Mitsubishi Materials Craftsmanship Magazine

BM007E

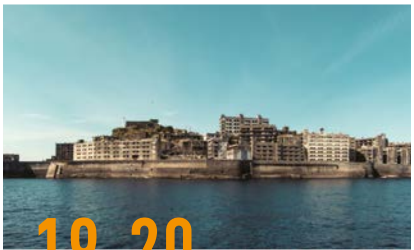
YOUR GLOBAL CRAFTSMAN STUDIO

SUPPORTING MEDICAL PROGRESS

Supporting the Medical Care Industry with Processing Technology

Vol. 7 Stories





Tsukuba

We continue to improve manufacturing with an eye on the future

Thank you for reading MMC's YOUR GLOBAL CRAFTSMAN STUDIO Vol. 7.

Volume 7 features the approach we are making in the medical field. In addition to our ongoing work in the automobile, aircraft and metal mould sectors, the past few years have also seen a focus on the medical industry. With an eye on further improvement, we hope to gain continuing support and take increased knowledge from the marketplace.

Along with the expansion of information technology and the globalization of business activities, the environment surrounding the manufacturing industry has witnessed significant change. We also feel the need to reconsider business procedures and goals in line with progressing technology and changing demographics. Such changes highlight the importance of the Your Global Craftsman Studio brand concept in ensuring the most effective solutions for customers as we maintain and improve business infrastructures to ensure safety and quality.

To maintain and improve business infrastructures, we keep a constant eye on the future to develop ever more innovative production technology and manufacturing capability based on accumulated wisdom and DNA that features ingenuity.

More than 7,000 employees are engaged in our carbide business both at home and abroad. Although not all employees come into direct contact with customers, our Customer First attitude expressed in the spirit of Mitsubishi Materials' Your Global Craftsman Studio brand concept ensures that we deliver the best products and services.

Yasunori Murakami
Vice President & General Manager
of Production Division
Metalworking Solutions Company
Mitsubishi Materials Corporation

YOUR GLOBAL CRAFTSMAN STUDIO

Akashi

Gifu

EYE on MARKET **MEDICAL INDUSTRY**

Technical innovation in regenerative medical devices

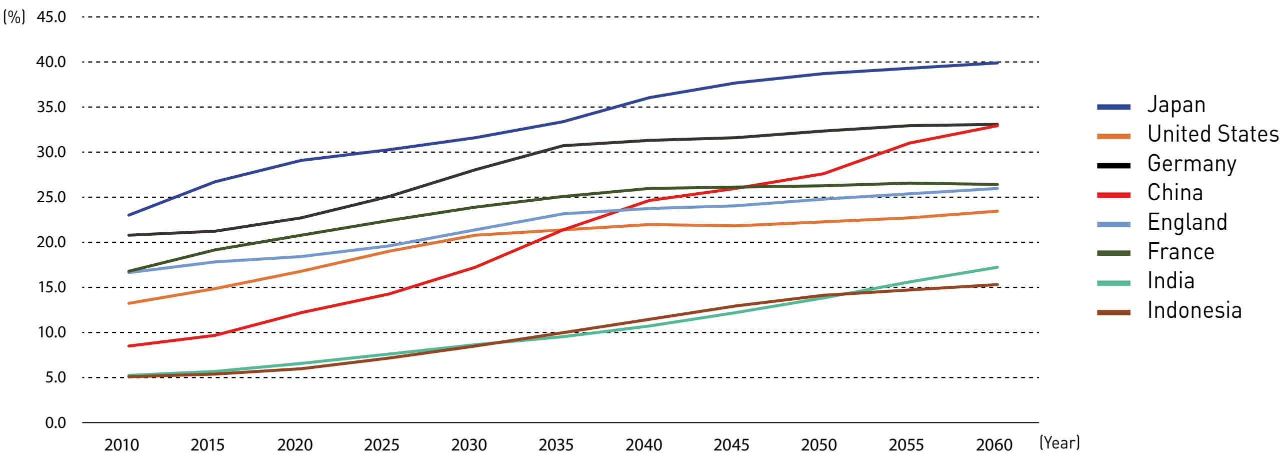
Environment surrounding the regenerative medical devices industry

The goal of regenerative medicine is the recovery of biological functions that have usually deteriorated due to disease, environmental factors and aging. The United States and Europe have dominated the regenerative medicine markets; however, Asian markets have been attracting increasing attention. Aging populations and improving standards of living, driven by significant economic growth in Asian countries have drastically expanded the need for regenerative medicine. Africa is also expected to become an important market in the future. These conditions suggest stable growth potential for regenerative medicine markets.

Regenerative medicine is classified into biological substitution and biological regeneration. Biological substitution is the use of artificial devices such as joints and bones to recover function. Biological regeneration strives to regenerate organs and tissue. Materials used in biological substitution are called substitutive devices. Although 3D printer technology for the production of surgical instruments and implants has found some practical application, the quality of this new method of manufacture remains lower than the existing methods, especially with regard to initial investment, material costs and manufacturing time, which serve as obstacles to meaningful progress.

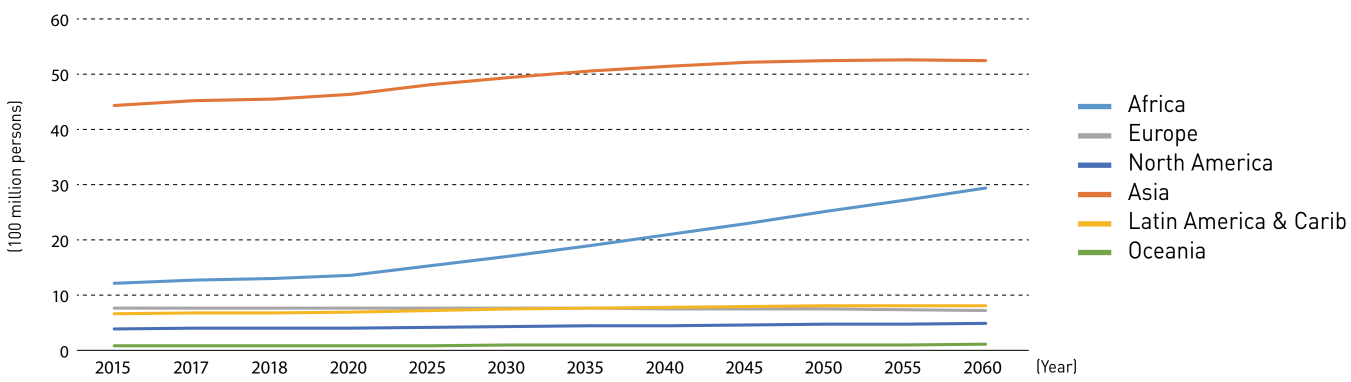
Meanwhile, aging populations in Japan, the United States and Europe have had a serious impact on medical expenses, which in turn affects national budgets. This has prompted accelerated research and development in medical technologies to reduce total costs. Therapeutic technology using iPS cells, which exhibits great biocompatibility, is safe and reduces patient burden, is nearly ready for practical use. However, before practical application can be fully realised, medical care systems (insurance/ certification) must improve and hospitals are also looking to advance their technologies.

Predicted changes in population age in major countries



Source: United Nations, Word Population Prospects The 2015 Revision

Predicted world population



Source: United Nations, World Population Prospects 2017

Increasing demand for improved productivity and cost reduction

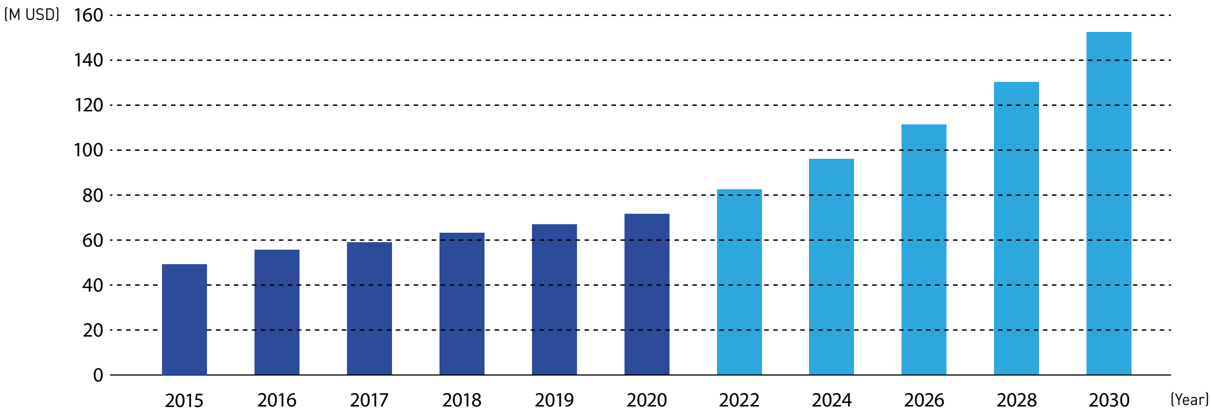
Substitutive devices are processed with cutting tools to a greater degree than general parts are. Hard-to-cut materials such as ceramics and carbon-fiber reinforced plastics (CFPR) have been increasingly used along with titanium, stainless and cobalt-chromium alloys. As new material development has advanced, machining has become a greater challenge. It is because of this, major medical device manufacturers face significant costs associated with research and development required to enter new markets. This forces cutting tool manufacturers to improve cutting technology and reduce costs through improvements in production technology to satisfy market needs.

Major substitutive devices





Substitutive device market prediction



Estimates by Mitsubishi Materials Corporation based on a major medical device manufacturer's annual report

