

YOUR GLOBAL CRAFTSMAN STUDIO



JAPAN QUALITY
*The Spirit of Japanese
Manufacturing*

Vol.4 Stories

Your Global Craftsman Studio



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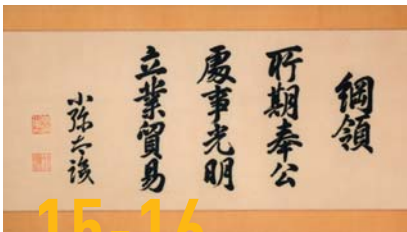
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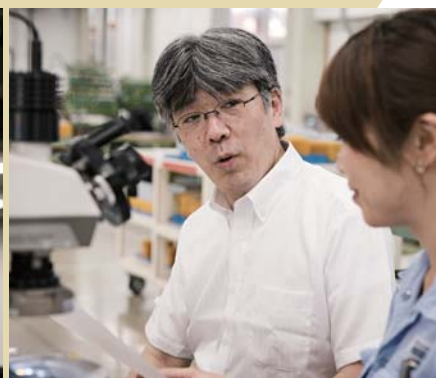
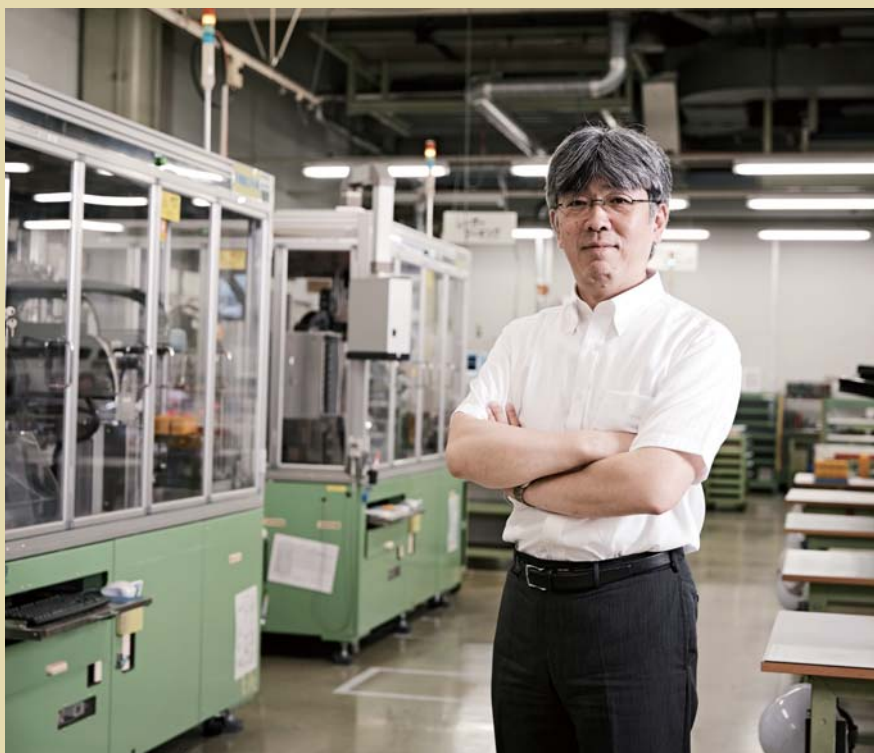
MESSAGE



Fumio Tsurumaki
Managing Executive Officer,
Mitsubishi Materials Corporation
President, Advanced Materials &
Tools Company

The term, "manufacturing," is a simple word, but has a deep meaning. Almost everything we manufacture supports our life in some way or another. The essence of manufacturing, I think, is the dedication of the manufacturer. Manufacturing starts from an idea of a product that we think will be useful or that might make people's lives better. We create a design, select the materials and decide upon a method that will turn our design and materials into a finished product. The dedicated effort, experience and skill of all those involved is cumulative and the resulting product is certain to exhibit qualities valued by the market, qualities such as visual beauty in colour or form, or functionality and usefulness. Some products are highly regarded by the public consumer in general and some are highly valued by specific groups of

people. How about tools? Few people are concerned about how a tool looks. What matters is durability, functionality and cost effectiveness. Like any product, however, the success of a tool is the result of the combined dedication and effort of everyone involved in its manufacture, the skill of the designer, the precision of the manufacturer, the earnestness of the service provider, the knowledge of the dealer, and, perhaps most importantly, the feedback from the customer that ultimately uses the tool as a key component in the process it employs to manufacture the products it develops. I am quite confident that Mitsubishi Materials' journal, "Your Global Craftsman Studio" exhibits the combined effort, experience and skill of Mitsubishi Materials Corporation employees dedicated to the manufacture of better products.



Our goal is to help our customers succeed

First published in April of 2015, this is the fourth issue of Your Global Craftsman Studio. In this issue, we focus on the spirit of Japanese manufacturing from the viewpoint of the manufacturers themselves and we asked many experts to talk about their work. It is certain that the common enthusiasm of these specialists in their individual fields is to manufacture the highest quality products that Japan has to offer, products that lead the pack in global competition. We often use the term Japan quality, but few link this with the impressive technology behind it. Spurred to excellence by customers who demand and expect the highest in quality and the uncompromising quality-first spirit of Japanese craftsmen, Japan produces leading-edge products that strive to stay ahead of the global competition. To keep pace with increasingly diverse customer needs, we continue providing highly valued products that represent the best in Japan quality.

Mitsubishi Materials Corporation also considers the quality of service

to be a critically important aspect of our products. The service I mean is the smooth delivery of products to customers, offering the most reasonable prices in the industry, and our timely and appropriate response to the needs of the customer. Our desire is to maintain our position as a company that customers can rely on when they need help. We chose the title, Global Craftsman Studio, as a declaration of Mitsubishi Materials Corporation's continuing commitment to providing services as a comprehensive tool studio for customers around the world. As tool manufacturers and professionals, we fully leverage our experience and know-how to help businesses succeed by providing individualized solutions to customer problems; and while we take the lead in designing proposals for our customers, it is an essential part of the manufacturing process we employ to listen carefully to requests and opinions to ensure the highest degree of customer satisfaction and success.

Mitsubishi Materials Corporation places a priority on the manufacture of new products and technologies, working closely with end users to find fast and effective solutions, sharing the excitement of success as we move forward together into the future.

Toshiyuki Taniuchi
General Manager,
Quality Assurance Division
Advanced Materials &
Tools Company
Mitsubishi Materials Corporation



YOUR GLOBAL CRAFTSMAN STUDIO



A Challenge from Japan

Bobsleigh Network Project from the Heart of Tokyo

With maximum speeds reaching up to 140 km/hour, competitive bobsledding is also known as Formula One on Ice. Clocking the best time for the win requires skilled bobsledders and state-of-the-art equipment. The great names in European high-performance racing, Italy's Ferrari, Germany's BMW and England's McLaren put the full force of their automotive engineering talent into the development of world-class sleighs. Joining the competition, small high-precision manufacturers in the heart of Tokyo are combining their supremely honed techniques to the manufacture of world-class bobsleds. The name of the project is The Shitamachi [heart of Tokyo] Bobsleigh Network Project. In this issue, we take a look at their history as we explore the essence of Japanese manufacturing.



Cooperation from
Koji Okuda and
Makiko Uchida
from the Ota City
Industrial Promotion
Organization.

Rapid Decline in Small Factories in the Heart of Tokyo

"Your craftsmanship is the best!" Jamaica Bobsleigh Federation President Chris Stokes came to Nagano to evaluate a bobsled designed and manufactured by a group of small factories in Tokyo, and immediately decided to adopt it for the Jamaican team. In addition to its stability, the precision processing and the capability of the project members to respond to the bobsledders' needs were immediately clear. The Jamaican bobsleigh team participated in the 1988 Winter Olympic Games in Calgary, Canada, the first time for a Caribbean nation to enter the bobsleigh event. Readers may have seen the movie "Cool Runnings," the story of the Jamaican team's path to the Winter Olympics. A combination of the Jamaican team's physical prowess and Japanese manufacturing quality marked the start of a new story at the 2018 Winter Olympics Games in PyeongChang, Korea. However, the road that led to this starting point was anything but smooth.

Many small factories involved in machine and metal processing are based in the Ota Ward, Tokyo. While 90% of these are medium and small-sized businesses employing 19 or fewer individuals, they engage in state-of-the-art processing with the most advanced

techniques to produce precision parts such as those used in the asteroid probe Hayabusa. With major companies shifting their production overseas in and after the 1980s, and the aging and retirement of small factory owners who had opened their businesses when the economy was booming in the 1960s and 1970s, the number of small factories has dropped from some 9,000 at the area's peak in 1983 to around 3,500 now. While small factories find it a challenge to mass produce at low cost, they excel in the production of small-lot prototypes requiring high skill levels and quick delivery and they have confidence in their techniques. However, what they needed was a way to let the world know about them. Material Co., Ltd. President Junichi Hosogai, a key figure in the Shitamachi Bobsleigh Network Project thought a good way to accomplish this would be through the Olympics. At the same time, Satoshi Kosugi, a member of the Ota City Industrial Promotion Organization, had the idea of exploring the possibility of small factories in the Ota Ward working together to manufacture high-quality bobsleds for the Olympic Games. Looking into this, he found that Japanese bobsledding suffered from a lack of funding, which forced many bobsledders to use old-style foreign-

made bobsleighs. Kosugi felt the fact that bobsleighs have many more parts than other equipment used in Olympic events, and that most of the parts from them are metallic, made them the perfect undertaking for the small factories in Ota. He proposed the idea to Ota Ward officials. The proposal was approved, but it was determined to be too much for the local administration to handle on its own and suggested that Hosogai himself head the project. Since Hosogai had been so enthusiastic about the proposal, even planning to cover the budget with funds from his own company if he couldn't convince the Ota Ward to support the project, he accepted the suggestion without hesitation. One day in December of 2011, the Shitamachi Bobsleigh Network Project, got its start. This was a project that would grow to involve many, including a former bobsledder living in Ota Ward, a race engine manufacturer and a university professor.

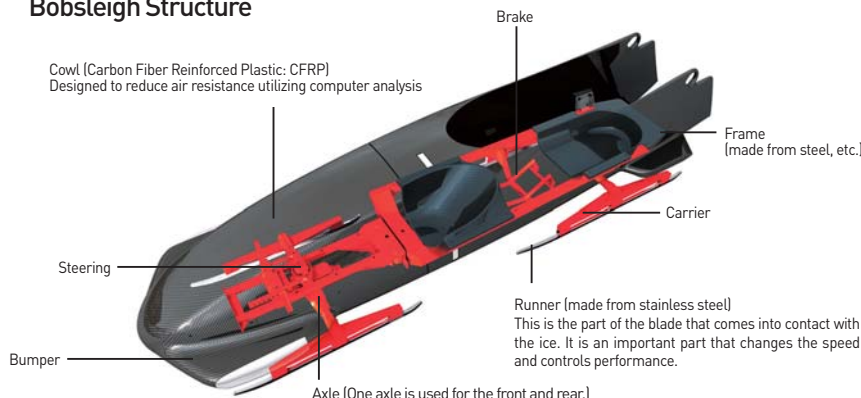


EYE on the MARKET SHITAMACHI BOBSLEIGH

Cooperation among Partners – Human Bond for Manufacturing

They say that “If you throw a paper plane with a design written on it through the window of a small factory in Ota Ward, you’ll have a completed product by the next day.” This is possible because of “nakama mawashi,” literally “passing something around to friends.” Taking advantage of their close proximity to one another, the small factories in the neighborhood are quick to ask one another to lend a hand to complete products. Hosogai felt that nakama mawashi would be a great plus for this project. He talked passionately about his idea with fellow manufacturers, sparking their imagination and interest in the project. He managed to borrow a bobsleigh from Sendai University. It was the first time he and his fellow project members had seen a real bobsleigh up close, and they jumped at the chance to dismantle it piece by piece and study the parts in great detail. They also studied the International Bobsleigh and Skelton Federation regulations closely before creating their design for the Shitamachi Bobsleigh, which was constructed of 150 parts. Hosogai invited factory owners in the Ota Ward to a briefing about the bobsleigh and ask for their

Bobsleigh Structure



cooperation on the project. About 30 owners attended the briefing and what Hosogai proposed to them was very simple. He laid out all the design drawings on the desk and asked each of them to select any parts that they thought they could or would like to handle. There were only two conditions. He told them that the project had no funding to cover their costs and that they would have only 12 days to complete the work. Though the two conditions raised eyebrows

around the room, one by one, the assembled craftsmen started to sound off: “We’ll handle the hull,” said one. “We’ll handle this shaft,” said another. In the end, there were no designs left on the table. By the very next day, Hosogai had already received some parts. At the end of 10 days, all the parts had been completed. Thanks to their cooperation, the parts fit together perfectly on the first assembly, allowing the Shitamachi One to be completed within only one and a half months.

