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Innovative manufacturing that gives momentum to the evolution of motors

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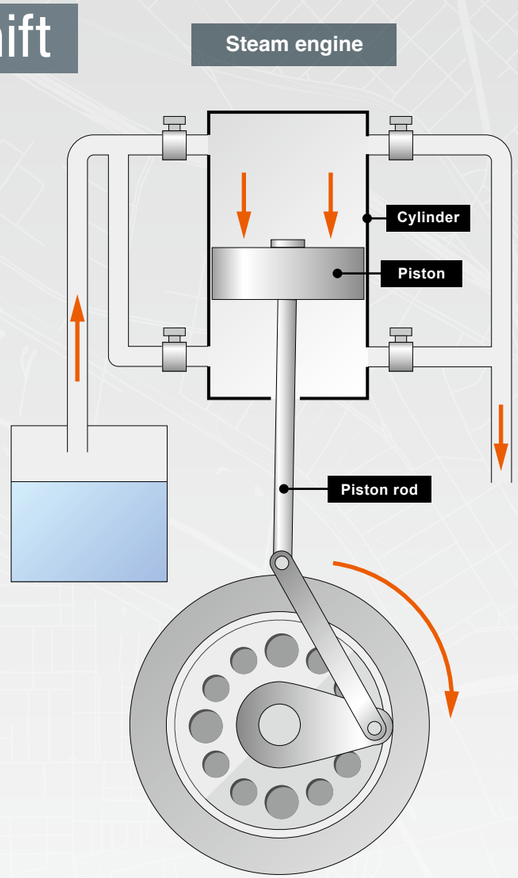
Manufacturing Technologies Behind the Mobility Shift

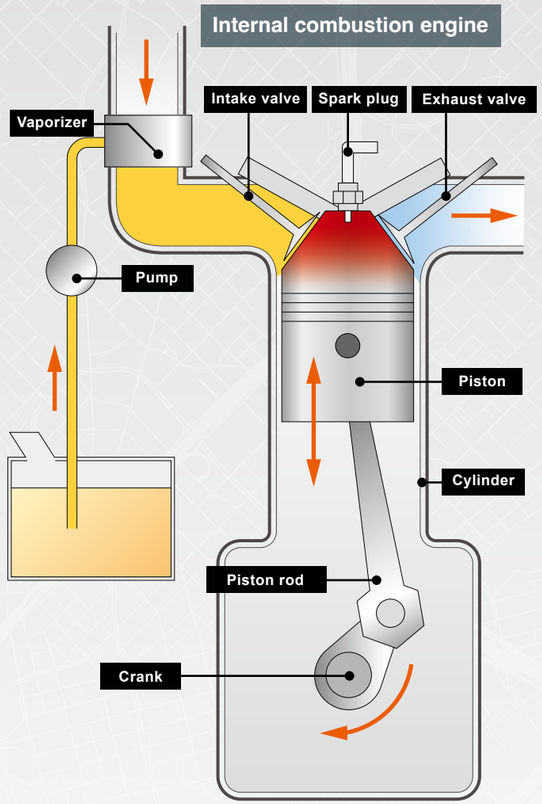
The beginning of the automobile industry

Automobiles are an indispensable part of our lives. As a primary method of transportation for people and goods, they are used in countless places around the world. The automobile was developed in France in 1769 as a transport vehicle to carry artillery batteries instead of horses. The vehicles of that time were steam-powered automobiles, which used a copper boiler and two cylinders to create a piston motion that alternately pushed one wheel to move. Although the steam-powered automobile was an invention with a very simple structure, the development of a vehicle using the most advanced technology of the time, was a revolutionary event that marked the beginning of today's automobile history.

Initially, automobiles used steam engines, but by the late 19th century, they were replaced by gasoline-powered internal combustion engines. This change dramatically improved their transport capacity and driving range, and in Europe, they were used as buses to travel between cities. At the time, automobiles were extremely expensive and could only be owned by the wealthy, but a turning point came in 1908 when Henry Ford of the United States released the Ford Model T, which became a massive hit among the public due to its affordability.

