

Electrical-discharge pioneer achieves highly accurate special processing leveraging proprietary technologies accumulated over many years

Hoden Seimitsu Kako Kenkyusho Co., Ltd. (HSK) was established in 1961 and led the industry as a pioneer of electrical-discharge machining. HSK has approximately 180 EDMs and uses these to process various metal products, including its flagship product - dies for aluminum extrusion. We asked HSK about its strengths, etc. in the electrical-discharge machining field.



HSK's main plant for dies for aluminum extrusion, Atsugi Plant (Atsugi, Kanagawa Prefecture). A row of 40 EDMs.

Electrical-discharge machining is a technology invented by a husband and wife team, B. R. and N. I. Lazarenko, of the former Soviet Union in 1946. Research in this field began in Japan shortly after the end of World War II, and in March 1954, the first EDM was manufactured in Japan.

HSK founder and present-day adviser, Shoji Futamura, was involved in the development of Japan's first machine. Mr. Futamura established HSK in 1961 with the aim of using Japan's first EDM for manufacturing applications.

HSK initially leveraged the features of electrical-discharge machining to manufacturing dies for aluminum extraction, targeting the manufacturers of aluminum sash used in window frames and other

products. Molds that apply a pressure of 5t/cm² or higher to extrude the sash frames use high-strength steel. Therefore, wire electrical-discharge machining was ideal for the micromachining that was needed. HSK has maintained Japan's top share of the dies used in the aluminum extraction market for over 50 years.

Later, with electrical-discharge machining technology at its core, HSK expanded its business to various special precision machining and surface treatment processes to achieve the heat-resistance and corrosion-resistance of metal, and design and manufacture high-accuracy presses among other applications. Today, HSK operates its business on a global scale, with nine bases including affiliate companies in

Japan and two bases overseas.

In-house development of jigs, tools and electrodes Capable of micromachining at the nanometer level

HSK strengths in the field of electrical-discharge machining are that it possesses the technical ability to develop its own jigs and tools, the electrodes needed for sinker electrical-discharge processing, the technologies required for optimal control of electricity flow, other functions needed to achieve electrical-discharge machining matching its customers' needs, sludge processing technology, and more. HSK's major distinguishing feature is that it utilizes the above-mentioned technical strengths to perform special machining unachievable by its competitors, such as micromachining metal with precision at the nanometer (nm) level and highly accurate drilling in steel several meters long.

An example of metal machining leveraging these proprietary technologies is the molding of the roll dies used to make patterns on metal surfaces, such as the side panels used for exterior walls of houses and high-tensile steel sheets. As the name suggests, a roll die is circular in shape and is, in fact, a set comprised of a convex die and a concave die. A pattern is applied to the surface of the die using a sinker EDM. The molding of a roll die requires the technology to design the

die in a 3D form so that the correct pattern can be achieved in addition to high-accuracy machining that ensures the convex and concave dies engage with an accuracy of 10μm.

In 1997, HSK began purchasing Mitsubishi Electric-made EDMs on a constant basis. Toshiyuki Yagi, Executive Officer and General Manager of the MP Solution Business Department, reflected on what led to this decision. "At the time, a large-scale project to install a manufacturing line to make dies for aluminum extrusion was being launched. The decision was made that HSK would purchase a large quantity of EDMs. I was in charge of production engineering at the time, so it was up to me to select the machines we would buy. As a result of various studies, we narrowed down the candidates to Mitsubishi Electric and one other company, and installed three or four test machines from each of the companies to make a comparative study. After performing ongoing tests for some time, one day

a machine just stopped. That was when the developer of the Mitsubishi Electric EDMs immediately came to the plant and spent two full days with us trying to find the root cause. It was eventually revealed that the problem was not the machine at all, but rather the type of machining oil being used. In consideration of this issue that had arisen, however, Mitsubishi Electric's engineer newly proposed that machining speed could be raised even further if the power source was improved.

At the time, there wasn't much difference in regards to product specifications with the other company. But we decided to purchase Mitsubishi Electric's machine due to the fantastic technical support we received."

This was the springboard for introducing Mitsubishi Electric EDMs to make not only dies for aluminum extrusion, but also for other machining tasks. Currently, HSK has a total of 180 machines counting both wire-cut EDMs and sinker EDMs, and many of these are made by Mitsubishi Electric.

Establishing the HSK Philosophy and maintaining and enhancing high-level technical ability

In 2012, HSK formulated the HSK Philosophy Handbook to provide specific explanations of its management philosophy (concept, stance and conduct) in order to continue nurturing employees with

high-level technical skills. The HSK Philosophy Handbook, which sets out the HSK concept regarding management, stance towards work, judgment criteria, stance towards customers and an uncompromising position towards products and services, was "mainly compiled by younger project team members," explained Akihiko Kosako, Assistant Manager of the Human Resources and General Affairs Management Department. He went on to say, "I believe the fact that our employees are always conscious of this management philosophy as they go about their work is the reason why we can maintain and enhance our technical skill."



MV Series - The wire-cut EDM made by Mitsubishi Electric installed in the fall of 2015.



Die for aluminum extrusion. This die is subjected to over 5t of pressure to extrude aluminum sash frames.



A wire-cut EDM processing dies for aluminum extrusion. HSK has top share of the market for this type of die.

Solution Case Study / Interview

HSK MP Solution Business Department,
Hoden Seimitsu Kako Kenkyusho Co., Ltd.

We are promoting manufacturing craftsmanship reform in a broad range of fields with electrical-discharge machining as our core technology

◀ Toshiyuki Yagi

General Manager,
MP Solution Business Department
Executive Officer

Profile

Born 1958. Joined HSK in 1977. Served as Electrical-Discharge Manager at Atsugi Plant, Production Engineering Group Leader, Deputy Manager (Plant Manager) and Business Department Manager (2014) until being appointed to his current position in September 2015.

— HSK currently operates around 180 EDMs, correct? Are there any other companies that have as many of these machines as you?

Yagi : We probably have the highest number. HSK was established over half a century ago. As the pioneer of electrical-discharge machining, we have continuously challenged ourselves to develop new technologies and break into new business territory. The feature of electrical-discharge machining would have to be that it can be performed with high accuracy on materials of any hardness or shape. I personally have been involved in electrical-discharge machining for 30 years and I'm still impressed by it.

— What areas are you currently challenging yourselves in?