Shitamachi One Performance is put to the Test

The Shitamachi One test run was conducted by a pair of bobsleighters who had won two consecutive Japanese National Championships. They said they were very anxious about testing a sleigh that they had never worked with before. However, when the pair saw the serious attitude of the craftsmen, they felt reassured and their confidence in the sleigh grew. On the first test run, they beat the time that took first place in the previous year. They said that Shitamachi One was much easier to handle than bobsleighs made

overseas. Hosogai told them that he would happily make any adjustments they would like if they were interested in using the Shitamachi Bobsleigh at the Japanese National Championships scheduled to take place in 10 days’ time. “Yes!” was their immediate response. While rushing to make it available for the championship, Hosogai found that they required some additional parts. They were nearing the deadline and only had one day left. In spite of the pressure, the craftsmen came through. Each factory handled a part

of the process, from material procurement to welding. They finished at midnight and the new parts were brought to the championship venue on the first scheduled bullet train and on that day the Shitamachi Bobsleigh made its debut in an official championship race. Compared with the test run held 10 days prior, the new bobsleigh bettered its time by more than one second. The Shitamachi Bobsleigh took first place in spite of the fact that this was its first time running in a championship competition; and of course the win put the Shitamachi Bobsleigh and the Shitamachi craftsmen in the spotlight.

On the Way of Making a Dream Come True

Shitamachi Bobsleigh development advanced to a fifth version. Sadly, however, the Japan Bobsleigh, Luge and Skeleton Federation decided not to adopt it for the Sochi Olympics because of the lack of time for test runs. For the PyeongChang Olympics, too, the newly hired coach decided to adopt a German-made bobsleigh. The Shitamachi Bobsleigh manufacturers refused to give up, however, and they offered their bobsleigh to three overseas teams. The Jamaican team replied to them first and the Shitamachi Bobsleigh Project brought them to Japan for a test run. They decided to use the bobsleigh immediately after they tested it and the team started development of a new model for the Jamaican

team. They employed an integrated structure carved from solid material to increase the aerodynamics of the frame, and in October 2016 they achieved the lowest level of wind resistance in history. What had started as a dream had become a successful reality. This success was made possible because all of the small factories in the Ota Ward had pursued the same dream and in turn created a strong new bond amongst them. The spirit and techniques of the craftsmen have gradually been brought to every corner of the world; and now small factories, each with only a few employees, are working together to compete with major manufacturers such as Ferrari and BMW. The challenge continues.



Special
Feature

A Challenge from Japan

Bobsleigh Network Project from the Heart of Tokyo

EYE on the MARKET SHITAMACHI BOBSLEIGH

Project Members Interview!

The Future of Shitamachi Bobsleigh and Small Factories

Cultivating a New Breed of Craftsmen that Thrive in Global Competition

Junichi Hosogai, President, Material Co., Ltd.

- Please tell us a little bit about Material Co., Ltd.

Hosogai: Before I founded Material, I was working for a small sales company providing materials to small factories. When I visited engineering companies, I often wondered how much the materials that I was selling for 100 yen would sell for after processing. When I finally asked, I was surprised to learn that the products sold for as much as 100,000 yen. There I was, I thought to myself, working hard to sell a 100-yen product to make an 8-yen profit, when our company could be machining it ourselves and turning that 100-yen material into a 100,000-yen product as well. I told the owner of the company I was working that I would be happy to learn the machining techniques so that we could handle the full range of manufacturing, from material selection through to processing and sales. However, the owner rejected my offer immediately because he thought it wasn't a good idea for a material supplier to handle processing too. I couldn't give up though, and finally decided to start a new business that sold added value. When I was 26, which was in 1992,

I set out on my own and founded Material Co., Ltd.

- Material Co., Ltd. places a priority on cultivating the skills of the employees and because of this many Material operators have acquired a Grade 1 Technical Skill Certification.

Hosogai: I currently employ 11 operators and I am proud to say that 9 of them have acquired certification. Remember back in school, if we were having trouble with a subject, we could ask our teacher for help or go to a tutor; but we can't do that after we start working. Employees have as much if not more to learn than students do, but practically speaking they have neither the time nor the money to go back to school after work. This prevents talented people from improving and realizing their full potential. Before a manufacturer has time to discover and nurture that talent, the young employee has left the industry. I decided to host seminars at my company to change this by giving employees the chance to learn the skills required for certification. We have an instructor that comes to the company

Material Co., Ltd. handles all the processes of manufacturing, from material selection to the sale of processed parts. We interviewed Junichi Hosogai, President of Material Co., Ltd., head of the Shitamachi Bobsleigh Network Project, to ask about the project and his thoughts on Japanese manufacturing.

every Friday to teach. This is a comfortable and convenient learning situation for the employees, and they all try their best to improve their skills. When they receive their certification, their confidence and pride increase; and it's a wonderful feeling for them to see the admiration in the faces of their coworkers and to hear the customers compliment them on their technique.

- Please tell us your thoughts about Japanese manufacturing and international competitiveness.

Hosogai: Because major manufacturers have sufficient staff, they tend to assign specific roles to each department. The downside of this is that while, say, the person in charge of procurement is an expert in purchasing products, that person might not know a whole lot about processing. That person needs to know the technical aspects as well as prices and delivery dates for the materials he is dealing with. This is why I believe that major manufacturers need to build cooperative relationships with medium- and small-companies that are familiar with processing. Meanwhile, small factories need to improve their individual specialised techniques and proactively advertise their skill in high-added-value processing, which would allow them to get involved in bidding for contracts. When I started this company, I did not have any specialist areas to offer to our customers.





I simply tried my best to make all the work we got our specialty. I believe that if we have a strong desire, dream, or clear purpose in business, we can achieve it.

- What role did nakama mawashi in Ota Ward play in the Shitamachi Bobsleigh Network Project?

Hosogai: In a practical sense it is hard for each of the factories in Ota Ward to handle the entire manufacturing process. Some have special plating techniques and others have highly advanced machining or sheet metal working techniques. Indeed, many of these small factories have unique techniques that can be used in niche fields. The cost of handling everything though would be tremendous and price them out of the market. Even if the product is well manufactured and highly useful, it would be impossible to move at the price they would have to charge to cover their costs. On the other hand, these small factories can share their individual specialties to reinforce our competitiveness against prices offered by the major manufacturing companies. This cooperation among factories is our strength.

-In the processing of parts for bobsleighs, how do you think the small factories take advantage of their capabilities?

Hosogai: When we need to make changes and express what we need in the abstract, they can figure out what we need immediately. It is a major advantage that the craftsmen at small factories can quantify abstractions and immediately make fine adjustments at short notice, and it's these things that really matter when it comes to improving bobsleighs. Bobsleighters are not

engineers, so they can't give the craftsmen specific descriptions or exact figures. With this in mind, it's a great advantage that the craftsmen can quickly figure out what adjustments they need to make in response to vague comments like, "It's a bit too light," or "It should be more resilient."

- The Shitamachi bobsled has improved. Tell us about the latest version.

Hosogai: Our approach to bobsleigh manufacture is to try as much as possible to reduce the number of parts that require welding. The reason for this is because welded metal joints cause shrinkage, and shrinkage leads to slight distortions. What we did was to machine complete parts from one piece of material whenever we could. We also worked to interlock parts that needed to be connected. In fact, we were able to machine an eight-part combination that had been welded on previous versions into one section.

-The Shitamachi Bobsleigh was not adopted by Japanese teams. What was your motivation to continue working on the project?

Hosogai: We started this project with the goal of showing the world what our small factories in Ota Ward were capable of. If we had given up just because Japanese teams decided not to adopt our model, our project would have been a waste of time, energy and resources. If we had given up, everything that we had accomplished would have ended at that moment. The thought of giving up before achieving our goal never occurred to us! I also believe that continuing in spite of challenges creates chances.

- What are you hoping to accomplish in the future?

Hosogai: I think Ota Ward has developed as a manufacturing centre that offers a wide range of solutions for global markets. Many of our colleagues and their families live here, and I hope that we can already make this an even better place for our children. It would be great if we could all work together to realize this vision. I am also thinking about ways of working with other regions in Japan to advance revitalization. As a Japanese person, I understand unique Japanese values, including high-quality manufacturing. If we keep seeking higher quality manufacturing, we will be able to popularize Japanese products that are highly trusted around the world.

- This is the last question. For you, what does it mean to be a craftsman?

Hosogai: A craftsman, I think, is a person who has a consistently high level of skill. A craftsman, I think, is a goal oriented person, a person who continues doing what he or she has decided to do until it is finished. Beyond this, however, is the fact that while the spirit of craftsmanship has remained the same, new technologies have developed one after another, technologies such as AI, Industry 4.0 and IoT. For this reason, it has become more important for craftsmen to develop not only technical skill, but managerial skill as well. I want to create an environment capable of cultivating a new breed of craftsmen, craftsmen with both the traditional spirit and flexible management skills that allow them to respond better to changing markets.

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EYE on the MARKET SHITAMACHI BOBSLEIGH

Project Members Interview!

The Future of Shitamachi Bobsleigh and Small Factories

Small Factories Established Stronger Bonds by Pursuing the Same Dream

Kotaro Kurosaka, President, Sanyo Kikai Seisakusho

- Would you tell us about your company's specialty?

Kurosaka: We are good at machining thin metal piping and flat plates that tend to deform when gripped by machinery. We specialize in machining extremely thin and extremely soft materials like aluminum. With materials such as these, even the slightest impact can result in significant deformation. This requires that we ensure the highest degree of exactness, including the use of the correct chucks, applying the correct machining parameters and selection of the right tools to finish the product.

- What do you see as the strength of Japanese manufacturing?

Kurosaka: I would say that Japanese manufacturing is very considerate. Japanese manufacturers place a great deal of emphasis on customer convenience; that is, we think about how the customer is planning to use the products we manufacture. These customers are sometimes end users and sometimes another manufacturer who further processes the product. An example of this is when we manufacture parts that other

companies will combine in subsequent steps in their manufacturing process, we visualize the finished product to determine how our part can best contribute to the convenience and success of manufacturers downstream. This is, I think, a particular strength of the Japanese manufacturer.

-Such consideration for others was exhibited in the machining of parts for the Shitamachi bobsleigh. It is the essence of nakama mawashi. How do you feel about this nakama mawashi culture?

Kurosaka: My grandfather opened a small factory in Ota Ward in 1948. When he started, there were many more factories in the area. Currently, the number of those small factories has dropped drastically because of the lack of people to pass them on to, a declining business environment and the smaller operations moving overseas along with major manufacturers that have expanded internationally. Ota Ward itself has undergone significant change as well. Where small factories once stood, now apartment buildings have sprung up one after another; and this has weakened the once close relationships that were common among factories. Before the Shitamachi

Sanyo Kikai Seisakusho has been machining air compressor parts for 68 years. The company has 15 lathes and 4 machining centres and has built trust through expertise in machining technology. Third-generation president Kotaro Kurosaka works side-by-side with his employees to pursue high value-added machining.

Bobsleigh Network Project, I didn't know much about people working at the factories in Ota Ward. The project changed that quite a lot. Before the project, while I may have heard of a company, I really had no idea what they did. There were some craftsman that I heard had good skill but were hard to get along with. Once the project started though, I found that these were all great people. After getting to know the individual craftsmen at factories throughout the project, I gradually became more involved in the nakama mawashi that existed during my grandfather's time. Everyone is in manufacturing, so it's easy for them to understand what one another are thinking. With this mutual understanding among them, they share the same enthusiasm and a sense professional pride that promotes cooperation.

- What is the most memorable experience the Shitamachi Bobsleigh Network Project has given you?

Kurosaka: I remember one day we had a part that required a 5-axis machining center. One of the project members asked us to take care of it because we had the machine for it. The problem was that we had used the machine for multi-face machining but not for 5-axis machining, and we really didn't know how to use it properly. I hunted around for someone in Ota who could handle the machining and found a





A small diameter radius end mill manufactured by Mitsubishi Materials was used for curved surface machining, and roughing type end mill was used for rough machining during the process of manufacturing Shitamachi bobsleighs.

factory that regularly used the machine. Unfortunately, the owner was too busy to handle the piece. Lucky for us, however, he offered to show us how to use the machine for 5-axis work and even made a program for the machining. After we talked about a few important points on the phone, he tailor made a program for our machine. We had never worked together before, which would normally be disconcerting; but the program he made for our device worked perfectly. All we had to do was to set up the machine and press the button.

- Have you noticed any changes in your company since the Shitamachi Bobsleigh Network Project started?

