Motion Company ― Technology and Strengths

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1. Introduction

The Motion Company develops, manufactures, and sells servo motors, delivering products to customers worldwide. We excel at customizing products to meet specific customer equipment requirements by leveraging our long-cultivated strengths in motor design and production technology.

The purpose of customization is to enhance equipment performance and strengthen market competitiveness. Customization examples include modifying motor windings to optimize characteristics for the customer unit, adjusting connectors and cover shapes to fit components into limited spaces, and designing output shafts and mounting flanges for smooth equipment integration. When customizing, we collaborate with customers from the planning stage to define motor specifications, enabling us, as servo motor professionals, to engage closely in their development efforts.

Meanwhile, the wide range of customization options requires our factories to handle high-mix, low-volume production. Although such production generally reduces productivity due to increased setup time, our advanced production technology has overcome these challenges. By strategically allocating workers and automated equipment, we have minimized setup time and cycle time while maintaining high-quality production lines supported by our production guidance system.

This article presents examples of customer-specific customization and innovative approaches to improving production efficiency. It also introduces the production engineering services launched in 2024, showcasing the new value we provide.

2. Customization Tailored to Customer Equipment

Customization requirements vary significantly depending on customer equipment. This chapter presents three examples of customization designed for different applications.

2.1 Customization for semiconductor manufacturing equipment

A standard motor is usually supplied as a unit with the rotor and stator enclosed in a housing (flange, frame, or bracket). However, integrating the housing into the customer's equipment can reduce overall size without compromising motor performance. In this case, we provide the rotor and stator separately, as shown in Figure 1, for installation into the customer's equipment. These products are called built-in motors.

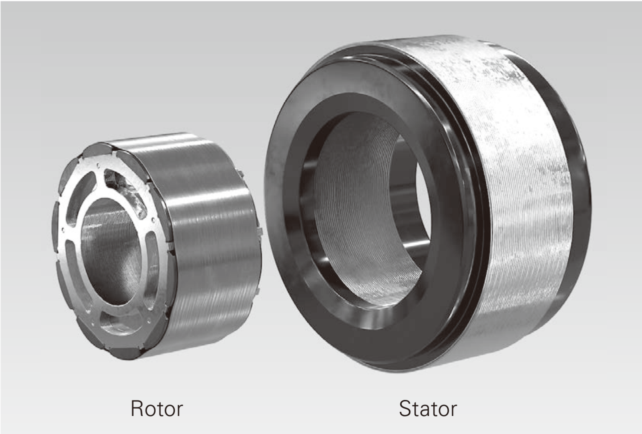


Fig. 1 Built-in motor

Figure 2 shows a wafer conveyor robot for semiconductor manufacturing equipment. These robots use a single-core, multi-axis structure with two or more output shafts on a single axis, and our built-in motors are used for these robots.

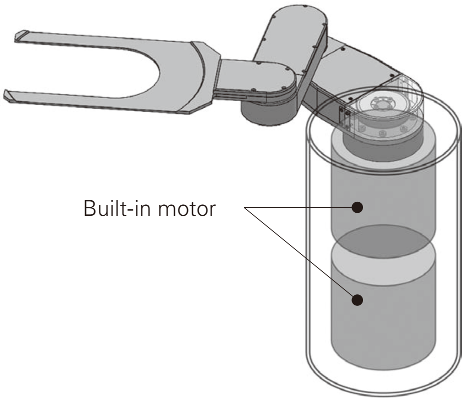


Fig. 2 Wafer conveyor robot

The motors for wafer conveyor robots do not require high maximum speeds but must deliver high torque at low speeds. Furthermore, because these motors operate under special conditions, including vacuum and high-temperature environments, they must be constructed with specialized materials. Customized built-in motors are suitable for reducing equipment size while satisfying these demanding specifications. During design, either the inner or outer rotor type is selected based on the structure of the customer's equipment. Materials are then chosen according to the operating environment. Furthermore, the core shape and winding specifications are determined to achieve the required torque characteristics. We use 3D models to design the motor structure, ensuring minimal space usage and preventing interference with customer equipment.