Yagi : In the area of extrusion dies, we are working on achieving a "correction-free die". This means when a die designed and fabricated by HSK is loaded into our customer's

press, it is capable of machining at the expected accuracy from the first batch of parts.

If I put it that way, some may think "Of course machining should be as per the specified accuracy." But in the world of extrusion, this is actually quite difficult. No matter how accurately we manufacture a die to meet specifications, each customer's press has its own little quirks, so dies have to be corrected through a process of trial and error in the actual press in order to increase machining accuracy.

In order to solve this issue, we introduced a simulator to simulate the same machining environment as our customer's press and are attempting to develop a correction-free die.

— What points do you pay attention to in order to train employees with such skills?

Yagi : On-the-job training is essential to acquiring electrical-discharge machining skill. We also recommend our employees to participate in the

National Skills Competition. Obtaining this qualification helps employees refine their skills and provides motivation.

In addition to Mitsubishi Electric's technical support strength come being evaluated highly for good surface properties and more

— Most of your EDMs are made by Mitsubishi Electric. What do you think of these machines?

Yagi : In terms of performance, Mitsubishi Electric machines provide excellent surface properties. In the extrusion of aluminum sash, the molded surface becomes the product's skin, so having a high-quality finish is a must. In addition, Mitsubishi Electric EDMs stand out from the rest owing to their operability. They feature special-purpose software so the operator only has to input the machining conditions. After that, the machine automatically adjusts the amount of electricity and waveform. This means anyone, not only highly experienced operators, is capable of high-accuracy electrical-discharge machining. HSK is pleased with Mitsubishi Electric machines due to this aspect of taking user-friendliness into consideration.

In addition to that, Mitsubishi Electric's technical support is just as high-level as the performance elements I have mentioned. To provide a concrete example, normally when you contact a machinery manufacturer regarding a breakdown, you have to wait until they come to provide support, and



(left) Akihiko Kosako, Assistant Manager, Human Resources and General Affairs Management Department. (right) Haruka Ideno, Sales Manager, EDM Section, Industrial Mechatronics Sales Department, FA Systems Group, Mitsubishi Electric.

there is no choice but to halt operation of that machine in the meantime. But, Mitsubishi Electric's call center provides phone-based support by asking for details on the type of symptoms, and then explains a countermeasure to that may help. This means we can continue production using that machine, which something we are very grateful for.

Furthermore, if on-site support is required, engineers are dispatched in no time at all. Not to mention, we are extremely grateful to Mitsubishi Electric for always performing maintenance during periodic inspections before breakdowns occur, which contributes to increasing operating rate.

However, even though most of the EDMs currently in operation are from Mitsubishi Electric, it is not as though we completely rule out other manufacturers. Even now, in accordance with our company rules, whenever we plan on purchasing a new machine, we always request quotes from a number of manufacturers, run trials, and then decide which model to install. However, the fact we keep coming back to the Mitsubishi Electric EDMs is, I believe, due to the high-level of technical support.

Expand businesses producing dies and parts in one-stop

— Moving forward, what areas

does HSK plan on challenging itself in?

Yagi : Ever since establishment, HSK has developed its businesses with electrical-discharge machining as its core technology. But another significant feature of the company is that it also possesses all of the functions necessary for industrial parts production, from electro-chemical machining and surface machining to the design and development of equipment and parts assembly.

Moving forward, HSK will combine its various technologies to expand upon the existing businesses of consignment-based machining and die fabrication leveraging electrical-discharge machining to become a one-stop provider of everything required for parts

production, from materials procurement to cutting, machining, heat treatment and assembly.

We have already established an integrated production line at our Komaki Plant (Komaki, Aichi Prefecture), where we began manufacturing key components of aircraft engines in August 2015.

HSK's mid-to-long term growth strategy is to leverage electrical-discharge machining in order to manufacture various industrial products with high added-value and advance our businesses even further.

Corporate Data

Hoden Seimitsu Kako Kenkyusho Co., Ltd.

Net sales
¥10 billion (consolidated, term ending February 2015)
No. of employees
478 (as of February 2015, incl. part-time employees)
Main Businesses
Consignment-based machining of various metal products using primarily electrical-discharge, consignment-based manufacturing of various dies and metal surface treatment processing, development and fabrication of mechatronics products, parts processing, press composite systems, etc.
History
1961 Hoden Seimitsu Kako Kenkyusho Co., Ltd. established and consignment-based electrical-discharge machining started
1963 Manufacturing of aluminum extrusion started
1999 Registered as over-the-counter stock with Japan Securities Dealers Association (present day JASDAQ Securities Exchange)



Sinker EDM in operation. The secret to highly accurate machining is electrodes, jigs and tools developed in-house.



Iiyama Plant with Mitsubishi Electric sinker EDMs. (Iiyama, Kanagawa Prefecture)



Nichidai Corporation

Growing from a garage factory to a world-class cold-forging die manufacturer

Nichidai Corporation is a world-class precision die manufacturer for cold forging. Utilizing EDMs and other devices, it manufactures cold-forging dies primarily for automotive parts and forged parts, and has expanded its business to the assembly of automotive parts and manufacturing filters for industrial use. Nichidai was asked about its features and thoughts on technical development.



Nichidai was founded in 1959. The company's founder and first president, Yoshiaki Tanaka, rented a garage in Tenmae, Osaka and established Tanaka Gokin Seisakusho (Tanaka Alloy Works), where three employees manufactured drawing dies for drawing wires. It was literally a "garage factory" beginning for the company.

Mr. Tanaka strongly believed in technical development from the time the company was founded. Japan's first EDM was developed in 1954, but Mr. Tanaka wanted to process cemented carbide, the material from which drawing dies are made, so he studied the literature of the inventors of electrical-discharge machining, the Russian engineers, B. R. and N. I. Lazarenko. He then modified a drilling machine and built his own EDM. This machine offered

performance superior to the machines sold commercially at that time, and contributed significantly to increasing the company's sales of wire drawing dies

In 1967, the company relocated its head office to a newly constructed plant with a floor space of approximately 660m² in Neyagawa, Osaka Prefecture, and the name was changed to Nichidai Corporation. The name "Nichidai" incorporates the founder's goal of being the "Number one die manufacturer in Japan."