Kurosaka: Orders have been changing. We did not know the specialties of individual factories in Ota. Before the Shitamachi Bobsleigh Network Project started, and we had scant idea what the different factories in Ota could handle. As the project advanced, however, we became more and more familiar with their operations. Naturally, we started asking other factories to handle jobs when our workload was heavy and we had short delivery dates. We now have very good circulation among the factories in Ota. People have also become more familiar with the name, Shitamachi Bobsleigh," so our customers in other

areas have come to know about the skills and techniques that our small factories in Ota have. The greatest change, though, has been a significant increase in the motivation of our employees. The pieces we and each of the other craftsmen in Ota manufacture are only individual parts that are combined to create a final product; and while people don't usually give much thought to the individual parts that go into a product, our products go into a bobsleigh that competes with other world-class bobsleighs. If Shitamachi bobsleighs perform well at the Olympic level, we will have accomplished our goal of showing the world what the factories of Ota Ward can do.

- What were the difficulties involved in manufacturing parts for Shitamachi Bobsleighs?

Kurosaka: It was hard to machine a frame from one block of material. We machined a block of S45C; and the middle of the frame needed to be hollowed out to reduce weight. The program for this machining requires CAM; and even if the program works just fine in the CAM simulation, we often get insufficient machining or too much machining due to deflection or deformation. Then there is weight, which is key for bobsleds; however, weight is not the only concern. We also have to look at

overall balance, which is very important because the weight of bobsleighters sitting front and rear is different. Another difficulty is that bobsleigh parts are generally welded, and this causes deformation. To address this, we machined our bobsleigh parts as much as possible rather than fabricating them. We are happy that engineers from other countries are often surprised by the smoothness and beauty of the sleigh structure. While we can't know for certain how much the machining of parts has helped the performance of the sleigh, as craftsmen, we give it our all if there is a possibility that we can improve it. Bobsleighters who have used our bobsleighs have told us that their high rigidity means less vibration on corners.

- This is the last question. What is important for craftsmen?

Kurosaka: Craftsmen should always do their best to turn their wisdom and technique into originality and ingenuity. What we manufacture is industrial products, not traditional artistic crafts. In a world moving at high speed, skilled craftsmen need to set their sights on innovation. Otherwise, they will soon be left behind the times. It is important not to be satisfied with the current state, but to move forward.

**Special
Feature**

A Challenge from Japan

Bobsleigh Network Project from the Heart of Tokyo



FOCUS on PERFORMANCE

Uniquely Evolving Japanese Machining Craftsmen

PART1: Syousin Machinery Works Co., Ltd. (Kobe City, Hyogo Prefecture)

Enhancing Inventiveness in Preparation for the Arrival of Machine Tools Equipped with AI

Reproducing Delicate Noh Masks with a 5-Axis Machining Centre


Syousin Machinery Works Co., Ltd. has been engaged in machining for over 50 years at the Kobe High-Tech Park for cutting-edge technology companies in Kobe. Always looking for innovation, founder Shoichi Mashima implemented 5-axis machining centres ahead of other companies about 20 years ago and has since strived to achieve the highest quality precision machined parts by employing the most advanced machine tools. Currently, the company machines a wide variety of parts for use in gas turbines at thermal power plants and engines for aircraft and submarines.

Around 2010, in addition to its regular work, the company started manufacturing products utilizing its own machining know-how to highlight its highly-

advanced technological capability. It has manufactured completely machined stainless tumblers and beer glasses, Edo Kiriko glasses, wine glasses, and Noh masks, which is a traditional Japanese handicraft. The Noh masks manufactured with the 5-axis machining centre represent its accumulated technology. Syousin Machinery Works President Masanobu Mashima said, "When I saw a carved wooden Noh mask at a souvenir shop during a trip, I wanted to reproduce the precision utilizing a 5-axis machining centre." The first process was to rough machine a block of aluminum alloy measuring 180 mm × 180 mm × 300 mm, and finish the horns, facial expressions and other details, including wrinkles, without re-gripping the block. "This super-precise processing cannot be performed by high-performance machine

tools alone. Inventiveness is essential in the selection of tools, choosing the machining processes and making original jigs. This is the spirit that underlies our management policy, 'Manufacturing with a Wealth of Inventiveness!' In 5 or 10 years, machine tools with artificial intelligence (AI) will become common. Our work on such products is designed to improve our inventiveness to a level beyond the capability of AI." Because of this Noh mask, manufactured in cooperation with DMG Mori Co., Ltd., Syousin Machinery Works was selected as one of 10 Japanese representatives at the Machining Expert Contest, a contest for 5-axis machining organized by the University of Hannover, Faculty of Mechanical Engineering and Hannover Centre for Mechatronics (Germany).

Craftsmen Talking to Tool Machines



While the size and weight of the final products are being reduced, the machining industry will also be increasingly required to produce super-thin and super-fine parts. President Mashima said, "Even if machine tools are equipped with AI, super-thin and super-fine parts are not easy to machine. We are now perfecting our skill in this area with the reproduction of a paper plane but made of aluminum alloy with a thickness of only 0.2 mm. We machine an aluminium plate to a thickness of 0.2 mm, and provide a super-fine finish on the surface using a solid end

mill. Since the material needs to be very thin, we need to be extremely careful and quick in machining to prevent bending and breaking. This is accomplished by adjusting the cutting force." Yusuke Konami, Chief of Production Department, told us about the dedication of the craftsman, "Although it is the same as our regular work, super-fine machining requires us to "talk to the machine." Operators touch a part of the machine they use to sense the sound and vibration to adjust the machining parameters, the form of jigs and method of clamping."

Masanobu Mashima, President, Syousin Machinery Works Co., Ltd.



Yusuke Konami, Chief of Production Department,
Syousin Machinery Works Co., Ltd.

Japanese products are highly regarded for their quality. Looking into the history of the industry in Japan, we can find thousands of small- and medium-size companies that continued improving their technology amongst fierce competition to ensure quality. In this feature, we visited three companies that have established unique manufacturing methods with a small number of employees to survive in this industry while envisioning the future of the machining industry from their own viewpoint. We asked about their dedication and enthusiasm for manufacturing.

- PART1** Syousin Machinery Works Co., Ltd.
(Kobe City, Hyogo Prefecture)
- PART2** Kirishima-Seiko Co., Ltd.
(Kirishima City, Kagoshima Prefecture)
- PART3** Kitami Mould Steel Co., Ltd.
(Saitama City, Saitama Prefecture)



Original products made by unique ideas



Only 0.2 mm thickness aluminium-made "paper" plane

Skilled Craftsmen Visualize the Entire Process, from Start to Finish

President Mashima said, "Skilled craftsmen can grasp the designer's intention by looking at drawings and simple sketches, visualize the machining processes from start to finish and select the best method to produce the finished piece quickly and efficiently. This is, I believe, the strength of Japanese craftsmen. They never separate the individual processes. While they concentrate on their work, they keep the entire process in mind. This aluminum paper plane was created by teamwork. I just gave Konami a sample

of the paper plane I made. They are good craftsmen." Konami said, "My techniques are not up to this level yet. I want to be as skilled as the craftsman sent from one of our partnership companies. Using a centre lathe and a turning tool that he made himself, this craftsman processed parts from rough finishing to final finishing with precision and speed as if the parts were machined by an NC machine tool. He also managed the processes and continuously checked the quality until the piece was completed.

I probably can't imitate everything he was doing; but for sure I learned a lot from him." Mashima also said, "Craftsmen exhibit sensibility in manufacturing, and that sensibility is developed through continual effort." He continued, "Our company gives a brazed turning tool to newly hired employees in the hope that they will develop into good craftsmen. They grind and polish the tool by themselves, check the form of the edge and experience the hand feed of the centre lathe to develop their sensibility."

Mitsubishi Materials Cutting Tools Suitable for Difficult-to-Cut Materials

Syousin Machinery Works started using tools made by Mitsubishi Materials around the year 2000, which is about the time Mitsubishi Materials released end mills with Impact Miracle coating. Suhara from Mitsubishi Materials looked back to the time and said, "At that time, Syousin Machinery Works mainly used tools made by overseas

manufacturers. However, we heard via a trading company that they were looking for better quality tools. So we visited them and talked about our products. When they tried them, everyone there was surprised by the smoothness of the machined surface of stainless steel materials. Since then, they have mainly been using our tools."

President Mashima said, "Tools made by Mitsubishi Materials are high quality and long lasting. The machining of 64 titanium, 55 titanium, nickel and Inconel, which are all difficult-to-cut materials, and also super alloys used for gas turbines cannot be machined effectively without Mitsubishi Materials tools."

Becoming the Priest that Spread the Gospel of Small- and Medium-Size Companies

President Mashima pointed out that since globalization has taken root, manufacturers have felt increasing pressure to reduce costs to remain competitive; but companies in the same industry are competing for work without thinking ahead seriously. "Most companies' estimates for parts processing include labour and machine costs, but do not include rents, utility costs, quality or delivery management costs. They

are often afraid to include overhead costs in their estimates because customers complain that prices are too high. What we need to do is to sell ourselves better. We need to help the customer understand what goes into production, what the real cost of the piece they have ordered is. If we can do this, customers place their orders with confidence that they are receiving the finest quality work at reasonable prices.

It is time that more companies adopt this attitude of including the real costs of delivering a component and enlightening customers about what quality means. Doing this will help to raise the position of small- and medium-size companies in the Japanese machining industry. We will do our part by continuing to develop new technology to advance the development of the industry."

(Right) Takenobu Suhara, Akashi Sales Office, Osaka Branch,
Advanced Materials & Tools Company, Mitsubishi Materials Corporation



PART 2: Kirishima-Seiko Co., Ltd. (Kirishima City, Kagoshima Prefecture)

Machining Super-Complex Forms Equivalent to or Greater than 5-Axis Machining with 3-Axis Machining Centres High Difficulty Parts Machining

Kirishima City, the second largest city in Kagoshima, is located in the centre of the prefecture. Many well-known manufacturers have established bases in the city, and small- and medium-size companies that boast advanced technology are also scattered throughout the area. Kirishima Seiko President, Tamotsu Nishishige, worked at a company that machined precision parts for the optical communication and semiconductor industries, but the company went bankrupt due to excessive capital investment. Supported by co-workers who expressed a desire to work with him and together with partner companies that were willing to provide equipment for free, Nishishige established Kirishima-Seiko Co., Ltd. in

August 2006. When they opened, they only had 5 employees and 5 machines. "We are good at machining parts with complex forms. Doing so usually requires high-performance machining centres. However, because I did not have enough financing to acquire machine tools at that time, we discussed using a 3-axis machining centre that we already had. We developed exclusive jigs and established a unique "curve cutting method" in less than one year," said President Nishishige. With this unique method capable of machining complicated forms without re-gripping, they could significantly reduce the number of processes. This single-pass machining enables higher speed



Tamotsu Nishishige, President, Kirishima-Seiko Co., Ltd.

and precision that leads to super-fine machining but increases yield ratio. Kirishima-Seiko was certified as an Innovative Management Company by Kagoshima Prefecture in 2008 because of this technology. They have since built a new plant that is capable of operating 24 hours a day and moved the business to its current location.

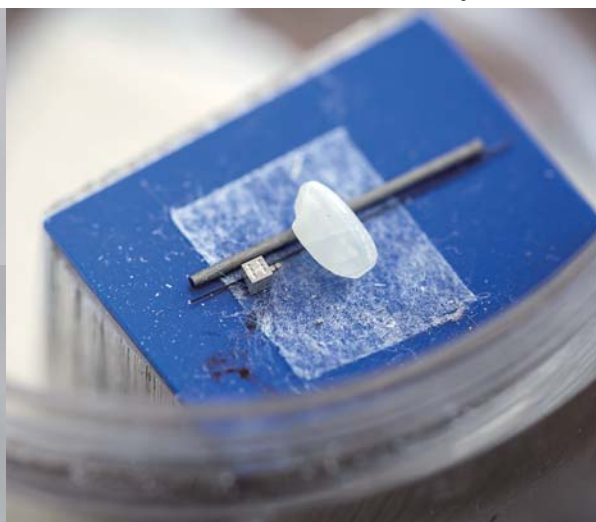
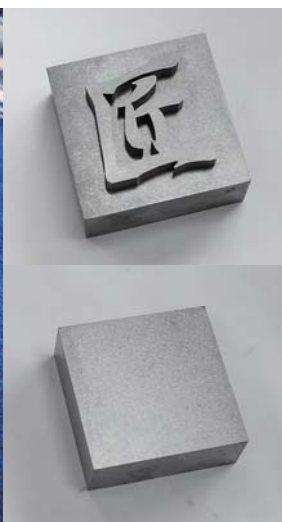
Producing an extremely small dice measuring 0.2 mm³ and an ultra precision "jigsaw piece"

Kagoshima Industrial Support Center asked Kirishima Seiko if they were interested in participating in an exhibition in Tokyo. It was a chance for them to show products that could highlight their technology. "I decided to advertise our complex super-fine machining utilizing our 3-axis machining centre. I thought it would be a good idea to exhibit products that have a strong impact on people to attract their attention," said Masanobu Hotokeyama, Chief of Manufacturing Division. The manufacture of these items required no welding or assembly of other parts. They used only machining to manufacture chains without joints, a bird cage that features a bird and a cage as one unit as well as pyramids with a decorative chain inside. The pyramids

in particular were highly regarded and singled out with a Technique Award in the Prototype & Test Part Category at the Dream Contest sponsored by a machine tool manufacturer. Their techniques have gradually improved and they finally succeeded in making a dice measuring just 0.2mm³. On these stainless steel dice, they also machined numbers; that are invisible to the naked eye unless magnified, with an extremely small end mill. These extremely small dice drew interest from local newspapers and other media and visitors to the exhibitions and their plant were very impressed by these and the other products.