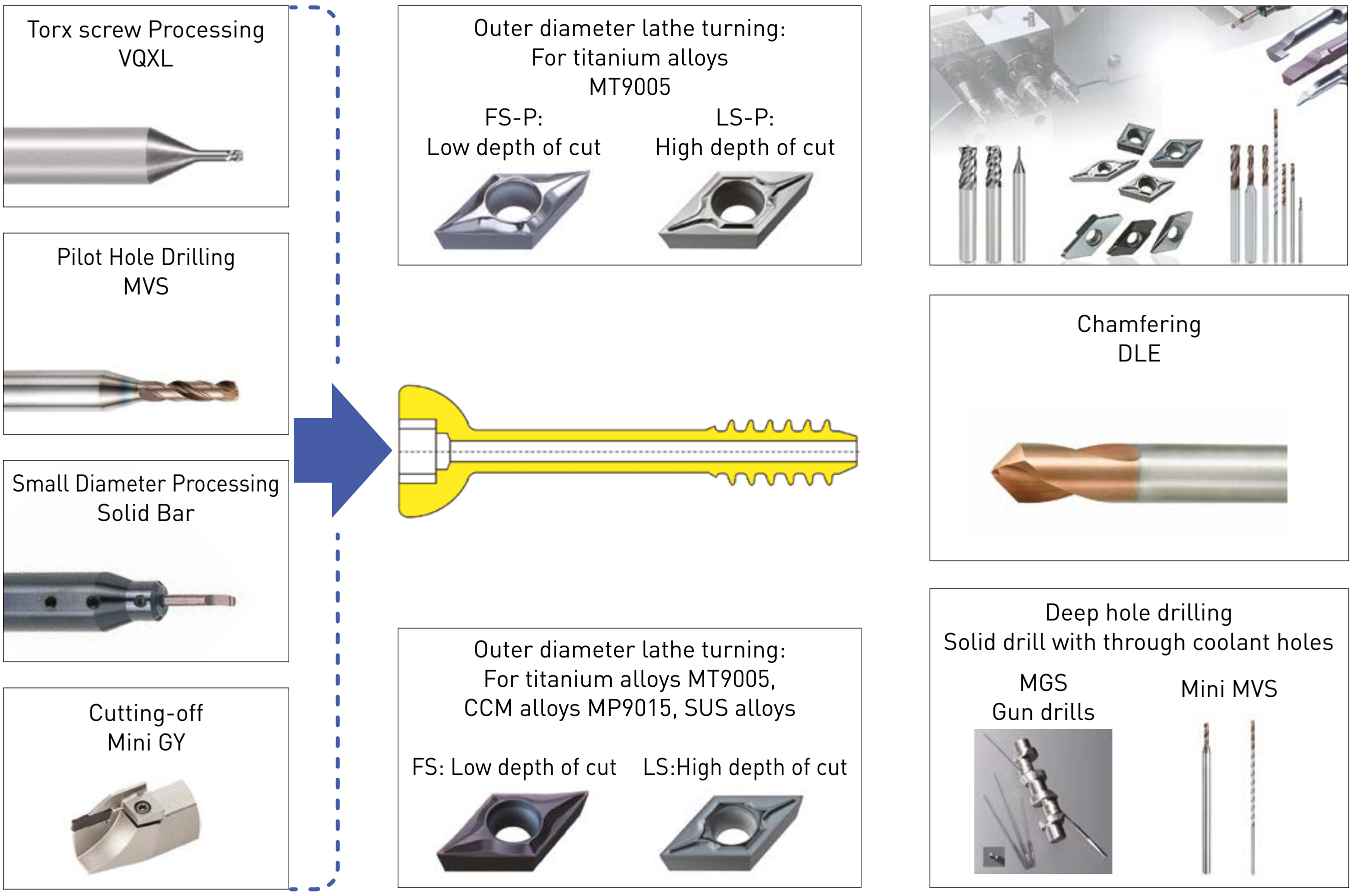
EYE on MARKET **MEDICAL INDUSTRY**

Providing total solutions to the medical care industry

Effective use of cutting tools improves the processing of substitutive devices

Hard-to-cut materials such as cobalt-chrome, titanium and stainless alloys are often used for substitutive devices. This means extremely short tool life for the tools that machine them, which requires manufacturers to strive for improvement. Along with improved wear resistance, applications such as small diameters and deep holes in cobalt-chrome alloys used for substitutive devices present a challenge. Mitsubishi Materials has commercialised products that improve tool life and processing efficiency through the development of the base ingredients. As one of only a few cutting tool manufacturers that provide solutions for such an extensive range of complex applications, Mitsubishi Materials is highly regarded for processing hard-to-cut materials used by medical care device manufacturers in the North American market, one of the major markets for substitutive devices.

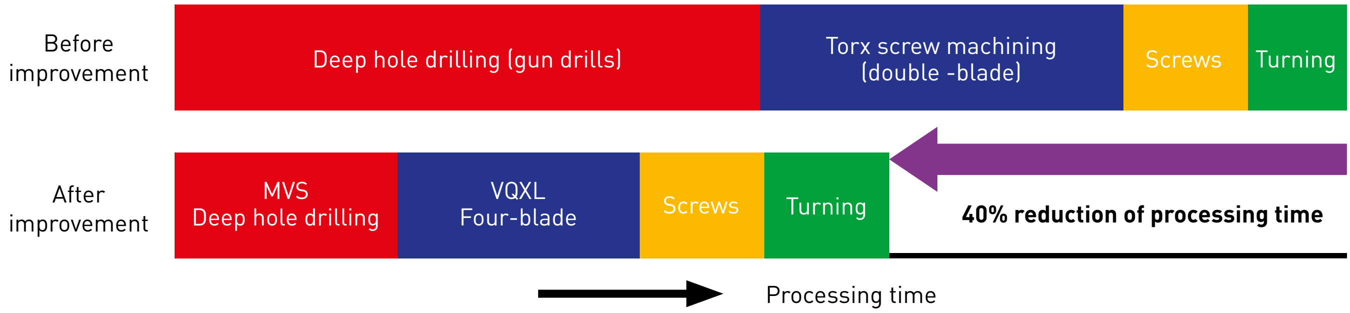
Total Tooling



Medical screw tooling

Improvement Case

Increasing tool life and improving the efficiency of processes that cause bottlenecks



Work material	Ti-4Al-6V	
Machine to be used	Small-size CNC automatic lathe	
Process	Deep hole processing	Torque processing
Tools to be used	MVS0180X30S030	VQXLD0050N025
Machining parameters	n = 1,750min^{-1} fr = 0.02mm/rev	n = 35,000min^{-1} F = 300mm/min Ap = 0.03mm
Coolant	Oil (Internal 7MPa)	Oil (External)

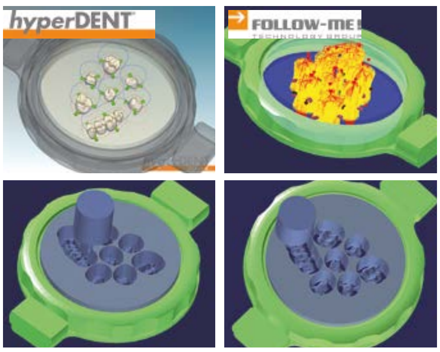
MVS

VQLX

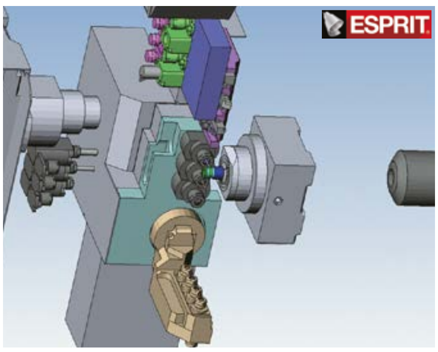
Improving customer satisfaction through enhanced proposals

Multi-task machining centres and five-axis machine tools have been used to manufacture complex medical device parts. These machines have made it possible to improve productivity while reducing manpower requirements, which has accelerated cost reduction. The increasing complexity of processing technology that such change brings makes proposals for improved machining and technical development through the enhancement of cutting tool performance. We are now required to provide total solutions utilising cutting tools, machine tools, CAM and analysis.

Mitsubishi Materials (MMC) has worked in cooperation with machine tool manufacturers and CAM software suppliers to implement multi-task machining centres (including small automatic lathes), five-axis machines, and a wide range of CAM to prioritise the enhancement of highly-advanced proposals. MMC continues to be a comprehensive cutting tool manufacturer capable of proposing customer-oriented and globalised total solutions for the substitutive device market.



Dental CAM Simulation



CAM Simulation for Small Automatic Lathes

Small Automatic Lathe with Low-frequency Vibration Cutting Function

FOCUS on PERFORMANCE

CASE 1

Star Micronics Co., Ltd

(Kikukawa City, Shizuoka Prefecture)

Engaged in the development and manufacturing of Swiss-type automatic lathes suitable for medical device manufacturing. The company has approximately 30% of the global market share.

Fumio Masuda
Executive Manager, Sales & Marketing Dept.
Machine Tools Division

Noriaki Ozeki
Manager, Technical Sales Support Sec.
Sales & Marketing Dept., Machine Tools Division

Daisuke Suzuki
Executive Manager, Development Dept.
Machine Tools Division

Automatic lathes for users developed by users

Star Micronics Co., Ltd. opened its doors in 1950 as a small parts factory with only six employees. The company began with the manufacture of precision parts for watches using automatic lathes from Switzerland and Japan. To produce higher quality precision parts, the company shifted to manufacturing its own machine tools for in-house use. The shift was driven by the founder's desire to develop an automatic lathe. The company touted its product as "Made by machinists for machinists" and soon began receiving orders for automatic lathes from other companies. "We have been manufacturing a wide range of precision parts using machine tools that we have developed internally. Our Development Division takes feedback on the usability and reflects it to the development and improvement of new and existing products. This is a major strength that we have," said Fumio Masuda, Executive Manager, Sales & Marketing Department, Machine Tools Division.

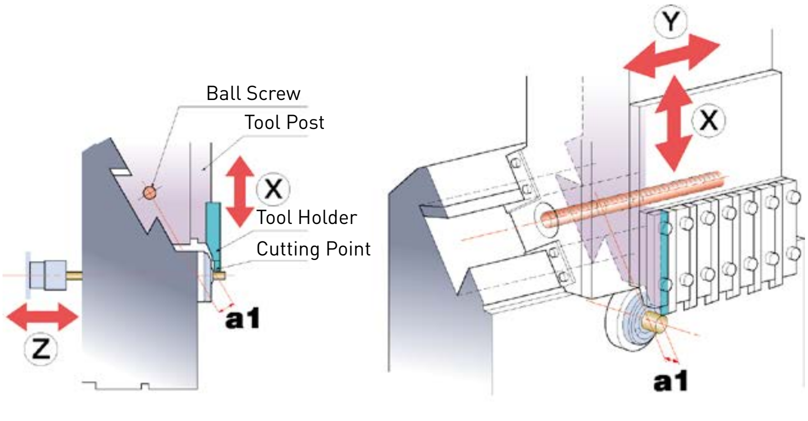
Star Micronics started global expansion of its automatic lathe sales with exports to England in 1962. Currently, they have established production, sales and service structures in Europe, the United States and Asia. They do not rely on distributors and sales agencies, instead they send employees directly to customers to provide thorough before and after sales service of their products. Such close attention has been highly regarded by the market, and their Swiss-type automatic lathes have now captured around a 30% share of the global market, establishing their position as the leading automatic lathe manufacturer. Their Swiss-type automatic lathes have also been used in the manufacture of bone screws, artificial tooth implants, auxiliary material for joints and much more.

The combination of long thin geometries and difficult-to-cut materials that comprise a lot of medical components, means that they are difficult to manufacture without Swiss-type automatic lathes. This is why Star's products have been chosen by the medical industry as the machine tools of choice. "Additionally, because bone screws and other parts used in medical treatment are placed inside our body, they must conform to extremely high standards, conform to blood compatibility and be corrosion resistant. To meet these demanding requirements, they are manufactured from difficult-to-cut materials such as titanium alloys and also require extremely high geometrical accuracy," said Noriaki Ozeki, Manager, Technical Sales Support Section, Sales & Marketing Department, Machine Tools Division.

Superior machine rigidity enables machining for medical devices

Swiss-type automatic lathes have designs and specifications that respond to such exacting requirements and are highly regarded by medical device manufacturers.

"When developing Swiss-type automatic lathes, we focused on machine rigidity. We utilised a slant-bed structure with trapezoidal sliding dovetail type surfaces. In this structure, fixed and movable parts are constructed in a way that brings the ball screw centre closer to the cutting point and therefore reduces the moment load during cutting. This reduces the vibration caused by cutting resistance and improves accuracy. This makes it possible to maintain smooth, stable machining accuracy even when significant changes of the cutting depths are required," said Daisuke Suzuki, Executive Manager, Development Department, Machine Tools Division.
In addition to the dovetail slant bed, the application of a wide range of structures, including a spindle sleeve sliding surface that supports the cutting load on the spindle during processing increases machine rigidity. They also elaborated on a wide range of ingenious designs to realize an even higher degree machining precision.
"For example, artificial teeth for dental implants sometimes require the drilling of a hole 80 mm deep, but only 1.8 mm in diameter. Drilling such holes on the main side of a machine is a problem due to limitations in length; therefore, we fit an attachment on the spindle on the back side that can drill up to 100 mm hole depth," said Ozeki, Technical



(From left) **Junya Maki**, Manager, Kikukawa Branch Office, Sanritsu Machinery Co., Ltd.) **Keiichi Kuroda**, Sales Div. Fuji Sales Office, District Manager, Mitsubishi Materials, **Hiroaki Ohara**, Sales Div. Fuji Sales Office, Mitsubishi Materials, **Shoichi Fujisawa**, Drill, CBN & PCD Products Development Center, Tools R&D Group, Mitsubishi Materials

Sales Support Section Manager. Also, in order to restrain thermal displacement, a unique design has been applied that makes it possible to measure and predict heat changes and to adjust the machine accordingly. "Medical professionals sometimes visit us to observe the manufacturing process. Therefore, we also focused the design on building a simple structure that prevents oil leakage, this in turn helps cleanliness," added by Fumio Masuda, Executive Manager, Sales & Marketing Department. Meanwhile, the Star motion control system was developed for superior overall control. This system changes spindle speed at the most appropriate timing and ensures smooth movement throughout the cycle to achieve a significant reduction in non-cutting time. During preparation for subsequent steps, the system reduces cutting feed to allow adjustments at predetermined locations and timing. This helps to reduce vibration and increases accuracy.

