every aspect of production at one plant. Instead, production requires myriad subcontractors to produce and supply parts. As aircraft become more complex, more time is required for production because of the need to maintain quality and safety. To decrease production time, larger-scale and quicker component production is necessary. When the market recovers from COVID-19, it is essential to recover as rapidly as possible, which will require improved productivity.

As a machining tool manufacturer, Mitsubishi Materials is required to make proposals that allow manufacturers to achieve rapid production by using high-performance products based on accumulated technology.



[Fig.1 Market Growth Forecast until FY2019]



[Fig. 2 A Sample of Air Passenger Transport Recovery Forecast (Source: Market Forecast regarding Commercial Aircraft 2020-2039 Issued by the Japan Aircraft Development Corporation)]

Special Feature Manufacturing for Flight

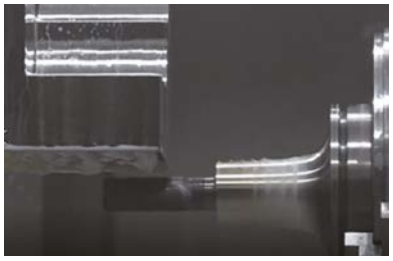
EYE on MARKET AEROSPACE INDUSTRY

Tools Manufactured to Achieve Speed

To increase productivity and speed, it is essential to either increase processing speed or to machine parts quickly using larger cutting tools. Either way however presents unique challenges because of the advanced technology required for tools and the special materials used in aircraft manufacturing.
Mitsubishi Materials continues to work on these issues by applying accumulated material and moulding technologies.

The wide variety of high performance cutting tools shown below, makes it possible for customers to achieve rapid, high volume processing.

Machining Titanium

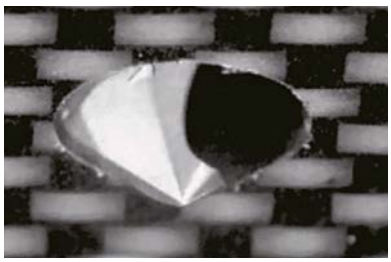


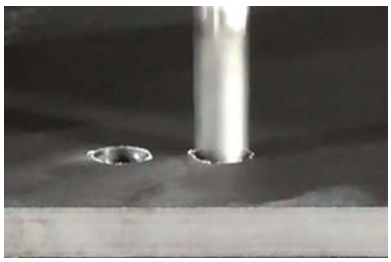
Specifically in regard to processing titanium alloy, a special material used in aircraft manufacturing, end mills and indexable insert-type milling cutters whose material removal rate per minute (MRR) exceed 300 m3/min make it possible to perform large scale material removal in a short period of time.

Machining Heat Resistant Super Alloys (HRSA)

Ceramic-type end mills are capable of processing heat resistant alloys used in engines that are impossible to process at high speed with existing cemented carbide tools because of the heat generated during processing.

Machining Carbon Fibre Reinforced Plastics (CFRP)





Drilling tools that are capable of high precision and efficient processing of lightweight; but extremely difficult to machine, CFRP materials.

Flying Faster

Another way for aircraft manufacturers to increase productivity is to have several manufacturing plants. Manufacturers have been quickly expanding global productivity by opening plants not only in China and Singapore, but also in Southeast Asian countries while manufacturers from the United States have also been opening plants in Mexico.

This is a trend that has already spread across the whole aerospace industry.

Mitsubishi Materials has for a long time had operational, technical and manufacturing bases in Europe, the United States and many other countries. This has allowed better connections with domestic facilities and made it possible to respond rapidly to individual customers in different areas. Due to current market conditions, aircraft manufacturers have started changing or consolidating manufacturing sites. However, even if aircraft manufacturers change prioritized areas, Mitsubishi Materials is able to respond promptly to conditions by utilizing its global network.

MESSAGE For the Future of Aircraft

Aiming to provide outstanding solutions to customers in the aircraft industry, Mitsubishi Materials organized its own Aerospace Department four years ago. Since its establishment, the department has been providing technical support to improve productivity and reduce processing costs in customers' manufacturing lines whilst making proposals for a wide variety of tooling.

Through approaches to highly-difficult issues unique to aircraft parts, including heat-resistant superalloys, CFRP and other composite material machining, a structure has been established to provide solutions that meet customer needs.

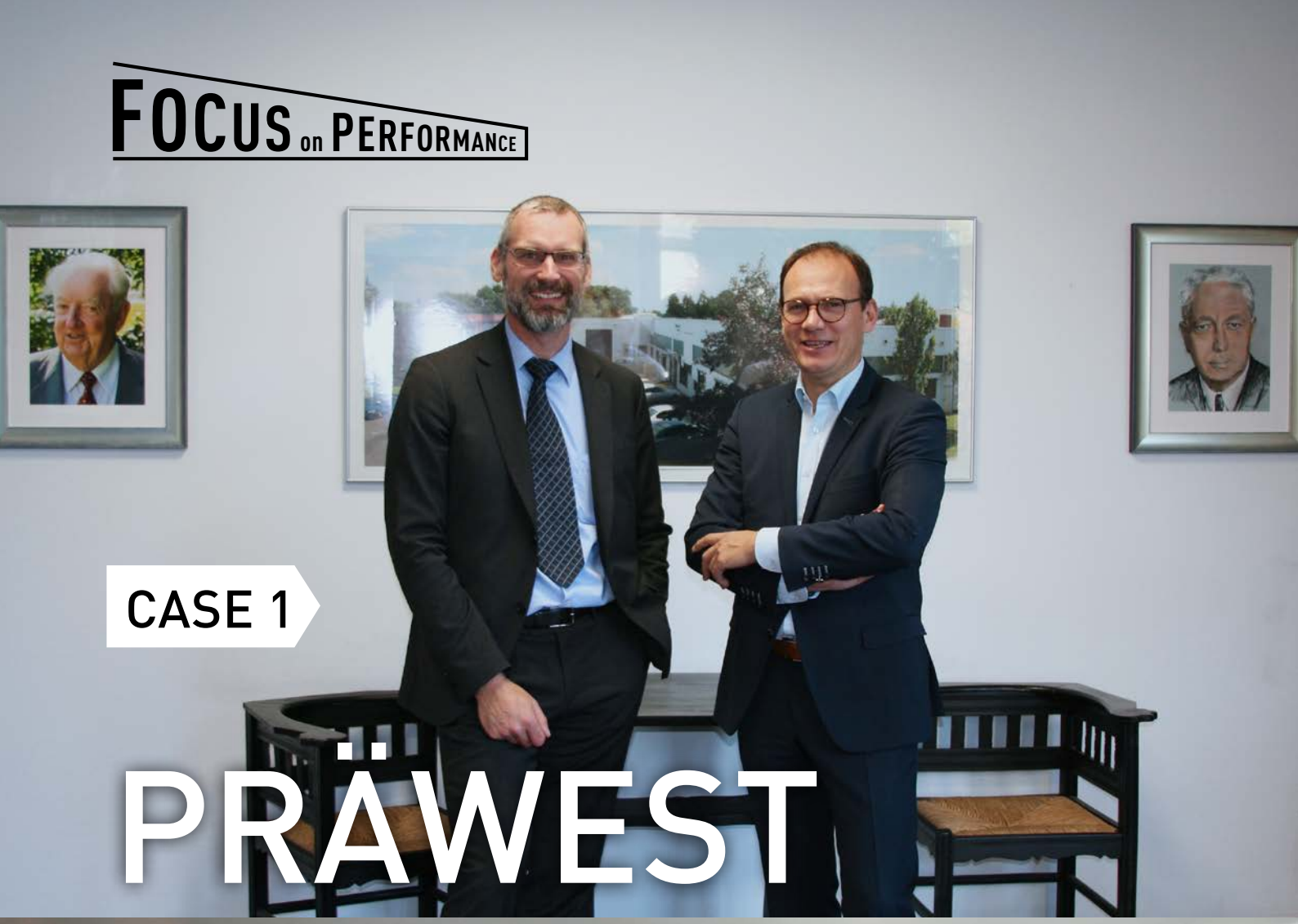
A lot of aircraft components are manufactured from difficult-to-cut materials. Mitsubishi Materials has a long history of developing tools capable of machining these materials and has introduced a wide variety of tools to the market over the years.