With prices reduced through massive production, automobiles became accessible to individuals. Following the United States, Europe also saw the birth of people's cars such as the Austin 7 and the Volkswagen Type 1 (Beetle). As a result, the widespread of automobiles - so called "motorization," occurred worldwide, becoming a catalyst for the great development of the automobile industry.





The internal combustion engine that evolves alongside mobility

With the rise of motorization, automobiles, once merely tools for transporting people and goods, have transcended the realm of practicality and become an indispensable part of people's lives.

On the other hand, the widespread adoption of automobiles has also led to various social problems, such as air pollution, fuel consumption, and traffic accidents. To address these challenges, continuous research, development and engineering advancements have been pursued, leading to the evolution of the automotive industry in response to the societal demands of each era. The diversification of powertrains is one example of this evolution. To accommodate users' lifestyles and preferences, a wide variety of vehicles are in use worldwide. These include gasoline and diesel-powered internal combustion engines (ICE) as well as electric vehicles (xEV: a general term for electric vehicles), including hybrid vehicles (HV) and fuel cell vehicles (FCV).

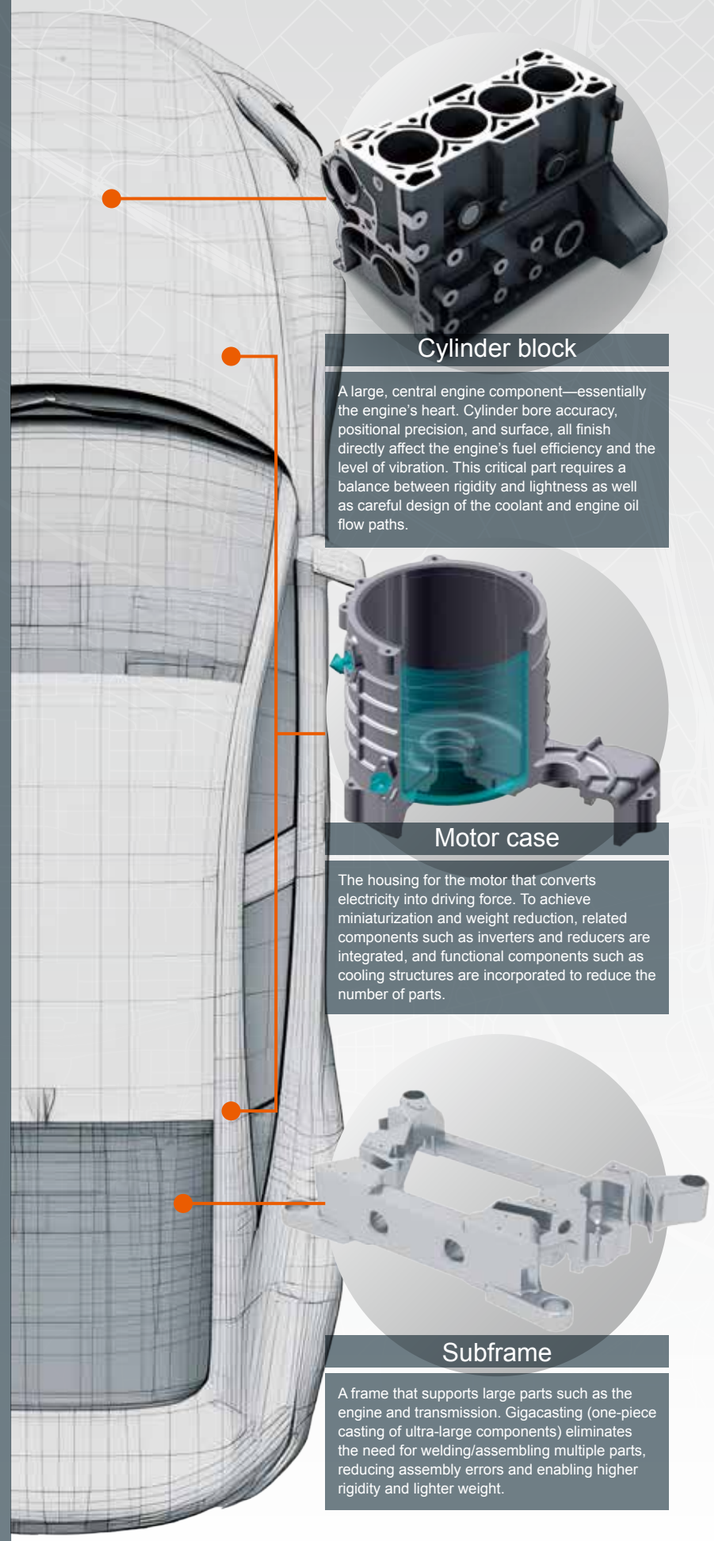
Beyond the diversification of powertrains, there has been advancements in driver assistance features and the development of autonomous driving technology, which can be considered the culmination of these efforts. The emergence of software-defined vehicles (SDV) can be regarded as a milestone in software advancements for vehicles. Furthermore, the practical application of flying cars, a long-held dream of humankind, demonstrates a continuation of the evolution of "mobility" that transcends the conventional boundaries of automobiles. As an industry supporting this evolution of mobility, the automotive industry is currently undergoing what is considered the most significant transformation in its history.