Many metal cutting companies employ highly-complex manufacturing applications, such as forming cylindrical bars into squares or other shapes. Lathes with low rigidity frequently fail to meet the desired geometrical standards for these types of product, therefore, the improved surface finishes and accuracy of Swiss-type automatic lathes are of great benefit for companies that have encountered such problems.

Tools that allow maximum machine performance

The partnership between Star Micronics and Mitsubishi Materials started in the early 2000s. At that time, the materials being processed by automatic lathes were shifting from free-machining steels to stainless steels. This material change was used increasingly for injector systems for automobile engine, and use of SUS316 and titanium materials in medical device parts also increased. While chip control is important in stainless steel machining, tool life is a major factor for automatic lathes. However, they tend to use oil coolants that are not as effective for stainless steels. Furthermore, difficult-to-cut titanium materials are used often to manufacture medical device parts, and this means greater challenges when drilling. To address these challenges, smaller diameter drills with through coolant holes, coated with high heat resistant coatings were required. As a solution, Mitsubishi Materials developed the MWS drill using a VP coating with an extremely high heat resistance. Since its launch Mitsubishi Materials and Star Micronics have used the MWS high-performance drill for test applications and also included them as part of turnkey package tooling. Keiichi Kuroda, who was in charge of sales in 2000, looked back that time and said, "We used a wide range of small-diameter long drills for various in-house applications, and this led us to recommend these drills for deep hole processing." We asked Mr. Ozeki what his impression of Mitsubishi Materials was at that time. He said, "The tools we used to process aircraft parts had high durability, and even when the feeds and speeds were increased, the tools continued to produce high-precision parts. When I was assigned to China, we started to use Mitsubishi Material tools for medical parts due to previous experiences when manufacturing aircraft components. Overall, I was impressed with the quality of the tools." At Star Micronics exhibitions in Europe and the United States in 2016, we tested a solid carbide spot/chamfer drill that was under development on a Swiss-type automatic SR series lathe. It provided excellent performance, and this led to use of the DLE spot/chamfer drill at exhibitions both at home and abroad in FY2018. In June that year, the DLE series of drills was introduced to the market. Drills Development manager Shoichi Fujisawa, (Drill, CBN & PCD Products Development Center, Tools R&D Group, Mitsubishi Materials Corporation) explained the characteristics of this new drill: "Existing spot drills had

(Left) **Takuji Uchiyama**, Assistant Manager, Technical Sales Support, Sales & Marketing Dept., Machine Tools Div., Star Micronics Co., Ltd.
(Right) **Masahito Mukouyama**, Assistant Manager, Sales & Marketing Dept. Machine Tools Div., Star Micronics Co., Ltd.

sharp edges, which were often chipped during the machining of hard-to-cut stainless materials. Making many prototypes to ensure the strength of the edge solved this problem; and after repeated inspections, we decided to apply a double-angle point geometry. We also combined this with point thinning that realised low resistance to reduce the load on the machine tool."
Mr. Masuda said, "Machine tool compatibility is important for improved processing accuracy. We would like tool manufacturers to carry out development from a wide range of perspectives, including feed, speed and chip control, to develop tools that allow maximum performance for individual machines."
"Hiroaki Ohara, Sales Division, Fuji Sales Office, Mitsubishi Materials said, "The development of this new spot drill is a prime example of our commitment to deliver ever better tools for our customers."

Responding to developments in the medical industry

Mr. Ozeki, Technical Sales Support Section Manager told us about their future vision, "We are planning to expand the sales of products related to the medical industry in India and other regions with large populations. It is essential for us to consider measures to reduce costs and for us to develop not only Swiss-type automatic lathes, but also fixed-type automatic lathes that respond to the increasing demand in the United States for spinal plates. Our main job, though, is addressing customer feedback regarding technical issues. Along with providing solutions we also want to make proposals that lead to better results for customers." Mr. Suzuki, Development Department Executive Manager, continued, "We have been working for more than three years on developing structures for each module that are compatible with other machines to reduce costs. The most important priority for machine tools is development, and this is something that will always remain true. We felt great responsibility to design products that satisfy customer needs, and we maintain a particular focus on improving machine rigidity.

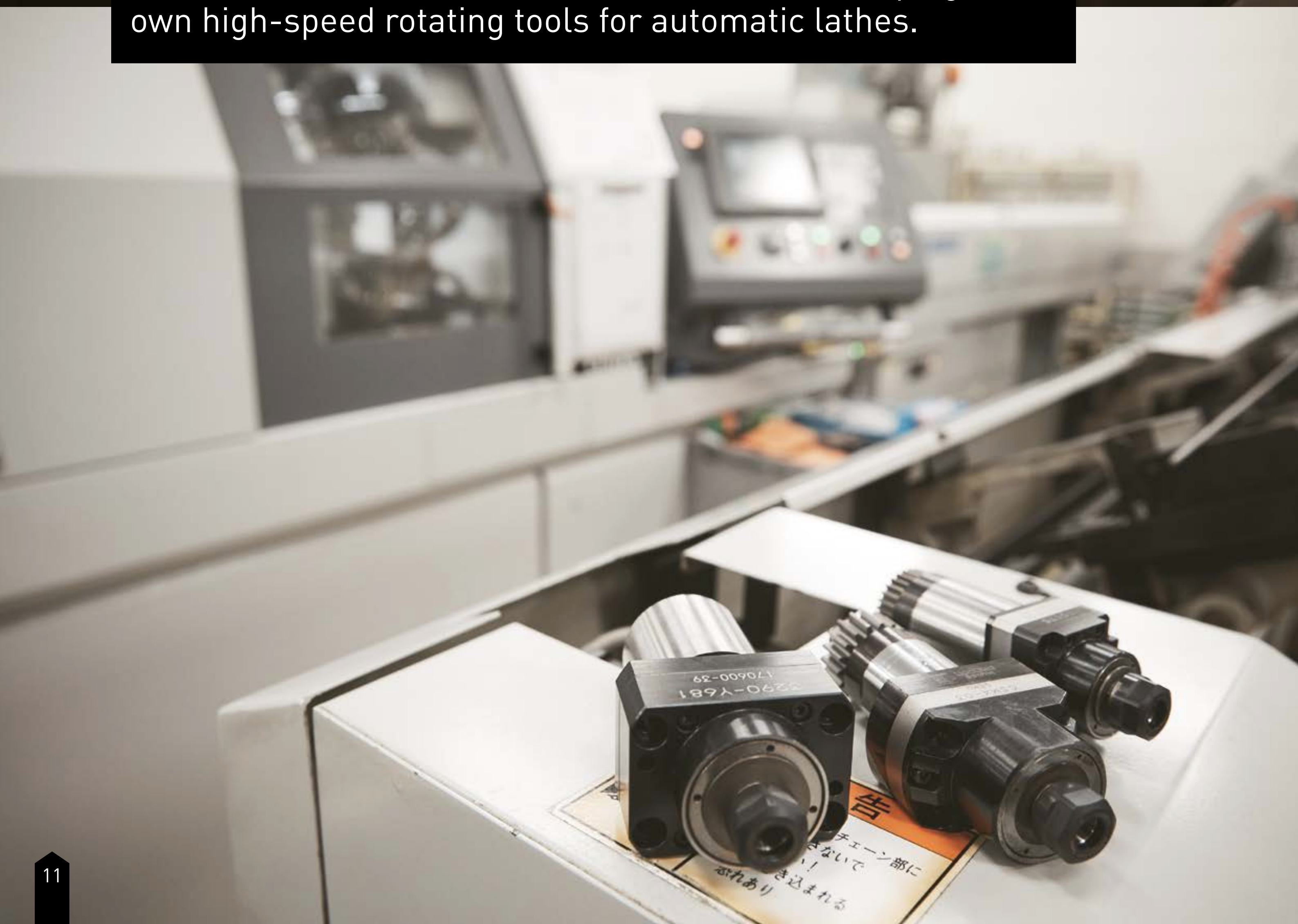
They also want to develop machine tools capable of processing hardened steels for high-precision parts, and hope that tool manufacturers can develop inserts that support this goal. Mr. Fujisawa, Tools R&D Group, Mitsubishi Materials Corporation strongly said, "The strength of our group is in the manufacture of materials and tools, and we excel at development and manufacture of tools for hardened steels. We will continue responding to customer needs using high-performance tools developed to satisfy an ever wider range of material applications.
The challenges manufacturers face change significantly over time. Mr. Masuda, Star Micronics Sales & Marketing Department Executive Manager said, "It is predicted that the spread of electrical vehicles in the future will reduce the number of automotive parts. However, demand for the small-size precision parts that we manufacture will increase along with the trend of minimisation and the need for precision in final products. Using our position in such a growing industry, we will continue innovating to ensure that our products satisfy customer needs." Mitsubishi Materials will continue working with Star Micronics as we move into the future to fulfill our mission to contribute to further growth in the medical industry around the world.

CASE 2

Suzuki Precion Co., Ltd.

(Kanuma City, Tochigi Prefecture)

Japanese super-precision machining capable of drilling holes smaller than the diameter of a hair. Developing their own high-speed rotating tools for automatic lathes.



Isao Suzuki, Executive Vice-President, Suzuki Precion Co., Ltd.

Two crises increased management's ability

Two buildings stand on a wide expanse of land along the Oashi River in Kanuma City, Tochigi Prefecture. The plant built in 1991 began as a small work place more than half a century ago and was founded by Etsuro Suzuki, grandfather of current President Takuya Suzuki.
Etsuro loved making things and gathered friends to found the company and started work making shoe decorations. Following this, the company shifted to general parts machining. In 1971, Suzuki Precion Ltd. was founded to start full-scale machining of metals.
The company increased its workforce to 10 and added NC lathes to its hydraulic equipment. Vice-President Isao Suzuki looked back that time and said, "The 2nd generation president, my older brother, Yosuke Suzuki, really loves special machines and implemented a wide range of such equipment. He first operated the NC lathes himself and at that time they were programmed by using a punched paper tape."

While serving as a subcontractor for manufacturers, the then President Yosuke Suzuki had an experience he would never forget. On a visit to a customer's office, he was wearing work shoes that had oil on them from the floor of his factory. The customer scolded him harshly: "Don't ever come into my office in dirty shoes." It was this experience that caused President Suzuki to realize the importance of sorting, setting in order, and shining (3S), and he started prioritizing factory cleanliness.

In 1991, the company moved the factory to its current location. In 1992 they reorganised the company into Suzuki Precion Co., Ltd. However, it was about the time that the Japanese "bubble economy" collapsed and the company encountered its first business crisis due to a significant decrease in work. President Suzuki felt that they should not continue as a subcontractor simply waiting for work. He hired managers to reinforce the company's sales force and the number of customers began to grow. At the same time, the company also focused on developing a better work environment for employees.

While improving its business, the company also started machining dental implants, which gave them a chance to machine titanium materials for the first time. Company sales at that time were driven by shafts, arms and computer parts, of which a few million units were being produced every month. However, when President Suzuki visited Southeast Asian countries such as Thailand, he was shocked to see that their plants were manufacturing the same parts 24 hours per day. He quickly realised that the production base for the parts Suzuki Precion was manufacturing would eventually move out of Japan to where labour costs were cheaper. As he was considering changes in the company's management strategy, he received news that would threaten the very foundation of his business. In 2001, the company's largest partner, a partner that accounted for approximately 30% of sales at that time, declared bankruptcy. This was Suzuki Precion's second business crisis. The Vice-President looked back on this and said, "Suppliers changed their attitude quickly and told us that they would supply materials and tools on a cash basis only. Our major bank rushed to us to check our ability to repay loans. I thought we were finished."

A positive attitude improves technical strength

After the bankruptcy of the company's major customer, Suzuki Precion decided to make a bold change in its management strategy. They shifted target production to medical equipment, switched their manufacturing method from small-item large-scale production to larger-item, small-scale production and focused on securing orders with a higher degree of engineering difficulty.

