

Special Feature Article

The Future of Automobile Development and Production from JIMTOF ~ Automobile Manufacturing Changing with the Spread of Electric Vehicles ~

While auto parts manufacturers are facing drastic changes in their business environment, machine tool manufacturers are focusing on proposals that will lead to solutions. At the 31st Japan International Machine Tool Fair (JIMTOF2022) held last November, cutting machines for electric vehicle (EV) parts, which are expected to become popular in the future, were prominently displayed. Also on display were products that contribute to carbon neutrality by reducing CO₂ emissions, as well as products that contribute to process consolidation and automation as a measure to address labor shortages at manufacturing sites. We will examine the future of the manufacturing field based on the exhibits of various companies.

The automotive machine tool market is booming for EV.

Machine tool manufacturers are focusing on proposals for cutting machines designed for key EV components such as motors and batteries. Particularly prominent were motor shaft machining centers. Murata Machinery, Ltd. developed a CNC Turning Center for shaft machining, which is designed for cutting metal such as motor shafts used in EV and exhibited it as a reference at JIMTOF. The machine can complete complex internal and external machining of shafts in one machine, and automatically transfers workpieces (products) before and after machining. The company aims to launch the product after making improvements based on user feedback obtained at exhibitions and other events.

JTEKT Corporation also exhibited a wide cylindrical grinding machine specialized for motor shafts for the first time. This machine can grind shafts of different diameters simultaneously, and the grinding process, which previously required three grinding machines, has been consolidated into a single machine. The length of the production line has also been reduced by up to 70%.

Machining centers for large motor cases are another product that companies are focusing on. Makino Milling Machine Co., Ltd. 's L2 vertical machining center has a proven track record in the machining of ABS valve bodies and was demonstrated at JIMTOF for cutting motor cases. The L2 is compact, measuring 850 mm wide and 2135 mm deep, and after cutting, the entire pallet can be

turned upside down after cutting to complete the internal chip cleaning process. The company says, "EV motor cases often undergo design changes," but by consolidating the processes, they can respond flexibly.

Light and robust protection for the heart of the battery

There was also a series of exhibits related to "battery cases" that protect the batteries, which determine the driving performance of EV, from shocks. In addition to withstanding aging and deterioration in hot and humid environments, lightness is also important for automotive use. Each company proposed processing technologies to meet these needs.

Yamazaki Mazak Corporation has developed a specialized machine for "Friction Stir Welding (FSW)". FSW is a technology to soften and stir materials by frictional heat applied with a drill to join them. Compared to bolted joints, FSW can reduce size and weight. The company expects demand for FSW to increase with the spread of EV and will develop a specialized machine with increased joining speed.

In addition to battery cases made of steel and aluminum, which are currently the mainstream, battery cases made of carbon fiber reinforced plastic (CFRP) and other composite materials may expand in the future. TEIJIN LIMITED has already begun supplying a "multi-material battery box" that combines glass fiber-reinforced plastic and metal.

In anticipation of this demand for CFRP processing, Mitsubishi Electric Corporation has developed the "CV Series" laser processing machine exclusively for CFRP. It can handle CFRP with a thickness of 3 mm or less and can process curved surfaces with a three-dimensional head. The processing speed is 6 meters per minute for 2 mm thick CFRP, which is faster than cutting with a machining center or water jet. It also has excellent machinability for fine holes.

On the other hand, laser processing results in a rough-cut surface, and there is a risk of burning the surface. The company's challenge is, "To what extent is this acceptable in terms of the product, and can we make it OK according to the application standards of the customer?" However, the company has already received inquiries from automotive parts manufacturers overseas for battery cases.

Overcoming Production Site Challenges with Automation, Complexity, and Digital Utilization

Manufacturing sites must respond to changes such as the "EV shift". On the other hand, labor shortages remain a major challenge. At the same time, it is necessary to address issues such as the reduction of greenhouse gas emissions. Machine tool manufacturers are responding to these issues through "process integration," "automation," and "digitalization."

Murata Machinery, Ltd. exhibited its "Flex EZ Loader LOPROS," a setup change support system, as a proposal for automation to handle a wide variety of production. The system simplifies the replacement and adjustment of chuck jaws by extending the stroke of the chuck jaws, which are used by automatic transfer robots to grip workpieces, so that a single unit can handle a variety of workpieces (objects) of various sizes. The company aims to adapt its 2-axis CNC Turning Center, which has been used to machine parts for automatic transmissions (AT), to a variety of applications, including parts for EV.

DMG MORI CO., LTD. 's "NZ QUATTRO" has four turrets, enabling complex machining on a single machine. The "NZ-platform" has been delivered to a European manufacturer as a machining center for EV motor shafts, and the company plans to expand the number of customers for applications requiring small-lot, precision machining in the future.