Advancements in materials used for aircraft parts are constantly evolving and the machinability of these newly developed materials tends to become ever more difficult. As a tool manufacturer continuing to develop new products capable of processing these materials is essential. The past four years has seen the introduction of many new products to the market, and there will be a continued commitment to improving these products as well as adding even more high-quality products to the range to meet demand.
The global manufacturing industry has been affected by COVID-19 and the aerospace industry has been one of the hardest hit. According to the industry forecast, although it may take time for recovery, the industry is expected to grow as before once COVID-19 is brought under control. After this, aircraft will be flying people and cargo around the globe once again and the technology accumulated through aircraft parts processing will be essential. The aerospace industry will continue to be a focused market as Mitsubishi Materials continues partnering with the aerospace industry and contributing to its growth.

Yohichi Akashi
General Manager, Aerospace Dept.
Metalworking Solutions Company
Mitsubishi Materials Corporation

Special Feature

Manufacturing for Flight



CASE 1

PRÄWEST

PRÄZISIONSWERKSTÄTTEN (PRECISION WORKSHOP)

DR. -ING. HEINZ-RUDOLF JUNG GMBH & CO. KG

75 YEARS OF CUTTING-EDGE MANUFACTURING AND MACHINING TECHNOLOGY

Christian Hoppe, head of tool department and development, Präwest

Reiner Wahlers, managing director, Präwest

Dr. Benjamin O'Shea, managing director, Präwest

Introduction

PRÄWEST is a group of companies manufacturing specialised parts up to a diameter of 2500 mm, including a wide variety of turbines, static parts and casings used over a wide range of industries ranging from aerospace through to heavy plant. The company is equipped with modern machine tools and applies the latest cutting technology to ensure the highest quality components and assemblies, whilst also continuously monitoring emerging trends such as additive manufacturing.

Over the last years, complex applications that require high precision machining of difficult-to-cut materials for components with strict regulatory and technical standards have become part of the company's daily business. For applications where the in-house tooling solutions don't reach the anticipated results, the company seeks advice from tool manufacturers to benefit from their expertise.

This editorial casts a retrospective glance at the company's history and illustrates the partnership between Präwest and Mitsubishi Materials over the last decade.

Foundation of Quality

Präwest was founded by an aerospace industry expert, Mr. Heinz Hampel in Bremen, Germany in 1945 after the end of World War II. Due to the turbulent post-war period that led to government restraints on aircraft manufacturing, the company started operations with special machining applications for the tobacco industry. Two years later the company returned to the roots of its founder and concentrated its activities on the machining of aerospace parts.

From the onset, Präwest focused on product quality and the company soon established itself in the civil aviation business in Germany. Until the late 1970s the company, even with as few as 25 employees, experienced steady output growth and flourished as a small but highly specialised workshop for machining aerospace parts. However, in the early 1980s the business was acquired by Dr.-Ing. Heinz-Rudolf Jung who was to lead the company to its next level.

Building on the company's good reputation, the new, visionary owner focused on technology setting new strategic objectives. These included further expansion of the company into the aerospace industry, but more importantly a diversification of operations into other business areas, such as automotive, oil and gas and energy, but with the emphasis remaining firmly on quality.

The diversification enabled the company not only to explore and develop new business opportunities but also leverage its technological competencies, by strengthening and modernising its aerospace business. Präwest was one of the first companies to introduce and deploy simultaneous 5-axis CNC machining in Germany, and thereby achieved higher accuracy and performance for special components and niche products. What once started as a local small-sized company upon the initiative of one man, soon developed into the modern international company that it is today.

iMX tool heads in the re-grinding process

Specialised machining of components for heavy industry

Planning of optimum machining strategies for complex geometries

Precision iMX tooling

Adapt and Specialise

Today, Präwest is a tier 1 supplier to major OEMs worldwide and comprises of three independent entities: PRÄWEST, specialised in machining of large, heavy-weight parts; PRAE-AERO founded in 2015 in Lower Saxony, dedicated to mass production processing of smaller parts for the aerospace sector; and CHAMPION PRECISION, founded as a joint venture in 2017 in China for selected niche products.

The Präwest group confidently meets new machining challenges with a committed development team and a state-of-the-art machine park with over 130 CNC machines and 24 robots. The diversification of the company becomes evident by the number and versatility of different products machined in each company. These include parts for aerospace, turbines, organic rankine cycle systems, turbo charger compressors & turbine wheels, vacuum technology systems as well as for the energy, oil & gas industries.

Machining requirements with regards to materials, shapes, sizes and geometries have changed drastically over the past few decades, therefore flexibility and adaptability play a pivotal role for manufacturing companies. What seems revolutionary and profitable today may soon become obsolete. This is especially prevalent in the aerospace sector where the latest big step change in technology has been already realised with the launch of advanced fuel efficient aircraft engines such as the Rolls Royce Trent series, the GE-9X and the Pratt & Whitney GP and PW1100G series which is one of the two engine options for A320neo.

This advancement meant specialisation in product niches became essential. Reiner Wahlers, managing director of Präwest says about the market development: "The industry landscape is constantly evolving in a 5 to 10-year cycle. If we want to keep pace and remain competitive, we must change too. Whereas ten years ago, aluminium structural parts such as wing spars, flaps and airframes dominated our operations, today, we are fully specialised in engine parts, including both gas flow parts and casings."

Machining specialised aerospace parts such as blisks, blades, vane clusters, impellers or rings and discs are problematic for many manufacturers. The challenge lies primarily in the nature of the raw materials, which are difficult to machine. Titanium alloys, Inconel, nickel and cobalt based alloys as well as stainless steels and other heat resistant alloys are some of the most common materials used for such components. These materials are also the ones that Präwest possesses highest expertise in machining. Consequently, when it comes to acquiring new customer projects, three elements influence the company's decision: Applications in difficult to machine materials; applications with complex geometries; and applications with the ability to reach a certain level of automation. Dr. Benjamin O'Shea, managing director of Präwest, confirms: "If two out of the three criteria are fulfilled in the customer's request, it is most probably an attractive project for us and a contract that we want to win."