Jun Hanawa, who joined the company's sales staff at that time said, "President Suzuki told us to get the orders first and then the company would find a way to fulfill them. He told us to be confident and think positively." This positive attitude also led to improvement of the company's technical strength. They focused on winning technically difficult orders and finding ways to meet the requirements. They also created a database so information could be shared with others at the company.

In addition, the experience of machining dental implants significantly increased their technical strengths. While manufacturing parts that are extremely small, but require strict dimensional tolerance, the company's precision and fine machining techniques improved. One example of such improvement was the ability to machine a 0.03 mm diameter hole, which is smaller than one strand of hair, in a stainless steel plate.
"The key to successful machining is the proper setting of conditions. When cutting titanium dental implants in particular, achieving better machining conditions significantly changes production efficiency. This does not mean, however, that quick cutting is the best because it is often necessary to take 20 to 30 minutes per part. We manufacture on a 24-hour schedule a large production run and optimise it considering the lifetime of the cutting tools. This could be achieved with unique know-how accumulated through the machining of difficult-to-cut materials.

Jun Hanawa,
Executive Operation Officer,
Suzuki Precion Co., Ltd.

Yuzo Morita, Sales Department
Suzuki Precion Co., Ltd.

Kazuhiro Ugajin, IB-SPINDLE Chief
CNC 4 × Mechanical RPM Multiplier Spindle

Discovering a way to surmount challenges in medical equipment manufacturing

While the company proceeded with its shift to medical equipment manufacturing, they learned about the revision of the Pharmaceutical Affairs Act (current Pharmaceutical and Medical Device Act) from customers in 2006. They acquired a Medical Equipment Manufacture License under the new act that imposed stricter regulations on medical equipment manufacturing. In 2007, they also acquired ISO9001 and ISO 13485 certifications. ISO 13485 is the standard for medical equipment manufacturing and quality management systems. "The acquisition of these certifications made a big difference," said Yuzo Morita from the Sales Department. He continued, "ISO13485 is essential for medical equipment manufacturers. However, few of our competitors had acquired certification, so it became a strong advantage for us."
In 2009, Suzuki Precion exhibited at Medtec Japan, one of the largest exhibitions for manufacturers and developers of medical equipment. "All of the companies at the exhibition except ours had many more employees than we did; but having the medical device manufacturing license and ISO13485 certification raised interest in our company. When customers began contacting us, we began to see our efforts paying off," said Hanawa.

Kazuhiro Ugajin added, "Dental implants are very small, but require a high degree of technical capability to prevent imperfections, and ensure dimensional accuracy. Biological implants, on the other hand, simply require different sizes, which was difficult for us."

In 2010, they participated in a medical equipment exhibition in Germany for the first time; and in 2012, they participated in MD & M West, the world's largest exhibition for medical equipment, parts and materials in the United States. They also exhibited at the Japan Pavilion sponsored by JETRO, and were fortunate to meet someone that would bring a significant boost to their business.

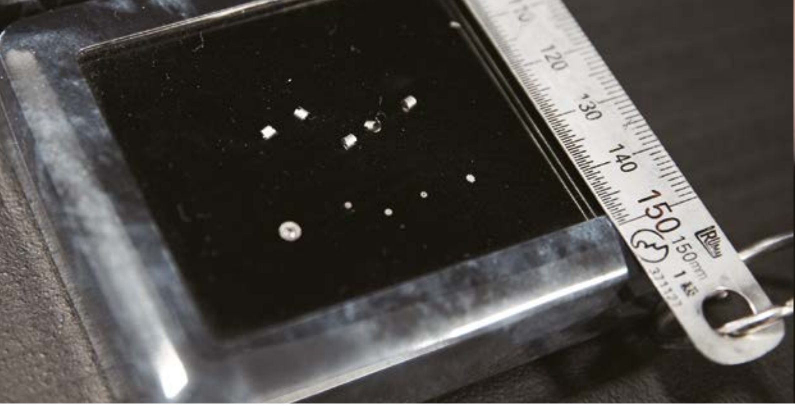
"One of the people on our development staff," explained Hanawa, "had a friend living in the United States, and that friend visited our booth. When he saw parts we had produced that were the size of a grain of rice, he was extremely impressed with the technique and introduced our products to others at the exhibition. He brought an engineer working at one of the world's top medical equipment manufacturers. This led to business negotiations and orders, and a relationship with the customer that continues to this day."

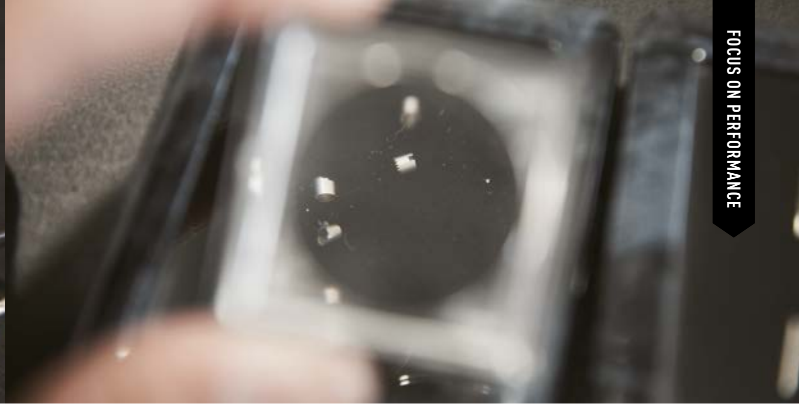
In 2012, the company reached a turning point. They received the Nippon Brand Award for the IB-SPINDLE, a 4 × RPM high precision, mechanical speeder tool, using precision machining technology developed by the company for CNC automatic lathes.

Developing unique company brand products to become an OEM supplier

The development of the IB-SPINDLE started from the previous president's dream of the company developing its own products. The company first produced 50,000 to 60,000 rpm spindles for machining centres and lathes. They made the mistake, however, of not considering specific customers, so sales suffered.
In an attempt to correct this, they changed their approach. Considering that most automatic lathes only rotated at 5,000 to 6,000 rpm, if they developed spindles whose circumferential speed could be increased, production efficiency per hour would increase. This would be an advantage for the company and manufacturers alike. This is how the IB-SPINDLE came into being. The IB-SPINDLE features ultra-precision planetary gears that increase CNC automatic lathe speed four-fold. "It is a spindle unit capable of increasing speed, developed to achieve high-precision and cost-performance in the processing of parts for medical equipment. We decided that this would fit the market," said Ugajin.

IB-SPINDLE does not require a control





unit or connections. Replacement with existing tools requires only one wrench. While increasing the speed of rotation by four times using the same power as the existing rotating tools, the IB-SPINDLE can reduce the deflection accuracy of the main body to within 3μm for micro-hole drilling and small-diameter end mill processing.

Currently, we are supplying the IB-SPINDLE to Peterman type automatic lathe manufacturers as an optional part through the OEM supply system, and we are also selling to metal cutting manufacturers both at home and abroad. From 2013, they started full-scale sales that totaled 92 units in 2013 and had expanded approximately seven-fold by 2017. "Currently, IB-SPINDLE accounts for about 25% of all company sales," said Morita.

Shifting business to expand into target markets outside machining

Suzuki Precion's sales comprise medical equipment (approx. 50%), IB-SPINDLE (approx. 25%), and semiconductor producing equipment and automobile parts (approx. 25%); but the company is planning to focus on medical equipment and the IB-SPINDLE rather than ultra-precision machining technology.

Mr. Hanawa said, "We consider Suzuki Precion as a total advisory company. The technology required in manufacturing is not limited to machining alone. We integrate other elements of technology from the development and design stage to ensure the best approach for customer's needs. We want to be a one-stop supplier providing a full range of support, from inspection, cleaning and sterilization through to packaging for medical equipment. In order to do so, we established a Class 10,000/ ISO14644-1 Class 7 rated clean room. With a focus on reducing labour load, we also implemented a multiple-piece system and 24-hour operation to improve production efficiency. We also want to ensure a wide range of new ideas, so we prioritise the creation of a corporate climate that allows employees to express themselves freely."

To expand its range of business, Suzuki Precion joined REG Partners, an organization of small and medium sized corporations engaged in a wide range of manufacturing. Established by Tanaka Medical Instruments Co., Ltd., each company in the partnership gathered their individual technology to work on the development of spinal implants for orthopedic treatment. We attracted attention in the market with the commercialization of Class II medical equipment. After confirming that it did not infringe upon an earlier patent, the RENG Spinal System sold by KiSCO Co., Ltd. was marketed under an agreement among partner companies to disclose technical information, prioritize profit as an organization and allocate profit based on the contribution of each company. The unique approach to development was recognized when REG Partners received the 6th Medtec Innovation Award.

Suzuki Precion also assigned a Vietnamese trainee who had accumulated experience in Japan to take charge of IB-SPINDLE sales in overseas markets and dispatched him to METALEX, an exhibition held in Thailand. They consider Vietnam as the second most important overseas base, after the United States.

They introduced the MIT Force 3 mm, a needle for laparoscopic surgery, at Medtec Japan 2017. Although it has a very thin shaft, it has rigidity capable of minimizing deflection to meet the increasing need for minimal invasiveness in surgical treatment. Suzuki Precion changed business strategy with a shift from the production of medical equipment to the expansion of sales of products that it developed to increase its competitive strength by leveraging the ultraprecision machining technology that they had accumulated. Their shift is an example that the machining industry would do well to follow.

CASE 3

Takayama Instrument, Inc.

(Arakawa Ward, Tokyo)

Blade thickness at the edge is only 0.08 mm.
Scissors used deep into the brain.
Leveraging technical skill to help doctors save lives.

A small-size machining centre S191 made by BUMOTEC operated at the Arakawa Factory

Ryushi Takayama, CEO, Takayama Instrument, Inc.

Called an artist for his machining technique

When we entered the 1st floor of a building that looked like an ordinary house in Arakawa Ward, Tokyo, a small machining centre S191 from BUMOTEC (Switzerland) caught my eye. CEO Takashi Takayama had traveled to Switzerland to purchase this high-performance machine. He related what the BUMOTEC President said to him after the sale had been completed. He was surprised that a company with fewer than 10 employees wanted to purchase this machine. When he saw how effectively Takayama had employed the S191 to manufacture products, however, he called him an artist.

"BUMOTEC now tells Japanese companies considering purchasing their machining centres to consult with me first. It looks like I'm working as a volunteer consultant for BUMOTEC," said Takayama with a laugh".

Another factory has three of these machining centres. "These are the TRAUB, Swiss-type CNC automatic lathe TNL series, manufactured by INDEX in Germany. There are only three in Asia, all at our factory."

Takayama Instrument employs these machines from overseas to manufacture scissors and tweezers used in neuro bypass procedures. Domestic market share for the scissors has reached approximately 90%, which means that most of the neurosurgeons in Japan are using them. One Takayama Instrument product is called the Kamiyama Microscissors Muramasa Special. These micro scissors were custom developed for Hiroyasu Kamiyama, a neurosurgeon at Sapporo Teishinkai Hospital.

They have become the global standard for scissors used in neurosurgery. The thickness of the edge is only 0.08 mm, extremely thin, but very sharp. With a sales force active in 30 countries, overseas sales have grown to account for approximately 30% of the company's turnover in the two years since they were introduced to the market.

"I'm spending about 100 days a year outside Japan for business. As the number of exporting partners increases, the need to adjust to conform to regulations in different countries has increased. Satisfying the requirements for all production processes has been a challenge, but it's well worth the effort to achieve customer satisfaction," said CEO Takayama.