In addition to advancements in various functions such as autonomous driving and driver assistance, new concepts of automobiles are emerging where software advancements significantly influence the vehicle value, as exemplified by SDV. Meanwhile, to address environmental concerns, weight reduction is being pursued to improve fuel efficiency. Furthermore, advancements in materials and structures to protect drivers and pedestrians from potential accidents are essential. Hardware advancements are also progressing, including the development of various components to accommodate diversifying powertrains and structural components utilizing new materials and technology. This technological development and evolution in both software and hardware are supporting a major transformation in today's automotive industry—namely, the evolution of mobility.

Manufacturing innovation that supports the evolution of automobiles

The journey of the automobile began with the rhythmic pulse of steam engines. Through continuous waves of innovation, it has now reached a pivotal turning point. What was once dominated by internal combustion engines (ICE) has evolved into a landscape where electric (xEV) and hybrid (HV) vehicles are gaining prominence, with multiple drive technologies now coexisting. Amid the global trend towards decarbonization, this evolution is accelerating even further. Efforts to develop CO_2-free internal combustion engines fueled by hydrogen as well as to reduce CO_2 emissions from manufacturing to the usage of the vehicles are advancing, transforming the very nature of automobiles.

At the heart of this transformation lies the sophistication and functionality of its components. While achieving weight reduction, ensuring strength, and improving safety, components are evolving at an unprecedented pace to accommodate diversifying powertrains and to advance automotive performance. We will introduce the sophistication of components that support the evolution of automobiles and the latest machining technology that makes this evolution possible.



Cylinder block

A large, central engine component—essentially the engine's heart. Cylinder bore accuracy, positional precision, and surface, all finish directly affect the engine's fuel efficiency and the level of vibration. This critical part requires a balance between rigidity and lightness as well as careful design of the coolant and engine oil flow paths.

Motor case

The housing for the motor that converts electricity into driving force. To achieve miniaturization and weight reduction, related components such as inverters and reducers are integrated, and functional components such as cooling structures are incorporated to reduce the number of parts.

Subframe

A frame that supports large parts such as the engine and transmission. Gigacasting (one-piece casting of ultra-large components) eliminates the need for welding/assembling multiple parts, reducing assembly errors and enabling higher rigidity and lighter weight.

Evolution of machining accuracy to achieve higher efficiency in internal combustion engines

An internal combustion engine (ICE) converts the energy generated by burning fuel into mechanical power. A crucial aspect of its performance is improving the "thermal efficiency," which indicates how much of the heat energy generated by combustion can be utilized as power. In addition to developing fuel injection technology for more efficient fuel combustion, improvements in the engine's shape and precision have also been required. These include lengthening the cylinder section to increase the compression ratio, smoothing the surface of sliding parts to reduce mechanical losses, and achieving high axial precision to smoothly and efficiently absorb shaft vibrations that can reach several thousand to tens of thousands of revolutions per minute.