At the time, cold-forging technology was just starting to be introduced into Japan's industry for automotive parts manufacturing. However, the cemented carbide dies for cold-forging were all expensive imports, so automotive and parts manufacturers were looking for a domestic company capable of manufacturing cold-forging dies. This

was how Nichidai, with its cemented carbide machining technology, was singled out from the rest. In this way, the company shifted its focus to dies for cold-forging of auto parts and expanded business rapidly in line with automotive industry growth.

Launch of a precision forging business Deepening and broadening the technological base

In 1971, the company's head office and factory moved to the current location in Tanabe-cho, Kyoto. In 1988, the Ujitawara Factory was completed in Ujitawara-cho, Kyoto. Here, a hydraulic 3-axis double-action press was installed, marking the company's entrance into precision forging, with the company preparing a system to research forging technology itself. President and CEO, Corporate Officer Motonobu Furuya explained, "By handling everything from the upstream processes to the downstream processes of cold-forging, we became able to engage in technical development hand-in-hand with our customers, thereby deepening and broadening our technological base. This was a turning point for the company."

Now the company responds to requests from automotive and parts manufacturers by manufacturing dies for a diversity of forged parts, such as suspension systems and engine components, as well as manufacturing prototypes and mass production forged parts. Over the



A row of EDMs at the No. 3 Ujitawara Factory.

years, the cost of manufacturing automotive parts has gradually fallen owing to the shift from machining to forging. Nichidai has also contributed significantly to achieving this cost reduction. President Furuya stated proudly, "In the past, expensive, special-purpose machines were needed for cutting bevel gears and cross joints. But today they can be mass produced with cold forging."

In addition to the "net shape business" of manufacturing cold-forging dies and precision forged parts, Nichidai is currently expanding into the "assembly business," involving the assembly of components for turbochargers used in diesel engines, and the "filter business," involving the production of sintered wire mesh filters with Nichidai's proprietary sintering technology. Total net sales of 14 billion 264 million yen was comprised of 51.2% net-shape business, 34.2% assembly business and 14.6% filter business (consolidated, term ending March 2016).

Drawing out the ultimate performance together with EDM manufacturers

When Nichidai was founded, it made its own EDMs. But, as production increased, it ultimately shifted to a policy of purchasing commercially available units. The company began installing Mitsubishi Electric EDMs in the late 1960s when operating the Neyagawa Plant, and today has several dozen operating, including

both wire-cut and sinker EDMs.

Corporate Officer and General Manager of the Production Headquarters, Masato Ito, expressed his satisfaction with Mitsubishi Electric, saying, "In order to provide the high quality our customers seek, we have to draw out the ultimate performance from our EDMs. This cannot be done without the cooperation of processing machine manufacturers. We often ask the impossible of Mitsubishi Electric, but they always do their absolute best to support us."

In 2005, Mr. Ito worked together with Mitsubishi Electric and other companies to develop a 24-hour operating robot cell system incorporating three DIAX EA12V EDMs, a robot conveyor made by Nichidai and a 3D coordinate measurement machine (CMM). The die for manufacturing is selected from electrodes of various shapes and then the robot sets it in the EDM. After electrical-discharge machining is completed, the robot transports the processed die to the CMM to be measured. This system confirms the part is within tolerance before proceeding to the downstream process.



Final CMM measurement inspection of a cold-forging die manufactured in an EDM.

However, there was no precedent for this type of technical development and difficulties emerged. Mr. Ito commented, "We have actually called Mitsubishi Electric and the 3D CMM manufacturer at midnight during trial operations and requested their presence. The development took time, but the Mitsubishi Electric members persevered to the very end. Thanks to them, everything is running smoothly now and production has significantly improved."

In 2015, Mr. Ito installed the Mitsubishi Electric MX-600, the first EDM for oil-submerged processing, and saw an influx in orders. Normally, wire-cut electrical-discharge machining is performed while submerged in water, but using oil results in a better quality finish. The issue is that electrical-discharge machining in oil takes around two or three times longer than water, thus productivity is low. As such, Mr. Ito made some outrageous requests of Mitsubishi Electric, such as "Double the processing time! But as a result, they made us machines with the same high processing accuracy and a processing speed improved by several percent."



In 2015, Nichidai installed a Mitsubishi Electric MX-600 oil-based processing EDM.



A 24-hour robot cell system with three Mitsubishi Electric DIAX EA12V EDMs, a robot conveyor made by Nichidai and a CMM.

Solution Case Study / Interview



Nichidai Corporation

Nichidai is a company that exists because of technology

Aiming for the cold-forging die frontier based on the spirit of VSOP

◀ Motonobu Furuya

Corporate Officer
President and CEO

Profile

Born in Yamanashi Prefecture in 1955. Joined Nichidai in 1998. Served as Director in 1999, Vice-President in 2001, and President and CEO since 2002.

What are Nichidai's distinguishing features?

Furuya : Nichidai is a company that exists because of technology. The majority of dies manufactured around the world are for sheet metal or plastic forming, but dies for cold-forging only account for a mere 3 to 4% of Japan's die production. However, cold-forging dies are subjected to high stress, and therefore require a high level of technology. Nichidai will continue refining its technologies and challenging itself to be the world's best.

Our founder, Yoshiaki Tanaka, made a pun related to brandy grades with "VSOP." This is a term coined by Mr. Tanaka standing for "Vitality, Specialty, Originality and Passion." "VSOP" is the origin of Nichidai. Conceiving technologies, manifesting these into products, maintaining close communication with customers and popularizing products. Nichidai upholds the spirit of "VSOP" in all of

its divisions: development, production and sales.

Mr. Tanaka also stated, "Take pride that Nichidai is the top company in cold-forging die technology in Japan and think for ourselves." He believes that a company will only grow if it has engineers capable of thinking and acting for themselves.

What type of employee training do you provide to nurture such engineers?

Furuya : "When we were still a fledgling organization at the time of founding, we just took an iron fist type of approach. But now that we have grown into a large company, that simply won't do. These days, in addition to on-the-job training, we provide training with the help of external experts."

I believe it is my duty to guide Nichidai towards further growth while ensuring the good environment and culture of our company that takes a "work with autonomy" approach is carried on despite our larger-size.

Nichidai also expanded into Thailand in 2013, correct?

Furuya : Yes, and the reason for this is because there are many Japanese automotive manufacturers in Thailand and it is the world's hub of automotive parts exports. We nurture engineers in Thailand as well. But it won't work if we just try to apply the same training that we do in Japan. We do our best to provide training suitable for the Thai culture.