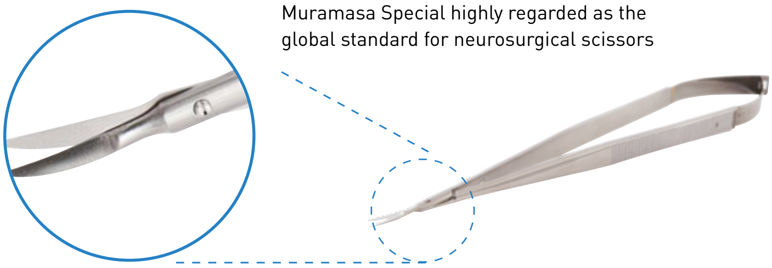
Muramasa Special custom-made for a physician

Since its foundation in 1905, Takayama Instrument has manufactured scissors, scalpels and other tools for medical use. Until they mechanised, however, everything was made by hand. "We didn't have drawings, just old samples that our craftsmen used for comparison. It was like we were starting from scratch each time. I knew we had to mechanise to ensure stable quality for mass production." However, with little know-how in machining and no machine tools, Takayama hit the books to learn. He read up on material engineering and machining. He implemented and adjusted machines and designed tools by himself to develop effective methods and techniques.

Meanwhile, CEO Takayama met Yasuhiro Kamiyama, a surgeon well known for his outstanding skill. Dr. Kamiyama also developed surgical instruments in the hope of advancing the state of neurosurgery. One of these is the Kamiyama Microscissors Muramasa Special.

To cut out small lesions located deep in the brain, the blade edge needs to be as thin as possible. However, the extremely thin edges prevented the two blades from aligning smoothly, and this resulted in a loss of performance. Dr. Kamiyama then considered adopting blades that were bent like a curved lance to add rigidity. Takayama took this idea and succeeded in producing micro scissors that now provide a sharp cut.

Since then, CEO Takayama has been engaged in product development based on requests from Dr. Kamiyama. Takayama also asked Dr. Kamiyama for permission to watch surgeries so he could observe the movements of the surgeon's hand during procedures. Reading many books on neurosurgery and observing the actual movement of the surgeon allowed him to deepen his understanding and pick up many ideas for new product development.



Muramasa Special highly regarded as the global standard for neurosurgical scissors

Masaki Nakamura, Chief at the Arakawa Factory, Takayama Instrument, Inc.

TRAUB made by INDEX in Germany
Swiss-type CNC automatic lathe, TNL series

Designing tools to reduce the load on the surgeons

While observing surgeries, CEO Takayama noticed something important. Neurosurgical procedures last at least two hours. The core is only about 20 minutes, during which the lesion is removed, but the neurosurgeon has to maintain a high degree of concentration throughout the procedure.

"Even when tired, the surgeon cannot relax for an instant. I wondered what I could do to reduce the load on the surgeon. After watching many surgeries, I understood how the surgical field looks and how much space they have in the operating room. I decided to develop easy-to-use tools focusing, on cutting and suturing."

This led to the development of tweezers with tungsten tips. Suturing requires tweezers and microneedles. However, the material was stainless, which was slippery. It takes eight stitches to suture a blood vessel measuring 1mm in diameter, and few surgeons are skilled enough to do this easily.

Takayama worked with Dr. Rokuya Tanigawa, who trained under Dr. Kamiyama, to develop better tools. One of these was tweezers with tungsten tips that would not slip. "Having tweezers with non-slip tips has reduced suturing time from 20 to 15 minutes, and it has completely changed the technique that surgeons use. About 600 units were sold in Japan during the first year alone."

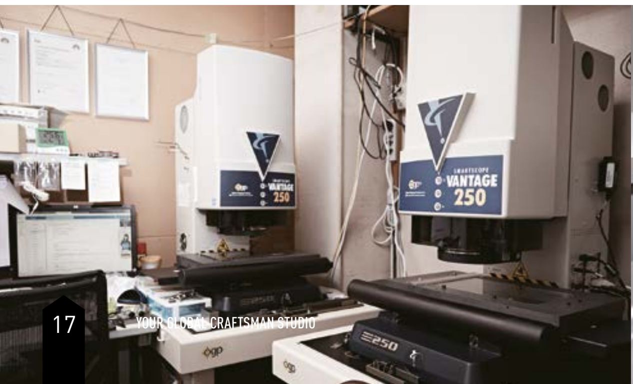
Takayama told us that the idea of adding something to the edge to prevent slipping was not new; and when they asked a contractor to have tungsten added to the tips, they could not handle it easily. Then they figured out how to maintain tungsten in the condition of plasma, ionized, then let the tungsten infiltrate the edge of the suturing tool."
It is actually a simple idea, but it was built upon the foundation of an extensive knowledge of metals. How does he continue to have such innovative ideas? Takayama says, "I'm always looking for ways to make surgery safer."

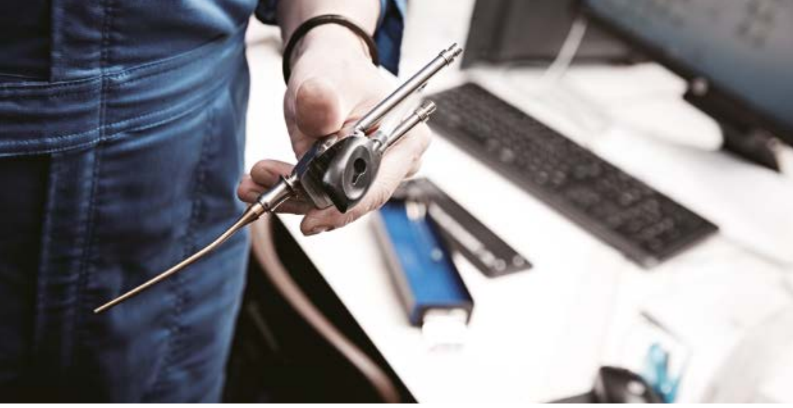
Accuracy and safety that saves lives

Takayama Instrument tools are highly regarded by surgeons because they shorten the time required for procedures. The instruments cut well and grasp securely. Improvements in the quality of endoscopes and other optical equipment enable more delicate procedures, but such surgeries require the highest quality instruments.
To ensure such quality, CEO Takayama employs expensive, highly functional and rigid European machining centres. The BUMOTEC machines allow all processes, from cutting to milling, to be completely automated. However, it took time to come this far.
"First, we created drawings from the samples we had. Next, I used the drawings to design programs for the machines. I observed the machine movements and designed programs for all the patterns that I could think of. In the end, I had about 100 programs. When I ran the programs, though, the tools collided so I asked the manufacturer to make adjustments. The excellent working relationship we have with BUMOTEC allowed us to achieve the modifications we required to the point that our machines are almost completely customised."

They worked tirelessly to modify the machines and increase performance through a wide range of improvements. It was hard to achieve accuracy in continuous operation because materials like titanium alloys are hard to cut, and this caused workpieces to slip in the chucks. To correct this, they designed different programs for different parts, used special tools and developed special lubricants.

Takayama Instrument has developed a wide range of manufacturing methods in-house, acquired ISO13485 certification and passed inspection by the United States Food and Drug Administration (FDA).





Newly developed suction device with an irrigation function. A uniquely developed surgical tool, requested by Dr. Kamiyama.
It took five years to develop this all titanium tool for both suction and irrigation. Already patented internationally.

"ISO13485 requirements are very complex, and compliance was a major challenge with the in-house processes we had in place. To identify better approaches to the requirements, we consulted with an expert. This allowed us to satisfy the requirements in a way that was more compatible with our established systems. As a result, we customised processes to satisfy all the requirements and passed final inspection.

However, when customising processes, production quality is not the only concern. A current project being carried out in collaboration with companies in the medical and engineering industries, CEO Takayama placed the highest priority on safety. This is a very detailed and painstaking process. For example, Takayama considers the potential for risk if part of an instrument can't be sterilized completely, or corrosion caused by combining different materials. "What if an instrument breaks during a procedure? What if a surgeon drops a screw because it is slippery? You can never overdo risk management, and we fully leverage the know-how we have accumulated over our 100-year history to ensure the highest degree of safety. Importantly, because our products have a great impact on lives, we never stop thinking about safety."

Improvements that ensure the highest degree of efficiency and precision

CEO Takayama says that there is always room for improvement in cutting tool manufacturing. "Takayama Instrument's strength in manufacturing is built upon a firm foundation of craftsmanship, and we have continued to improve upon this strength to supply the highest quality in value-added products through automated machining. We handle hard-to-cut titanium alloys, and accept the challenge of processing special parts that require us to implement unique procedures. In some cases, using an end mill for plastics produces better results than when processing titanium alloys, a material that is difficult to grip with chucks. Implantation is required to be a minimally invasive procedure; therefore, all edges need to have a round honing. In such machining, tools have to cut accurately even at high speed. Considering such a wide range of conditions, we want suggestions and advice from cutting tool manufacturers on the best conditions and how to maximize their capability."

Factory Chief Masaki Nakamura said, "Mitsubishi Materials promotes product development for medical use and tool development for automatic lathes. I am especially interested in products and know-how for hard-to-cut materials. The Smart Miracle End mill Series for hard-to-cut materials and mirror finished turning inserts for titanium alloys are very close to our needs. We'd like to test them."

CEO Takayama told us what he expects from Mitsubishi Materials: "Although I have plenty of ideas, and because we design instruments for specific needs, tool manufacturers may not see a major benefit in developing tools for our smaller-scale production. I feel strongly that collaborative relationships between machine and cutting tool manufacturers will become increasingly important. Mitsubishi Materials is impressive in the area of product development, and we are looking for help in enhancing the quality of our products with Mitsubishi Materials' know-how and technology as cutting tool professionals."

Our vision has not changed. We continue to develop instruments that enable surgeons to operate safely and comfortably. If we can safely reduce the time required for procedures, patients will benefit. We maintain this spirit in product development and improvement of manufacturing processes. Products based on this spirit save lives around the world.

HISTORY OF MITSUBISHI

Vol. 7

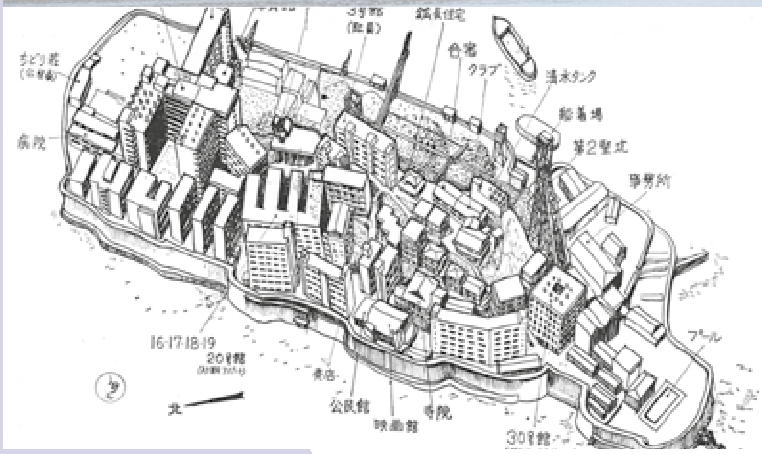
A coal mining operation from Mitsubishi Mining Co., Ltd.

Gunkanjima Island (Battleship Island)

Located in Takashima-cho, Nagasaki City, Hashima Island is also known as Gunkanjima Island (Battleship Island). It served for 84 years as a coal mine operated by Mitsubishi Mining Co., Ltd. (currently Mitsubishi Materials Corporation). The name Gunkanjima comes from the island's appearance of it floating on the sea with smoke billowing from its chimneys, making it look like a giant battleship. Gunkanjima became world famous in 2015 when it was listed as a UNESCO World Heritage Site as a part of "Sites of Japan's Meiji Industrial Revolution: Iron and Steel, Shipbuilding and Coal Mining." In this feature, we look back at the history of this facility that supported Mitsubishi's mining business.

A panoramic view of Hashima Island (Gunkanjima).

Currently, entry to the island is prohibited except for some areas. The island has also been used for filming movies.



Beginning of Hashima Island and Mitsubishi Mining

Following a 50-minute boat ride from Nagasaki, we arrive at Gunkanjima Island, part of which was listed as a World Heritage Site in 2015. The island measures 480m from north to south and 160m from east to west. This is approximately three times its original size after six reclamation projects were carried out to expand the island. Now abandoned, it was owned by Mitsubishi Mining Co., Ltd. (currently Mitsubishi Materials Corporation) and supported its coal mining business for over 100 years.