The horizontal machining center HCN-4000 NEO features a high-precision indexing table and excels at milling, drilling, and boring from various directions. Its high-precision positioning makes it ideal for high axial precision machining, and its powerful spindle enables parts to be machined under optimal machining conditions. It also supports turning with orbit machining, enabling high-precision, high-value-added machining with a single machine. Furthermore, it can be connected to multiple units using the PALLETECH system for extended automated operation, making it ideal for efficient parts manufacturing.

Horizontal machining center

HCN-4000 NEO

e-Axle and advanced machining technology supporting electrification

Electric vehicles (xEV) convert electricity stored in a battery into mechanical power using a motor. There are various types, including hybrid vehicles (HV) that combine an internal combustion engine with an electric motor, and fuel cell electric vehicles (FCEV) that generate electricity using hydrogen while driving. The e-Axle, which integrates the components of a motor, inverter, and reduction gear, is a unit that plays a role equivalent to a conventional engine and transmission. In order to further miniaturize and reduce weight of the vehicle, it is necessary to reduce the number of parts and incorporate an internal cooling structure. A new processing engineering called Friction Stir Welding (FSW) is used to manufacture advanced components.

The FSW-460V vertical machining center is a special purpose machine designed for Friction Stir Welding. This process, which involves stirring different materials to be joined together with a special tool to create a single, integrated joint, enhancing the reliability of the parts while reducing its size and weight. It also helps reduce the use of sealants and jointed parts. Equipped with a high-rigidity spindle and a unique sensing technology, it achieves high-speed and high-precision joining. Furthermore, the base vertical machining center equipped with an ATC function also performs machining. The entire process from pre-processing to joining and finishing can be integrated into a single machine.

Vertical machining center with friction stir welding function

FSW-460V

Gigacast transforms vehicle body structures and machining of large parts

The evolution of automotive components extends to the design and manufacturing methods of vehicle bodies and structural components. A prime example of this is the gigacast, which involves the integral casting of ultra-large components. Traditionally, car bodies and frames were made by welding and fastening multiple parts together to create large components, but gigacasting produces them as a single large component.What would normally consist of tens or hundreds of parts is reduced to one, allowing the consolidation of machining processes previously performed on each individual part and reducing errors during part assembly. The gigacast method is attracting significant attention as an innovative technology, and there is a growing demand for new machine tools to handle the large components to be cast.

The VARIAXIS i-1050 simultaneous 5-axis machining center is ideally suited for machining these large cast components. Its wide machining area and large tilting rotary table enable multi-face machining of large parts without workpiece attachment / detachment. The No.50 spindle is ideal for heavy and high-speed cutting of aluminum workpieces and can accommodate large, special tools for process integration. While supporting process integration and high-precision machining without the attachment / detachment of the workpiece, the powerful mill spindle enables high-speed cutting, reduces machining time and enables high-precision machining and mass production of large parts.

Simultaneous 5-axis Vertical Machining Center

VARIAXIS i-1050

Customer Report 01

HEIWA SANGYO Co., Ltd.

A group of essential workers who support infrastructure

"We are committed to a style of directly listening to the requests of our prime contractors." This is the business philosophy of Heiwa Sangyo Co., Ltd. (Minato-ku, Tokyo, CEO Yasuhiro Yao), which handles products for aerospace and defense sectors. They strongly believe that continuously supplying millions of types of parts in small quantities is essential to the manufacture of high-quality parts for the industry.

A double-column multi-tasking machine operating 24 hours a day: INTEGREX e-1250V/8

HEIWA SANGYO Co., Ltd.

CEO	:	Yasuhiro Yao
Head office	:	2-2-18 Mita, Minato-ku, Tokyo, Japan
Number of employees	:	189

https://www.heiwasangyo.co.jp

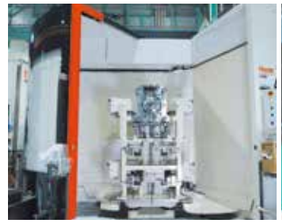
平和産業株式会社

Yasuhiro Yao, CEO

CEO Yao (center) and employees working at the Komagane factory.

