CYBER WORLD

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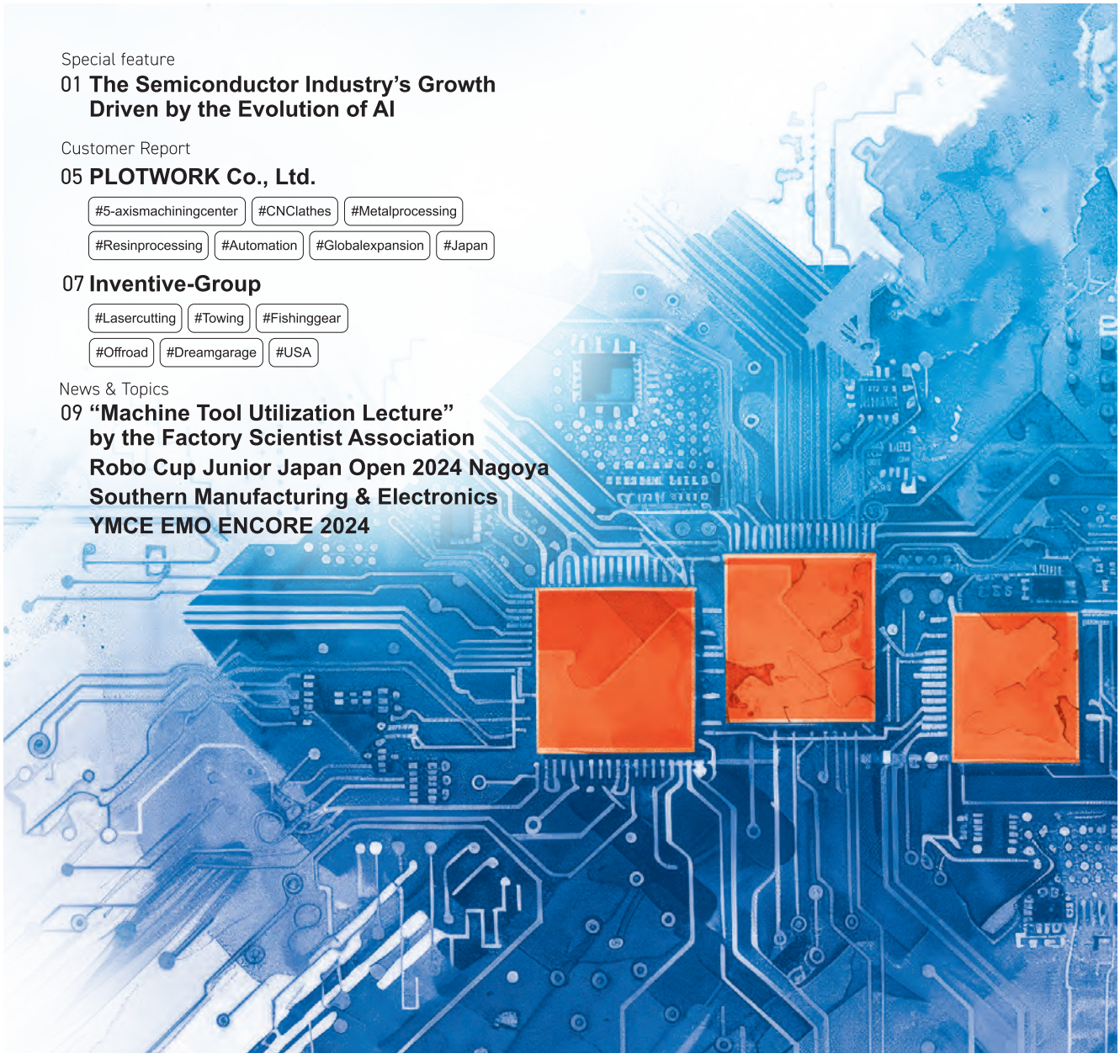
Evolution and change, the present and future of semiconductors and machine tools