Even support development of original specification EDMs

You seem to have a long-standing relationship with Mitsubishi Electric EDMs, correct?

Furuya : Yes, I've heard it began toward the end of the 1960s, which is before I joined the company. I believe our founder, Mr. Tanaka, was extremely grateful to Mitsubishi Electric for accepting an installment-based sale using a promissory note as Nichidai was still struggling with financing at the time.

The majority of Nichidai dies and forged products are low-volume, high-mix products, and EDMs are absolutely essential for processing. The number of EDMs we own has increased in accordance with the expansion of our businesses, and one reason we continued to use Mitsubishi Electric machines is the fantastic after-sales service.

Moreover, in order to manufacture special dies, it is not uncommon for EDMs to require original specifications. For example, in 2013, Nichidai and Mitsubishi Electric jointly



A row of various machine tools at the No. 2 Ujitawara Factory



(right) Masato Ito, Corporate Officer and General Manager of the Production Headquarters.
(left) Satoshi Aoki, Sales Manager and Section Chief of the EDM Section, Industrial Mechatronics Department, Kansai Branch, Mitsubishi Electric Corporation.

developed an original wire-cut EDM robot system to manufacture atypical electrodes. This machine now plays an effective role in high-accuracy die manufacturing. Nichidai also highly regards the stance taken by Mitsubishi Electric regarding technological development.

A company that opens up new technologies has a bright future

What type of company do you want Nichidai to become?

Furuya : I believe the ultimate point when it comes to satisfying our customers' demands is technology. This is because, at the end of the day, low cost and short lead times are made possible through technology.

To date, we have developed various technology in order to forge a wide variety of parts. But forging technology is unlimited and there is no end in sight. Perhaps the future will bring a processing technique that combines forging and sheet metal. Nichidai is working with Osaka University to develop new forging



The wire-cut EDM robot system jointly developed with Mitsubishi Electric in 2013 to manufacture atypical electrodes. Playing an effective role in high-accuracy die manufacturing.

technologies. A company that neglects technology has no future, but a company that opens up new technologies has a bright one. Currently, Nichidai takes pride in the fact we are one of the most sophisticated cold-forging die companies in the world. But if we stop now, this won't last.

Our company's name, Nichidai, incorporates our founder's goal of being the "Number one die manufacturer in Japan," and this has been achieved in regards to cold-forging dies. There is no detailed data on cold-forging dies, so this is just my assumption, but Nichidai may even be world number one in this field. Even so, we will not let our guard down due to this position, and continue refining our technologies even further.

Finally, please comment on the Nichidai baseball team. Many companies have been forced to disband their baseball teams due to poor business performance, but the Nichidai team has been active since the team was formed in 1997.

Furuya : Thanks to our baseball

team, our company is now known throughout Japan. But we aren't able to support them like larger corporations, who are regulars at intercity and JABA games. The baseball players themselves work full-time from early morning and practice in the evenings every day. Despite this, we have made it to the Intercity Series twice and JABA four times.

When our team makes it through preliminaries to secure a spot in national competitions, our employees are really excited and it creates an excellent feeling of unity in the company. Passionate motivation and a sense of unity are absolutely essential to a company's growth. That is how our baseball team really contributes to Nichidai.



The company baseball club, formed in 1998, has grown into a powerful team that produces professional baseball players.

Corporate Data

Nichidai Corporation

Net sales
¥14 billion 264 million
(consolidated, term ending March 2016)

No. of employees
645 (consolidated, as of March 31, 2016)

Main Businesses
Development, production and sales of precision forged dies for automotive parts, mass production of precision forged parts, assembly of turbocharger parts for diesel engines, development and production of sintered wire mesh filters.

History
1959 Founded as Tanaka Gokin Seisakusho (Tanaka Alloy Works)
1967 New factory completed in Neyagawa, Osaka Prefecture and re-established as Nichidai Corporation
1971 Head office and factory relocated to Tanabe, Kyoto Prefecture
1988 Ujitawara Factory completed
2000 Listed on JASDAQ
2008 Thai subsidiary established

Solution Case Study



Nihon Haken Co., Ltd.

Supporting advancement of the automotive industry with diamond cutting tools finished on electrical-discharge machines

Nihon Haken is headquartered in the city of Anjo, Aichi Prefecture, and specializes in manufacturing special cutting tools using industrial diamonds and cemented carbide. The company has provided automotive-related manufacturers with premium-quality cutting tools for around 50 years and now has operations in Indonesia.

The late founder, Minoru Inagaki, first established Nihon Haken Kogyo in the city of Toyota, Aichi Prefecture, in 1967. "Our founder was a craftsman with advanced cutting skills, and was a diehard idea man at the same time. When he founded the company, he thought about whether to go into jigs or cutting tools, and decided that cutting tools had a higher business potential due to their consumable nature. He started operations with five employees," commented Tsuyako Iwase, CEO and President, a position she has held since 2011.

Initially, the company's primary business was re-grinding tools. However, when it relocated its head office to Kariya, also in Aichi Prefecture, in 1969, it began making special cutting tools from cemented carbide as products and this soon became the company's forte. These carbide tools were adopted by Nippon Denso Co. Ltd. (present day

Denso) and Toyota Industries Corporation, and business grew rapidly. This was right around the time of full-scale motorization in Japan, and the automotive industry was experiencing rapid growth. As production volume was increasing in leaps and bounds, in order to increase production, parts manufacturers were looking for tools with good durability that didn't crumble or wear easily, even when used for high-speed cutting. Nihon Haken's carbide tools met these needs with certainty and earned a strong reputation.

The next turning point for the company came in 1995 when it entered the diamond cutting tool domain. Ms. Iwase reflected on the time, saying, "Machine tools used in automotive manufacturing were becoming capable of higher speeds and higher accuracies, and cutting tools needed to follow suit. We

responded to this issue by entering the business of diamond cutting tools, which are cutting tools with industrial diamond blades attached to the tip. These are even harder than cemented carbide. Diamond tools are not only capable of high-speed, high-accuracy machining, they also have a service life ten times greater than carbide tools. Not to mention they offer great cost performance as the price is only around three to five times more. At that time, diamond tools were only just starting to be used, so we made the decision to enter this domain at an early stage."