Komagane Factory, located at the foot of the central Japan Alps

#Multi-taskingMachine #Automation #PrecisionAluminumProcessing
#Difficult-to-cutMaterials #AircraftIndustry #Japan



INTEGREX e-1250V/8 equipped with a custom-designed clamp angle head tool rack for engine case production.

The company also manufactures machining tools in-house.

INTEGREX i-200H S for machining complex-shaped parts

In-house jigs / tools that support the business

Heiwa Sangyo Co., Ltd. was founded in 1963 by Takao Yao, the father of the current CEO Yasuhiro Yao, as a tool trading company. It was incorporated in 1967 and started its machining business, including mold manufacturing. In addition to its head office, the company has six factories in Chiba, Tochigi, Nagano, Mie, and Nagasaki prefectures. To avoid the risk of supply chain disruption, each location is connected by a video conferencing system to ensure a stable supply chain.

Since its founding, the company has adhered to a business approach of listening directly to the requests of its main contractors. "In order to provide high-quality products that meet requirements, we do more than just follow the contract drawings — we work to build open, candid relationships with our clients," says Mr. Yao.

In the case of aircraft, once a company starts working on a part, it must continue producing the same part for decades. The company has a proven track record of reliably supplying high-quality parts for years, which has led to earning great trust from prime contractors. As a strategy to thoroughly pursue quality and achieve the required quality, the company also manufactures jigs and tools used in its machinery in-house. "Among the tools, almost all of the end mills are manufactured in-house. Our strength lies in being able to freely manufacture them according to the characteristics of the machines in operation and the applications says Atsushi Kusakabe, Chief Marketing Officer West Area.

Applying dedicated pallets for maximum productivity

The company's first Mazak machines were the INTEGREX e-1060V and VARIAXIS 730-5X, introduced in 2001. "We wanted to test the difference between the milling-type simultaneous 5-axis machines from other companies that we had been using up until then, and the turning-type machines," said Mr. Yao. At their Funabashi and Ichikawa factories in Chiba Prefecture, they have installed seven machines, starting with the INTEGREX e-1060V in 2004, followed by the INTEGREX 200-IVS, INTEGREX i-450H S, INTEGREX e-670H, VORTEX i-800V/8, etc.

The Komagane Factory, which primarily handles the manufacturing of aircraft-related products, has introduced the INTEGREX e-1250V/8 (2015) and INTEGREX i-200H S (2024), among others. The manufacturing line, which consists of six INTEGREX e-1250V/8 machines arranged in sequence, is custom-built to meet specific requirements. It is equipped with a dedicated tool clamp angle head tool rack on a pallet, in order to cut the inside of the huge engine case.

The Komagane Factory handles a wide range of products for the aerospace and defense sectors, from aircraft components to engine cases. Therefore, it is difficult to summarize the effect of introducing Mazak machines but CMO and West Site Manager Kusakabe says, "Processing time was cut by roughly one third after the introduction." Production efficiency is expected to increase even further once the double-column 5-axis machining center VERSATECH is installed and the currently under-construction No. 6 Factory becomes fully operational.

A workplace that maximizes employees' experience

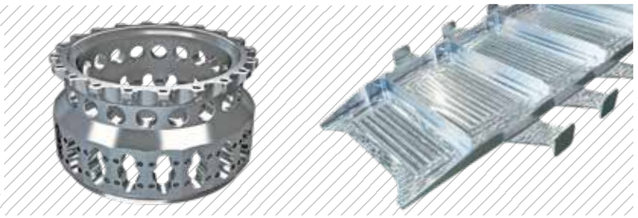
The company's product range, encompassing not only the aerospace and defense sectors but also trains and power generation equipment, all have requirements for long-term, small-volume supply. Mr. Yao's proud emphasis on "dedicating oneself to subcontracting" stems from the fact that the company positions itself as a group of essential workers supporting the social infrastructure.