E

AI × Semiconductors

Machine Tools

The Semiconductor Industry's Growth Driven by the Evolution of AI

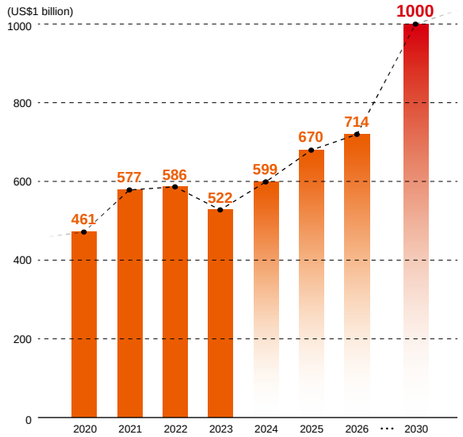
In recent years, artificial intelligence (AI) has become more common in our lives. Vehicles with driving assistance systems are widely used, and test drives of autonomous buses, which do not involve any manual operation, are in the final stage. AI-based image discrimination technology has been introduced for inspection with industrial robots, and is already being used at many manufacturing sites.
AI is also used to generate creative content, such as in the utilization of generative AI models for advertisements, graphic production, and product packaging design development. The images on this page are also generated using AI software. AI now has the potential not only to improve the efficiency of information processing and communication but also to promote cultural innovation, such as the creation of new business models and the generation of music and video.

The generative AI that has received significant attention is ChatGPT, which was developed by OpenAI. What surprised us most was that it generated natural sentences that looked like they were written by a human. What makes this possible is that the program learns large amounts of text data, understands its patterns and structure, and then generates sentences based on the input information provided. It is said that 175 billion parameters were used to train GPT-3 (one of ChatGPT's language models). Such advanced learning requires semiconductor chips with high-performance processing capacity.
The rapid development of AI will lead to increased demand and production of semiconductors. The overall AI market size is predicted to be $1.9 trillion in 2032. In particular, the market size of generative AI, which is being developed in many countries, was $40 billion in 2022 but is predicted to expand to $1.3 trillion in 2032.

The global demand for semiconductor equipment is expanding as the semiconductor market grows

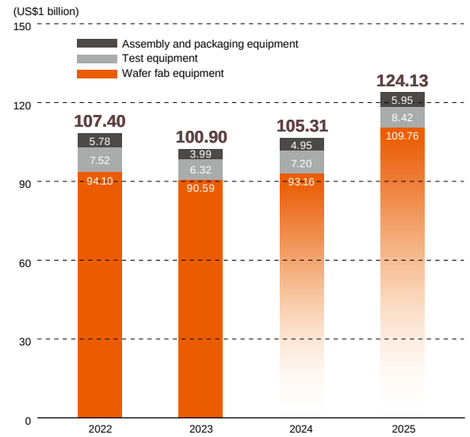
The global semiconductor market, where demand is increasing as technology advances, has continued to double every 10 years since the 1990s, achieving dramatic growth. The global semiconductor market is expected to exceed $500 billion in 2021 and reach $1 trillion by the early 2030s (Figure 1). This rapid growth reflects the reality that technology in people's lives continues to become more complex, and the need for innovation will never diminish.
Along with the rapid growth of the semiconductor market, demand for semiconductor equipment is also increasing. Global sales of semiconductor equipment increased to $107.4 billion in 2022. It is expected to reach approximately $124 billion by 2025 (Figure 2).
Behind this market expansion is the advancement of two areas of semiconductor equipment: the "front-end process,'' in which semiconductor chips are fabricated on silicon wafers, and the "back-end process,'' in which the manufactured chips are packaged. Semiconductors are generally manufactured through four processes: design, wafer fabrication, front-end processing, and back-end processing. Each process involves a large number of semiconductor equipment, and many of the parts that make up this equipment use Mazak's technology and machine tools.
As a leading machine tool manufacturer, Mazak has a rich product lineup to handle a variety of machining processes, as well as a number of automation systems using transport devices and robots that match the production system of our customers.
A wide variety of parts are used in semiconductor equipment, which have different roles depending on the manufacturing process. In addition to materials such as stainless steel, iron, and aluminum, special materials such as quartz glass and carbon graphite, which are called brittle materials are used. In order to process these parts with high precision, customized machine tools with unique functions and technologies are required.
Mazak has a wealth of experience and track record in the semiconductor industry, and offers highly reliable solutions with solid technology and product capabilities.