Table 1 lists typical built-in motor specifications. A base design with dimensions closest to the customer's requirements is selected, and the optimized windings minimize cost and lead times.

2.2 Spindle motor customization

One of our core product areas is spindle motors used in machine tools. Figure 3 shows a spindle motor. Spindle motors generally operate at high speeds, requiring specialized winding configurations and rotor designs. For machine tool spindles, we manufacture motors with maximum speeds ranging from 10,000 min^{-1} to 27,000 min^{-1}. The balance between the maximum speed and torque can be adjusted to meet customer specifications. To increase the maximum speed of a servo motor, for example, customization may include modifying the winding specifications or magnet arrangement. Servo amplifiers can be adjusted by changing the current-control parameters in the high-speed range. In some cases, modifications to the customer's controller may also be included.

A key strength of our approach is the ability to optimize the entire servo system including the motor, servo amplifier, and the customer's controller enabling us to propose and implement optimal customization.

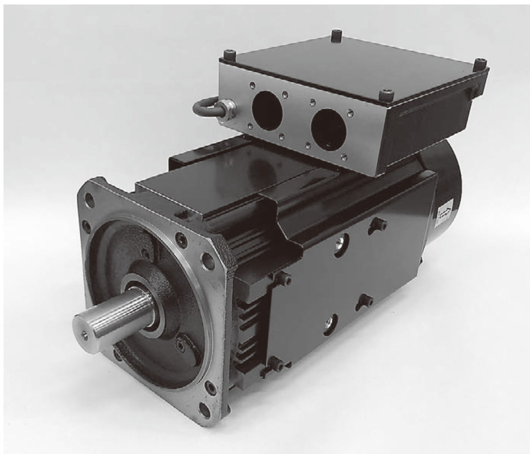
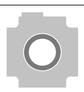
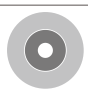


Fig. 3 Spindle motor

Table 1 Typical built-in motor specifications

Shape	Stator size			Rotor size		
	Dimensions [mm]	Inner diameter [mm]	Length [mm]	Dimensions [mm]	Inner diameter [mm]	Length [mm]
	40 × 40	ø24	23.5	ø23	ø16	9
	60 × 60	ø33	27.5	ø32	ø22	12
	ø80	ø50	71	ø49	ø22	63
	ø123	ø72	44	ø71	ø35	37

2.3 Energy savings through high-efficiency motors

We have achieved significant energy savings for customer equipment by replacing the induction motor previously used on a given axis with a synchronous motor. This customization is based on our *SANMOTION R* series motor, our standard product (Figure 4).

The newly designed rotor in this customization reduced resource and energy consumption in the customer's equipment while enhancing the efficiency of the development process.

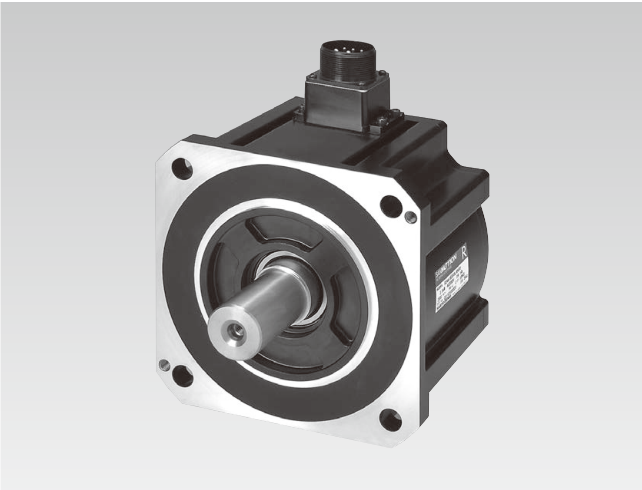


Fig. 4 SANMOTION R series motor as a customization basis (180 mm sq. size)

2.3.1 Motor resource efficiency

An embedded-magnet synchronous motor was used to reduce permanent magnet usage by 20% compared to an existing servo motor of the same output. The motor's outer diameter and volume were reduced by 40% and 60%, respectively, compared to the existing induction motor. By significantly reducing rare-earth content and structural components, the customer's equipment became more resource-efficient.