Therefore, while maintaining close cooperation with each of the main contractors, the company is also focusing on creating an environment that enhances the "value of human resources" within the company by combining the strengths and knowledge of employees with diverse skills. "By being dedicated to being a professional subcontractor and accumulating small successes, we want our employees to experience the joy of manufacturing. If we can provide a place where each individual's experience can be utilized to the fullest, our overall capabilities will naturally increase," says Mr. Yao.

The company is not limiting itself to its core business of cutting, but is expanding its processing areas to drive improvements in product unit prices. It plans to actively pursue capital investments and factory expansions aimed at unmanned and automated operations, striving to improve productivity while maintaining reliable quality.

Workpieces processed by Mazak machine

Aircraft parts machined by Mazak machines.



Customer Report 02

POWEEND

Driving the future of wind power solution

As renewable energy continues to draw global attention, POWEEND, a France-based company (CEO: Guillaume Verdonck), is working to redefine the wind power industry through the design and manufacturing of the Eole5, a 1 MW wind turbine, along with its blades and generators. POWEEND has shared with us their strategy behind why they are not only committed in manufacturing their products — why they are also committed to services such as electricity selling in B2B.

24H machining of large workpieces using VARIAXIS i-800 NEO and industrial robots

POWEEND

CEO	:	Guillaume Verdonck
Head office	:	11 Av. Marc Lefrancq, 59121 Prouvy, France
Number of employees	:	50

https://www.poweend.com

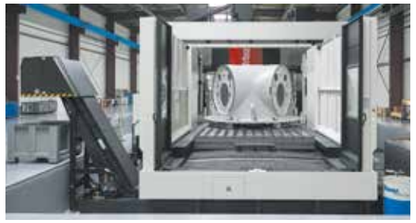
Guillaume Verdonck CEO

Employees of POWEEND

Large-scale components for wind turbines manufactured by POWEEND

#WindPower #EnergyIndustry #5AxisMachining #DoubleColumnMachiningCenter #France

High-rigidity double column machining center FJV-60/80 that supports POWEEND's high-precision machining



5-Face double column machining center VERSATECH V-140N in process of machining the rotor head part

On the way to becoming a local, low-carbon energy supplier

POWEEND was founded in 2020 and is headquartered in Prouvy, in northern France. Led by CEO Guillaume Verdonck, the company's vision is clear: build an alternative in the wind power industry in France, without any public subsidy. Rather than deploying conventional wind turbines that commonly exceed 150 metres, POWEEND focuses on its Eole5 — a mid-sized turbine designed to generate power efficiently within industrial parks and economic activity zones, to promote a locally rooted, low-carbon energy supply, for direct consumer self-consumption. Eole5 is large enough to be efficient, small enough to be accepted.

"Our production capacity will significantly increase year on year, and we aim to manufacture and install 30 turbines annually by 2030," says Mr Verdonck. This vision is supported by the expertise cultivated over 15 years through experience in designing and manufacturing wind turbines, along with Mazak's latest machine tools that underpin the company's production system. Mr Verdonck comments "We invested in large-scale machine tools to enable 24-hour machining of multi-ton components and to manufacture wind turbines on automated production lines similar to those used in the automotive industry," expressing high expectations for Mazak machines.

High precision ensures repeatability of tight tolerances in mass production

At POWEEND's headquarters plant, Mazak machines such as the 5-axis machining center VARIAXIS i-800 NEO, the double-column machining center FJV-60/80, and the 5-face machining center VERSATECH V-140N are in operation. These machines are responsible for the integrated machining of key components including hubs, main shafts, nacelles, generator chassis, rotor plates, and poles.

Due to the nature of wind turbines, extremely high accuracy and durability are required. Mr Verdonck explains, "In addition to the machines' high reliability and machining performance, the prompt after-sales service and attentive technical support were decisive factors in our investment."

He further adds, "We are also highly satisfied with our ability to integrate processes while achieving both the machining quality required by the wind industry and high productivity." Although quantitative comparisons are still limited as the new plant is in the start-up phase, positive results are already being observed. We were able to confirm the high level of repeatability in meeting the dimensional requirements of the mass-produced components, right after we introduced the VARIAXIS, notes a project manager. The minimal gap between target and actual production cycle time has also been highly evaluated.