Figure 1: Changes in Semiconductor Market Size



Source: WSTS, Gather, SEMI Forecast, 4Q23

Figure 2: Semiconductor equipment: Outlook for total equipment by segment



Source: SEMI Semiconductor equipment Market Statistics Report, December 2023

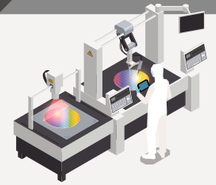
Semiconductor manufacturing process

1 Design

Semiconductor design involves designing integrated circuits in which electronic components such as resistors, capacitors, and transistors are mounted on a single substrate.

- Circuit/pattern design
- Photomask creation

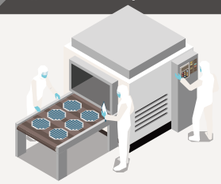
2 Wafer fabrication



Slice the silicon ingot with a special saw and polish the surface. Corrects wafer thickness variations, distortions, and scratches.

- Wafer cutting
- Wafer polishing

3 Front-end process



This is the process of creating the circuit part of a semiconductor. Wafers are created from raw materials such as silicon. Various processes are performed to form circuits.

- Surface oxidation
- Thin film formation
- Exposure/development
- Ion implantation
- Electrode formation
- Photoresist coating
- Etching
- Cleaning
- Flattening
- Wafer inspection

4 Back-end process

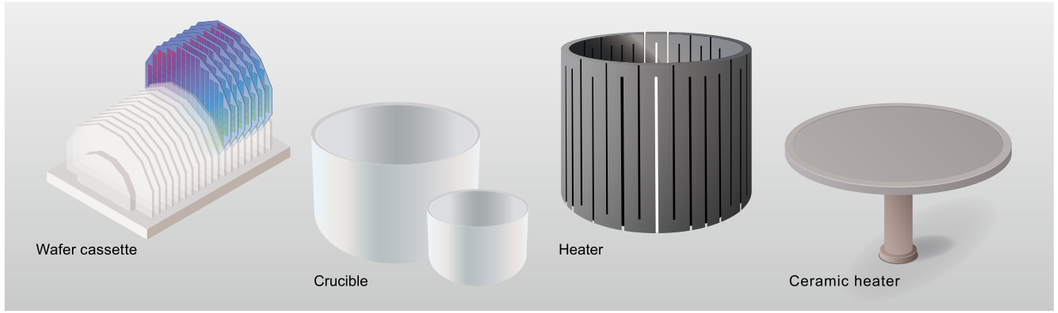
The integrated circuit is sliced and diced into chips and placed onto a substrate to protect the circuit parts.

- Dicing
- Wire bonding
- Molding
- Final inspection

Mazak Technology Supports the Semiconductor Industry

The semiconductor industry is developing rapidly against the backdrop of increasing demand for semiconductors due to not only AI but also rapid digitalization and expansion of EV sales. On the other hand, with the rapid growth of the market, various issues have come to light. In order to support the semiconductor industry, Mazak has assembled a specialized team and will propose optimal solutions to solve customers' problems.

Brittle material machining / automation system



Many semiconductor manufacturing processes are performed under high temperatures and highly corrosive environments, so that common materials cannot withstand these conditions. Therefore, materials with high heat resistance and corrosion resistance, such as quartz glass, carbon graphite, and ceramics, are used for parts of semiconductor equipment.
For example, wafer manufacturing uses crucible-shaped fused silica or carbon graphite, and etching processes use ring- or plate-shaped fused silica. These materials are called brittle materials because they are hard and brittle, and are processed by grinding with a grindstone. Sludge generated during machining can have a negative impact on the mechanical drive parts and coolant tanks, so it is essential to take dust-proof measures on the machine side.
Mazak machine tools can be customized specifically for machining brittle materials, such as dust-proofing the drive unit, electrolytic corrosion countermeasures for bearings, dust collection during dry machining, and filtration systems during wet machining. These measures are essential for high-precision machining and quality maintenance, and Mazak has a rich track record in this field.