Coal was found on Hashima Island around 1810. It was heavy coking coal of higher quality than coal generally mined in Japan. Mining started in earnest in around 1870. In 1883, it was owned by Sonrokuro Nabeshima, the feudal lord of the Nabeshima Domain, who had worked to modernise the operations. In 1890, it was purchased by Mitsubishi Mining, which had operations at the Takashima Coal Mine near Hashima Island. The purchase price was 100,000 yen, the equivalent of 2 billion yen in today's economy.

History of Hashima Coal Mine

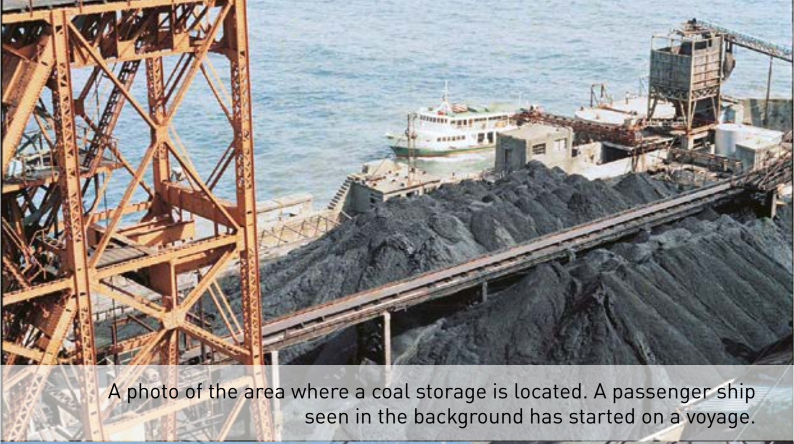
Coal production at the Hashima Coal Mine continued for 84 years after Mitsubishi Mining's purchase. Production can be classified into four distinct periods. The first, between 1890 and 1914, was mainly focused on expansion and Mitsubishi Mining accelerated coal production to between 100,000 and 200,000 tons annually. They built housing and other facilities for workers and an elementary school was built to accommodate the increasing population of children in the workers' families.

The second period between 1914 and 1945 was the prewar production period when deep mining and technical innovation contributed to a record high production of 410,000 tons. This level of production continued until Japan's defeat in World War Two. Earlier in this period in 1916, when most of the housing in Tokyo was one-story structures, Japan's first reinforced concrete apartment building, Building No. 30, was built on Hashima.

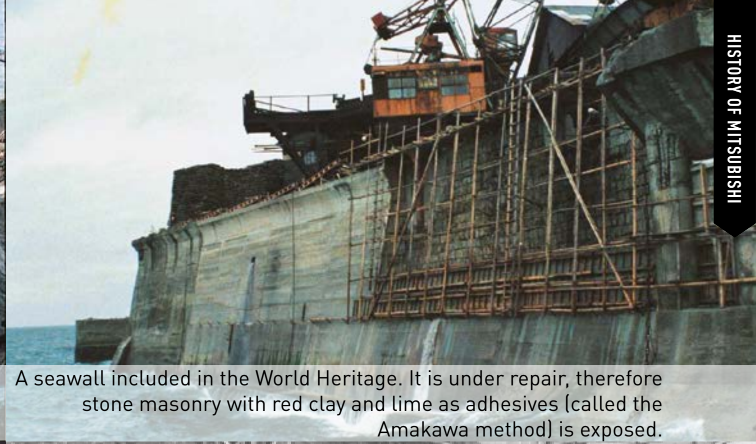
During the postwar period between 1945 and 1964, coal production decreased. However, an annual rate of 300,000 tons per year was maintained and the population was gradually increased to 5,259 by 1959, the highest in Gunkanjima's history. Population density at that time was nine times that of Tokyo.

Life at Hashima Coal Mine

Along with the expansion of production at Hashima Coal Mine, and even with limited space, living conditions were always being improved. Hashima Island became home to a wide range of facilities beyond those related to



A photo of the area where a coal storage is located. A passenger ship seen in the background has started on a voyage.

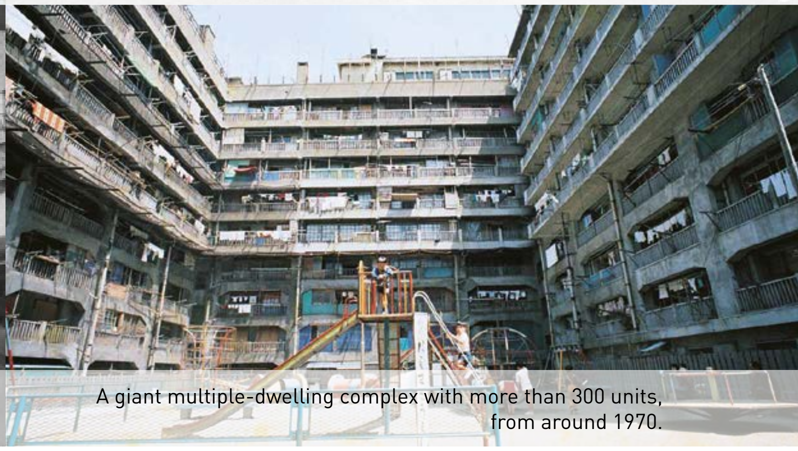


A seawall included in the World Heritage. It is under repair, therefore stone masonry with red clay and lime as adhesives (called the Amakawa method) is exposed.

Showing the east side of the Japan's first reinforced concrete apartment block, built in 1916 (Building No.30).

Children playing baseball inside the empty municipal swimming pool, around 1952.

A movie theater. Mitsubishi gave priority to this to enrich employees' lives.



A giant multiple-dwelling complex with more than 300 units, from around 1970.

coal mining operations. Residents had housing and many other facilities that enhanced their quality of life. With elementary and junior high schools, hospitals, temples, a movie theater, hair salons, pachinko halls, mahjong parlors and bars, the island had just about everything available the same as cities on the mainland did.

In addition, there were many events on the island. Residents enjoyed summer and May Day festivals, plus recreational activities both on and off the island were organized by the residents themselves. The Yamagami Festival on April 3 of each year was also a big event. Hashimia Shrine was home to the mountain god and this place was where the employees and their families prayed for safety. On festival days, the entire island was excited about the wide range of events that took place and in addition portable shrines blessed by the priest at Hashima Shrine were paraded through the streets by residents.

Closure of Hashima Coal Mine
Inclusion in the World Heritage Sites

During the restoration and final period between 1964 and 1974, due to the shift of the government's energy policy from coal to petroleum, Mitsubishi Mining laid off and reassigned employees and the population of the island also decreased. While other coal mines closed one after another, however, Hashima Coal Mine significantly increased production despite the decrease in population through the full-scale mechanisation of mining in new coal seams. Production continued at 300,000 tons annually, however, due to a decrease in the demand for coal, it was announced in 1974 that Hashima Coal Mine would close. In 2001, Mitsubishi Materials Corporation donated Hashima Island to Takashima Town. In 2005 a merger between Nagasaki City and Takashima Town placed Hashima Island under the administrative control of Nagasaki City; and in 2008, Gunkanjima was opened to the general public. In the following year, they proposed that Hashima Island be recognized as a Site of Japan's Meiji Industrial Revolution. In 2015, it was listed as a UNESCO World Heritage Site as a part of "Sites of Japan's Meiji Industrial Revolution." This has increased its popularity as a travel destination for visitors. So even after closing, Gunkanjima Island has remained an important part of Japan's industrial history.
The island now serves as a reminder of the hardworking people who supported the growth of Mitsubishi and the modernisation of Japan.

Craftsman Story

Vol.8

Masayasu Hosokawa: R&D, Solid Tools Devel. Centre Solid Tools Devel. Sect. Joined in 2014	Hina Ikuta: Aerospace Dept. Akashi Aero Sect. Joined in 2015	Shinichi Ikeda: Aerospace Dept. Akashi Aero Sect. Joined in 2007	Akimitsu Tominaga: Aerospace Dept. Akashi Aero Sect. Joined in 1999	Yoshitaka Tsuji: Aerospace Dept. Akashi Aero Sect. Joined in 2004

For processing graphite Diamond coated end mill (For Finishing) DF End mill series

DF2XLBF

A CVD coating with the perfect balance for sharp edged materials

Launched in 2016, DF2XLBF was developed as a special product for a specific customer. The development goal was to prolong the life of tools used in the processing of hard composite resin materials to approximately twice that of existing products. Although the in-house small-lot test on the prototype revealed favorable results, the medium lot test at the customers' site was disappointing.
Their tireless efforts, however, led to unexpectedly long tool life. It was the determination of young staff that brought success.

DF2XLBF

The evaluations

– Would you please give us the background of DF2XLBF development?

Tominaga: Mitsubishi Materials already had a CFD diamond coated end mill for machining graphite. This new DF2XLBF is used for finishing and the letter "F" actually stands for "finish". It was originally developed as a special product ordered by a customer in the medical industry, and we later expanded sales to all customers.

Hosokawa: We were initially asked by the customer in November of 2014 to manufacture the tool. They wanted to improve tool life on hard composite resin materials. The goal was to double the existing tool life. Although this was extremely difficult, we began making and testing prototypes and by the next summer, our customer reported that our product had passed in-house inspection and we began receiving orders. To be honest though, the real development started from that point.

– Did you have any trouble after delivery of the product?

Tominaga: When the customer started using our tool at its manufacturing sites, there was a significant deterioration of tool life. Of course, we made improvements each time a problem was found and we tested quality through in-house inspections to confirm the basic performance before delivery; but actual performance at the manufacturing sites varied and was altogether unsatisfactory.

Hosokawa: The customer was irritated one day and said we should think about stopping development. We suspected that there must be a fundamental problem somewhere, so we asked the customer to allow us to visit their site. The customer's attitude toward our request was very severe: "It has been taking too much time for inspection and development, and the results have been completely unacceptable. We feel we can do without Mitsubishi's tools." When we examined the manufacturing processes, however, we noticed something important. The individual parts they manufactured had slightly different forms. In other words, the machining load differed depending on the part. We considered the difference in the form of each part and quickly improved the cutting edge geometry. We were confident that the improvement would solve the problem and asked the customer for just one more chance to test the new edge geometry.

– What made you so confident in the result?

Tominaga: It was simply the optimization of the coating and edge geometry. Hard composite resin materials cause serious abrasion, but they are not iron metals that tend to react with carbon. Therefore, we used CVD diamond coating, which has extremely high abrasion resistance. In general, CVD coating film tends to be thick, which makes it hard to create sharp edges. However, the tool we developed was for finishing and so required sharp edges. So, we optimized the coating to be thin enough to enable sharpness, but thick enough to resist abrasion.

Hosokawa: We also improved the neck diameter and cut length. Increasing rigidity and tool life generally requires a larger neck diameter and shorter cut length, but we needed an end mill with a smaller diameter for insertion into the deeper sections of components because of the characteristics of their forms. This meant that we needed a smaller neck diameter and a longer cut length. We considered what neck diameter would be rigid enough but not cause interference during machining. We decided that a diameter change from 1.90 mm to 1.86 mm might suffice. Although it was such a slight difference, we were excited to see if this would solve the problem.

Last test determines our destiny

– What was the customer's reaction?

Hosokawa: The customer agreed to allow us one more chance to test the tool, but with certain conditions. Under the same processing environment, that is work materials, cutting conditions and machines, we were required to machine a designated number of parts within a set time limit with favorable results before conducting a final test at the customer's site. We started test machining, knowing this would be the last chance for Mitsubishi Materials. During this process, Ms. Ikuta was key.

Ikuta: It was my first year after joining Mitsubishi Materials, and I was very nervous about being assigned to such an important project. We took pictures of the tool edge and components and checked them after machining one batch of five parts. One part took 30 minutes. Therefore, one batch took around three hours. We repeated the process every day until we finished 40 batches (200 parts). We sent 10 batches to the customer, who then checked the results.

– When did you start feeling that you would be able to achieve good results?