Improving productivity and reducing cost with Mitsubishi Electric wire-cut electrical-discharge machines

Diamond tools are manufactured by soldering diamond chips cut from wafers made of industrial diamond onto a tool made by machining



The diamond tool manufacturing line consisting of 20 wire-cut electrical-discharge machines, 19 of which are made by Mitsubishi Electric.

cemented carbide, then put through a finishing process to increase blade accuracy. Diamond is hard, therefore it is difficult to machine in anything other than a wire-cut electrical-discharge machine. Not to mention, it takes over one month to manufacture diamond tools, therefore a number of expensive wire-cut electrical-discharge machines are necessary to maintain operations. For this reason, many tool manufacturers were hesitant to enter the diamond tool business. However, Nihon Haken went out on a limb and purchased three wire-cut electrical-discharge machines all at once.

The first electrical-discharge machine the company installed was not made by Mitsubishi Electric, but by another company. The machine utilized a ball screw coated in grease for lubrication, therefore an issue arose in which the grease that dispersed during operation in the factory would adhere to the carbide grinding chips and wear away the ball screw. As such, the ball screw had to be replaced annually, resulting in excessive maintenance costs.

This problem was resolved by the FX Series, a wire-cut electrical-discharge machine made by Mitsubishi Electric and purchased by Nihon Haken in 1997. Due to this model having a design where the machining oil is automatically supplied, there is no concern that the ball screw will deteriorate due the

adhesion of grinding chips. As Senior Managing Director, Masao Inagaki reflected, "It helped Nihon Haken improve production efficiency and reduce cost at the same time." He added, "Mitsubishi Electric wire-cut electrical-discharge machines offer high processing accuracy, and are therefore highly compatible with diamond. We sincerely appreciate the level of after-sales support from Mitsubishi Electric. It really helps that they have a service base close by and always respond swiftly."

For this reason, every electrical-discharge machine installed by Nihon Haken since 1997 has been Mitsubishi Electric-made. Today they operate a total of 19 machines.

Claiming a large share of the business in the Mikawa region Constructing a new head office and plant to meet increased demand

Diamond tools currently represent 70% of the company's net sales and while carbide tools account for the remaining 30%. The quality of Nihon

Haken tools is highly regarded by automotive-related manufacturers and other companies in the Mikawa region. According to Hideshi Ito, Section Chief of the Sales Department, "Nearly 30% of all diamond tools used in the Mikawa region are made by Nihon Haken."

Production volume continued to grow, and in November 2016, the company relocated to a new head office and plant in Anjo, Aichi Prefecture. Ms. Iwase discussed the aim of building the new plant, "The number of orders for diamond tools had increased rapidly over the past several years. Our old plant in Kariya was quite small, so we couldn't increase the number of machines. Our new location is three times the size of the old one, so we had plenty of room to install existing equipment and we secured space for any equipment we may need to meet production increases or new product development purposes. We are now prepared to meet future increases in demand."



Manufacturing process for diamond cutting tools. Diamond blades for industrial use are processed in a wire-cut electrical-discharge machine (left) and accuracy is confirmed in a microscope. This process is repeated until the product is finished.



Diamond tools fresh off the manufacturing line. Made by soldering diamond chips onto a cemented carbide tool body.



Diamond chips cut from a diamond wafer in a wire-cut electrical-discharge machine.

Solution Case Study / Interview



Becoming a full-fledged electrical-discharge engineer in diamond tool manufacturing requires five years of experience

Masao Inagaki Senior Managing Director ▶



Profile
 Born 1972. Joined Nihon Haken in 1995. In charge of electrical-discharge processing in the Diamond Manufacturing Department.
 2007 Became General Manager of Diamond Manufacturing Department
 2011 Became Senior Managing Director
 2013 Appointed dual role as President of PT. NIHONHAKEN

— **What makes your company special?**

Inagaki : Nihon Haken designs and manufactures entirely custom-made special cutting tools to suit our customers' specific processing needs. All of our 30 to 40 processes require advanced skills, knowledge and experience.

We have complete confidence in the quality of our skills and products. In that sense, our company's special feature is perhaps that we provide training and guidance to develop outstanding technicians.

Visualization of craftsman skills and nurturing of multi-skilled workers

— **What type of skill is required for diamond tool manufacturing?**

Inagaki : The wire-cut electrical-discharge machining of diamond is a manufacturing process that requires a particularly high level of skill. The two processes involved, machining the industrial diamond wafer into material for the blade and

finishing after binding the diamond to the tool body, have entirely different machining conditions, not to mention different blade thicknesses make it necessary to adjust machining conditions. Accordingly, this work is the responsibility of an experienced technician, a so-called "craftsman that handles CNCs."

Furthermore, the same tasks must be repeated over and over; specifically, each time a spot is machined, it has to be checked in a microscope, conditions adjusted appropriately, and then re-machined. By doing this, finish the blade with a unit accuracy of microns.

In the case of complex-shaped products, it sometimes takes more than 20 hours to perform the wire-cut electrical-discharge machining alone. A minimum of five years' experience is needed to properly acquire the high level of skill required for the electrical-discharge processing of diamond.