Process integration using 5-axis milling machines is also a trend. Although the use of 5-axis machines has not been widespread due to installation cost issues, they are attracting attention in Japan due to the need to reduce labor and improve efficiency. Makino Milling Machine's V100S vertical machining center for die manufacturing is expected to reduce lead time for large dies such as exterior panels and instrument panels, which are complex to process.

To improve process efficiency, digital technology is also expected to be utilized. Okuma Corporation has revamped its computer numerical control units (CNC) for the first time in about 10 years and implemented a "Digital Twin". This enables advance verification of machining in a virtual space, and real-time motion data obtained through the Internet of Things (IoT) is used to achieve quick and highly accurate machining simulations. Furthermore, by feeding back discrepancies between the verification results and actual machining, more accurate machining is possible. The company representative explains, "If we can accurately simulate the workpiece before machining, we can set delivery dates more accurately and operate the factory more efficiently".

Furthermore, the company also supports manufacturing sites with carbon-

neutral measures. Aiming for both improved productivity and energy conservation, the company is proposing "Eco Suite Plus" functions, such as pausing the machine during idle, starting machining operations immediately after startup, and visualizing CO₂ emissions. The company is stepping up its proposals in the expectation that demand for environmental responsiveness, which is currently centered on Tier 1 companies, will spread to Tier 2 and below.

Automotive parts suppliers also focus on machine tool business using their own technology.

Auto parts manufacturers are also focusing on the machine tool business, utilizing their own manufacturing expertise.

JTEKT Corporation is taking advantage of its "being both a supplier and a user" and is using the needs of parts production as a hint for the development of machine tools. Demand for machine tools for internal combustion engines, which has been the company's mainstay, is forecast to decline in the future. Therefore, the company is shifting its product portfolio by expanding its EV-compatible machine tools and finding commercial opportunities in general-purpose machines.

The G3 Series of medium-size cylindrical grinders applies the "steer-by-wire" technology developed for automobile steering to the optional manual grinder. When the grinding wheel contacts with the workpiece, the handle mechanically becomes heavier, enabling fine adjustments. On the other hand, the computer-controlled machine can automatically set machine conditions, making it possible for both experienced and inexperienced operators to take advantage of the benefits of both digital and analog technology.

Nidec Corporation is increasing the rate of in-house production of "E-Axles," and in August 2021 acquired Mitsubishi Heavy Industries Machine Tool (now Nidec Machine Tool), which manufactures gear grinding machines, etc. In February 2010, it also acquired OKK (now Nidec OKK), and is focusing on the machine tool business.

Nidec Machine Tool's gear grinding machines and chamfering machines are expected to grow particularly within the Nidec Group. EV requires gears with high precision to improve transmission efficiency, electricity costs, and quietness, as well as to extend cruising mileage. It is also essential that the processing method be suitable for mass production.

In general gear processing, the gear shape is formed to a certain degree by hobbing, which involves cutting the gear shape while rotating the blade,

followed by chamfering to remove burrs, and shaving to smooth the tooth flanks with a cutter, before heat treatment. Nidec Machine Tool has developed high-precision equipment suitable for mass production, such as integrating shaving into the hobbing process. The company intends to increase its presence in markets with growth potential, particularly in China and India.

Nidec Group will combine Nidec Drive Technology Corporation's presses and Nidec Machine Tool and Nidec OKK's machine tools to form the "Machinery Business Group," which will grow into a new pillar of its business. The company plans to increase its sales to 500 billion yen in 2025 and to 1 trillion yen in 2030, including through future acquisitions.

Potential for utilization and diffusion of 3D printers

The use and spread of additive manufacturing (3D printers), which is expected to be utilized in a variety of situations, continues to be proposed by various companies with the aim of expanding its use in the automotive industry.

3D printers, which use metal or resin powder for layered modeling, do not require molds and can perform complex processing that could not be done by casting. For this reason, 3D printers are currently used mainly in prototyping parts. The advantage is that prototypes can be made quickly without the need for molds when considering multiple parts in the development process for mass production, and 3D model data can be easily modified. It is also used to manufacture "one-of-a-kind" parts for low-volume production vehicles.

On the other hand, the disadvantages are the cost of the powder material and the lengthy molding time. In some cases, it takes several hours to mold a single part, and mold processing is better suited for mass production. In Europe, efforts are reportedly underway to discard molds for parts of car models that are no longer in production, and to manufacture replacement parts using 3D printers. In Japan, efforts have already begun to use 3D printers for restoration parts for some cars that are not in production, such as sports cars, etc. It has been pointed out that the actual modeling time and cost can vary greatly depending on whether the design is made with the use of a 3D printer in mind, and this could be a "game changer" for the automotive parts manufacturing scene.

It can be said that it is people and machine tools that support the production of auto parts manufacturers. By attending to the challenges faced by the manufacturing site and offering solutions, we can support and carry-on Japanese manufacturing even in this once-in-a-century era of great change.