Präwest not only has its own high-tech workshop but also a tool grinding facility and a quality assurance department. With a total of twelve CNC grinding machines, plus a new ERP-system for automated tool registration and an advanced CAD/CAM software, the Präwest Group is fully equipped to design and manufacture customised cutting tools. For aerospace applications where highest precision serial production with high level of automation

Tool pre-setting and storage

Preparation of 5 axis machining

Christian Hoppe, head of tool department and development, Präwest, **Wolfgang Schmidt,** sales representative and **Takayuki Azegami,** product design engineer aerospace, MMC Hartmetall GmbH

is required, the tool pre-setting, optical surface measurement and calibration processes are carried out digitally, directly on the machine. Christian Hoppe, head of the tool development department, says: "We have established certain workflows linked to our tool database, enabling secure transmission of tool geometries, pre-setting data and re-grinding information, so we can quickly upload all needed tool information to the machines."

Latest Technology

Cooperation and co-engineering with other industry professionals play a fundamental role for the company's success. Mitsubishi Materials is one of the cutting tool suppliers Präwest has partnered with to improve its production efficiency and optimise the machining process of parts such as vane clusters and blisks.

It was 2014 when the iMX high feed head end mill series with exchangeable heads was introduced to Präwest by Wolfgang Schmidt, sales representative at MMC Hartmetall GmbH, the European Headquarters of Mitsubishi Materials, as the ideal solution for the machining of clusters. Mr. Hoppe remembers: "We were unsatisfied with the performance of the in-house tooling. Additionally, the machining strategy, which was mainly trochoidal milling, clearly didn't live up to our expectations to machine the narrow channels within titanium vane clusters and be able to leave the minimum material for finishing. When the iMX series outperformed every other tested cutting tool, as well as optimising the overall machining process, we realised that this tool would soon be our first choice not only for the machining of the clusters but also for other applications with similar machining strategies and parameters."

The iMX series is the screw in head end mill system from Mitsubishi Materials that combines the advantages of both solid carbide and indexable insert end mills. This is made possible because the taper and end clamping faces of the head and the holder are both solid carbide – only the threaded part is composed of steel. This provides accuracy of the carbide clamping faces when a change of head is needed, whilst the benefits of a steel thread embedded in the carbide head and holder, over a purely carbide thread also adds reliability and strength.

Mr. Schmidt says: "After analysing Präwest's initial requirements, it became clear that the exchangeable heads of the iMX series would be ideal. Additionally, the wide range of different types of geometries and long reach shanks available meant that these tools could effectively and reliably machine the complex shapes and materials specified by Präwest's engineers. The first diameters tested

Turning inserts and machining strategy

Helicheck Pro machine for fully automated measurement of tools

Highly skilled technicians operating the CNC grinding machines

were the 10, 16 and 20 corner radius types and it was found they could machine very close to the final nett shape. This provided a time saving when compared to other solutions because there was no longer a semi-finishing step needed."

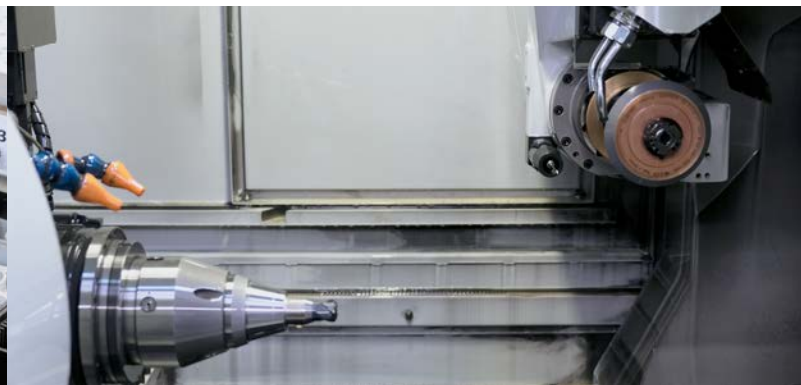
Whereas for many manufacturing companies reducing machining time is decisive for the selection of cutting tools, Präwest focuses on process stability and reliability as well as cost-efficiency. Mr. Wahlers says:" We don't look for the fastest way to machine a part. It's the total process cost that is important to us, therefore we gladly consider tool recommendations from Mitsubishi Materials and other tool manufacturers. We need to be confident that every single time, the part will come off the machine exactly the way it should be. That was the case with the iMX." Today, Präwest utilises the iMX series for the manufacture of vane clusters in four 5-axis CNC milling machines in four different stages, producing over 1000 clusters yearly. The iMX series has also been introduced on the serial production process of the blisk and other applications with similar machining strategies.

Re-grinding

The cooperation between Präwest and Mitsubishi Materials goes back many years starting with the supply of VP10RT grade turning inserts. However, the introduction of the iMX was a milestone in the longstanding partnership, which now reaches beyond the usual customer-supplier relationship. Mitsubishi Materials follows Präwest's development steps, standing by to assist, consult and train their highly skilled team. Cost-efficiency is particularly important and influences the company's purchasing behaviour towards other manufacturer's cutting tools. Mr. Hoppe says: "Every time we calculate the total process cost of an application, the cost for the cutting tools is a major factor, but, our ability to successfully re-grind tools in-house without unnecessary logistical delays offsets the initial cost and is one of our competitive advantages. After professional re-grinding training by the experts of Mitsubishi Materials, the iMX cutters met our expectations in this aspect too."

Re-grinding high feed precision carbide tools with geometrically complex cutting edges such as the iMX series is challenging. The tool can drastically lose performance if the edge shape and overall dimensional tolerances are not met after grinding. This can result in loss of tool life and can create the potential to scrap the expensive raw material. Therefore, Mitsubishi Materials gladly agreed to provide grinding machine programmes and trained Präwest how to grind the iMX cutters. This was carried out by a member of the iMX development team, Takayuki Azegami. He is a product design engineer for aerospace applications at the European Headquarters of Mitsubishi Materials,

High precision manufacturing and regrinding capabilities



Modern workshop and machining facilities

The year 2020 brings 75 years of progress and success in manufacturing at Präwest

and says: "When I first visited Präwest's re-grinding facilities for the training, any concern I might have had was immediately eliminated. Looking at the highly skilled staff and the state-of-the-art equipment that uses end-to-end automation to prevent human errors, I was confident about the success of the re-grinding project. Furthermore, it gave me great satisfaction to observe a tool that I had helped create, being involved in high level machining at one of our international customers."

Continued Cooperation

The successful implementation of the iMX series strengthened the partnership between the two companies and opened new avenues of cooperation. With the recently founded solutions centre, MTEC Stuttgart (Mitsubishi Materials Technology & Education Centre), Mitsubishi Materials can now provide Präwest with an advanced facility and the engineering know-how for their cutting tests. This will further enhance open innovation and co-development.

One of the future projects is an application of a semi roughing pocket milling in a stainless steel component, with a tool overhang length up to 180 mm. Mr. Wahlers says: "It is the first time we trust a partner with a cutting trial. In the past, we relied on our own means and expertise, but our positive experience of the collaboration with Mitsubishi Materials brought the benefits of such a partnership to the forefront.

