SANMOTION Products and SDGs

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1. Introduction

With growing interest in the SDGs (Sustainable Development Goals), initiatives and products supporting these goals are receiving increasing attention.

The "sustainable and prosperous society" envisioned by the SDGs aligns with our corporate philosophy of creating society where "we help all people achieve happiness." Fulfilling this philosophy leads to the achievement of the SDGs.

This article presents cases of SANMOTION product proposals to customers, as well as our product development and production activities. These initiatives, guided by our corporate philosophy, demonstrate how we contribute to achieving the SDGs.

2. Resolving Social Issues through Businesses

One of the SDGs goal to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" identifies stable food supplies and sustainable agriculture as critical social issues.

This chapter presents an example where SANMOTION products were proposed for agricultural equipment use as a way to help address these social issues.

2.1 Proposal for broccoli harvesting robots

Agriculture requires constant human management such as cultivating crops, harvesting, and maintaining farmland.

However, in Japan, the aging agricultural workforce and declining population involved in agriculture makes it increasingly difficult to secure sufficient labor.

For this reason, automation and enhanced efficiency in agricultural work is becoming essential. To support this transformation, we are actively promoting SANMOTION products for agricultural equipment.

The rising production and consumption of broccoli have created a demand to reduce the labor-intensive process of harvesting the crop manually.To address this need, we propose SANMOTION products in equipment designed to automatically harvest broccoli.

Figure 1 shows a broccoli harvesting robot operating in a field. These robots automatically navigate fields, use image recognition to identify harvestable broccoli, and automatically harvest the crops.

For the traveling axis of this broccoli harvesting robot, we proposed the 100 mm sq., 1.5 kW AC servo motor and the 50 A EtherCAT type AC servo amplifier from our *SANMOTION G* AC servo systems.

Fig. 1 Broccoli harvesting robot

The *SANMOTION G* servo systems, which feature compactness, light weight, and high efficiency, have been widely used by customers since its launch in 2022.

The *SANMOTION G* servo systems are certified as Eco Products under our own standards due to their low environmental impact and contribution to energy conservation. In addition, it was also honorably awarded the Good Design Award 2023.

The *SANMOTION G* motors are 20% shorter in length and 34% lighter compared to our conventional products. These improvements, along with enhanced performance and efficiency, have been well-received by customers.

The compact size allows for a smaller drive mechanism,

creating more space for harvested crops at the bottom of the machine. In addition, the lighter and more efficient servo motor and servo amplifier reduce the overall weight of the machine in motion, enhancing energy efficiency for the entire system.

We will remain committed to addressing social issues by promoting our products in the agricultural equipment market and advancing automation and labor efficiency.

Our domestic production and development facilities in Nagano—including Kangawa Works, Fujiyama Works, and the Technology Center—position us to support sustainable farming practices and address the declining number of successors in agriculture, contributing to the local community.

3. Creation of a Fulfilling Workplace and Product Development Combining Personnel Training

The SDGs to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" emphasizes the importance of fulfilling workplaces and initiatives that drive economic growth.

This chapter highlights initiatives that align with this goal of creation of motivating workplaces and product development combined with personnel training. It includes the Technology Center's new wing, our joint development efforts with the Design Department of SANYO DENKI PHILIPPINES, INC. (SDP), and a case study on simulation technology.

3.1 Making more use of Technology Center's new wing

In 2021, the new wing of the Technology Center began operations with the aim of improving productivity in design and development. The new wing is equipped with new facilities such as a 10-m method anechoic chamber, a vibration testing lab, and a durability testing lab with sound barriers. These have expanded our design room and laboratory space, which serves as the foundation for design and development.

Creating the spacious design and evaluation environment equipped with high-performance facilities, our designers are highly focused and motivated in their development efforts.

This section presents an example of the use of the 10-m method anechoic chamber, which contributes to reducing radiated emission levels.

High-precision, high-frequency parts often increase radiated emission levels, which we previously managed through PCB near magnetic field analysis and pattern layout redesign.

With the new chamber, we can now perform 10-m method tests in-house, replicating certification tests by third-party bodies. This allows accurate measurement of radiated emission levels to confirm that they are within the limit prior to certification tests, avoiding the need for rework.

Figure 2 shows radiated emissions measured in the anechoic chamber of the Technology Center's new wing during the development of the *SANMOTION G* servo amplifiers. The results demonstrate a significant reduction in high-frequency radiated emissions caused by reference clock signals, such as oscillators, compared to the previous product. The use of this facility also shortened the evaluation period.

The advanced facilities of the new wing, including the anechoic chamber, enhance productivity and innovation in design and development. By leveraging these facilities effectively, we aim to accelerate sustainable industrialization and foster ongoing innovation.

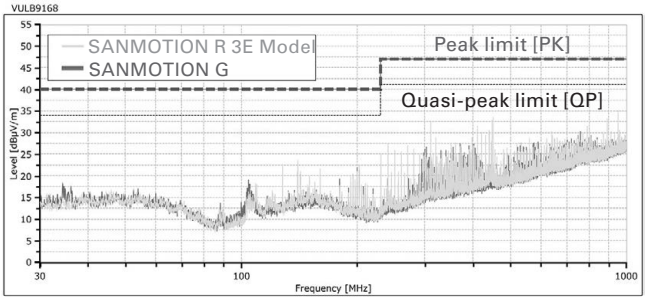

Fig. 2 Radiated emissions
(10-m method, horizontal axis)

3.2 Joint development with SDP Design Department

To advance global design and competitiveness of our products, the SDP Design Department has been engaged in the design and development of SANMOTION products.