— **What sort of HR training do you have in place to develop experts?**

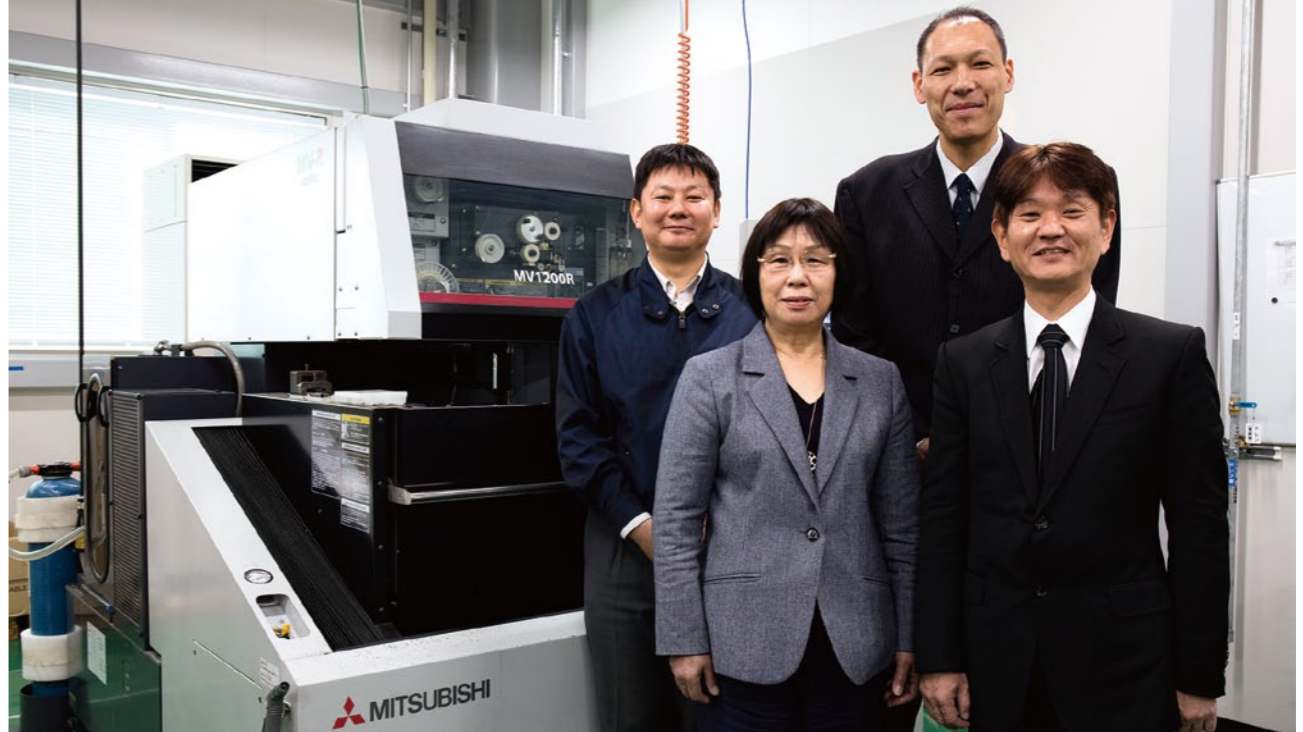
Inagaki : Basically, we rely on on-the-job (OJT) training, but that alone is problematic as we can't evaluate the skill level of each worker. For that reason, we began using a skill chart last year and now improve each employee's skill using this chart as a reference point. The X axis shows the

various skills necessary for each process and the Y axis shows the name of the employee. They color in the skill they have acquired and this makes it possible to grasp individual skill level at a glance.

Utilizing this skill chart, we can systematically compensate for skills each employee may be lacking through OJT. We hope that this will result in developing multi-skilled workers capable of multiple machining.

— **Why do you place more importance on developing multi-skilled workers than craftsmen with specialist skills?**

Inagaki : For example, processes that require a high load, such as electrical-discharge machining, have a tendency to take longer to complete. Therefore, people in the downstream processes waiting for products have a lot of spare time on their hands. If all of our workers are multi-skilled, those normally in charge of downstream processes can support those working on electrical discharge, thereby enabling us to balance out the work load and improve yield. In the past, we had a policy of training experts; however, Japan's automotive industry seems to be shrinking and there is a risk that orders will decrease. Therefore, I believe it is important to develop multi-skilled workers and maintain a balance between demand and equipment.



(front row, from left) Tsuyako Iwase, CEO & President, Masao Inagaki, Senior Managing Director (back row, left) Hideshi Ito, Section Chief Sales Department. (back row, far right) Hiroyuki Tomonaga, Nihon Haken's Sales Account Manager and Manager of Electrical-Discharge Machines, Industrial Automation Machinery, Chubu Branch, Mitsubishi Electric Corporation (currently Senior Manager, Kyushu Industrial Automation Machinery).

Establishment of an Indonesian base in response to customers' overseas expansion

— **It is said that Nihon Haken's first overseas expansion was to Indonesia. Is that right?**

Inagaki : Yes. This is because our major customers are automotive-related manufacturers and they are accelerating their overseas expansion. Unlike Japan, the automotive market in Asia and the rest of the world is still very much in the process of expanding. Diamond tools are still not commonly used in regions other than Europe, the U.S. and Japan, so we decided to establish an overseas base where we foresee a potential for future market growth.

We studied China, Mexico, Germany and the U.S. as candidate locations, but ultimately we chose Indonesia in light of the low labor cost and relatively good public order.

In 2013, we took one Mitsubishi



Skills are essentially passed through OJT. The photo shows a cemented carbide tool being machined by a worker during OJT.

Electric wire-cut electrical-discharge machine from Japan and first began a re-grinding service for special cutting tools for local automotive parts manufacturers. The local Mitsubishi Electric person in charge visits our plant regularly to perform maintenance on the machine, which is extremely helpful.

Business is going smoothly and we currently have the equipment there in full operation.

— **Do you provide the same training for local Indonesian employees as you do for Japanese?**

Inagaki : The culture is different from that of, so we do take a different approach to training. But Indonesian people are nimble with their hands and very quick to learn. In general, I am satisfied with our decision to expand into Indonesia.

— **What is your strategy is for future growth?**

Inagaki : My dream is that Nihon Haken will specialize in diamond tools and expand its share of the



Final inspection prior to shipment. An experienced worker confirms processing accuracy by viewing a microscope image on an expanded display.

global market. Particularly, in regards to Southeast Asia, the adoption of diamond tools is behind the rest of the world, so first I'd like us to focus on leveraging our Indonesian presence. Back home in the Japanese market, I'd like us to concentrate on R&D so we can also develop new special cutting tools.

— **Finally, please comment on what you think of Mitsubishi Electric and any requests you may have of them.**

Inagaki : The development of new processing technologies is absolutely essential to the R&D of new tools. I'm looking forward to being able to continue consulting with Mitsubishi Electric on various topics into the future.

Corporate Data
Nihon Haken Co., Ltd.

Head office
 1-1 Matsubara, Enokimae-cho, Anjo City, Aichi Prefecture
 No. of employees
 84
 Main Products
 Special cutting tools (diamond tools, carbide tools)
 History
 1967 Established in as Nihon Haken Kogyo, Toyota City, Aichi Prefecture
 1969 Relocated head office and main factory to Kariya City, Aichi Prefecture
 1980 Changed company name and established Nihon Haken
 2013 Established T. NIHONHAKEN in Indonesia
 2016 Relocated head office and main factory to Anjo City, Aichi Prefecture

Solution Case Study



Proud of the dies produced in-house, we are delivering high-precision plastic parts to the world

YUWA Corporation is a precision parts manufacturer that makes plastic parts for the connectors used in smartphones and other devices. Its integrated production system incorporates everything from dies to injection molding, enabling the company to make high-precision parts with a short lead-time. YUWA also has production bases in China and Vietnam.