As the demand for semiconductors increases, the production volume of parts is also increasing. Particularly for parts that are consumables in the manufacturing process, it is necessary to ensure a large quantity so that they can always be supplied to the manufacturing equipment. In order to meet this demand, it is essential to introduce an automated system that can operate continuously for long periods of time while maintaining a high level of quality.
Mazak has received high praise for its creative system proposals for automation systems that combine customized machine tools and workpiece transport system using robots. There are various materials and shapes for parts used in manufacturing equipment, such as carbon graphite heaters, stainless steel vacuum chambers, and aluminum cooling plates.
To automate the machining of these parts, Mazak recommends the combination of multi-tasking and 5-axis machining centers, which achieves process integration and robots, as well as the PALLETECH system, a pallet transport system. Our specialized staff will assist you with everything from proposing automation that allows long-term continuous machining, to support for system installation and start-up, according to your needs.

This is the one in Mazak!

VARIAXIS i-700 NEO

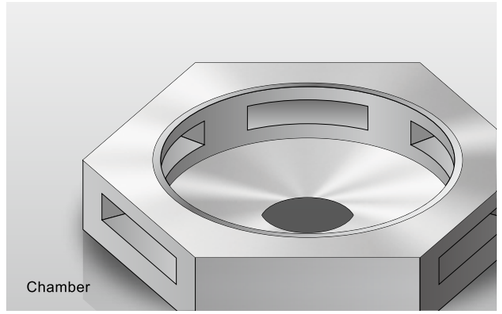
◎ High-accuracy machining of multiple and inclined surface, as well as simultaneous 5-axis machining.
◎ Spindle variations to meet a wide variety of machining requirements.

This is the one in Mazak!

PALLETECH

◎ The system can be flexibly expanded according to the production situation.
◎ Productivity is improved by adding tools and materials to system operations.

Shaping machining



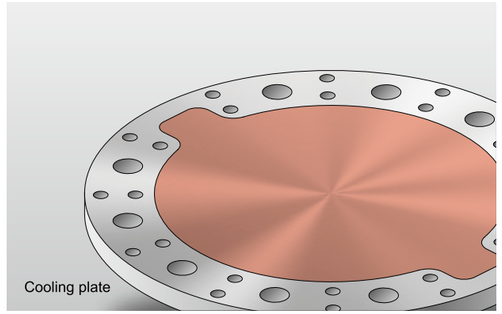
Shaping machining is a scratching process performed using a special tool. It is used in vacuum chamber manufacturing, which requires high-precision machining and surface smoothing and is mainly used to process sealing surfaces on materials such as stainless steel and aluminum. To create a vacuum inside, rigidity that can withstand atmospheric pressure and precision of the mounting surface of the lid are important. In order to prevent air from entering through the gaps in the device using an O-ring, the sealing surface must be highly airtight, and shaping technology is useful for this purpose. This machining method produces a well-oriented cut surface, so compared to end milling, there is no need for a post-machining polishing process, leading to a significant reduction in man-hours.
Vacuum chamber machining involves complex machining such as multi-face, lathe, and mill machining. The multi-tasking INTEGREX e-1600V/10 machine is introduced for this reason, where significant process integration can be achieved. It is also possible to incorporate a multi-tasking machine with a turning function into the automation system and connect it to a horizontal machining center on an FMS line. In this way, Mazak is also good at proposing solutions tailored to your machining needs.

This is the one in Mazak!

INTEGREX e-1600V/10

◎ Double column construction suitable for machining large workpieces.
◎ Productivity is improved with multiple surface machining, free curved machining by simultaneous 5-axis control and turning.