2.3.2 High-efficiency motors

Motor design incorporated inductance to reduce switching harmonics in the current, improving efficiency by 14% over the existing induction motor. This directly reduced the energy consumption of the customer's equipment.

2.3.3 Development optimization

Despite being a synchronous motor, the motor can be controlled without a position sensor by detecting changes in inductance, just like an induction motor. This has enabled the current inverter to be used as is. By using our standardized stator components, we minimized initial costs and development time. Leveraging existing assets improved our customers' development efficiency.

3. Production Equipment Suited for High-Mix, Low-Volume Production

To accommodate a wide range of customization needs, we have developed and introduced numerous production equipment suited for high-mix, low-volume production. This chapter presents two representative examples, highlighting the creative approaches behind their development.

3.1 Segment magnet insertion equipment

The process of inserting segment magnets (hereafter, "magnets") into the rotor is critical, as positional accuracy, adhesive application, and magnet adhesion directly affect motor performance and quality.

Traditionally handled manually, this process required flexible staffing to match fluctuating production volumes.

Figure 5 shows equipment that automatically inserts magnets into the rotor, enabling high-mix, low-volume production with improved motor quality. The following sections describe the key components and the creative approaches of the equipment.

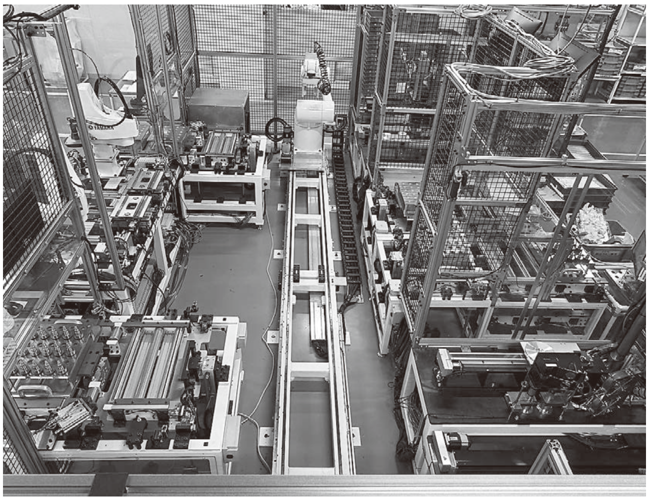


Fig. 5 Segment magnet insertion equipment

3.1.1 Magnet inspection using image processing

Magnets, supplied as unmagnetized loose pieces, are fed to the parts feeder, which orients them correctly. A SCARA robot picks up each magnet, and image processing inspects their appearance to automatically identify defects and dimensional issues. Defective magnets are removed, preventing flawed components from reaching downstream processes.

3.1.2 Parallel production using traveling rails and articulated robots

After inspection, magnets are inserted into the aligning jig and transported to the insertion process.

Because magnet insertion is time-intensive, two insertion stations were established for efficient production. Articulated robots on traveling rails distribute magnets to each station automatically, minimizing wait times and improving productivity.

3.1.3 Batch magnet attachment and high-frequency heating

A specified number of magnets are attached in batches on the alignment jig, ensuring positional accuracy and proper adhesion. High-frequency heating of rotors shortens the heating time within the process.

These approaches minimize insertion time, improve productivity, and ensure consistent quality.

3.2 Brake assembly and inspection

The electromagnetic brake (hereafter, “brake”), built inside the servo motor, holds the motor shaft in place when power is off. As it is a critical part for assuring safety, the brake assembly and inspection processes require high reliability and precise operations.