Hosokawa: It was around the time that we had finished processing about 150 parts. My concern changed to confidence and after completing 200 parts, we reported our results to the customer. The customer conducted tests at each manufacturing site and achieved an average of four times the tool life of the existing tool. The results had significantly exceeded the original goal, and the customer was visibly pleased. Our in-house testing could be conducted successfully within such a short period of time because of Ms. Ikuta's efforts.

Ikuta: I just continued machining as much as possible. I was fully aware of the project's importance for Mitsubishi Materials, so I concentrated on moving forward.

Tominaga: The key to success in this case was two young employees of the project team. Employees with experience like us are often quick to decide that a request is impossible. Both Mr. Hosokawa and Ms. Ikuta, however, were new enough not to let a request that seemed impossible get in their way and were eager to make this work. They were positive and not worried about failure.

– Do you have a message for our readers?

Hosokawa: We are very proud of the DF2XLBF. Its price, tool life and cost performance ratio are excellent. We recommend this tool for the processing of materials to which CVD diamond coating can be applied.

TECHNOLOGY ARCHIVE

Metal mould development driving the evolution of inserts

Manufacturing technology of metal moulds is essential for insert production

High-performance materials frequently used in cutting-edge fields such as the automobile, aircraft and medical industries are hard to process; and this has driven the advancement of cutting tools. While uniquely formed inserts with newly added capabilities have been developed in the tool industry, the history of geometry technology is not well known. One of the departments that supports insert manufacture is the Mould Group. This department manufacture moulds that are essential for the production of inserts. Let's take a look at the history of Mitsubishi Materials' mould manufacturing from the time before the NC machine was popular, to the present day.

CLOSE UP

The role of metal moulds for insert manufacturing

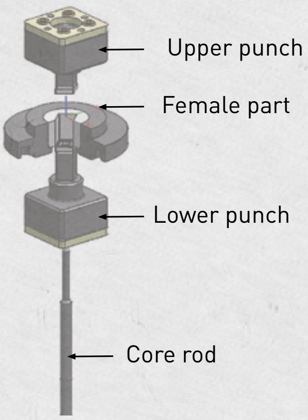
The following processes result in carbide inserts:

1. Tungsten (WC) is mixed with cobalt (Co) and dried to produce powder.
2. The powder is placed into a mould and pressed.
3. The pressed powder is heated at 1,300 degrees C or higher to make a sintered body.
4. The sintered body is machined (ground, honed, etc.).
5. The final product is CVD or PVD coated, then a final inspection is conducted.

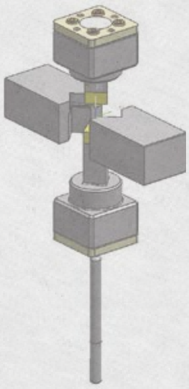
Most of the inserts manufactured by Mitsubishi Materials are created through these steps. Step 2 on the left (presswork) uses metal moulds for the manufacture of inserts. A mould is installed on the press machine, filled with the powder and then pressed. With an automated press line, several thousand pressed powder forms can be manufactured in 24 hours. The moulds are designed to withstand a few hundred thousand pressings.

Mould parts and combinations

General mould

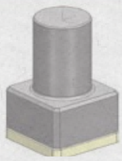


Special mould
(Type that separates the female part)

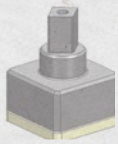


Procedures for the manufacture of moulds for upper and lower punches

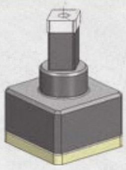
1. Punch material



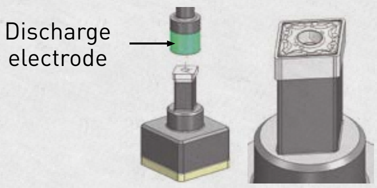
2. The neck is formed by machining



3. Carbide material is fixed to the neck by brazing



4. A breaker is formed on the carbide material by EDM (electric discharge machining).



1 1970 ~

The dawn of inserts

Mitsubishi Materials launched brazed tool holders in 1956. These were made by attaching cemented carbide blades onto the edge of a copper shank by using a silver brazing method. While they featured excellent abrasion-resistance, fracture-resistance and high machining performance, the cost was prohibitive because the entire tool holder had to be discarded when any part of it was damaged.

To address this problem, we developed tools with replaceable carbide inserts. The first inserts were simple triangular, square or circular shapes with flat faces. Soon afterwards the first chip breakers were formed on the rake face to improve chip control and reduce machining resistance. It is worth noting that it was difficult at that time to form breakers by grinding, even simple cross-sectional shapes proved challenging. Added to this was the fact that inserts with ground breakers had a longer manufacturing lead time as well as a higher price. This prompted us to develop a method of directly embossing the breaker onto the surface of the insert during pressing. This enabled chip breaker formation into the carbide material by the forming the faces of the upper and lower punches of the press mould using electric discharge machining (EDM). However, because we only had general-use milling machines for producing electrodes, we could only manufacture breakers with a simple cross section along the edge. These were called perimeter breakers.

TECHNOLOGY ARCHIVE

2 1980 ~

Beginning of the NC era
Appearance of moulded chip breakers

NC machining centres became popular around 1980. The introduction of three-dimensional CAD made it easier to create NC programs for the processing of electrodes, which allowed complex curved surface machining using ball nose end mills. This flexibility in designing breakers instantly expanded to allow the manufacture of a wide range of chip breakers for different purposes. This made the development of the MA type and standard breakers with a 7-degree positive rake angle possible.

Before the development of machining centres, the programming data for electrode machining was input using punched paper tape and floppy discs. This entailed difficult procedures that we cannot imagine now. Yoji Takimoto of the Mould Group remembered the old procedures well and said, "Paper data tape was used to input the data. This black paper tape had holes punched in it and the information given by the sequence of the holes was read by a special machine. This was a long and drawn-out process and the information for just a simple perimeter breaker would mean a tape about 10 m long. It also took time to input the data; and if we made a mistake, we needed to start from the beginning. It took a lot of time and energy."

Then, specialists would use manual measurement devices such as toolmaker's microscopes and micrometers to confirm that the finished mould conformed to the drawings. It was difficult to measure the space between the female part and the upper and lower punches, therefore, they used a uniquely developed technique called Suriawase (manual adjustment) for fine manufacturing adjustments.

3 2000 ~

Curved cutting edges, two-hole inserts
and other complex insert geometries

After the year 2000, all the insert and mould designing was done using three-dimensional CAD. From the three-dimensional model, CAM capability had improved to enable the creation of programs to machine electrodes used for EDM. This drastically enhanced design flexibility, not just for breakers, but for the entire insert. In addition, measuring devices and the equipment used to manufacture moulds improved significantly. It was because of these improvements, inserts with new geometries that were impossible to make with the standard technology, became possible.

The three-dimensional measurement devices implemented around that time also made it possible to accurately measure the new geometries. These improvements in processing and measurement technology drove advances in manufacturing. Along with the progress of such manufacturing technologies, mould production also increased rapidly.

Tomotsugu Goda who was involved at that time looked back and said, "Due to the expanded flexibility of insert design, orders from the development group became more complex. Our role is to produce moulds to form pressed powder units based on requests. CAD allows easy modeling, but producing the actual pressed powder units is a challenge.

Our mission, however, is to develop a method to realise all the forms that the development staff request.

4 2010 ~

Aiming for further improvement with new machining technology and innovative ideas

After 2010, inserts with more complex forms were launched one after another. Major examples are inserts for the VFX cutter with vertical cutting edges and horizontal holes, and inserts for the VOX series with multiple corners and moulded chipbreakers. Some inserts had forms whose pressed powder unit could not be removed from the female part of the mould by using the regular pressing method. Therefore, special moulds that could separate the female part were developed.

As insert performance increases, forms tend to become more complex, which in turn makes the manufacturing of the moulds more difficult. For example, spilt moulds mean more parts; and this requires that each part to be more accurate to fit properly. The procedures for setting the moulds in the press machines also becomes more complex.

Throughout its long history, the Mould Group has contributed hugely to the commercialisation of a wide range of inserts by improving the moulds, developing machining methods and upgrading preparation. Mr. Goda, who was involved in solving the problems of producing a wide range of moulds said, "I encourage the new product development team members to speak out and make requests. While we may not be able to realise their ideas, we will work tirelessly with them to try. We never know what we can accomplish until we try. Striving for innovation is the real charm of mould manufacturing."

Kentaro Ono is in charge of press work in the same Production Engineering Department. He was in the Mould Group for 10 years and he wants customers to appreciate the intricacies of inserts. Each insert is the result of the enthusiasm and technique brought to bear by dedicated professionals. He told us his vision at the end of the interview, "When people in this industry, including our customers, see our inserts, I hope they wonder how we did it. With this in mind I would like to continue creating such innovative products."

Looking back at the history of the development of moulds for inserts

Moulds are our life, so when we see a product, we naturally start imagining what the mould used to make it looked like. A mould is like the shadow of the article they produce.

The moulds we manufacture don't appear in front of the customer, but inserts are impossible to make without them. We each feel individual responsibility and pride in the important work we do as professionals supporting the development and manufacture of outstanding inserts.

Young employees who have only been with the company for a short time also contribute significantly by identifying problems and making proposals for new machining methods. We continue to cooperate with one another without regard to age or experience to manufacture innovative moulds.

(From left)
Kentaro Ono, Production Engineering Dept. Production Engineering Group (When we interviewed them).
Yoji Takimoto, Production Engineering Dept. Mould Group
Tomotsugu Goda, Production Engineering Dept. Mould Group

Education base in China for cutting tool markets

ABOUT US

TianJin LingYun Tool Design Co., Ltd. – MTEC TianJin (China)

China launched its China Manufacturing 2025 initiative to promote further industrial growth. In this feature, we focus on MTEC TianJin, a technical centre strengthened to support Chinese market movement.

Ask the Director of MTEC TianJin

Hiroyasu Shimizu
Director, Cutting Technology Center,
TianJin LingYun Tool Design Co., Ltd.

Providing timely, high-quality solutions in cooperation with technical centres around the world.

Renewed MTEC TianJin

MTEC TianJin (China) was founded at TianJin LingYun Tool Design Co., Ltd. in 2004 as a base for machining technology education and application services tailored to customers in China. Thirteen years after its foundation, it was reorganized in October 2017 to respond to growth and changes in the Chinese market. Japanese-affiliated companies have already entered TianJin, a city located just 30 minutes southeast of Beijing by high-speed rail. TianJin Airport and Chubu Centrair International Airport, which is located in the heart of the Japanese automobile industry, are connected by direct flights.

When MTEC TianJin was founded in 2004, China was already serving as a global factory. However, with the announcement of Chinese Manufacturing 2025, the Chinese version of Industry 4.0, in May 2015, the manufacturing industry is predicted to grow even further. In order to attract Chinese automobile and other manufacturers with high technical capability, it is necessary to provide not only education in the basics and applications of machining, but also comprehensive machining solutions that include the most up-to-date CAM, CAE, simulation technologies and tooling support.

Mitsubishi Materials has six technical centres around the world. Each centre has equipment suitable for the needs of each region. In addition, they have access to different types of equipment that can be shared when needed. When one of centers lacks the specialised equipment required to effectively handle a request from a customer, it can be transferred to a technical centre that has the required equipment. For example, when an MTEC TianJin customer requires an application to be machined on the horizontal machining centre with an HSK100 spindle, owned by the Central Japan Technical Center (MTEC Gifu) in Japan, MTEC TianJin can ask MTEC Gifu. In addition, the MTEC TianJin translation department translates technical documents from Japanese to Chinese to make them quickly available in China. Furthermore, the majority of staff at MTEC TianJin is able to communicate in Japanese, which ensures the timely sharing of information about new

products and technology developed in Japan.
We respond to each customers' request with care, implement the solution technology developed in Japan and introduce the most advanced machining technology developed in China to the world.