FSW (friction stir welding) / mirror finishing



Temperature control is one of the important elements in semiconductor manufacturing, and it is necessary to bond the lid and base of the cooling plate used in the etching process. The cooling plate has a groove that circulates the cooling liquid inside and is made of materials such as aluminum, stainless steel, and copper.
FSW (friction stir welding) is a technology that welds materials that have been softened by frictional heat while stirring them. Unlike conventional welding technology, this method does not use any material other than the workpiece, and the material does not melt, resulting in a bond with higher strength and less distortion. It is possible to join not only the same material but also different materials such as aluminum and copper.
The FJV-60/80 FSW and VTC-530/20 FSW manufactured by Mazak are machines with an FSW technology and highly rigid structure capable of high-precision machining. By integrating the processes of cutting the base, joining the lid, and finishing the surface into a single machine, waiting time and transportation time for each process are reduced, resulting in a shortened product delivery time.

This is the one in Mazak!

FJV-60/80 FSW

◎ High accuracy double column machining center with No. 50 spindle and FSW technology.
◎ Suitable for a wide range of applications, from multiple surface machining of large parts to machining of thin parts.

Customer Report 01

PLOTWORK Co., Ltd.

Applying the technology cultivated in resin processing to metal processing

PLOTWORK Co., Ltd. (Moriguchi City, Osaka Prefecture) was established in 1996 with the main business of producing test models. Currently, about 70% of the materials the company cuts are resin, and about 30% are metals, mainly difficult-to-cut materials. The collapse of Lehman Brothers in 2009 prompted the company to enter the metal processing industry.

Pallets of MPP, the compact multiple pallet stocker system are lined with test models of various shapes

PLOTWORK Co., Ltd.

CEO	:	Tsunenoshin Tamura
Head office	:	1-5-26 Minamiterakata Minamidori, Moriguchi, Osaka, Japan
Number of employees	:	66

plotwork.com

The fourth factory performs high-precision machining, mainly using 5-axis machining centers

CEO Tamura (center) and employees

CEO Tsunenoshin Tamura

#5-axismachiningcenter #CNClathes #Metalprocessing #Resinprocessing #Automation #Globalexpansion #Japan

The QUICK TURN 200 painted black to match the interior of the factory

Workspace set up in the atrium of the fourth factory

Well-organized tool preparation room

Entering the field of metal processing

"The jobs I thought I would find were nowhere to be found. When I finally found a job, the prices were extremely harsh." CEO Tsunenoshin Tamura reflects on part of the impact that the collapse of Lehman Brothers had on management.
Mr. Tamura, who was forced to respond to "unexpected" changes in the environment, sought a way out by cutting aluminum materials. "We had been consulting on metal processing for some time, and we thought we could make use of the high-precision machining technology and know-how in shortening delivery times that we had cultivated through resin processing."
The company chose Mazak machines to enter the new field of metal processing. In addition to existing CNC lathes and 3-axis machining centers, the company successively introduced the 5-axis machining center VARIAXIS i-500 (second factory) in 2019, and the VARIAXIS i-600 with MPP (fourth factory) in 2022. Mazak machines contribute to high-precision machining of metal products.
In addition to entering the metal processing business, the company is also proactively implementing measures, such as opening reception 24/7 and shortening production lead times by operating on Saturdays and Sundays. Business performance has steadily recovered by promoting a "factory operation system that puts customer needs first, 365 days a year," said Akihiko Miyamoto, Senior Managing Director and Factory Manager. "365-day operation" is still widely known as the company's signature, which cannot be imitated by other companies.