Contribution to reduced environmental impact in manufacturing

Looking ahead, Mr Verdonck identifies the introduction of advanced equipment and automation solutions as a key strategic priority. "By advancing automation in processes such as rotor manufacturing and blade polishing, we aim to optimize production, shorten production cycle time, improve quality and repeatability, and reduce unneeded tasks," he explains.

In addition to product development, POWEEND is also addressing one of the major barriers to the expansion of wind power projects: the complexity and lengthy duration of permitting procedures. The company is developing a one-stop service that covers everything from site assessment and administrative procedures to installation, maintenance, and eventual decommissioning. For the clients, industries, factories, that means "nothing to think about, nothing to invest."

By stepping beyond the traditional role of a supplier, POWEEND seeks to solve industry challenges comprehensively, stating that it will "approach the issues facing the wind power market from both product and service perspectives."
For a company committed to promoting a locally rooted low-carbon energy supply, reducing the environmental impact of its own manufacturing operations is an unavoidable challenge. In this context, the adoption of the VARIAXIS NEO series — achieving a 46% reduction in power consumption compared to previous models — contributes directly to the company's vision.

Workpieces processed by Mazak machine

A range of wind turbine components machined by MAZAK machines

Mazak News & Topics

Mazak expands India's production capacity to meet growing demand

Mazak will invest in equipment to increase production during 2026 at its production facility, Yamazaki Mazak Machine Tools Pvt., Ltd., located in Pune district, Maharashtra, India. The factory began operations in March 2023 and currently produces three models of vertical machining centers in the VC-Ez series: VC-Ez 410IP, VC-Ez 510IP, and VC-Ez 660IP. Demand for machine tools in India remains strong and is expected to stay healthy as markets expand across a wide range of industries, including automobile, agricultural machinery, aerospace, and oil and gas. In particular, the VC-Ez series has been successful in gaining new customers, mainly job shops, and also expansion into overseas markets. Exports to Southeast Asia began in 2024, and sales in the European market began in 2025. Demonstrating a steady increase in export performance. Against the backdrop of this expanding demand, Mazak plans to increase the production capacity of vertical machining centers at the factory from 40 units per month to 60 units per month by the second half of 2026.

Yasuhiko Suzuki of the Advanced Development Center, received JSME "Technical Achievement Award."

Photo, right: Yasuhiko Suzuki, Director of the Advanced Development Center

Yasuhiko Suzuki, Director of the Advanced Development Center at the Product R&D HQ, has received the Technical Achievement Award in the Manufacturing and Machine Tool Division from the Japan Society of Mechanical Engineers (JSME). This award is given to individuals who have made outstanding contributions to the development of the production and machine tools field over many years through the development of original technology, products, and manufacturing methods. Mr. Suzuki is the second person from the company to receive this award, following Akimitsu Nagae, Honorary Director of The Yamazaki Mazak Museum of Machine Tools.
Since joining Mazak in 1989, Mr. Suzuki has been engaged in leading-edge research and development, primarily in the field of NC control. He has spearheaded a wide range of engineering developments, including the development of CNC systems such as the IMAC series and PREVIEW 3, as well as quadrant protrusion compensation, progressive backlash compensation, and the intelligent thermal shield function in MAZATROL MATRIX. Furthermore, he has accumulated a wealth of experience in a wide range of fields, from spindle and servo engineering to various compensation functions, including relocation detection devices and the learning function of the AI thermal shield in MAZATROL SmoothAi. In particular, his patented quadrant protrusion compensation and thermal displacement compensation engineering, Intelligent Thermal Shield, has greatly contributed to improving machining precision and has received high praise when presented at academic conferences.
Furthermore, he has contributed to industry-academia collaboration, including serving as Vice Chairman of the International Machine Tool Engineers Conference (IMEC) for many years. These achievements have been highly evaluated, leading to this award.