Traditionally, workers measured parts using micrometers and carefully selected suitable spacers—a time-consuming and attention-intensive process. To improve productivity, we integrated image processing technology and multiple sensors into a new brake assembly equipment, allowing automatic and accurate part handling. This automation significantly reduced labor hours while ensuring reliable assembly. Certain tasks, such as securing components to the conveyor pallet and tightening screws, remain manual. In high-mix, low-volume production, this appropriate combination of automated and manual work is essential.

Figures 6 and 7 show brake assembly and inspection equipment, arranged side by side for a one-piece production flow from assembly to inspection. We will highlight our key development features in designing the equipment.

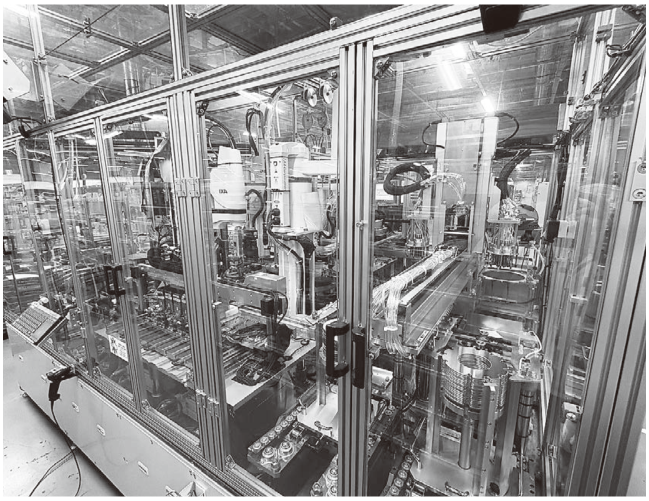


Fig. 6 Brake assembly equipment

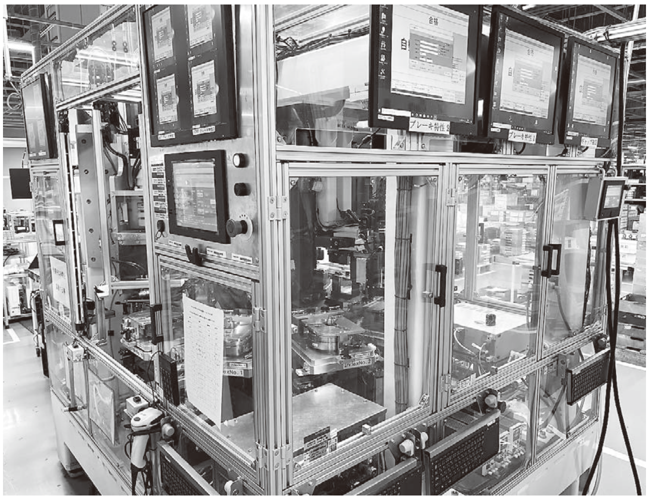


Fig. 7 Brake inspection equipment

3.2.1 Assembly using image processing

Brakes are assembled using SCARA and Cartesian robots. The yoke is placed first on the far bottom, followed by sequential stacking of the inner plate and friction plate. In the layering process, multiple cameras mounted on the robot hand calculate the positional difference of each part. These values are converted into robot coordinates to achieve high-precision positioning.

3.2.2 Automatic thickness measurement for proper spacer selection

The inner and friction plates are sandwiched between high-precision ceramic measuring plates from above and below, and the thickness is automatically measured using multiple displacement sensors. Based on this measured value, a suitable spacer that provides a sufficient gap between the yoke and inner plate is automatically selected and picked up. This time-consuming, concentrating process has now been automated, achieving improved productivity and stabilized quality.

3.2.3 Simultaneous inspection using an index table

After assembly, the brake undergoes various inspections before the product is completed. In the inspection process, the index table ensures synchronization with the assembly cycle. After securing each product on the conveyor pallet, the product automatically moves through each inspection station for characteristics testing, backlash inspection, and static friction inspection. Parallel execution allows all inspections to be completed within the assembly cycle time.