Recently, they made an object similar to a jigsaw piece. The piece was a Japanese kanji character, takumi (craftsman). The character, takumi, and the base in which the piece fits were machined out of carbon steel, with ultra fine precision and just 3 μ clearance. The fit was so precise that when laid flush, the "jigsaw piece" seems to disappear into the main base. The idea came from when they were watching TV and saw a similar product. President Nishishige asked Hotokeyama, if they could replicate such a thing, to which Hotokeyama immediately answered, "Yes, of course." "I was skeptical, but he brought me a finished product in a few days," said Nishishige pleasantly. This flexibility, wisdom, and the drive to seek something new in manufacturing reflects the strength of the company.

Extra small products manufactured using super-fine machining



Extra small workpiece measuring 0.2 mm³, which is much smaller than a grain of rice

Using the existing machinery creatively is the real pleasure

They focused on doing as much work as they could get for three years after the company opened its doors, accepting any and all orders, including those that came in late at night or during holidays. Looking back on that time, President Nishishige told us that he was asking himself many questions at that point in his career – “Was this really what I wanted to do? Was this the company I wanted to build? Did I think my employees were really happy?” During that time, he showed workpieces that his company had machined at an exhibition that received impressive comments. “That bolstered my confidence, so I decided to focus on mastering complicated precision machining, at a level that requires techniques and skill that cannot easily be imitated.” With the motto, “Never say we can’t. Just try hard,” they have continued highlighting their specialty in difficult-to-cut materials and super fine machining. This has led to their handling of a wide range of super precision parts, including components and devices for the semiconductor, healthcare, satellite and other industries. Mitsubishi Materials tools are essential for such high-level machining and Chief Hotokeyama said, “The precision and sharpness of the Mitsubishi tools are

beyond comparison and they deliver what we need, when we need it.”

When Kirishima-Seiko receives a request for an estimate, top management studies the drawings, identifies problems and discusses ways to deliver the highest quality work at the lowest cost. They then deliver a proposal to the customer, who reviews it. Only after the customer is fully satisfied with the proposal does Kirishima-Seiko submit an official estimate for the high added-value parts machining.

The question was raised whether the employees prefer 3-axis or 5-axis machining centres. “Well,” Chief Hotokeyama told us, “it’s more efficient in terms of work allocation to have two 3-axis machines than it is to have one 5-axis machine. Besides efficiency, the real pleasure in manufacturing is putting our heads together in a process of trial and error to achieve the most out of the existing equipment. It is more enjoyable for us to try attain the same high quality results with a 3-axis machine as with a 5-axis machine, because it challenges us to improve our technique and this makes us proud as craftsmen.”

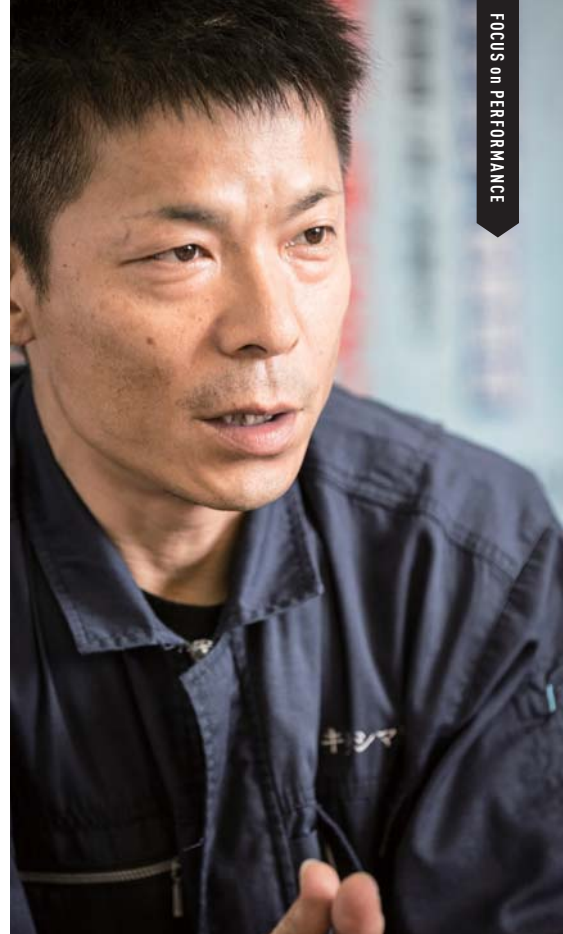
Kirishima-made products for the world

In the 10 years since Kirishima-Seiko opened its doors for business, its high-quality technology has been shown by the mass media and this has helped the company to continue to grow. Their orders from companies in Kansai and Kanto have increased and the number of employees has expanded from 5 to 36. President Nishishige said, “We had an event to celebrate the company’s 10th anniversary in August of this year. All the employees took part in the preparation and the event. Around 150 people attended, including employees, family members and special guests and everyone had a great time. At the end of the event, the employees surprised me with a present.” This demonstrates the warm atmosphere at Kirishima-Seiko that makes employees feel

secure; this in turn enables them to fulfill their potential in manufacturing. This is one of the strengths of Japanese small- and medium-size companies.

“Thanks to the employees and the community, this company has grown so much. To repay their kindness, I continue to promote the advancement of machining to highlight the advanced technology and skill that goes into the high-quality products manufactured in Kirishima. I also want to develop new machining technology that surpasses the confidential curve cutting method to achieve further efficiencies and cost reductions.” President Nishishige continues looking to the future for the company and the community.

(Left) Yoshiyuki Kanezaka, Kyushu Sales Office, Osaka Branch, Advanced Materials & Tools Company, Mitsubishi Materials Corporation





(Left) Kitami Mould Steel Co., Ltd. President Yuichi Kitami
(Right) Kitami Mould Steel Co., Ltd. Executive Director Tomoyuki Murata

PART 3: Kitami Mould Steel Co., Ltd. (Saitama City, Saitama Prefecture)

Innovating by Excluding Technical Drawings: Defying the Conventional Wisdom

New Metal Moulds Vitalizing Japanese Manufacturing

Metal moulds are key to the production of the wide range of products being manufactured around the world; and Kitami Mould Steel Co., Ltd. (KMS) manufactures and sells mould bases. Established in 2002, KMS is a young company in an industry where experience and know-how are essential for survival and despite these difficulties for a start-up company, it has thrived. We asked what made this possible.

"It was the skill and experience of craftsmen that supports Japanese

manufacturing," answered President Yuichi Kitami. "It doesn't help us, though, if we focus on experience and know-how, but ultimately lose out to global competition. Along with market globalization, basic customer needs such as quality, delivery dates and costs have become more demanding. With the motto, 'Energizing Japanese manufacturing,' we decided to establish a production system capable of quickly responding to customer needs while ensuring that skill and tradition is also passed down."



Becoming Independent to Focus on Customer Satisfaction

"When I started in this industry, most of the top management of small- and medium-size companies in Japan was made up of company founders who were working hard to expand their businesses by establishing trusting relationships with individual customers. The company that I was working for though, did not seem to care much about responding to customers' needs. I felt that was the wrong attitude, but knew that I would have to strike out on my own if I wanted to do something about it. That pushed me to start this business," said President Yuichi Kitami, who had been in sales and marketing before starting the business. At the beginning in 2002, KMS did not have its own plant, which forced it to outsource production; but in 2005, KMS finally built its own plant. However, even when the business seemed to be on track, the company still had its share of ups and downs. One of the problems was that experienced craftsmen employed at the company often insisted on sticking with their own manufacturing styles and this interfered

with being able to respond to customers requests, such as changes in specifications or delivery dates. Because of problems like this, KMS gradually lost customers to its competitors and the company's future was put in jeopardy. However, instead of giving up, this critical situation sparked a fire in President Kitami's competitive nature. He visited overseas manufacturers to look for ways to break out of the company's difficult situation.

"When I saw the high productivity levels at overseas manufacturers, I realized that they were ahead of Japanese manufacturers in using data rather than depending on the experience of individual craftsmen. The difference I could see between Japanese and overseas manufacturers was quality. In other words, if we could establish an effective system of production that could compete with overseas manufacturers, but add Japanese quality, I thought we could break through."



Enabling Newly Recruited Employees to Work as More Experienced Staff in Just Two Weeks

Kitami came up with an idea that departed significantly from the conventional method of manufacturing.

background in sales and marketing helped me to see problems differently."

"I designed a standard system, such as the model applied to fast-food restaurants and convenience stores that would enable employees at all levels of experience to machine materials at a consistently high level of quality. If I had been an engineer, I might not have come up with such an idea; but my

He started by developing unique machining programmes and establishing a production system. Yutaro Fukuhara, Head of the CAD System Development Department, said, "Developing a system and software that would allow us to manufacture our own products required a monumental effort, and I felt I would never get through it. However, after a lot



(Right) Kohei Horiuchi, Distribution Sales Section, Sales Division, Advanced Materials & Tools Company, Mitsubishi Materials Corporation



(Left) Kunihiro Iizuka, Chief of Iwatsuki Plant 2, Kitami Mould Steel Co., Ltd.
(Right) Yutaro Fukuhara, Head of CAD System Development, Kitami Mould Steel Co., Ltd.



Many young female employees are engaged in the Programming Office.

of time and effort, approximately 80% of the manufacturing processes were completely systemised. I knew that our competition would not be able to do this easily.”

Surprisingly, there are no drawings at the factory, only machining instructions. Operators do not refer to drawings when they are working on a component. “Perception

varies and each individual looks at the piece differently when they refer to a drawing. We discussed the content and expressions used in the machining instructions at great length to make it possible for everyone to prepare, machine and measure in a standardised manner to prevent operator error,” said Tomoyuki Murata, Executive Director. Although Kunihiro Iizuka, Plant Chief, felt

anxious at first about not having a drawing to look at, he said, “Now I feel that referring to a drawing is an outdated method. Machining instructions made the work more efficient and provide an increase in quality. We still have room to improve, but we are trying hard to establish a system that allows all operators here to manufacture high quality products quickly and efficiently.”

Overall Optimisation Achieves a 5 to 10 Fold Increase in Speed

President Kitami said, “Increasing the speed of a specific process will not increase the speed of the entire process. The key to increasing speed is to ensure that all the processes flow at the same speed. Reducing the time during which machines stop operating leads to increased speed,” which is the basic KMS manufacturing policy. Therefore, KMS divides each process into individual operating sections,

and also divides labour into individual processes. Assigning one operator to each process allows each operator to learn skills more quickly and this leads to reduced scrap, less difficulties and irregularities. Currently, KMS has achieved a surprising rate of production, one that allows it to finish components 5 to 10 times as fast as its competitors; leading to customers having extreme faith in KMS delivery dates. It is not only

the manufacturing method that is unique though. KMS has a motorsport team and many employees come to the circuit on race days to support the team. Such activities have helped to cultivate an atmosphere of unity among employees and increase their motivation. President Kitami said, “We will continue such activities with the hope that the manufacturing industry will become more attractive for young people.”

Continuous Search for Unique Manufacturing that Stays Ahead of the Competition

President Kitami said, “We expect durability from cutting tools. Price is less important because our priority is being able to continue operations. Any problem with a tool forces the employee to focus on one machining operation, which makes it difficult to handle multiple operations at the same time. When this happens, the speed of the entire machining process slows, which leads to increased cost. The MVX series from Mitsubishi Materials has a solid reputation among operators.” Cutting

tools play an important role in realizing the excellent production system we have developed at KMS. Plant Chief Iizuka said, “The new system allows us to precisely calculate the time required for machining each process and this has significantly reduced overtime work. Cutting tools are critical in our business and we completely trust and rely upon Mitsubishi Materials for these tools.”

President Kitami also said, “Until we

established our current system, employees worked until late at night to deliver products by the deadline; but that did not lead to increased profits. That was a tough time for everyone. It’s hard to break old routines, but we believe that applying innovation to increase the speed of production will increase our competitive advantage in the global market.” Having built a new head office in 2015, KMS is placing a priority on cultivating human resources as well as expanding business.