YUWA is a precision injection molded parts manufacturer that produces plastic parts for connectors and other components. The company was established in 1975 by Yorikatsu Watanabe, YUWA's chairman and father of the current CEO, Minoru Watanabe.

Yorikatsu made the decision to establish YUWA while he was working for a condenser manufacturer, as he realized the number of plastic electronic components was increasing. The company was established in Komoro City, Nagano Prefecture, originally under the name Yuwa Dies Manufacturing, Inc. The word "Yuwa" means "friendship and harmony" in Japanese and expresses the bond among company employees. In 1989, the name of the company was changed to what it is today when it was reorganized into a publically

traded stock company.

As the company name suggests, the founding business of YUWA was die manufacturing.

However, in 1977 the company introduced two injection molding machines and began producing plastic parts using its own dies. At the time, it made plastic parts for the relays and connectors used in electronic components, as well as parts for syringes, cassette tapes and more. Even today, it does not sell dies externally, but rather specializes in the manufacture and sales of precision injection molded parts.

An integrated production system from die manufacturing to injection molding

The key feature at YUWA is that the company offers integrated

production from die manufacturing to injection molding. When the company first began its injection molding business, the accepted style was for die manufacturers to make dies and molding manufacturers to make molds. It was rare to find a manufacturer with an integrated production system offering everything from die manufacture to molding. But YUWA decided to take this direction based on the policy of "Good molds aren't possible without good dies" (Chairman Watanabe). This policy is upheld even today, reflecting the fact that YUWA continues to make all of its dies in-house, even as a major group with consolidated annual sales exceeding 10 billion yen.

The main focus of current business are the fine-precision connectors used in smartphones, plastic parts for cameras and insert molding products.

It also produces electronic components for automobiles and precision plastic parts for medical measuring instruments. In 2003, YUWA established Yuka Precision (Wujiang) Co., Ltd. in Wujiang District, China as a joint venture with a Taiwanese company. In 2007, YUWA independently established YUWA VIETNAM in the suburbs of Ho Chi Minh City, Vietnam, where it started producing injection molded parts in 2008 and dies in 2010.

The company's Japanese production base for injection molded parts is the head office and main plant in Komoro City, which began operation in 1994. The aim of the Komoro plant is "automated dust-free manufacturing," and as such, has implemented comprehensive dust



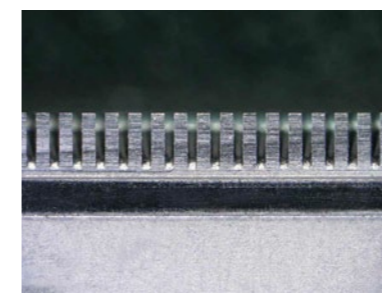
The wire-cut EDM line at the Die Technical Center is where YUWA manufactures its dies. The room temperature is maintained to within $\pm 0.5^{\circ}\text{C}$ in order to secure high machining accuracy, and the machining water used is filtered rainwater that is almost entirely mineral-free.

prevention measures and automatic collection of the regranulates generated during materials supply and the molding process. Currently, the Komoro plant operates a total of 88 injection molding machines with just two operators on night shift.

The heart of the company is its die plant located adjacent its head office and main plant. This plant was built in 2007 and is named the Die Technical Center as the core of YUWA Group's die technologies.

Dies are made by first fabricating parts through machining using wire-cut EDMs, surface grinding, die-sinking EDMs and other processes, and then assembling these parts. President Watanabe describes the accuracy of dies used to produce smartphone parts as follows:

"When cell phones first became popular in the 1990s, the connector pitch was 0.75mm. Over time, this grew narrower to 0.5mm, 0.4mm, 0.3mm, and smaller. Now YUWA mass produces connectors with a pitch of 0.175mm. In line with this



The teeth of a comb with a width of $0.08 \times 0.5\text{mm}$ made in a die-sinking EDM.

increased demand for accuracy, our dies are required to machine with a precision in the realm of microns."

In order to produce high-precision dies with good stability, the Die Technical Center, which maintains an ambient room temperature at $\pm 0.5^{\circ}\text{C}$, and features 9 wire-cut EDMs, 11 die-sinking EDMs, 8 machining centers (MCs), 19 grinders and many other machine tools. All die-sinking EDMs and most wire-cut EDMs are Mitsubishi Electric products. President Watanabe emphasizes that, "In order to ensure all of our machine tools achieve high accuracy and micro-machining, they have been improved in collaboration with the machine manufacturers and customized to YUWA's unique specifications."

Pursuing a better operation ratio for EDMs Targeting automatic operation at night and on weekends

YUWA not only focuses on the machining accuracy of its dies, but



A completed die for producing moldings used in precision electronic components.

also proactively engages in efforts to improve the operation ratio of its machinery. President Watanabe discussed the current status, commenting, "The target we are aiming for is the same as that of our molding plant, automatic operation of our wire-cut EDMs, die-sinking EDMs, MCs and other equipment during the night and on weekends. Currently, we are at the stage where our machines operate 640 hours out of the 720 hours in a month."

In regards to the die-sinking electrical-discharge process, YUWA introduced an ATC, which was improved with the cooperation of Mitsubishi Electric, and a processing machine with a workpiece changer. This means that automatic operation 24 hours a day, 365 days a year is already possible.

Meanwhile, automatic operation has not yet been achieved for wire-cut electrical-discharge machining due to the issue of automatic wire connection and various factors, such as wire disconnection and roller wear, that lead to short stops. In particular, automatically connecting fine wires, which is essential in precision machining, was a major issue. However, as President Watanabe explains, "When we introduced the MP1200, we asked Mitsubishi Electric to improve the automatic connecting unit, making it possible to achieve automatic connection."



"EA8PV ADVANCE" is a die-sinking electrical-discharge machine (EDM) equipped with an automatic electrode changer—called an "ATC"—and workpiece changer. With Mitsubishi Electric's cooperation, the EDM is made to YUWA's specifications.