Synergies with financial benefits in the metalworking industry are not rare, but when it comes to building new partnerships, other values matter. While often luck plays an unquestionable role at the start of a partnership, namely offering the right technology at the right time and place, factors such as open communication, information sharing, trust and commitment influence the quality and future of the business relationship. Dr. O'Shea concludes:" Quality has always been one of Präwest's fundamental principles over the past 75 years. The anticipated high quality is also reflected in the products and services of Mitsubishi Materials. Acting more as a cutting-edge technology partner rather than a purely sales focused company is what we value most in this partnership."

About the future cooperation and further business support for Präwest, Akihiro Kittaka, team member of the business strategy department of Mitsubishi Materials in Japan, says: "Mitsubishi Materials is a global player in the cutting tools sector and operates worldwide for international customers. Following Präwest's recent expansion in China we are pleased to have the opportunity to create bridges between existing technologies and applications and support our customer's new and future business operations in Asia, and of course with the same high-quality standard as in Europe."

Partnership and technology sharing is a cornerstone of a successful cooperation

HISTORY OF MITSUBISHI

Vol. 8

Supporting technical innovation

Central Research Institute

In 2017, the Central Research Institute celebrated the 100th anniversary of its foundation in Oi-cho, Shinagawa-ku, Tokyo by the Mitsubishi Joint-stock Company. Starting with around 30 members, the Central Research Institute gathered specialists in mining and other scientific fields and has conducted cutting-edge development supporting the growth of Japan and improvement of the technological level of metal processing. In this feature, we introduce the history of the Central Research Institute.

1939 - Main building of the Mining Research Institute at the time of its completion

A complete view of the Mining Research Institute in 1963

Empress Kojun observed iron oxidizing bacteria with a microscope (Right: Showa Emperor, Middle: Empress Showa <Empress Kojun>)

The Mining Research Institute – Achieving the dream of Koyata Iwasaki

After becoming president of Mitsubishi Goshi Kaisha in 1916, Koyata Iwasaki lamented the lack of research in the metals industry in Japan. He said, "Although manufacturers in Japan are eager to import or copy technology from Europe and the United States, they are loath to invest money in private research facilities or for nurturing researchers. It's a shame to rely solely on national or government-operated institutions." To address this shortcoming, he established the Mining Research Institute (Currently the Central Research Institute) in Shinagawa-ku, Tokyo.
The Mining Research Institute focused on seven areas of research – ore dressing, wet smelting & the chemical industry, the electric furnace industry & alloys, coal & by-products, analysis, firebrick & cement and the prevention of smoke pollution. Metallic materials research was started on Stellite alloys and TRIDIA (1932), the material that would be used in the manufacture of cemented carbide tools ahead of other companies in the industry. This pioneering development put Mitsubishi ahead of other companies and at the forefront of the modernization of Japan.

Opening the Metal Processing Department, the third pillar of the Central Research Institute

Having passed through the wartime and post-war period, liberalization of trade and rapid technological innovation began. In 1963, as part of its long-term plan to promote the stabilization of management, Mitsubishi Metal Mining Co., Ltd. added the Metal Processing Division to the already operational Mining Division and Smelting Division as the three major pillars of the company. Along with this change, the Central Research Institute aggressively promoted the development of a wide variety of new metal processing technologies. In 1954, cemented carbide manufacturing technology from DEW in the former West Germany was implemented, and the Research Institute started full-scale research on the basic properties of cemented carbide and the development of new tool materials. As a result, TiC cermet, ceramics and TiC coating were commercialized as new tool materials. In addition, the Research Institute worked on the synthesis of cubic boron nitride (CBN) as an ultra-high pressure sintered material and succeeded in particle-size crystal formation (0.3 mm) for the first time in Japan. This success accelerated research on new cemented carbide materials. Along with this, research on aluminium alloy and titanium alloy machining, magnetic materials and sintered parts contributed to the improvement of the machining business.

Research on business-based services promptly linked with management

In 1976, the Mitsubishi Metal Corporation Central Research Institute became independent. It promoted business-based research to enhance performance.
In the field of metal processing, the institute worked with the Research Development

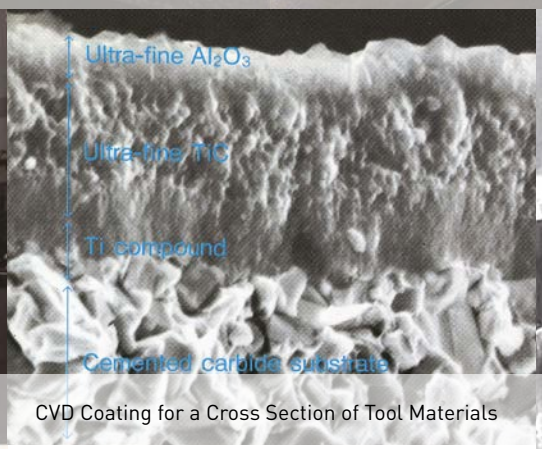
Current Central Research Institute located in Naka City, Ibaraki Prefecture

1939 – A group photo taken to commemorate the transfer to Omiya (On the rooftop of the main building)

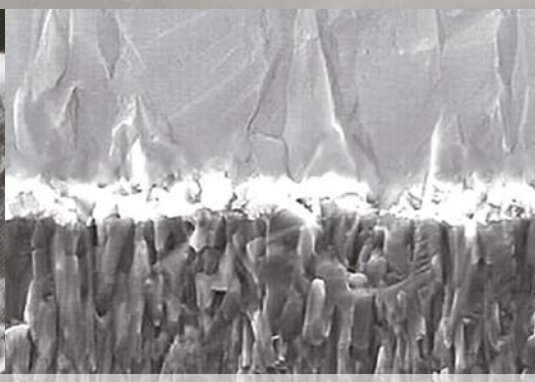
A Laboratory in the Main Building of the Mining Research Institute

A Library on the 4th Floor of the Main Building of the Mining Research Institute

An Electron Microscope Installed in 1949



CVD Coating for a Cross Section of Tool Materials

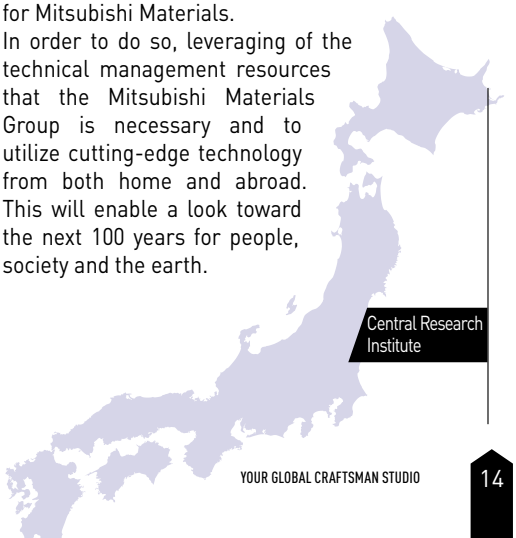


Advanced Al_2O_3

Corporation of Japan in 1984 to conduct research on the practical application of low-pressure artificial diamond manufacturing technology, before other companies around the world did so. This resulted in improved adhesion to the base cemented carbide material; the major challenge at the time, and led to the world's first mass production technology for artificial diamonds. This proved to have excellent wear resistance which can extend product life 3 to 5 times that of the existing cemented carbide tools. The development of tool materials has been promoted using ultra-high pressure sintered body tools and ceramics, and in 1984, they succeeded in developing "Non-Coated CBN series", a CBN ultra-high pressure sintered tool with ceramic binding phase that had twice the tool life of existing CBN sintered tools. In regard to CVD coating technology, they succeeded in developing TiC coating (the first diamond coating) in 1970 and a 3-layered coating tip, whose top surface was coated with Al_2O_3, in 1977. In regard to PVD coating technology, there was a successful development in 1979 and 1980 of the UP Process, a new coating technology which proved to extend tool life up to three times longer than existing tools. Mitsubishi Materials has founded advanced development strategies that will lead to major progress.