The crucial role of MPP in shaping the company's future

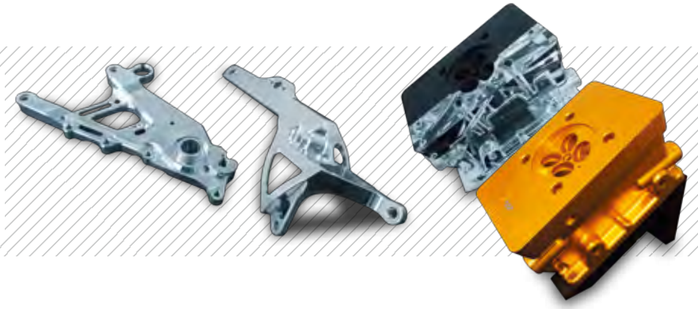
The two VARIAXIS models introduced at the second and fourth factories are positioned as the keystone of metal processing at the company.
"I used to operate Mazak's AJV-18 vertical machining center at the factory I worked at before founding the company, so I felt an affinity for Mazak machines. The Mazatrol, in particular, is extremely easy to use. I was also surprised at how advanced it has become. That's why I chose the Mazak machine without hesitation for machining the aluminum test models," said Mr. Tamura.
The MPP added to VARIAXIS i-600 is a space-saving, multi-stage pallet stocker system that accommodates 12 pallet changers. "I hired this system not because we wanted to do something else with it but I wanted to see what would happen. That's why I believe that the future of the company will be determined by how well we use this system." This seems to be a testament to CEO Tamura's confidence and ability to take on challenges, having overcome the collapse of Lehman Brothers with Mazak machines.
Mr. Miyamoto commented, "Compared to the conventional three-pallet system, the advantage is that we can leave jigs and vices on the pallet. In other words, we can start machining quickly because we don't have to do set-up work for new projects. I feel that the setup time has decreased with the introduction of the VARIAXIS i-600 with MPP. When doing the same work, the productivity has doubled," he said, praising the machine's contribution.

Anticipated full-scale operation of U.S. factory by fall 2025

The company, which has set its sights on a production system using Mazak machines, is looking to the United States as its "next market." PLOTWORK USA was established in Michigan in August 2023 to meet the needs of local customers. The company aims to decide on specific locations in 2024 and begin full-scale operations in the fall of 2025.
"We are planning to use Mazak machines as our main equipment after considering the popularity of the machines and the reliability of the machines in the United States. In addition to conducting the same business locally as in Japan, we will utilize the jig manufacturing know-how that we have accumulated over the years. We are also considering developing new products" said CEO Tamura.
For Mr. Tamura, who asserts that "the future of the company will be determined by how we use the MPP," their efforts in the United States will be a major test.

Workpieces processed by a Mazak machine

Metal and resin products processed with a 5-axis machining center



Customer Report 02

Inventive-Group

At the core of the job is ‘Innovation’

Towing products, fishing products, off-road UTV accessories, and manufacturing solutions - all these products are created at Inventive-Group, located in Mountain Home, Idaho, U.S.A. Under the slogan ‘One company, four brands’ Inventive-Group is dedicated to creating products that are more user-friendly and bring greater satisfaction to their customers with ‘Innovation’ as their motto.

High-performing FT-150 FIBER boost productivity

Inventive-Group

Director of Excitement with Platinum Status	: Chuck Ceccarelli
Head office	: 2915 Industrial Way, Mountain Home, Idaho 83647, U.S.A.
Number of employees	: 108

inventive-group.com

Mazak machines and employees of the Inventive-Group

Management philosophy displayed in the office

#Lasercutting #Towing #Fishinggear #Offroad #Dreamgarage #USA

Laser cutting machine in action

Large capacity bundle loader for pipe material

Mr. Chuck Ceccarelli, Director of Excitement with Platinum Status

One company, four brands born from innovation

As a previous tow truck business owner and driver, Mr. Chuck Ceccarelli started manufacturing and selling towing equipment in the mid-1990s in Mountain Home, Idaho, U.S.A. with his wife. His commitment to 'Innovation' in creating user-friendly products has paid off, leading to the growth of the business and In the Ditch Towing Products was founded in 2007.
Mr. Ceccarelli always looks for ways to achieve maximum efficiency, and his stance is not limited to working alone. Pursuing fishing as a hobby, he started making his own fishing products. With the growing demand for his products from other fishing enthusiasts, Fish Fighter Products was successfully introduced to the market in 2015. Later, two additional brands, RazorBack Offroad UTV Accessories, specializing in off-road UTV accessories was established and from that emerged Inventive Products, which offers manufacturing solutions such as adjustable welding tables.
Today, In the Ditch Towing Products, Fish Fighter Products, RazorBack Offroad and Inventive Products make up Inventive-Group, a company that emerged with four distinct business ventures.