Being an effective partner
I joined TianJin LingYun Tool Design Co., Ltd. in 2008. I am assigned to the Cutting Technology Center, which handles a wide range of work carried out at customer's sites. For example, we provide technical seminars and services as well as machining trials. The Cutting Technical Center had been conducting trials on prototypes on request from the Development Division in Japan rather than from customers; and although we responded to customer requests for lectures at technical seminars, recognition of the Cutting Technical Center among companies in the Chinese market remained low. However, better public relations leading up to and following the re-opening of the centre succeeded in bringing in many visitors from both in and outside the company. I'm looking forward to even more people coming to see us.
Recent growth in the Chinese market is significant. Along with this, requests for solution services as well as product quality and performance enhancements have also been increasing. In response to this, the Cutting Technology Center has shifted its focus to machining trials and technical support. In striving continuously to be an effective partner by quickly responding to changes in customer needs, we go beyond the provision of trials to provide attractive total solutions. Everyone at the technical centre is committed to providing the quickest and most effective solutions as we work to increase our standing among customers in China.

Ask the Cutting Technology Team Manager

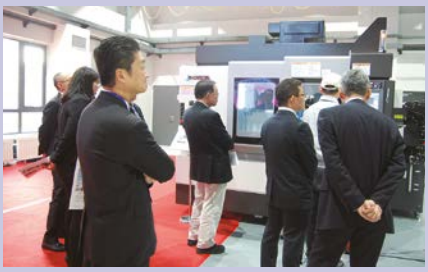
Fang Fan
Manager, Cutting Team, Cutting Technology Ctr., TianJin LingYun Tool Design Co., Ltd.

Delivering the quickest, most effective solutions to every customer we serve.

MTEC TianJin Solutions

1 A wide variety of education programs

2 Demonstrations using actual equipment



3 Machining trials to cover a wide range of requests

CUTTING EDGE Vol. 7

Hiromitsu Tanaka, R&D Div., Machining Technology Ctr., Solution Group

Analytical technology designed to visualise problems and improve processing

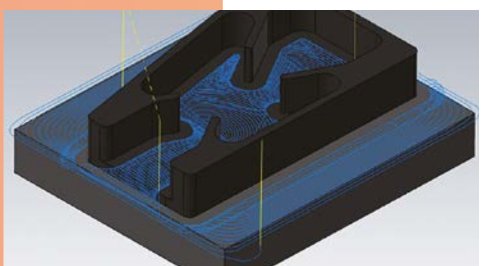
Providing analytical solutions accumulated through tool development

The wide variety of solutions provided by the Mitsubishi Materials Machining Technology Center includes machining trials, proposals for machining methods utilizing CAM, telephone consultations, seminars and technical services. One focus is analytical solutions utilising technology accumulated through product development. Such analytical information contributes to the improvement of quality and efficiency at manufacturing sites. However, it is difficult for the customers themselves to clearly understand certain aspects of machining such as load and deformation. To help customers better understand, Mitsubishi Materials designs proposals for improving machining processes through a combination of analytical technology and experience utilising three methods of analyses - rigidity, chip form and machining load.

Among these, machining load analysis is frequently employed to visualize the load on the material and cutting tool (main component force, thrust force, spindle force, etc.). To realize highly efficient machining, it is important to understand tool characteristics. It is not too much to say that an understanding of machining load is key to efficient machining. However, our goal is not only to conduct analyses, but also to increase the quality of our proposals to optimise machining conditions. For example, although recent CAM software is capable of automatically creating tool paths after stabilizing machining load, they cannot accommodate the characteristics of a wide range of tools and materials and they are sometimes not effective for actual machining. We try to calculate more accurate machining loads, analyze deformation of the work materials and jigs and consider how to shorten machining time to make the most appropriate proposals for improvement.

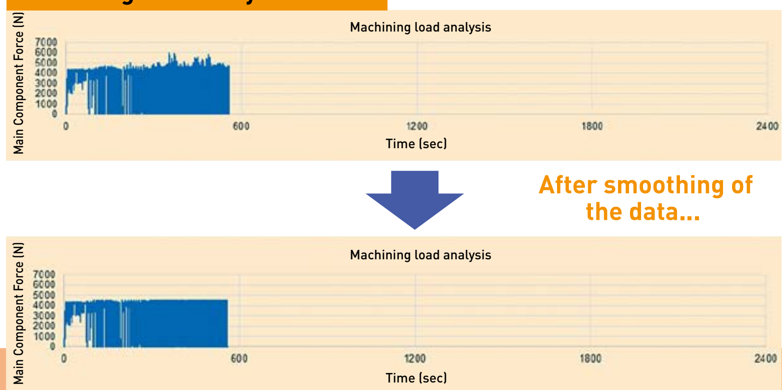
Improvement of machining utilising machining load analysis and CAM

High-efficiency rough machining (TROCHOID + Climb Milling)



Tool	VQMHVRBD 1600R 100 (φ16×R1)
Tool protrusion	40 mm
Work material	SCM440 (27HRC)
Spindle speed	2,000 → 3,000 min-1 (150 m/min)
Feed	480 → 1,800 mm/min → Variable between 1,680 and 1,800 mm/min (Max. fz 0.15 mm/tooth)
Depth of cut	ap 12 mm, ae 6 mm → ap 30 mm, ae 2.5 mm
Coolant	Air blow
Machine tool	Vertical type machining centre (HSK A63)
Volume of discharged chips	36 → 135 cc/ min
Machining time	39 → 10 min

Machining load analysis results



With the optimal use of tools
Stable Machining + High-efficiency Machining
+ Long Tool Life

Wang Wei, Research & Development, Machining Technology Centre, Solution Group

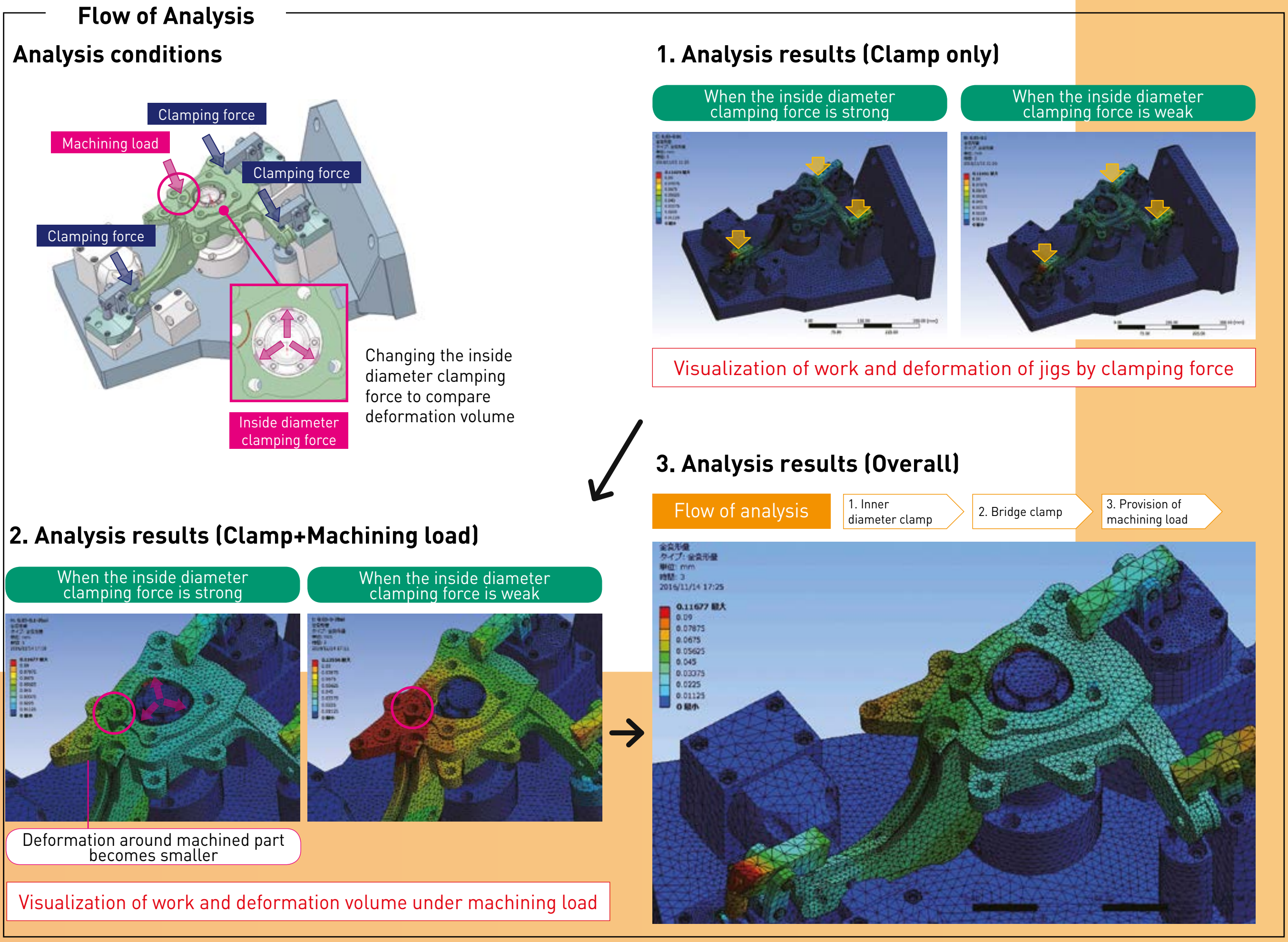
Harumi Kosaka, Research & Development, Machining Technology Centre, Solution Group

Increasing quality of proposals for improvement using analytical data

It is necessary to obtain 3D modeling and NC programs data from customers to conduct analyses. However, we often require more information, so we cooperate closely with other departments. Ms. Kosaka, who is in charge of analyses, says: "We first focus on what customers explain. However, we consider the reasons for the results of our analyses to identify the fundamental problems. When solutions derive from the results of our analyses and the questions we pose, we feel a great sense of satisfaction. Success is not simply a matter of the analyses we conduct or the software we use, but our logical consideration of causes and results."

In 2017, Mitsubishi Materials implemented reverse engineering, heat transfer analysis and other technologies. At the same time, we accumulated analytical results, compared these with actual measurement values to increase the accuracy of analytical values. We try to improve accuracy not only through the combination of innovative machining and our tools, but through proposals for innovative machining methods that increase the economic benefits.

There are currently five specialists assigned to the East Japan Technical Center (Saitama City) providing about 10 analytical solutions every month, and we are planning to increase staffing in the future. In addition, the number of requests from customers in Chubu Region has increased. We will expand the functions of our second technical support base, the Central Japan Technical Center (MTEC Gifu), to facilitate speedy services, and we are planning to develop the same system at our overseas bases. Making comprehensive approaches with technical services, analyses and machining inspections will improve the quality of our proposals and provide useful total solutions; in addition we will reinforce our capability to provide comprehensive solutions for machining.

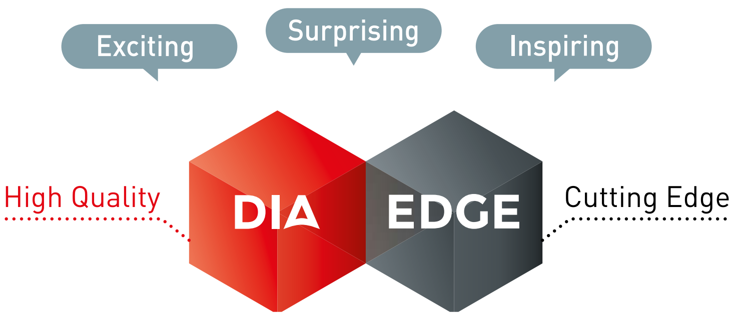


Jig models provided by OKS Co., Ltd.

DIAEDGE

Together with our customers, creating a better future

Announcing DIAEDGE, our new brand of tools,
that brings together our cutting-edge technologies, exciting all who use them.
Our aim is not only to offer value with our tools,
but to think together with our customers, share inspiration with them,
and continue to take on new challenges.



- Providing Best Solution Services
- Speedy Response

Customers and Mitsubishi Materials,
for mutual understanding and growth.

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