A Mitsubishi Materials research institute that continues seeking real values

From 1983 to the present, the Central Research Institute experienced a wide variety of changes. In 1983, it was merged into Mitsubishi Metal Corporation. In 1990, Mitsubishi Metal Corporation and Mitsubishi Mining & Cement Co., Ltd. were merged into Mitsubishi Materials Corporation, one of the largest material processing manufacturers in Japan. It had three research institutes and five centres with approximately 1,000 employees engaged in research and development.
Responding to such changes, the Central Research Institute reinforced its development capabilities. In order to improve competitiveness in manufacturing tool materials and to satisfy market needs, the institute furthered research on wear resistance in Al_2O_3 coating. In 2005, they succeeded in completing technology that controls crystal growth in the c-axis direction. Completing new technology at a rapid pace, the institute's research achieved a wide range of results that support current Mitsubishi Materials products. The mission of the Research & Development Division is to execute the development of new products, new technology and new businesses for Mitsubishi Materials.
In order to do so, leveraging of the technical management resources that the Mitsubishi Materials Group is necessary and to utilize cutting-edge technology from both home and abroad. This will enable a look toward the next 100 years for people, society and the earth.



Central Research Institute

Craftsman Story

Vol.9

Hideyuki Fujii
Gifu Aero Group, Aerospace Dept.
Joined in 2015

Shogo Tanaka
Group Leader, Gifu Aero Group
Assistant Manager, Aerospace Dept.
Joined in 1999

Hiroki Okumura
Production Engineering Group
Alloy Production Dept.
Joined in 2014

DSA Series – Solid Carbide Drill for Machining Heat Resistant Alloys

DSA Series

Achieving both high-quality holes and long tool life even when machining super heat resistant alloys

The DSA Series launched in September 2019 was developed for machining heat resistant alloys that are commonly used in aircraft engines. In the process of machining heat resistant alloys, heat caused by friction can easily build and cause work hardening. For this reason, cutting tools are required to have both accuracy and durability. The developers' commitment to producing the desired features to realize such difficult to achieve characteristics through repeated field testing over a three-year period resulted in innovative new products.

Three Outstanding Technologies and Cemented Carbide Materials that Supported these Technologies

– Why were DSA series developed?

Tanaka: "According to forecasts issued before COVID-19, the aircraft market would require more than 40,000 new aircraft over the next 20 years. With each of these requiring at least two engines, at least 80,000 engines will need to be manufactured. This means that tools for machining materials for those engines will be needed as well. Mitsubishi Materials manufactures WSTAR drills for multipurpose use, and we have an expanded range of drills for different materials (M, K, N, H types); however, the drills for machining heat resistant alloys (S type) were not yet available. This is why developing the DSA series and responding to market needs have been important issues for the company over the past few years."

Fujii: "In October 2016, the Aerospace Department was established. I was assigned to the department and put in charge of the development of the DSA series of solid carbide drills for machining heat resistant alloys."

– What are the conditions required for heat resistant cutting tools?

Fujii: "Aircraft parts require absolute reliability, and the materials are expensive. Therefore, it is essential to have high machining accuracy to avoid waste due to defects. In addition, cemented carbide tools are expensive, so customers may want to re-manufacture and reuse tools to reduce costs. This makes it important to design geometries that are easy to regrind and re-coat."

Okumura: "We considered materials based on hardness, toughness and durability as absolutely necessary conditions because the characteristics of cemented carbide change significantly depending on the balance of tungsten carbide and cobalt. As a result of repeated trial and error, we developed DP9020, a new PVD coated cemented carbide material with increased hardness and toughness as well as wear resistance."

– What are the characteristics of three major selling points?

Fujii: "Coolant, honing and margin all have important characteristics. When machining heat resistant alloys, discharge of coolant significantly changes lubricity and cooling ability. The through coolant hole is triangular in shape, the same as the existing type because it has proven performance. It was found that this shape increased lubricity without lowering drill rigidity. In regard to honing, which is associated with sharpness and durability, we sought a form that could achieve both stable chip generation and be resistant to edge chipping. Through discussion to determine the ideal margin width and edge form, we minimized the contact area to restrict the machining heat and reduce work hardening."

Tanaka: "In the machining of heat-resistant alloys, coolant is extremely important. Therefore, during development, we first determined the specifications for the coolant hole, then optimized the cutting edge form, honing and margin. In addition to simulations of fluid and rigidity analysis, we observed chip generation with a high-speed camera. This enabled us to adjust the form during development."

Seeking the best solution through in-depth field testing

– What was the main priority during the development process?

Fujii: "In regard to the honing, which influences tool life, we checked past development cases and took the time needed to identify the best form. We repeated the cycle of hypothesis and evaluation. The possibility of sudden defects in tools cannot be determined before actual machining."

Okumura: "It's the same as the carbide material. We checked the consistency of the carbide material used for the prototype drills and repeated this for the materials used for the actual production drills. This was done because the batch sizes of the material used for prototype drill testing and the material used for the manufacture of the mass production drills are very different. Changes in quality due to this difference in batch size would lead to differences in manufacturing conditions between testing and mass production. Therefore, the quality and consistency check are the most important process in the material development.

– How was the development process?

Tanaka: "We started development in October 2016, the same time the Aerospace Department was established. It took about two years to complete basic development, including the design, creation and evaluation of a prototype, then we repeated field tests along with confirmation for mass production. As a result, it took almost twice the time it takes to develop a standard product."

Fujii: "Although it took time to launch the product, our Sales Division actively advertised it to customers during development, which allowed us to gather information from a wider range of machining cases. In fact, customers use tools to machine materials in complicated forms, not just in the standard blocks used during the in-house testing environment. Tools must function under the customers' operating environment, not just in the test environment. Knowing the performance of the product being used by actual customers was invaluable for us."

Okumura: As we came closer to commercialization, we needed to consider materials for stable production. Even if our prototype could be made perfectly, we needed to address a number of issues to commercialize the actual product. After stabilizing the manufacturing process, we needed to satisfy customer requests after the products were introduced to the market. This is why we have to keep improving."

– Please give our customers a message.

Tanaka: "It goes without saying that for safety, aircraft parts are required to be absolutely reliable. This is especially true for parts used in engines. Our tools obtained approval for use in machining engine parts through field tests, which increased our confidence. The global supply system for the DSA series (including regrinding and recoating) has already been established, so customers can be rest assured that they can get the parts they need when they need them. We are also able to respond promptly to special requests for products. Please feel free to contact us any time about the products. We're also planning to expand product use to the heavy electric machinery industry."

Fujii: "The more customers use products, the more we benefit from feedback about performance evaluation over a wide range of conditions. We need to analyze such evaluations to prepare for prompt responses to individual cases. This calls for a system that allows us to accurately and quickly satisfy customer needs."