Don't foster craftsmen... Anyone can be a technician performing high-accuracy, highly reliable machining

CEO
Yorikatsu Watanabe

— Around when did YUWA start using Mitsubishi Electric EDMs?

Watanabe : I think it was around 1990. When I joined the company in 1993, there were already Mitsubishi Electric-made EDMs in operation. What really left an impression on me is when we newly constructed the Sakushi Die Plant in 1994. As a new employee, I was working with my senior colleague in developing a program to machine multiple parts using a die-sinking EDM. It was at this time that we received a lot of help from Mitsubishi Electric technicians.

It was through this experience that I gained a strong impression of Mitsubishi Electric as not only a company that sold machines of set specifications, but also a company that supported its customers by working closely with them. I also understood that Mitsubishi Electric promotes a system whereby it reflects its customers' needs into its development projects and leverages them in future machines.

Technological innovation in the field of electronic mobile devices, YUWA's specialty, is fierce. But it would be too slow to respond to technological innovation requests by customers after they are made. We must always stay ahead of our customers. For example, if a customer says to us, "The pitch for the next connectors used in smartphones need to be 0.4mm," we have to prepare for this becoming 0.3mm or even 0.2mm sometime in the future.

If we are able to propose a specification that exceeds a request a customer makes, we can increase that customer's development potential and earn a reputation as a reliable company.

This kind of manufacturing technology, one that anticipates future progress, is not possible with an off-the-shelf machine. It can only be achieved through various efforts on our part, and improving machines to meet our desired specifications by addressing high-level issues with the

Profile

1971 Born in Nagano Prefecture, Japan
1973 Began working for YUWA Corporation
2001 Appointed director
2012 Appointed CEO after serving as senior managing director

machine manufacturer.

Mitsubishi Electric is the EDM manufacturer that has responded to our toughest requests. For this reason, the number of Mitsubishi Electric-made EDMs used by YUWA has increased.

**"A machining accuracy of $\pm 1\mu\text{m}$ "
Achieving a target that was a
long-term goal**

— Currently, what kind of machining accuracy level are you achieving with your dies?

Watanabe : For ten years, inside the company I have been constantly saying I wanted a machining accuracy of $\pm 1\mu\text{m}$. Initially, others in the company thought I was being unreasonable and didn't take me seriously. But after persistently saying this for ten years, we did indeed achieve an accuracy of $\pm 1\mu\text{m}$.

Of the various processes involved in die manufacturing, the one that ultimately determines the accuracy is the die-sinking electrical-discharge process. YUWA's customers demand a parallelism and flatness for their moldings on the order of micrometers. For this reason, the die-sinking electrical-discharge process must achieve a machining accuracy of $\pm 1\mu\text{m}$. YUWA exerted maximum effort to achieve this, but it was thanks to Mitsubishi Electric's support that we succeeded in achieving a high-accuracy die-sinking electrical-discharge process.

— That kind of high-accuracy machining must require skilled craftsmen, right?

Watanabe : Actually, my approach is, "Don't foster craftsmen." Rather,



Second from the left is Tetsuya Sato, manager of the Die Business Department at the Die Engineering Center. Next to him is Yoshinori Ichikawa, manager of the center. Pictured on the far right is Keita Minamine, the Mitsubishi Electric salesperson affiliated with the EDM Section of the Industrial Mechatronics Sales Department at the FA System Business Headquarters.

"Look for expert techniques and crush them." In the past, achieving machining accuracy meant it was necessary to possess a certain skill in, for example, setting a workpiece inside a magnetic chuck. A craftsman would tap on the workpiece and judge whether it was good or bad depending on the amount of vibration in his fingertips. But that was a big factor inhibiting improvements in efficiency and reliability.

Our company now focuses on "eliminating special skills," which means we find tasks that depend on those skills and change them into tasks that anyone can perform easily and with confidence. Moreover, we make it so machines can perform such work. I think a good technician is able to achieve machining that anyone can perform with high accuracy and high reliability.

— In that case, how do you train technicians to be that way?

Watanabe : At YUWA, we value our training culture. Currently we produce dies in China and Vietnam as well, and we dispatch young employees



A grinder developed specifically for YUWA (both machine and grinding stone) in collaboration with the grinder manufacturer in order to achieve high accuracy.

who have gained two years' experience in Japan to these overseas bases as "sensei (teachers)." Of course, they encounter things they don't know as they teach. But when this happens, they fervently seek advice from their mentors back in Japan. By becoming teachers themselves, our employees can objectively assess their own skill level and gain an understanding of the level they need to reach and what they still need to learn; meaning they understand the need to study with a strong sense of purpose. It's like a tough version of on-the-job training.

— It will be a major focus to develop globally minded professionals moving forward, won't it?

Watanabe : In order to develop globally minded professionals, we currently accept students from Vietnam's Ho Chi Minh City University of Technology on internships, during which they gain experience at Yuwa for a period of three months. We select particularly outstanding students from these

interns, and then invite them to Japan to join a Master's course at Shinshu University as exchange students.

— Yuwa specializes in a field where technological innovation is fierce so you can't afford to relax, can you?

Watanabe : In the world of smartphones and automobiles, companies jump on the latest technological trends all at once, so there is a need to start mass production as early as possible. In order to stay on top in this kind of world, we must continue refining our die technologies, which is YUWA's core specialty, and become a company that can respond to changing times. This what I firmly believe.

Corporate Data YUWA Corporation

Head office
1-700, Nishihara, Komoro City, Nagano Prefecture
No. of employees
210 (500 at China plant, 1,300 at Vietnam plant)
Main Business
Small, precision plastic molding
History
1975 Founded as Yuwa Die Manufacturing, Inc.
1977 Began molding business
1989 Changed name to YUWA Corporation
1994 Commenced operation of new plant in Komoro City, Nagano Prefecture
2003 Established Yuka Precision (Wujiang) Co., Ltd. in China
2007 Established YUWA VIETNAM in Vietnam
2016 Selected as a "GANBARU (Vibrant) Small and Medium Enterprises 300" by Japan's Ministry of Economy, Trade and Industry



Plant 1 features a long line of 88 injection molding machines. In order to manufacture moldings for precision electronic components, the plant maintains an environment equivalent to a Class 100,000 clean room.



The die inspection process. Completed dies have a high machining accuracy of within $\pm 1\mu\text{m}$.