HISTORY OF MITSUBISHI

Vol. 4

Mitsubishi DNA Passed Down
to the Next Generation

THREE MITSUBISHI PRINCIPLES – SANKORYO –

Mitsubishi Materials originated from Tsukumo Shokai (the seed of the Mitsubishi Group), the coal and mineral mining business that Yataro Iwasaki started in 1871. The Mitsubishi Group has expanded over four generations, from Yataro to his younger brother Yanosuke, to Yataro's first son Hisaya, and on to Yanosuke's first son Koyata. Looking back over its history, we see common principles passed down over the generations. These principles called, The Three Mitsubishi Principles, became the common management philosophy for the entire Group of Mitsubishi companies in 2011. Here we explain these three principles that provide the foundation of common management practice among the Mitsubishi Group's approximately 650 companies.

1. Shoki Hoko – Corporate Social Responsibility

Strive to enrich society, both materially and spiritually, while contributing to the preservation of the global environment.

Fourth-generation President Koyata Iwasaki led Mitsubishi for 29 years from 1916, the years spanning from World War I to the end of World War II. He stated clearly on many occasions that "Corporate management should not be conducted from the perspective of profit, but from the standpoint of a national project." This Mitsubishi principle was passed down to each president, from Yataro to Yanosuke, Hisaya and Koyata Iwasaki.

Koyata Iwasaki also said, "Production is one of the country's most important activities. It is associated with national strength and has an impact on the economy and prosperity. Being engaged in production, we are, in a

real way, playing an extremely important role. The ultimate purpose of business therefore is to contribute to the nation and we exert our best effort in fulfilling this purpose (source: The Announcement at the Mitsubishi Mining Company Extraordinary Conference Held in 1920.)"

Koyata Iwasaki had a firm management philosophy, the social contribution expected in the growth of Japanese capitalism between the Taisho Period (1912-1926) and Showa Period (1926-1989). It is also a fact that our present affluence comes at the cost of the global environment. This fact makes it clear that our mission must be to change our way of business in ways that contribute to the maintenance and restoration of our irreplaceable global environment, and to the realization of physical and psychological affluence throughout society. This is how we interpret the meaning of shoki hoko at present.



The location of Mitsubishi at its foundation: Nishi-Nagahori in Osaka
(At the beginning of the Meiji Period – around 1870)



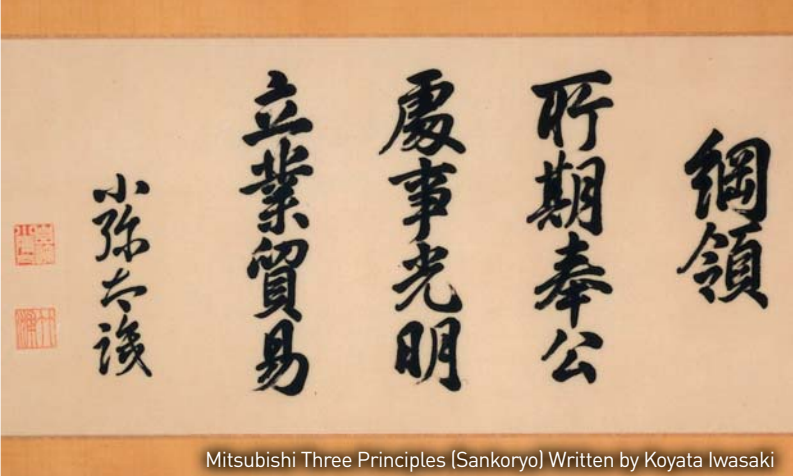
Mitsubishi Executives (Around 1880)

2. Shoji Komei – Integrity and Fairness

Maintain principles of transparency and openness and conduct business with integrity and fairness.

Shoji komei means fairness in all things. All Mitsubishi presidents, from Yataro Iwasaki to the present day have repeatedly insisted that Mitsubishi business management will not prioritize profit as an end in and of itself. Fourth-generation president Koyata Iwasaki in particular, was known to prioritize sincerity and to repeatedly caution Mitsubishi employees against focusing blindly on profits and pursuing unthoughtful investment to that end. He exhorted employees to maintain a high standard of ethical behavior in all transactions.

"The social position of corporations has advanced, and their growth is significantly associated with the growth of the nation.



Mitsubishi Three Principles (Sankoryo) Written by Koyata Iwasaki



Mitsubishi Head Office Building in Kanda-Awajicho [1888]



Tokyo Minami-Kayaba Head Office [Around 1877]

Yataro Iwasaki, 1st PresidentYanosuke Iwasaki, 2nd PresidentHisaya Iwasaki, 3rd PresidentKoyata Iwasaki, 4th President

Yoshioka Mine [Around 1902]



Mitsubishi Goshō Kaisha Main Building [Mitsubishi Main Building: Around 1922]

On the other hand, sadly, corporate morality seems to have deteriorated. Those in business must serve as an ideal model for others in their behavior and thought. While integrity and fairness are the most important aspects of business, it is shameful that people try to make fortunes at a stroke or through means that are contrary to our ideal of social justice. [source: An article "My Hope to the Club" written by Yanosuke Iwasaki, Vice-President, to the Mitsubishi Club Journal in 1915]."

Although fair competition based on free ingenuity is the basic principle of the market economy, we need to consider the sentiments of the general public, the customs of international society and compliance with law. We need to exhibit high ethical standards and conduct and promote transparency and openness in our business activities.

3. Ritsugyo Boeki – Global Understanding through Business

Expand business from an all-encompassing global perspective.

The biggest issue for modern Japan was the adjustment to globalization. Since the time of founding President Yataro Iwasaki, Mitsubishi has promoted this attitude amongst its employees. In 1941, on the day following the outbreak of the Pacific War, President Koyata made an announcement to the top management of all Mitsubishi group companies, "While governments have, unfortunately, started a war, we count many British and Americans amongst our partners. They have undertaken many projects with us and so we have a duty to protect their lives and interests." Considering the historical background at that time, he made a surprisingly courageous statement.

"Even if the government takes action against the businesses and assets of our British and American partners, we should prevent the trust and friendship we have developed with them from being damaged. Justice, humanity and responsibility demand that we protect their lives and interests using every means within the limits of the law. When peace comes again, we will once again cooperate together to contribute to the realization of world peace and the well-being of all [source: Speech made by Koyata Iwasaki at Mitsubishi Council in 1941]."

Respect for justice has been one of the basic principles of Mitsubishi Group since its foundation. This attitude of respecting justice from a global perspective in the midst of war embodies the Mitsubishi spirit. Mitsubishi Materials Corporation and other group companies keep the spirit of The Three Mitsubishi Principles (Sankoryo) in mind as they take further steps toward the future.



Craftsman Story

Vol.5

Yasuharu Imai
Development Team Staff
Advanced R&D Group
Joined in 1991

Hiroyasu Shimizu
Leader
Advanced R&D Group
Joined in 1993

Toshiyuki Obikawa
Professor, Department of Mechanical
and Biofunctional Systems, Institute of
Industrial Science, The University of Tokyo

Hidefumi Takahashi
Development Team Leader
Advanced R&D Group
Joined in 2000

Jet Coolant Technology

Jet Tech Holder

Increased abrasion resistance with the advancement of coolant-driven technology

The need for high-efficiency machining for difficult-to-cut materials has been increasing in the aircraft and other industries; and now, tools capable of performing under advanced machining conditions for extended periods of time are also required. For difficult-to-cut material machining, the use of turning tool holders using high-pressure coolant has gradually increased. Although proven to be effective in controlling chips, another goal, tool longevity, has yet to become stable. Special equipment is also required for high-pressure coolant. Therefore, machine shops have longed for standard tool holders that can be used on different machine tools while they improve abrasion resistance. In this feature, we interviewed three Mitsubishi Materials employees who have developed extremely effective coolant technology in cooperation with Professor Toshiyuki Obikawa from the University of Tokyo.



- First of all, would you please tell us about the characteristics of this technology?

Takahashi: The significant characteristic of our new coolant-driven technology, "Jet Tech Holder," is the placement of an L-shape nozzle that we developed at the edge of the holder to provide a powerful jet of coolant from the flank face of the insert to the cutting edge. Coolant is generally supplied from the insert rake face or to the flank face in reverse tool holder use. However, when supplied from the flank face, as shown in Fig. 1 (left), chips can interfere with the flow. Even when supplied from the rake face, the coolant does not enter the narrow, high-temperature, high-pressure space where the tool's rake face and the surface of a target material; which is rotating at high speed, come into contact. The end result is that coolant does not always effectively reach the edge that needs to be cooled. As shown in Fig. 1 (right), Jet Tech supplies high-pressure, high-speed coolant from the flank face to the edge to prevent it from becoming too hot. This makes effective edge cooling possible, which improves insert abrasion resistance. We also confirmed that this technology can prolong tool life by approximately 30 to 50% when compared general external coolant supplied from the rake face.

- Would you please give us the background of development?

Shimizu: We were working to address the significant deterioration of tool life experienced during the machining of difficult-to-cut materials, but we felt we lacked the in-house resources we needed to ensure the competitiveness of the new products that were under development. For this reason, we sought outside cooperation. We met with Professor Toshiyuki Obikawa of the University of Tokyo, who had been engaged in research on extending the life of tools used for difficult-to-cut materials. Professor Obikawa was investigating the effect of a system that directed air for cooling from the flank face to the edge. Impressed with the potential of this method to extend tool life, we began joint research in 2008.

Takahashi: Japanese tool manufacturers were not interested in coolant-driven technology at that time. Mitsubishi Materials was also not really enthusiastic about it then either. When I learned about this joint research, I thought it looked promising; but I was also worried about whether commercialization would be practical and whether the concept would sell.

Shimizu: In developing tools and technology, our Advanced R&D Group looks five to ten years into the future; but specific product development focuses on

introduction to the market within two to three years. I knew commercialization would be a challenge, but I felt this coolant-driven technology had potential. Besides, our group is named, "advanced R&D," and I felt coolant-driven technology was just that.

Takahashi: The biggest turning point during development was choosing between an air-assisted method to emit coolants, or direct acceleration of the coolant. After a great deal of discussion, we decided to prioritize ease-of-use under a wide range of environments and application of it to the different cutting tools employed in the market. This led to our choice of coolant rather than an air assist type. After this decision, we set to work on important details such as determining the most effective form and size of the hole that would emit the coolant and the amount of flow, etc. During this phase of development, Professor Obikawa's fluid analysis was extremely helpful. Because my knowledge of fluid analysis was rusty, I broke out my textbooks from college and brushed up on it. Through these efforts, we were able to complete the basic design concept for Jet Tech, which allowed us to start full-scale development for mass production and commercialization. We put Imai in charge of the most important aspect of the development, design!

Imai: I had just finished a large product development project. To tell the truth, a turning tool holder development

requires more effort, so it's difficult to get people motivated. Unlike the development of milling tools, which are popular projects, nobody looks forward to being involved in turning tool development. However, Takahashi's description of the basic concept of Jet Tech hooked me, so I signed up to the project. The basic effects had been verified, so I felt that I could concentrate on commercialization.

Takahashi: He says so now, but I still remember that when I told him about the project, he looked disappointed and clearly less than happy about the idea. In the end though, asking Imai to take charge of design for this product was the right move.

Imai: I love development and working on difficult-to-solve problems fits my personality.

- What difficulties did commercialization present?

Imai: The most difficult part was the form of the port that would emit the coolant because it should not be produced by machining.

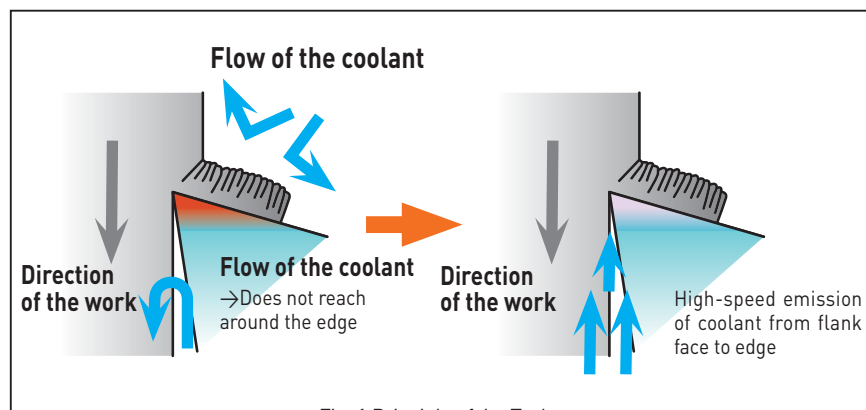


Fig. 1 Principle of Jet Tech



Jet Coolant Technology
Jet Tech Holder





There were no tool holders that had a coolant port around the edge, and mass production of such a tool holder via machining was not possible. In other words, it was necessary to make an independent part. Since I wanted to do something that no one had done before, I set to work.