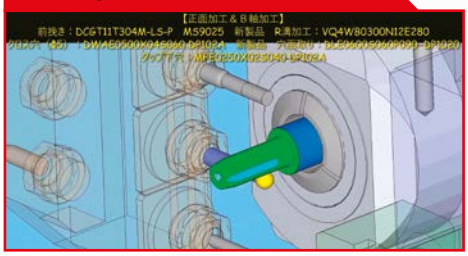
Okumura: "The launch of new products is the beginning of the project, not the goal. Our mission is to respond appropriately to a wide variety of requests from customers after they use the products at their plants. Please feel free to contact us for any small or complex issues."

DIA EDGE MITSUBISHI MATERIALS

Web Exhibition 2020

Plant Visit 360-degree (Omnidirectional) VR Content

Machining Simulation Video Content



Solutions by Industry/ New Products Section

ABOUT US

Web Exhibition

Check the most advanced technology and products online

Background

To prevent the further spread of COVID-19 in 2020, most of the trade fairs, exhibitions and seminars that allow the showing of products and services directly to customers were cancelled. Sales activities were also limited, and the opportunities to meet with customers were reduced. To respond to this new normal, a web exhibition was established to provide important information to customers.

Web Exhibition Content

Unlike a regular website, the purpose of a web exhibition is to highlight products and services to customers. It is also needed to provide explanations via the web exhibition that would normally be provided to customers in person. Therefore, the DIAEDGE web exhibition was created to be a virtual booth to show products as if viewers were actually visiting an exhibition. This not only helps customers find specific products easily, but also attracts customers who just drop by with nothing specific in mind.

It includes videos of machining using actual products in addition to simple explanations to allow customers to learn about the characteristics of products both visually and aurally. In addition, it allows customers to browse and download photos, 3DCG and catalogue PDF files for more further information about the products and services. The 3DCG in particular is a new approach that allows customers to choose different angles to see products. It is believed that this new approach will help compensate for customers not being able to touch the actual products.

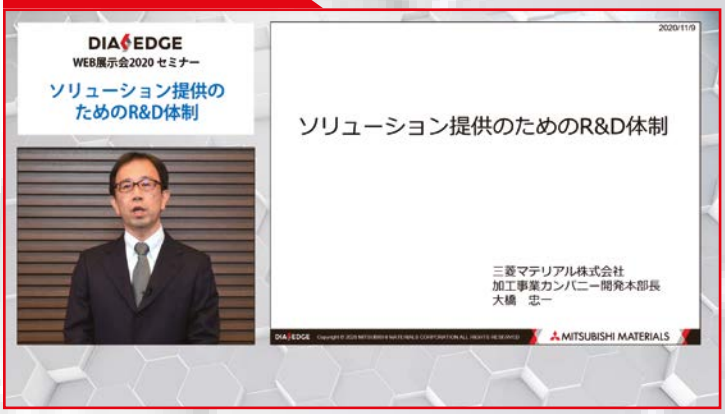
The exhibition section was classified by industry to make it easier for visitors to find specific tools suitable for individual machining environments. Because there are too many new products to fit in the new product section, the overflow is shown in the exhibition section.

In the healthcare industry section, machining solution videos using our new products and programs created with ESPRIT CAM software, based on machine data provided by Citizen Machinery Co., Ltd. are available for viewing.

In the solutions exhibition section, new approaches to remote machining testing that have high growth potential as a means of reducing risk of infection during the COVID-19 pandemic can be

Product 3DCG Content

Special Online Seminar



seen. Also offered are two online seminar programs, "Machining of Hard-to-cut Materials: State and Issues" by Professor Matsumura of Tokyo Denki University and "R&D Structure for Providing Solutions" by Mr. Ohashi, General Manager of Research & Development Division, Mitsubishi Materials. By registering, there is no limit on the number of times it will be possible to view these seminars.

The 360-degree VR Plant Visit is a completely new approach. The 360-degree virtual tour of the Tsukuba Plant and Central Japan Technical Center allows viewers to feel as if they are actually walking inside the building. This lets viewers see in all directions while watching the video. Detailed explanations are provided in a separate video made for those interested in more detailed information.

Delivering Up-to-Date Information Faster

New product information is traditionally provided to customers through sales routes and mail magazines. With the hope of providing even more timely and up-to-date information to all customers, it is now planned to use the web exhibition as a new approach to highlighting Mitsubishi Materials. Through this new approach, it is expected to increase interest and knowledge of products and give students interested in careers with Mitsubishi a better idea of what is involved.

Future Vision

The primary purpose of the web exhibition is to provide information on new products. It may be that this way of communicating with customers may be too one-way, so analysis of website access information to develop a structure that allows customers to find information about machining solutions and recommended products.

Please visit the website to see the above-mentioned content.

Japanese Version
http://carbide.mmc.co.jp/exhibition/virtual_exhibition_archieve/

English Version
http://carbide.mmc.co.jp/virtual_exhibition/en/

CUTTING EDGE Vol. 8

Innovation of Gear Machining Skiving Technology

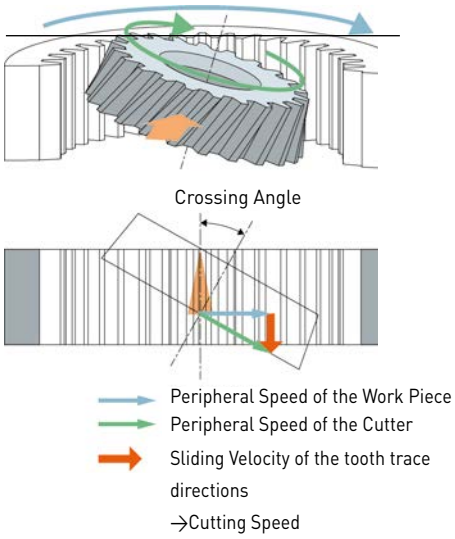
Next-generation machining technology that innovates gear production

While quiet fuel cells are replacing the internal combustion engine as hybrid and electric vehicles become more popular, planetary gears and other parts remain essential. These parts also need to be as quiet as the cars they are used in. Keys for improvement are weight reduction, high precision and rigidity.

Considering such changes for the future, skiving technology has attracted attention as a new gear machining method. Gear shaper machining and broaching are traditionally applied for internal gears and hobbing is used as a standard for external gears. Skiving has great potential as an alternative to existing machining methods for both internal and external gears.
The principle of skiving machining was developed in Germany about a century ago. In and after the 1970s, it was also considered in Japan. However, due to the lack of machine tool rigidity, it could not be brought into practical use. Along with technological progress in recent years, however, research and development for skiving has been actively pursued.
The original meaning of "skive" is to thinly peel. The principle of skiving is as follows:

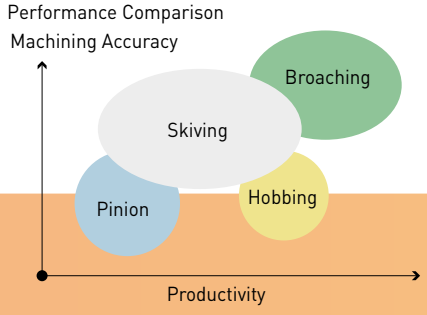
- The tool is set diagonally to the work piece, and a crossing angle for axes is provided between the rotating axis of the work piece and the tool.
- High-speed rotation after synchronizing the work piece and the tool generates sliding at the contact point. This sliding flakes off material to form the teeth of the gears.