Through an effective combination of automated and manual processes, the assembly and inspection process achieves improved efficiency, productivity, and quality consistency.

4. Production Engineering Services

With the transition from a division-based system to a business company system, the Motion Company launched production engineering services as a new business.

This chapter provides an overview of production engineering services and introduces the production guidance system, as one of the company's key initiatives.

4.1 Overview of production engineering services

Production engineering services leverage our long-standing expertise in robot utilization, automation technologies, and production system construction to help customers solve challenges in their manufacturing processes. The services are categorized into the following three areas:

1. Design, manufacture, and sale of machinery and equipment that support customer production
2. Design, manufacture, and sale of automated equipment that improves customer productivity
3. Design, manufacture, and sale of production systems that enhance customer manufacturing quality

In particular, the third category involves providing customers with our production guidance system, which is used in our own production sites. This service has received strong interest from customers who have not yet digitized their work instructions or who want to maintain detailed work history records.

4.2 Production guidance system

The production guidance system is designed to enable high-quality manufacturing by ensuring that products are produced in the same standardized procedure—by anyone, without errors, and efficiently—based on work instructions derived from drawings. The main features of the system include:

1. Digitization of work procedures
2. Connection and control of external devices
3. Recording of work history as traceable data

For the first category, work processes (hereafter, "steps") are divided into individual steps, which are displayed sequentially on a monitor, as shown in Figure 8. Steps are presented with photos, drawings, and text for easy understanding, allowing anyone to perform the work regardless of skill level.

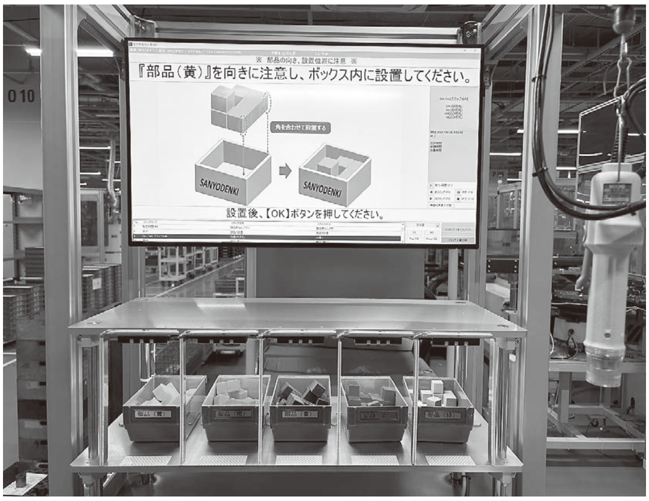


Fig. 8 Steps in the production guidance system

For the second category, each step is linked to external devices, for example, turning on LEDs attached to tools. Signals from sensors also control buzzers, guiding the operator visually and audibly. Moreover, values acquired from external devices can be used as criteria for step completion, ensuring work is performed without errors.

For the third category, all step information is stored in a database and can be used for analyzing work trends, identifying bottlenecks, and adjusting process balance. This contributes to efficient workflow management.

By implementing the production guidance system, high-quality products can be manufactured by anyone, without errors, and efficiently. The system supports operational reform and meets a wide range of customer needs.

5. Conclusion

This article has introduced three examples of technologies and core strengths of the Motion Company. These initiatives leverage our long-cultivated expertise in customized design and our production engineering capabilities, which enable us to manufacture numerous customized products efficiently and with high quality.

1. Customization tailored to customer equipment
2. Manufacturing equipment suited for high-mix, low-volume production
3. Production engineering services

The purpose of customization is to enhance the performance of customer equipment and strengthen market competitiveness. To achieve this, it is essential to thoroughly understand the customer's equipment and provide optimal proposals based on our experience. Hearing customers say, "SANYO DENKI made it possible" or "They delivered an excellent product" is our source of pride and our contribution to society. We will continue to work closely with our customers and remain committed to delivering customized solutions that create new value.

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