Shimizu: In fact, seeing an obstacle to manufacturing this design with the existing equipment, we gave up on machining the port and asked Imai to create the part.

Imai: First, we had to decide what material we should use for the prototype. Since a resin 3D printer was being used in other product development, we went with resin. Coolant emission was fine; but as might easily be expected, when we put it to the test in actual machining, the heat of chips quickly damaged it. We decided to make another prototype, this time using metal. We found a company handling 3D printers for metal and placed the order for the prototype parts.

Takahashi: At the beginning of development, we designed the part to be effective under normal water pressure. Some customers however, use high-pressure coolant and under such conditions, the nozzle would fly right off. Therefore, we needed to change the design to accommodate both normal and high pressure conditions. We also found that the screws that fix the part to the tool bent under high pressure, so we had to improve those as well.

Imai: At that time, Takahashi was coming at me with one request after another. We had our share of difficult discussions, usually based on, "This is not what you were asking for last time!"

Takahashi: Every time I asked Imai to

change specifications, he told me, "This is completely different from what you were talking about before!" He was right, but my motive was to ensure that the part would satisfy customer needs. Difficult as it was, Imai and I kept at it.

Imai: The advantage of making prototypes with a 3D printer is that we can perform tests with them and evaluate the results for improvement. The advancement of 3D printers has reduced the development period not only in the tool industry, but in just about every area of manufacturing.

Takahashi: After determining the final design, we verified the part under different machining conditions by changing coolant type and flow. Finally, we were ready to make a presentation to other companies at an exhibition held last year. The conference room was filled to capacity. We were asked many questions and felt a high level of interest among customers. Many asked us if the part functioned as well under normal pressure. I felt that people were very interested in the fact that a Japanese tool manufacture was working on new coolant technology. I was very pleased that we had kept at this without giving up.

- Please tell us about your future vision.

Takahashi: We first started sales with the ISO C-type geometry, and expanded to W, D, S, T and V-geometries. We are planning to apply this technology to products other than turning tool holders.

Shimizu: This technology should be used more broadly, even by other companies as an excellent way to increase service life. Indeed, it should be seen as an

industry standard that contributes to reduced production costs for customers. Really, this technology represents an improvement for the entire machining industry. I also feel that industry-university-government collaboration should be enhanced. Compared with activity overseas, Japan is not taking advantage of this nearly as much as it could. I want to follow this approach more and more.

- This is the last question. Please tell us what about manufacturing attracts you.

Imai: What I imagine becomes reality. My imagination is commercialized and makes customers happier. This is fantastic. Being engaged in development means doing something completely new. We may fail and encounter difficulties but our ability to work on, in spite of setbacks leads to our ultimate success. That ability is nurtured in no small part by our more experienced colleagues who encourage us to see failure as a learning opportunity and difficulties as a challenge. This comfortable environment is a key to the creation of something new.

Takahashi: I've been in development for 16 years. I put plans into final shapes and validate theory. When the theory and actual product match perfectly, it's a great thrill. Development is great fun for me because I am pursuing a goal that no one has reached yet. It may be the world's first, the world's best or even the only one in the world, and I am very proud to be doing such work. I will continue working on the development of new products to make our customers happier.

The photo on right shows the first prototype



Interview with Toshiyuki Obikawa, Professor at the University of Tokyo

University of Tokyo Professor Toshiyuki Obikawa is a leading expert in machining. He started research on machining when he was studying for his master's degree. The topic of his research was the effects of manganese sulphide (MnS) contained in free-cutting steel. We interviewed Professor Obikawa about the joint development of Jet Tech Holders with Mitsubishi Materials.

- What were the challenges you faced in research on difficult-to-cut materials?

Obikawa: Around 1980, when I became an assistant, machining targeted steel only. Difficult-to-cut materials such as titanium alloys and nickel-based heat-resistant alloys were extremely expensive and hard to obtain. However, I felt that Japanese machining technology for the aerospace industry was behind other countries, so I chose difficult-to-cut materials for my research. Machining generates heat and that heat causes significant deformation; but analyzing data to clarify this was very difficult. Analytical theories described in the technical manuals at that time were not about large deformation, but about stress. It was very difficult to analyze deformation.

- What research were you engaged in after that?

Obikawa: When I became a professor, MQL machining was popular as an environmentally friendly method. The use of a small amount of oil mist rather than a large amount of lubricant was the standard at that time and it had spread quickly since it reduced power consumption and machining costs. In the late 1990s, an automobile manufacturer reported that replacing the coolant pump could cut energy consumption by approximately 40%. I also examined the effects of MQL machining, investigating various points by using fluid analysis. When I was watching MQL machining tools that emit oil mist from both flank and rake faces, I wondered what would happen if compressed air were emitted from the ports in regular wet cutting. My experiments yielded favorable results. This is the Air Jet Assist (AJA) method. Using air however, cost a lot more than I had expected; and this led me to the idea that we should instead use coolant and emit oil mist from a smaller port. Next came the idea that we should emit compressed air only and then follow with a coolant.

- The idea of using air is innovative, right?

Obikawa: Using the AJA machining method, we thought we could push coolant by air. The flow speed of coolant is about 1 to 2 meters per second while the flow speed of compressed air is about 100 to 200 meters per second, which is quite a difference. We knew that MQL emitted air effectively, and we thought we would be able to use it. I was very lucky because the initial data in all of the research showed extremely good results. Often, unfortunately, if we obtain discouraging data at the beginning, we tend to abandon the idea.

- What were the challenges in the development of coolant technology?

Obikawa: First we examined the best size and form for the port. However, it is very difficult for students to freely adjust the size and form of the ports on prototypes. To address this we made an adaptor with ports on the edge of the nozzle, changed the diameter of the ports and measured both flow and speed. As the diameter becomes larger, the flow increases; but past a certain size, the speed drops. We discovered that approximately a 2mm² cross-sectional area yielded the best flow and speed, and we set that as the standard for design. Although I felt that emitting machining lubricant from both flank and rake faces would be ideal, I finally decided on the flank face only to prevent a decrease in speed with the increase of flow.

- What impressed you most about Mitsubishi Materials?

Obikawa: They helped our research immeasurably. The cross-sectional area of the port for the machining lubricant on the Jet Tech Holder was larger than the port for the air employed in the AJA machining method, so some ports were filled with adhesive. When we emitted the machining lubricant, the adhesives were softened by the lubricant and finally destroyed. We changed from circular to L-shaped ports, which also differ depending on the edge of each insert. I know that it must have been very difficult for Mitsubishi Materials to make and verify different forms for actual use.

- How did you feel when you finally completed the product?

Obikawa: I agreed with the idea of emitting coolant from the flank face and worked together with Mitsubishi Materials through a process of trial and error to complete the product. When I saw the final product, I felt it was simply beautiful. Tool holders are high added value products. When roughly calculated, 1 gram of an airplane costs about 200 yen and 1 gram of the most advanced hybrid automobile costs about 2 yen. One gram of an insert on the other hand, costs about 50 yen; and inserts are disposed of after a few milligrams of wear, which makes them extremely costly. I would like to continue research that expands the potential of cutting tools.



TECHNOLOGY ARCHIVE

History of Grooving Tools and the Enthusiasm of Craftsmen



History of Craftsmanship
that has Always Achieved
a Functional Beauty
Ahead of its Time

Some say that the history of grooving tools stretches back to 1898, when the first tool bits were manufactured. Mitsubishi Materials started producing its first grooving tool, a brazed bit, in 1956. In 1980, it developed the DG tool bit, the first bit with a replaceable cutting edge. Launched in 2008, the GY series adopted a superior clamp mechanism that dominated the market. In this feature, we trace the history of Mitsubishi Materials' grooving tools, tools that have risen to meet the challenging needs of industry.

TECHNOLOGY ARCHIVE

Part

1

1956 ~

Craftsmen competing to show their skill with brazed tool bits

Brazed tool bits are made by jointing a carbide cutting edge to the top of the steel shank. It was about 60 years ago in 1956 that Mitsubishi Materials launched its first grooving tools. JIS B4105 stipulated strict specifications that made no distinction between forms used by different manufacturers. Performance was determined by the quality of the carbide used in the cutting edge. At that time, there were few Japanese manufacturers that could manufacture carbide. Mitsubishi Materials' carbide had outstanding abrasion

quality and excelled in defect resistance, and its superior machining performance was highly regarded by the manufacturing industry during Japan's post-war recovery.

Craftsmen at that time generally adjusted the form, rake angle and honing of brazed tool bits utilizing their grinding machines to create conditions suitable for the materials and methods being used to improve dimensional and machined surface accuracy, and extend tool life. Their skills could be judged by the quality of the tool

bits they manufactured.

Brazed tool bits adopted different carbide for each material to be machined. The tail of each shank was colored differently to make it easy to ensure the right bit tool was being used for each material: blue shanks for steel, yellow for stainless, and red for cast iron. Some may still remember seeing these colorful tool bits on shelves. Currently, brazed tool bits are less common; but, they are still used to train young craftsmen.



Part

2

1985 ~

DG tool bits with replaceable cutting edges

When the cutting edge of a brazen bit is worn or damaged, the entire bit is changed. Because this includes the shank, it is not economical; and while the cutting edge can be polished to extend service life, highly-advanced skill is required to maintain cutting edge quality. This led the push for a high-quality, low-cost solution. That solution came in the form of tools with insert-type replaceable cutting edges made of carbide. The first such bit introduced by Mitsubishi Materials was

a cam-lock type used for machining outer diameters, which the company launched in 1960.

DG tool bits were launched in 1985 as grooving tools with replaceable edges.

The merits of DG bits included not only low cost and high quality, but also outstanding performance. DG tool bit inserts could be manufactured separately, which provided great flexibility in selecting carbide materials and coatings, and led to the

development of high-performance inserts. These characteristics took the market by storm by enabling high-speed machining that could not be matched by brazed tool bits. A chip breaker was provided on the rake face of the insert for chip control during the manufacture of inserts using the press sintering method. This chip breaker enabled lateral machining, which had been impossible with the existing brazed tool bits. Grooving tools have improved since then to become multi-functional tools.



HISTORY

History of Grooving Tools

1931 Tridia, a carbide tool, launched.

1956 Brazed tool bits (including grooving tools) launched.

1985 DG tool bit, an insert-type grooving tool, launched.

2004 New insert-type grooving tool development starts.

2008 GY series, new insert-type grooving tools, launched.

2017 New item in GY series scheduled for launched.



Part **3** 2008 ~

GY series: inspired by disc brake calipers for automobiles

After Mitsubishi Materials launched its DG tool bits in 1985, other carbide tool manufacturers worked to keep pace by developing new multi-functional grooving tools. To maintain its lead against increasing market competitiveness that challenged the supremacy of DC bits, Mitsubishi Materials moved quickly to push forward with the development of new products. Hidehiko Nagaya, who was then in the Research & Development Department in charge of milling tools, was asked to head up the new-product project.

"I was still fairly young at that time," said Nagaya, "and my experience was with tools in a different area. I was surprised and happy that the company asked me to take on such a large project; but, without the experience and knowledge I felt I should have to handle the responsibility, I was also quite nervous. I accepted the challenge, though, and set my sights on doing the best job I could."

Everyone involved in the project listened carefully to what customers around the world were looking for and learned that many were dissatisfied with combined units, which were major products for carbide tool companies at that time due to their excellent rigidity. The reason they were dissatisfied was that damage on the

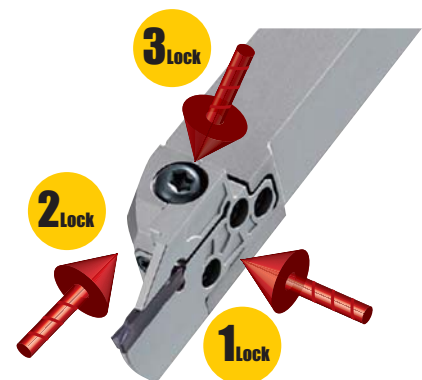
insert caused damage to the main body, and this resulted in the need to replace the entire unit, which was not economic at all. Modular type tools with replaceable inserts such as the DG tool bits were economic, but they were less rigid. Therefore, we decided to focus on developing a new modular-type grooving tool with rigidity equivalent to the combined unit.

Nagaya liked motor vehicles, especially motorcycles, and belonged to the auto club at his university. He continued participating in the JAF Gymkhana, a driving competition, after he started working at Mitsubishi Materials. "After the project started, I was continuously racking my brain to come up with new ideas. One day when I was reading a motorcycle magazine, I saw an article on radial-mount brake calipers, which were fixed vertically rather than the standard lateral placement to increase rigidity."