Principle of Skiving



Merits and Possibilities of Skiving

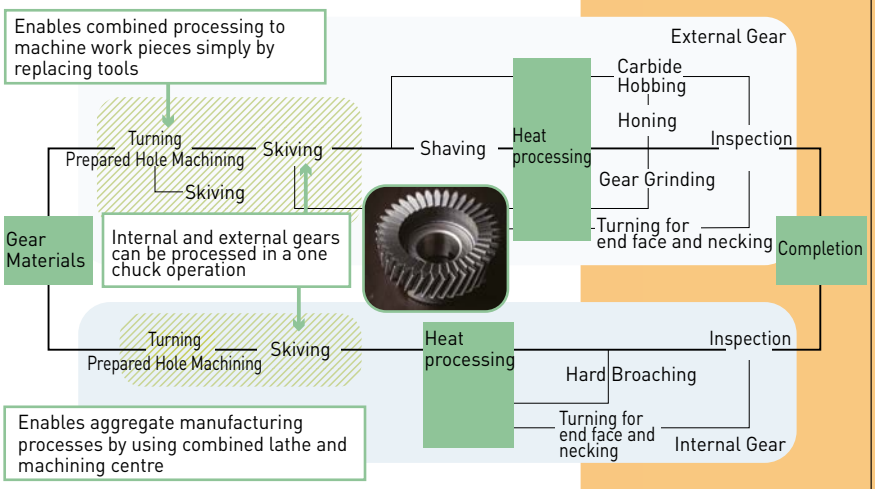
Skiving realizes advantages in a series of processes that existing machining methods lack. For example, skiving makes it possible to create blind-hole internal gears, which broaching cannot accomplish. Furthermore, skiving can perform accurate adjustment of tooth trace for crowning and hollowing, as well as adjustment of thickness and cut in the inner diameter of the hole.
While gear shaper machining is performed by a reciprocating motion, meaning that half of the motion is not used for machining, skiving machining is serial machining performed by rotational motion, which increases efficiency. In addition, skiving generates less vibration than gear shaper machining, which realizes improved accuracy.
The chart below compares the performance of broaching, pinion (gear shaper), hobbing and skiving machining.



Hiroyuki Norigoe,Development & Design section, Gear Cutting Tools Manufacturing Dept. Akashi Plant

Skiving with these products alleviates the need for specialize equipment. It can be performed with combined lathe and machining centre, which makes complete improvement of the production environment possible. Gear machining through hobbing and broaching requires different specialized machines; however, skiving can be performed with general-purpose machines that can perform a significant number of other machining processes.

Major Gear Manufacturing Tools and Processes



Aiming to extend tool life by using cemented carbide

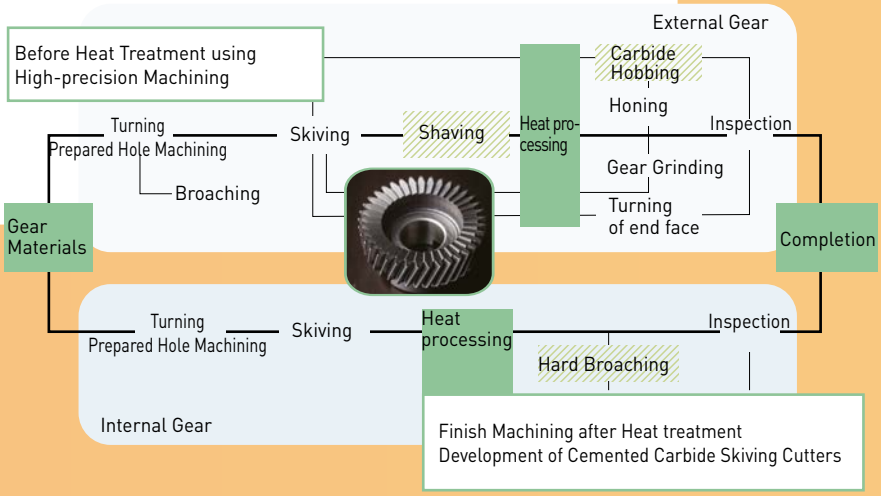
In order to make skiving even more practical, it is important to improve machining accuracy, productivity and tool life. If the crossing angle of the axes increases, machining speed increases. After carefully checking interference with work pieces, we determine and adjust angles to increase productivity. During skiving, rake angles change, which produces parts with high resistance to cutting and tends to shorten tool life.

As an outstanding solution to product life issues, Mitsubishi Materials is now offering cutting tools made of KHAZ materials with a GV40 coating. Such materials are already used for hobs and pinion cutters. KHAZ is made of high-alloy powder containing fine, high-hardness carbide for excellent wear resistance. The amount of carbide is optimized and gives significantly improved resistance to chipping. Research is also conducted on the application of cemented carbide to tools for future manufacturing. If cemented carbide is used instead of high-speed steel, it may significantly extend tool life. In addition, coating materials for even longer tool life are being researched. Simultaneously, work on applications for small-diameter gears and improved accuracy is ongoing.

If carbide skiving cutters can be manufactured, heat treated work pieces can also be machined. Finish machining after heat treatment, which is now done by a grinding process will also be possible by a skiving process. This will expand the potential for integrating tools and processes.

Mitsubishi Materials has accumulated design and analytical technology for shaving cutters and manufacturing technology for pinion cutters. In addition to such knowhow for the design and manufacture of tools, there is a commitment to advancing the development of cemented carbide skiving.

Future Vision



Enjoy Japanese Style

WA

Shrines and Temples

Nyakuichioji-jinja Shrine (Omachi City, Nagano Prefecture)

Mystical Japanese Spirit of Religion

"Gods, Buddha, ancestors, please help me!" is a common prayer in Japan. Although it may seem odd for adherents to monotheistic religions, Shinto gods and Buddha exist side-by-side in Japan. Nyakuichioji-jinja Shrine in Omachi City, Nagano Prefecture is a good example of Japanese thinking. A three-storey Buddhist pagoda stands next to the shrine's gate. After people visit the shrine, they pay a visit to the temple. This is not the only place in Japan where a shrine and temple stand next each other. Kofuku-ji Temple, known for its national treasure, the Statue of Ashura, standing face-to-face with the Shinto Kasuga Taisha Shrine in Nara was built in the 8th century. Jingu-ji, or combined Shinto shrines and Buddhist temples are a reminder of a culture in which gods and Buddha have existed in harmony for over 1,500 years.

According to Japanese mythology, gods and people were born of nature; and followers of Shinto have worshipped a variety of gods from ancient times. When Buddhism entered Japan, Buddha was accepted as another of these gods. Shrines are for the worship of nature, while temples are viewed as places to learn how to live a proper spiritual life. Some consider Shinto as shared belief, and Buddhism as a belief system for individual relief. For Shinto, which has many gods but no scripture, a key to understanding each shrine is to know what it enshrines. Both animism, which is the belief that the sun, mountains, waterfalls, large trees and stones, plants and other objects in nature possess distinct spiritual essences, and ancestor worship, in which the deceased are thought to become gods, coexist in Shinto. For example, Mt. Fuji is thought to be sacred and the three grand shrines in Kumano (Kumano Sanzan) enshrine the spirit of the mountains, while Meiji-jingu Shrine enshrines the souls of Emperor and Empress Meiji.