Management philosophy for continuous improvement

One company, four brands is the slogan that defines the business, and Mr. Ceccarelli oversees the day-to-day production for each brand as “Regional Director of Excitement with Platinum Status.”
The decision to stray away from traditional titles comes from his recognition that the company got to where it is today because of the Inventive-Group team. “My job is not more important” said Mr. Ceccarelli. “There is a shared responsibility within the organization.”
This reasoning aligns with Toyota's business philosophy which the company follows closely. Two points from the philosophy that Mr. Ceccarelli and the Inventive-Group team prioritize daily are respect for people and continuous improvement. The team has integrated these philosophies so effectively that other companies take tours of the meticulous Inventive-Group facility to learn more about their successful business practices.

Mazak machines as a new partner for innovation

The company, which initially started as a joint effort between Mr. and Mrs. Ceccarelli has grown to employ over 100 individuals today. In 2019, a new factory and office were constructed on a site of approximately 8000 m² (87000 sf²), which is equivalent to the size of a soccer field. Over two and a half years of construction, all employees were part of the decision-making process, where they carefully considered the lighting, facilities, and even the music in the new working environment.
In the same year, 2019, the company made a significant decision. "We switched to Mazak from the company we had been with for almost 15 years. It was a major, major commitment to change," explained Mr. Ceccarelli. “I got everybody from our team together and we talked about ‘did we make the right choice?’, and everybody feels that we made the right choice.”
After their decision, they invested in two sheet lasers, automation systems and the FT-150 FIBER. "Right now, we are cutting five to six days a week, almost 24 hours a day with two lasers. That was a major step in efficiency and we really do not need an operator. Everything is pretty much done in our nesting department."
Mr. Ceccarelli also praised the efficiency of FT-150 FIBER, which is the company's first tube laser. “We have the tapping and drilling option on the FT-150 so we are threading pipe and tubing and etching weld locations on pipe. Within the first six months, we were doing things with the tube laser, and we were like ‘oh my heavens, how did we miss this so long ago?’ It's been that remarkable to have that technology."
"Mazak provides a comprehensive training service and support system. They were a great help and really cemented our relationship. We switched to Mazak in our new facility and have not looked back," Mr. Ceccarelli stated firmly and decisively.
With Mazak machines as a new partner, the company’s innovation continues to thrive.

Workpieces processed by a Mazak machine

A variety of products made by laser processing

Mazak News & Topics

The expanding circle of factory scientists

Training session at Kanagawa Technical Center

In January 2024, the "Factory Scientist Machine Tool Utilization Course" sponsored by the Factory Scientist Association was held at the Kanagawa Technical Center. This is a practical course for those interested in improving business operations using IoT. Through the process of building their own system and collecting operating information from machines, participants can learn about IoT from its basics to its applications. After taking the course, some participants said, “I don't normally deal with IoT devices, but I would like to use a similar system in the future.” Mazak will continue to work with partners to promote digitalization at manufacturing sites.

Promoting the introduction of new material Mineral Cast

Mineral Cast is a composite material made by bonding ore with epoxy resin

Mazak plans to manufacture new models using in-house mineral casting as part of the environmental activities. Mineral casting is a composite material that combines ore and epoxy resin, and has excellent vibration damping performance and thermal stability, contributing to higher efficiency and precision of machine tools. Not only does it possess exceptional material properties, but it also has a low carbon dioxide (CO_2) emissions during the manufacturing process, making it environmentally friendly. Moving forward, Mazak will focus on expanding the use of mineral casting in new machine models.

Southern Manufacturing & Electronics - Southern Success for Mazak UK

Yamazaki Mazak U.K. Ltd. enjoyed a highly successful exhibition at Southern Manufacturing & Electronics held from February 6 to 8, 2024, with a stand that focused on maximizing productivity and profitability for manufacturers throughout the supply chain. There were approximately 800 exhibiting companies and around 9,000 visitors at the event.

Taking center stage at the show was the INTEGREX i-200H S Multi-Tasking machining center – one of Mazak's most innovative, compact and automation-friendly INTEGREX models ever manufactured. It was ideally suited to the diverse needs of attendees from a broad range of industry sectors, from automotive and aerospace through to general subcontract machining. Mazak also used its presence at Southern Manufacturing & Electronics to highlight its Mazak iCONNECT remote service and support package, which now has over 1,500 active users across Europe.