Mazak's largest private show in Japan, "DISCOVER2025," was held

From December 3rd to 5th, 2025, Yamazaki Mazak held DISCOVER2025 at its Minokamo Plant 1 / World Technology Center. This event is one of the largest private shows in Japan, which showcased 26 products - machine tools, laser processing machines, and automation systems. Highlights include the FT-250 high-speed fiber laser processing machine for pipes - making its debut in Japan - the INTEGREX i-250 NEO simultaneous 5-axis multi-tasking machine, and the CNC turning center QRX series, broadly introducing Mazak's latest technologies.
At the venue, a special lecture themed of "People × Data × Machines" was delivered by three speakers, including Masato Otsubo of the Factory Scientist, an organization that focuses on development of human resources that have skills to control data obtained at manufacturing sites. The importance of DX human resource development and the utilization of on-site data, providing attendees with new insights. Many customers had the valuable opportunity to directly experience the latest machines and machining technologies, gaining a deeper understanding of Mazak's development capabilities. Yamazaki Mazak will continue to provide solutions that solve on-site challenges and lead the next generation of manufacturing.

Mazak U.K. promotes next-generation talent development, by accepting new apprentices

YAMAZAKI MAZAK U.K. Ltd. (MAZAK U.K.) welcomed engineering apprentices in February 2026 to support the development of future talent. In cooperation with local training institutions, facility tours and exchange programs were conducted, with second-year apprentices sharing their experiences and highlighting the value of learning in a real manufacturing environment.MAZAK U.K. also held a completion and awards ceremony, where outstanding apprentices and their mentors celebrated their achievements and growth. Linked to the UK's National Apprenticeship Week, the initiative reinforced the importance of human resource development. Through these efforts, the company will continue to nurture the next generation of manufacturing talent.

Masatoshi Ito of the Product Development Division received the JSME' "Outstanding Engineer Award".

Masatoshi Ito of Software Development Department 2, Product R&D HQ, received the Outstanding Engineer Award (Gold Prize) from the Japan Society of Mechanical Engineers (JSME). Established in 2025, the award recognizes engineers from member companies who have made significant contributions to mechanical engineering and industry. Since joining the company in 2009, Ito has led R&D in cutting process analysis and chatter suppression, contributing to higher machine tool performance through spindle integrity evaluation and AI technologies. These achievements were highly recognized, leading to this award.

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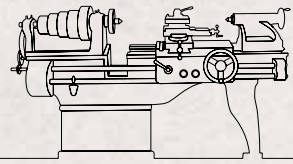
Machine tools, past and present

THE COLLECTION OF THE YAMAZAKI MAZAK MUSEUM OF MACHINE TOOLS



1972 Horizontal Machining Center DUAL CENTER 1800

The machine features an X-axis, Y-axis, and an indexing table positioned at the center, with spindles arranged opposite to each other on both sides.
The right-side spindle is designed for high-torque, heavy-duty face milling, while the left-side spindle is optimized for heavy duty face milling, and high-speed, high-power end milling.
This machine was originally conceived by Howard Hughes, then owner of Hughes Aircraft Company, with the aim of machining complex helicopter components with high precision and efficiency. His idea was brought to Burgmaster, where it was successfully realized.
At the time, this cutting-edge machine was introduced as "the quintessential machining center."
Teruyuki Yamazaki, the second president of our company, recognized the excellence of this design and formed a technical partnership with Burgmaster to commercialize it.
The machine was delivered to major domestic companies and had a significant influence on our subsequent product development.
The exhibited machine shown here was actually operated as part of the equipment at Mazak's Oguchi Plant.

Manufacturer: Yamazaki Machinery Works Ltd.
Country of manufacture: Japan

THE YAMAZAKI MAZAK MUSEUM OF MACHINE TOOLS

https://machine-tools-museum.mazak.com

YAMAZAKI MAZAK MUSEUM OF MACHINE TOOLS is a unique museum that specializes in machine tools. It is an interactive museum where visitors can see, touch, and enjoy all kinds of exhibits, which includes working historical machine tools and key industrial products made with the tools such as steam locomotives, automobiles, and aircraft.

Mazak

Yamazaki Mazak Corporate Website
www.mazak.com