Temples are classified by sect, with each sect following different teachings. Two major examples are the Shingon Sect founded by Kukai, and the Tendai Sect, whose teachings were spread by Saicho. Shinto and Buddhism existed in harmony until the so-called Meiji Restoration, during which the Tokugawa Shogunate that had governed Japan for over 300 years turned over the reins of power to the Emperor. However, because the new government considered Shinto the national religion, many Buddhist temples were destroyed. Until Japan's defeat in World War II, when Shinto was removed from the government, Buddhism was discouraged. After the war, the Japanese once again welcomed Buddhism. On New Year's Eve, people listen to bells ringing out the old year (joya no kane) at Buddhist temples, and on New Year's Day, people visit Shinto shrines to pray for fortune in the new year. Thus, the belief in gods and Buddha has blended naturally into the life of Japanese in the form of customs and habits.

Worship Etiquette and the Difference between Gods and Buddha

Entrance

The gate at the entrance of a shrine is called the torii, and the temple gate is called the sammon. The gate functions as a border between the physical and the sacred world. Going through the gate purifies us and allows us to pray to the gods. To show respect, people bow once at the gate before entering.

Objects of Worship

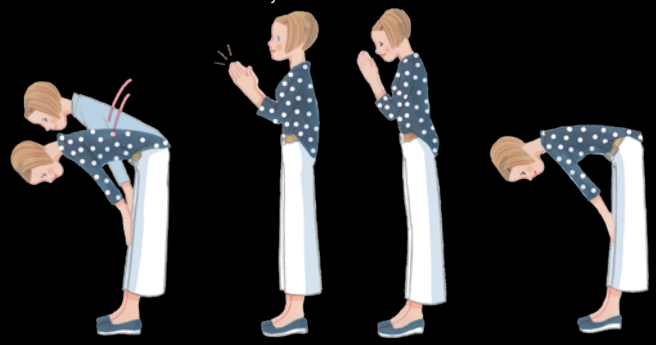
The major difference between shrines and temples is in their objects of worship. Shinto does not conceptualize gods in physical form because it believes that gods are in nature; namely, mountains, forests, and giant trees. Buddhism first worshipped pagodas with Buddha's ashes placed inside them, and later shifted to statues of Buddha.

Worshiping

Worshippers first enter the gate at a shrine or a temple, symbolically purify their hands and mouth with water. At both shrines and temples, worshippers also place coins into a collection box as an offering before praying. At shrines, after placing their offering in the collection box, worshippers bow twice, softly clap their hands twice, say a prayer, and bow once again. This came from the way that people showed respect to noble persons in ancient times. At temples, worshippers place their palms together at chest level, bow slightly and say a short prayer in front of the sacred statue of Buddha.

Shrines

1. Bow twice
2. Clap hands together softly twice
3. Say a prayer
4. Bow once again



Temples

1. Place palms together at chest level and say a short prayer in front of the statue of Buddha

Recommendation:
Visit Shrines and Temples Offering Special Programs

Takigyo – Waterfall Meditation (Purify yourself by meditating under a waterfall)

The purpose of Takigyo is to cleanse the mind, body and soul by sitting under a cold waterfall and enduring the sound, pain and cold. In ancient times, Buddhist initiates called shugenja or yamabushi performed Takigyo before ordination. After sitting under a waterfall to be unified with nature, you may discover something new about yourself. Takaosan Yakuoin Temple 2177 Takao-machi, Hachioji City, Tokyo

Crossing the Sanzu River at Mt. Osore

A manmade Sanzu River and a taiko, or arched Bridge that symbolize the separation between the physical and the spiritual world are located at the entrance of Mt. Osore, one of three great sacred mountains of Japan. Beyond the bridge, we see a mystical landscape that evokes heaven and hell in the afterlife. The bridge has a steep grade meant to symbolize a mountain of needles that prevents sinful people from crossing. Osorezan Bodai-ji Temple 3-2 Usorisan, Tanabe, Mutsu City, Aomori Prefecture

Fasting to Purify the Spirit

Fasting is thought to free us from evil thoughts. Stop eating for a few days to face yourself. Fasting is an ascetic practice to strengthen the spirit; and because it is believed that prayers made during fasting will be answered, it is practiced by Buddhist priests. The experience of fasting at a temple gives a chance to examine your day-to-day life. Koshin-ji Temple 5500 Koshin, Jinsekikogen-cho, Jinseki-gun, Hiroshima Prefecture

Shrines that Offer Special Blessings

Lottery: Hoto-jinja Shrine

Visit Hoto-jinja Shrine if the wish is to win big money at a single stroke. The name, Hoto, means to win treasures. The shrine got this name because many visitors won lotteries after praying here. Visit the shrine to see if it works.
Hoto-jinja Shrine
523 Takashima, Karatsu City, Saga Prefecture

Hair Restoration: Mikami-jinja Shrine

Mikami-jinja Shrine is the only shrine for hair in Japan. The soul of Fujiwara Unumenosuke Masayuki, the first hairdresser in Japan, is enshrined here. The shrine is known as a power spot for people who wish to increase the amount of hair on their head and for people in the hairdressing industry. There is a mound of hair within the precincts at which prayers for hair are offered. Mikami-jinja Shrine
10-2 Saga-Ogurayama-Tabuchiyama-cho, Ukyoku, Kyoto City, Kyoto Prefecture

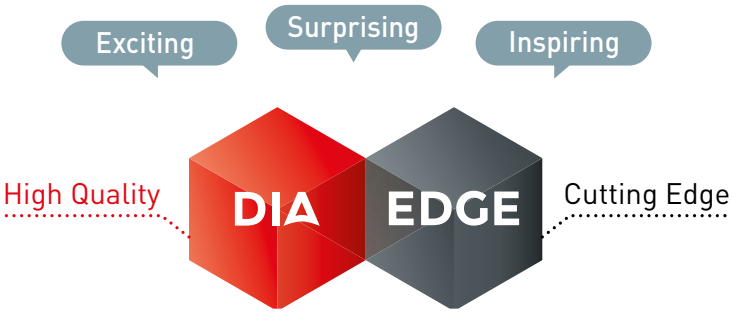
Dissolution of a Relationship: Yasui Kompira-gu Shrine

Because Emperor Sutoku came to the shrine to break away from the world of the flesh, it became a place to pray for separation from ills, including bad relationships with people. Passing back and forth through the small tunnel, pray to end a relationship with illness and bad habits such as smoking or gambling, and begin a relationship with good fortune. Yasui Kompira-gu Shrine 70 Shimobenten-cho, Higashiyama-ku, Kyoto City, Kyoto Prefecture

DIAEDGE

Together with our customers, creating a better future

Announcing DIAEDGE, our new brand of tools,
that brings together our cutting-edge technologies, exciting all who use them.
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.



- Providing Best Solution Services
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Customers and Mitsubishi Materials,
for mutual understanding and growth.

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