Alan Mucklow, Managing Director UK, Eire and National Distributors at Yamazaki Mazak U.K. Ltd., commented: "Southern Manufacturing is one of the most important dates in the UK team's calendar, and this year was a particularly successful exhibition. There is a strong desire among our customer base for solutions which can maximize machining output in the most profitable way. Both the INTEGREX i-200H S and Mazak iCONNECT portal were very popular among visitors and the UK sales team received high levels of inquiries."

Robo Cup Junior Japan Open 2024 Nagoya

- Supporting children who will lead the future of the robot industry

Mazak sponsors booth

2 teams won the Mazak Award

Robo Cup Junior Japan Open 2024 Nagoya was held at Port Messe Nagoya in March 2024. The Robo Cup Junior is an international competition for autonomous mobile robots for children under the age of 19. It focuses on providing a hands-on, scaffolded environment where children can grow to be the next generation of manufacturing leaders through the design and production of robots. A total of 186 teams and 459 players, who had emerged victorious in district tournaments held across Japan, were participating in this tournament.

Mazak awarded sponsorship prizes to teams in the soccer and rescue divisions as a tournament sponsor to support children who will be involved in manufacturing in the future. At the sponsor booth, the Ez LOADER 10, an automated cell using a collaborative robot, and sample works were exhibited. During the event, many children, youth and their families visited the booth.

YMCE EMO ENCORE 2024 – Latest machining innovations visit the Czech Republic

Yamazaki Mazak Central Europe s.r.o. hosted a highly successful EMO Encore event, where it showcased a selection of the latest Mazak machine tools at its technology center in Jažlovice, Czech Republic. The event was held for 12 days from January 26 to February 6.

The Czech Technology Center, established in 2012, features a showroom exhibiting state-of-the-art machinery and facilities for conducting technical seminars and training. It plays a crucial role as a support hub for customers within the Czech Republic and neighboring countries.

Attendees of the event were able to see the newest advancements in Mazak technology, many of which were previously debuted at the EMO 2023 trade far in Hannover. Nine different machine tools were live cutting throughout the event.

Visitors to the EMO Encore event comprised not only of manufacturing professionals, but also journalists and members of the general public. The event drew considerable interest from both a local and international audience, with many attendees traveling from neighboring countries including Slovakia, Hungary and Poland.

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VUILLARD, Édouard [1868-1940], "Still Life with Anemones", 1906, Oil on board

THE YAMAZAKI MAZAK MUSEUM OF ART
Collection Showcase

Still Life with Anemones

VUILLARD, Édouard

Vuillard was born in the town of Cuiseaux near Lyon, but he went to live with his mother, a dressmaker, in Paris. He was a life-long bachelor. His mother's dress shop became a gathering place for his art-student friends, who were attracted to the pretty seamstresses. Vuillard's unique sensibility was related to his experience of the textiles in the shop. He painted on thick paper rather than canvas because he liked the way the paper absorbs oil, creating a dry non-lustrous surface, similar to the tactile qualities of cloth. He loved to paint intricate decorative patterns like those on women's dresses or wallpaper, and because of this proclivity he, like his friend Bonnard, was referred to as an Intimist.

THE YAMAZAKI MAZAK MUSEUM OF ART

https://www.mazak-art.com

The Yamazaki Mazak Museum of Art was opened in April 2010 in Aoi Higashi-ku, the heart of Nagoya in order to contribute to the creation of a rich regional community through art appreciation and, consequently, to the beauty and culture of Japan and the world. The museum possesses and exhibits paintings showing the course of 300 years of French art spanning from the 18th to the 20th centuries collected by museum founder and first museum director Teruyuki Yamazaki (1928 - 2011), as well as Art Nouveau glasswork, furniture, and more.We look forward to seeing you at the museum.

Mazak

Yamazaki Mazak Corporate Website
www.mazak.com