Inspired by the concept, Nagaya focused on three-directional fixation to increase durability against the force of machining: from the front and diagonally upward as well as from the side. It was called a try-lock system. "When you look at the shape, it really has a simple structure. However, we did not have grooving tools capable of fixing inserts from the front. I was excited and really wanted to commercialize this system before someone else came up with the idea." Try-lock system development went very smoothly, and its high performance was verified using prototypes. However, the cost of manufacturing its modular blade, which had a complex form, had become a significant issue. "We applied complete machining to the prototypes; but this failed to meet time and cost requirements. I then decided to use press sintering technology that had been developed by Mitsubishi Materials. I think we were the first to succeed in using this technology to attach an insert to the main body of the tool. I also wanted a product that looked good and

could be distinguished from others at a glance." Nagaya continued: "The side of the modular blade was inspired by the thinning seen in racing car parts, a technique that provides both strength and light weight."

Finally, the modular-type GY series realized high rigidity equivalent to the combined type. It succeeded in reducing chattering vibration for broad machining conditions and in realizing high-quality finishing surface and long life. Since being launched in 2008, the GY series has received an overwhelming response from the market with sales quickly exceeding our competitors' products. The technological contribution to the industry was highly regarded, and Mitsubishi Materials was recognized with the 2009 Technological Achievement Award from the Japan Cemented Carbide Tool Manufacturers' Association (currently the Japan Cutting & Wear-resistant Tool Association). The GY series achieved its mission as the first new grooving tools that Mitsubishi Materials had introduced in 20 years. New items in the GY series scheduled to be launched in 2017 spring have been under development.



TECHNOLOGY ARCHIVE

CLOSE UP

Person in Charge of Intellectual Property Rights Supported the Development of the GY Series

Mitsubishi Materials holds the highest number of machining tool patents among domestic tool manufacturers. It is also among the top patent holders in the world. The number of patents usually acquired for one machining tool is about 1 to 2. However, the GY series has surpassed this with an amazing 19 patents. We interviewed Koyama and Hiyama, both Managers Chief Engineers in charge of intellectual property rights about the acquisition of patents for the GY series.

When- Mitsubishi Materials began GY series development in 2004, the Research & Development Development Department's Division's Koyama surveyed about 500 patents that had been acquired by other manufacturers. At the same time, the department also started examining the design drawings for the new product proposed by Nagaya's team. "I told them," Nagaya said, "that they needed to take extra care with any modifications to avoid the possibility of infringing patent rights held by other companies; and I was impressed with their attention to detail and ingenuity in moving forward despite this restriction. I admired their enthusiasm greatly."

In 2006, meanwhile, Hiyama, a certified patent solicitor on staff at the Mitsubishi Materials Intellectual Property Department, was assigned to the Cutting Tool Division, which was working on GY series development. "I was worried because of past patent disputes; but Nagaya's enthusiasm about innovation coupled with Koyama's familiarity with

cutting tool patents and the trust he had among developers made me forget my worries. Before I knew it, I was standing with them at the cutting tests."

The GY series entailed the development of a wide range of small parts such as modular blades, clamp mechanisms for inserts, breakers for inserts, and applications for inner diameters and edges. "One day," said Koyama, "we received notice that an overseas competitor had filed an objection to our application for a European patent. Although concerned, we also took it as a sign that the GY series was a growing force in the European market. The competitor claimed prior development; however, we argued that the innovative form of the GY series delivered performance that had never been achieved by other products, and our patent was granted."

"When we were in the long, dark tunnel of patent conflict with our competitors, Hiyama and Koyama lighted the way. I really appreciated them," said Nagaya. At Mitsubishi Materials, development staff and staff in charge of intellectual property rights share information during development. This is one of the company's significant strengths in the development of innovative products.



Three staff talking about the difficulties they faced at that time.
Noriko Hiyama, Manager, Intellectual Property Dept., Corporate Research & Development Dept. Chief Engineer, Intellectual Property Office, Technical Development Division (middle)
Takashi Koyama, Manager, Materials & Coating Development Center, Research & Development Div. Chief Engineer, Material & Coating Development, Center, Development Division (right)

Looking Back on the History of Grooving Tools

"Because JIS stipulated specifications for grooving tools used for brazed tool bits, details such as form and size, performance was standardized across the industry regardless of the carbide material used. However, there were no standards specifying the form or size of inserts such as those used for DG tool bits. The individuals involved in the development of DG tool bits were excited about the opportunity to differentiate their products from competitors. The GY series products we developed were the first new grooving tools that Mitsubishi Materials had produced in 20 years. Although there was significant pressure on us to come up with products that had great potential, we were fairly free to move in our own directions. Of course, we faced a number of difficulties

during development; but cooperation among the individuals in manufacturing, sales, development and intellectual property rights got us through the rough patches along the path to GY series commercialization. I can honestly say that the GY series came to fruition through the combined efforts of all employees at Mitsubishi materials, and all of us learned valuable lessons during this development project.

I am currently managing a cutting tools group, so I'm away from direct involvement in development; however, I still have lots of chances to meet and talk casually with young team members in situations that allow us to dispense with form. Through our talks at such times, we seek new ideas

that may have potential for development and commercialization. I've worked within this process of development and believe that the experience of success has a significant impact on the development of young employees; and I hope they continue the search for innovative cutting tools."



Hidehiko Nagaya, Cutting Tools Group, Indexable Tools Development Center, Research & Development Div.



ABOUT US

Chicago
Technical
Center

An Educational Base for Broad Areas in the United States

We report on the provision of total solutions and unique workshops being provided by the Chicago Technical Center.

Interview with the Marketing Director!

My goal is to create the
ideal solution for each and
every customer

Mike Pace
CTC Marketing Director,
Mitsubishi Materials USA



Striving to provide speedy and effective solutions

The Chicago Technical Center (CTC) was established in 2013 to enhance our ability to create total solutions and provide training programs for customers. Marketing Director Mike Pace said, "We provide materials, products and services that meet and exceed individual customer needs with the aim of maintaining our position as a respected leader in the cutting tool industry. The extensive range of solutions provided by us includes cutting tests, technical consultation via telephone, seminars, and technical support designed to ensure that our customers are able to utilize the full capability of our cutting tools." The CTC is located near O'Hare International Airport, one of the major hub airports in the United States. The geographical advantage enables Mitsubishi Materials USA to provide outstanding services to customers not only in North America, but in Mexico and Canada as well. Local time in Chicago is 15 hours behind Japan. Taking advantage of that time difference allows the company to accept orders for cutting tests in the evening

in the US, outsource the testing to Mitsubishi Materials in Japan, and have the tests results ready for the customer by the next morning. This quick response time is a significant CTC strength. Of course, they can do the same thing in reverse for customers in Japan. With technical centers around the world, Mitsubishi Materials can provide a speedy response to all of its customers. The CTC also has the machining room, located right next to the lecture room where specialized techniques and skills are taught, for demonstrations using actual tools. This layout is extremely convenient for customers. Customers can see the actual machining processes and results in the machining room, which is equipped with the most advanced machining center and a 4-axis lathe, which has increased the learning effect. Each training session accommodates 16 participants. This makes efficient and effective class management possible for the nine training sessions we provide each year. Because the United States is so large, we also dispatch lecturers to customers for which it is inconvenient to send representatives to the CTC. Pace said,



"We want more customers to use the CTC as a means to meet their needs; and we would like to present proposals that reduce processing costs, including tool costs, and provide solutions for high efficiency processing to improve the productivity for each customer."

Bringing to bear a tremendous amount of accumulated machining data to provide optimum solutions

Marc Kinnemann (in his 12th year at Mitsubishi Materials) is in charge of management at the CTC. The CTC conducts cutting tests for a wide range of tools. They also accumulate machining data on hard-to-cut materials and a wide range of processed parts to provide prompt solutions that meet individual customer needs. Mr. Kinnemann said, "We focus on the accumulation of machining data on parts for automobiles, aircraft, medical devices, and oil & gas equipment, and we are confident and proud of our ability to provide total solutions in all of these areas. The CTC leverages the experience and data it has accumulated in over 1,000 cases to provide high-quality value analysis proposals. Because machining

conditions and environments can and often do vary significantly from customer to customer, and tools may be used under conditions that we may not yet have encountered, we consider the widest variety of machining conditions possible in our search for more creative tools and machining methods."

Seminar participants deepening partnerships

CTC places a priority on not only providing customers with a place to learn, but on facilitating interaction with other seminar participants. At the end of the first day, participants have dinner and enjoy bowling together. Facilitating interaction on the first day deepens communication and understanding among participants, which encourages greater interaction in the sessions that follow. After lunch on the second day, participants go sightseeing in downtown Chicago and at Lake Michigan before having dinner at a lakeside restaurant. The CTC provides customers the chance not only to learn machining techniques that provide solutions to their individual problems, but also to establish partnerships with others in the industry.

Interview with the Manager!

Utilizing Accumulated Processing Cases to Provide Prompt and Effective Solutions

Marc Kinnemann
CTC Manager, Mitsubishi Materials USA



CTC Training Program

1 Lecture in the classroom



2 Machining demonstration



3 Interactions among participants



CUTTING EDGE

Vol. 4



Amazing Straightness with only 0.48 mm Deflection over 1km

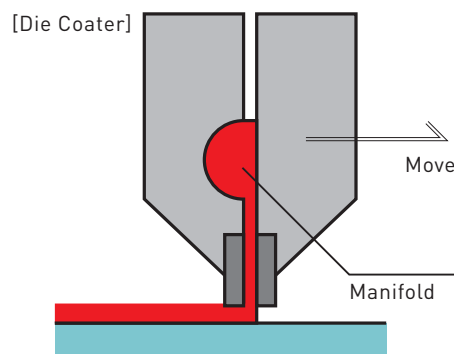
Slot Die Useful for Liquid Coating

A slot die is a tool used to apply liquid coating. It is often used for precision coating on liquid crystal panels, high-function film, and lithium-ion rechargeable batteries. The slot die structure combines a pair of stainless steel bodies with a cemented carbide edge that forms an opening for coating material. The coating material is delivered from a storage space on the body (manifold) to the edge to ensure even coating. Coating with a slot die is cleaner and more effective compared with other coating methods such as spraying because it prevents coatings from vaporizing or dispersing.

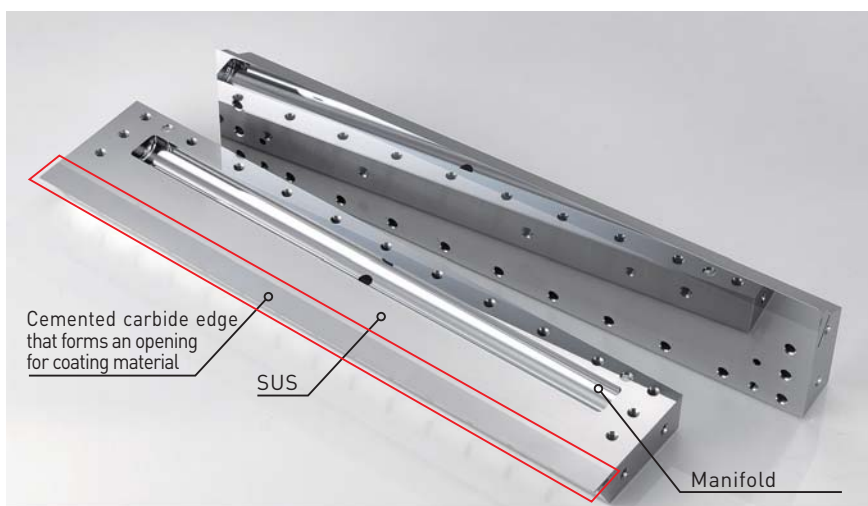
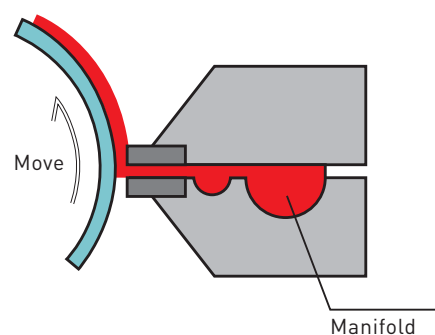
Utilizing its know-how as a cemented carbide tool manufacturer, the Mitsubishi Metals Tokyo Plant (currently the Mitsubishi Materials Tsukuba Plant) developed its first slot die with carbide edge in 1981. This was a die coater type slot die for film manufacturers designed for use in the production of audio and magnetic tape. Slot die production was shifted in 2000 to MMC Ryotec Corporation, which entered the industry with flat panel displays (FPD) used for liquid crystal TVs and computers. Maintaining its place as a leading slot die manufacturer, MMC Ryotec continues

to develop new coatings for large liquid crystal panels (2,880mm×3,130mm) and lithium ion battery electrodes.

■ Slot Die Structure



[Roll to Roll]





(From the left) Atsushi Hayashi, Section Head Assistance, Precision Technology Group, Wear-Resistant Tools Division, MMC Ryotec Corporation
 Ayumu Nagaya, Section Head, Manufacturing Department Slot Die Section, Wear-Resistant Tools Division, MMC Ryotec Corporation
 Takahiro Isoda, Sub Leader, Precision Technology Group, Wear-Resistant Tools Division, MMC Ryotec Corporation
 Toshihiko Kanayama, Group Leader, Precision Technology Group, Wear-Resistant Tools Division, MMC Ryotec Corporation

Seeking Ultimate Precision to Achieve Straightness and Reduce Surface Roughness

MMC Ryotec slot dies are manufactured using highly-advanced grinding technology and know-how accumulated over 30 years to increase straightness, reduce surface roughness and ensure consistent groove width. Straightness refers to an edge that is completely free of warpage. Deviation in the slot die is limited to approximately 1 to 2 μm per 1m, which is extremely precise. The long slot dies (for 2.5m) used for large crystal liquid panels were required to meet the same standard of straightness (1m) as regular panels, an extremely difficult standard to achieve in such a large panel. They changed the heat treatment and machining processes to reduce the residual stress and warping that occur in the pre- and semi-finishing processes as much as possible. They also sought installation methods and grinding conditions in the finishing process with the goal of limiting deviation to 1.2 μm over a 2.5 m long article. This equals 0.48mm per 1km. When you consider that 0.48mm is the width of a single graphite refill for a mechanical pencil, this was an amazing achievement.

Furthermore, the surface roughness of the carbide edge is approximately 0.1 μm (Rz) and that of the stainless steel main body is approximately 0.2 μm (Rz), giving it a shiny mirror surface. The groove width deviation of the edge that discharges coating materials is reduced to approximately 1 to 2 μm per meter.

“Hayashi, Nagaya and I had been designing and manufacturing slot dies for 30 years, since the beginning of development, and accumulated know-how,” said Kanayama. “Each slot die has the same design and size with slightly different features. Even if we try to process them in finish-machining based on drawings, we often need to change grinding conditions significantly according to differences in the material lot and heat processing,” said Hayashi, who is with the Technology Group. Talking about the pleasure of manufacturing slot dies, the Manufacturing Department’s Nagaya said, “When we understand such differences among slot dies and achieve the precision specified by a drawing, we feel great satisfaction.” Isoda, who

is the youngest of the group, has been developing new products that respond to diversified customer needs, products such as a three-layer coating slot die that is capable of handling three coating materials at the same time.

The slot die manufactured by MMC Ryotec has a leading share of the global market for lithium ion rechargeable batteries and liquid crystal panels. In China, it has captured the top share and is scheduled to introduce a re-grinding service for edges in 2017 to establish a firm position in the Chinese market, which is expected to grow further. MMC Ryotec also continues to seek out new customers that do not yet use slot dies.

History of Slot Die Manufacturing Sites

- 1981: Mitsubishi Metals Tokyo Plant begins manufacture of slot dies
- 1989: Shifts manufacturing to the Mitsubishi Metals Gifu Plant
- 2000: Shifts manufacturing to Ryotec Corporation
- 2011: Ryotec Corporation is renamed MMC Ryotec Corporation

*Straightness is measured at arbitrary positions in one direction and expressed as the minimum distance between two geometrically parallel flat surfaces that are vertical to the direction of straightness when holding the linear piece with the two surfaces (JIS B0621)



Japanese Swords



Japanese swords and their rich individual histories have fascinated people for centuries. Swords were first used as weapons in the Tumulus Period (3rd century). Swords seen in the Asuka (592-710) and Nara (710-794) Periods were called chokuto, or straight sword, a name that reflects their use for thrusting rather than slashing. The evolution of what was to become the classic Japanese katana the world has come to know began in the Heian Period (794-1192), which saw a surge in the demand for swords due to the many internal conflicts that took place during that period, the most famous of which is perhaps the clash between the Genji and Heike Clans known as the Genpei Kasen. Before this time, imported swords were valued over domestic blades for their quality. With each successive conflict, however, these early Japanese

swordsmiths (toshō) improved their craft, eventually arriving at the characteristic curved blade, or tanto that distinguishes the Japanese katana from other swords seen around the world. The introduction of cavalry to Japanese warfare spurred improvements in the length and arc of the blade to allow mounted warriors to more effectively wield their swords in battle, which is called tachi. With the emergence of samurai as the ruling class of the military government established in the Kamakura Period (1192-1333), skillful craftsmen cultivated under the Shogunate began to produce new types of bladed weapons such as the tanto (short sword), naginata and yari (pole weapons). Development continued as Japan faced the two Mongol Invasions (1274 and 1281) in the late Kamakura Period. It was at this time that the prevailing method of

battle shifted from individual combat to coordinated unit tactics, and bladed weapons were produced to meet the needs brought about by this change. Some of them are now national treasures. The Muromachi Period (1336-1573) saw the introduction of short swords, or kozori, swords for indoor fighting, or wakizashi, and the two-sword samurai style that we are familiar with today. They were also important products in overseas trade. By the Sengoku Period (1467-1590), which saw the rise of two famous samurai, Oda Nobunaga and Toyotomi Hideyoshi, the quality of swords had improved to such a degree that they had become prized possessions and symbols of authority, taken as spoils of war and presented as honors. The introduction of firearms brought rapid change.

Armor design shifted to emphasize ease of movement and improved protection. Along with this came the appearance of the uchigatana, a sword whose weight and length made it ideal for combat. The uchigatana is what we generally think of nowadays as the Japanese sword. In the Edo Period (1603-1868), laws were established to restrict sword ownership by class, limiting, for example, tradesmen and craftsmen to short swords. As peace spread during the Edo Period, sword use declined. At the end of the period (1853), however, sword use rose as forces within the nation again plunged into conflict. Although personal possession of swords was prohibited in 1876, they continue to fascinate us because we feel the proud history of the samurai that made them famous as they built the Japan we live in now.

History of Japanese Swords

[Period]

Nara	Heian	Kamakura	Nambokucho	Muromachi	Sengoku	Edo	Meiji
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[Sword Period]

Jokoto (Early Old Swords)	Koto (Old Swords)	Shinto (Newly Swords)	Shin-shinto (Very New Swords)	Gendaito (Modern Swords)
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Former Nine
Years War &
Gosannen War

Mongolian
Invasions

Onin War

Battle of Sekigahara

Haitorei Edict

Cavalry

Infantry Action

Tachi 1 (Long Swords)

Tachi 2 (Swords)

Uchigatana (Swords)

Wakizashi (Short Swords)

Tanto (Short Swords)

Yari (Spears)

Source: The Science of Japanese Swords Written by
Masashi Daimaruya (SB Creative, 2016)

Forging a Japanese Swords

Forging a Japanese sword requires strength and specialized skill, and swordsmiths are masters at creating designs, selecting material, and finishing. The following are the major steps involved in Japanese sword making.



1. Tama-beshi

The metal used to forge the sword blade, called the tama-hagane, is produced from iron or black sand. It is heated and forged to 6-10mm thick ingots before being broken into smaller pieces.



2. Tsumi-kasane

Swordsmiths select hardest pieces, which are suitable for the outer layer of the sword blade called the kawagane, and stack them on a tray.



3. Shita-gitae

This stack is heated to around 1,300 degrees Celsius and hammered to remove impurities. The block is folded and hammered repeatedly transversely and longitudinally.



4. Uwa-gitae

Imagining the intended hamon, or pattern he hopes to achieve on the jigane, or blade metal, the swordsmith heats and hammers the iron block to complete the kawagane.



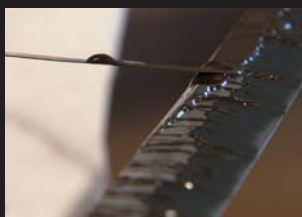
5. Tsukuri-komi

After combining the kawagane, the hard metal used for the outer layer of the blade, and shingane, the softer metal used for the core of the blade, it is heated for forging.



6. Wakashi-nobe & Ara-shiage

The material is heated to be formed into a bar. The bar is then formed into a blade with a small curve using a hammer, and roughly polished with grinding stones and other tools.



7. Tsuchi-oki

Imagining the hamon of the blade, blade clay, a mixture of clay, grinding stone powder, and coal dust known as yakiba-tsuchi, is placed on the blade.



8. Yaki-ire

The blade is heated evenly from the top to the bottom and quickly quenched in water to form the curve.



9. Sorinaoshi

Any warpage produced in the yaki-ire process is corrected by hand.



10. Mei-kiri

The signature, or mei is first written on the blade and then engraved with a chisel. The blade is completed and passed to other craftsmen such as scabbard makers (saya-shi)



11. Completion

Editorial Note

The publication of MMC Magazine Vol. 4 was made possible through the cooperation of many talented and dedicated people. I would like to express my deep appreciation to those who accepted our requests for interviews. The major reason we decided upon "Japan Quality" as the theme of this feature was that JIMTOF 2016, one of the largest international machine tool fairs in Japan, was scheduled to be held at the same time Vol. 4 was to be published. We were able to interview a number of dedicated professionals, company owners, craftsmen and others whose stories and thoughts we are sure will be of interest to all of our readers. I was extremely impressed by the passion, ambition and skill these individuals brought to the machining industry. I hope I can share that excitement with you, the readers. I also hope this feature promotes the advancement of the machine processing industry in Japan and in a world that is becoming increasingly globalized.

Yutaka Nada, Chief Editor

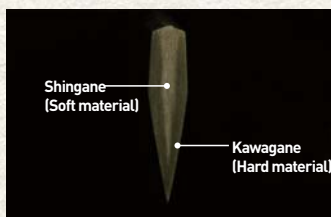
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Tip of the Japanese Swords

(1) The key is that the tip does not to break or bend.

The strength of Japanese swords is ensured by the selection of the best material for each part. The process of realizing the ideal combination of core softness and outer-layer hardness is called tsukuri-komi. Using softer metal (shingane) in the core helps to absorb and reduce impact, and wrapping it with a harder metal (kawagane) prevents the blade from bending.



(4) Iwaku - One of the attractions of Japanese Swords

It is also interesting to learn the legends related to each sword. For example, a famous Japanese sword called douji-kiriyasu-tsuna is said to have cut the head off an ogre. Heshikiri-hasebe is said to have been owned by famous warlord Oda Nobunaga. Nikkari aoe is said to have been so sharp it even killed a ghost.

(2) Other crafts related to sword making

The creation of a Japanese sword requires more than the swordsmith who makes the blade. A number of other craftsmen take part in the process, craftsmen such as polishers (togi-shi) who add sharpness and beauty to the blade, scabbard makers (saya-shi) who ensure the perfect fit for each sword, lacquer painters (nu-shi) who coat the scabbard, silversmiths (shirogane-shi) who make the metal fittings placed between the blade and hilt, hilt wrappers (tsukamaki-shi) who craft sharkskin and other materials, and handguard makers (tsuba-shi).

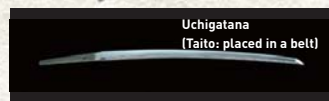
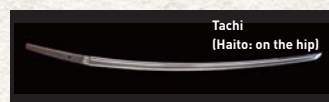


(5) How to become a swordsmith

Becoming a Japanese swordsmith takes five to ten years studying under a master and passing an examination given by the Japanese Agency for Cultural Affairs. There are currently approximately 350 licensed swordsmiths in Japan. Each licensed swordsmith is limited to producing 24 swords per year to maintain the high standard of quality.

(3) How to distinguish tachi swords from uchigatana

When we look at a sword, we notice that some blades are exhibited with the sharp edge upward and others are exhibited with the sharp edge downward. This is the difference between tachi and uchigatana. While a Tachi is carried with the blade edge facing downward for easy drawing when riding on horseback, uchigatana is carried with the edge upward for easy drawing while on foot.



(6) Purchasing a Japanese sword?

Japanese swords are sold at sword and antique stores. A Japanese sword certified as a work of art can be purchased by anyone. These are for display only, however, because carrying one in a public place or removing it from its scabbard are strictly prohibited.



Mitsubishi Materials is not just a tool manufacturer

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

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

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

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

YOUR GLOBAL CRAFTSMAN STUDIO MITSUBISHI MATERIALS



YOUR GLOBAL CRAFTSMAN STUDIO

The meaning of our logo

Our logo shows people, standing on a circle, holding hands. The circle represents the earth. Holding hands reflect our commitment to grow and succeed "hand in hand" with our customers and closely work with them to improve performance across the globe.

The shape of the logo embodies a variety of ideas. It captures the image of "cutting tools" combined with the dominant letter "M" of the Mitsubishi Materials brand name. It also depicts a flame that symbolises our passion for craftsmanship.