Since 2018, the team within the SDP Design Department that deals with SANMOTION products has contributed to design activities such as creating stepping motor drawings and providing technical support for mass production.

With the 9th Medium-term Management Plan launched in 2021, the SDP Design Department has focused on human resource development and improving evaluation environments in preparation of full-scale development work.

In 2022, an engineer from the SDP Design Department underwent a year of practical training at our Technology Center, gaining product knowledge, design technology, development processes, and evaluation methods for AC

servo amplifiers.

Figure 3 shows the servo amplifier evaluation testing process at the SDP Design Department. As a result of personnel training and the improved environment, the SDP Design Department is now capable of developing servo amplifiers.

In 2023, joint development efforts reduced the development period for expanding the *SANMOTION G* AC servo amplifier lineup by 2.5 months.

Fig. 3 Servo amplifier evaluation test at SDP Design Dept.

These initiatives not only enhance the skills and motivation of engineers in the Philippines but also improve product development capabilities and design productivity of the entire Group. Additionally, they contribute to promoting diversity, aligning with the goals of the SDGs.

3.3 Cases leveraging simulation technology

Previously, product development involved creating prototypes, evaluating them, and addressing any issues based on test results.

In recent years, designers have gained more autonomy to adopt new methods and technologies, applying trial and error to integrate them into practical product development.

These allow designers to use simulations to verify and predict design outcomes before prototypes are created, reducing rework, improving quality, and shortening development time.

Simulation technology has also proved very helpful in improving designers' skills. Comparing simulated predictions with actual results helps identify problems, analyze the causes, and propose solutions effectively.

This section showcases model base development, which serves as a case study on leveraging the simulation technology that we have cultivated up to this point.

3.3.1 Model base development

We adopted model base development to optimize control systems for the *SANMOTION G* servo amplifier. This process involves creating a model(note 1) of a servo motor or servo amplifier, simulating movements, and verifying performance before proceeding to product development, thereby further increasing efficiency.

3.3.2 Product development leveraging model base development

The process flow of model base development is illustrated in Figure 4.

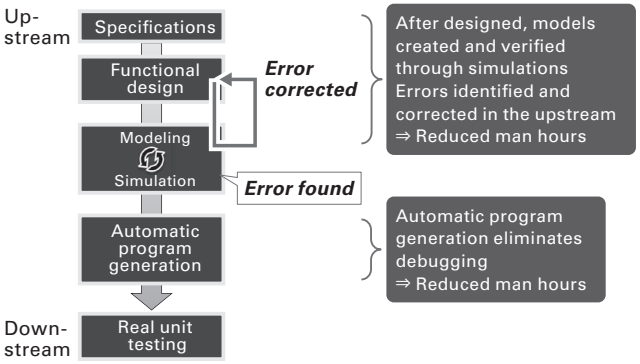

Fig. 4 Model base development workflow

The development steps are as follows.

1) Determine the product specifications.
2) Generate a functional design based on the specifications.
3) Create a model from the functional design (see Figure 5).
4) Check if the model complies with the coding guidelines and correct it (see Figure 5).
5) Validate model movements through simulations and fix errors (see Figure 5).
6) If results don't meet specifications, refine the functional design and finalize the model (see Figure 5).
7) Automatically generate the program from the finalized model and implement it on the actual product (see Figure 6).
8) Evaluate and validate the actual product.

(note 1) A "model" refers to a simplified block diagram for a subject system.

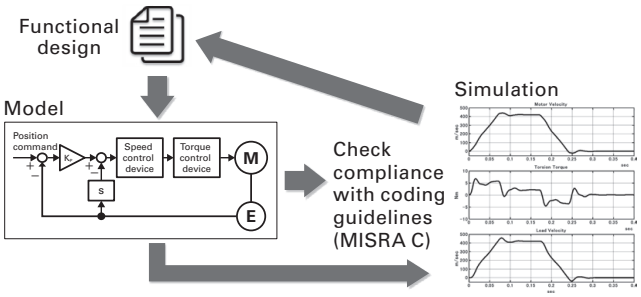

Fig. 5 Modeling and feedback of simulation results

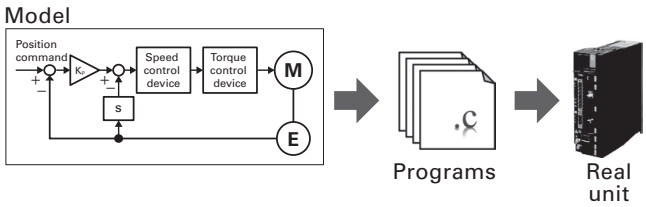

Fig. 6 Automatic program generation

This development method provides the following benefits:

- Verifications in the upstream process of development prevent errors from occurring in downstream.
- Automatic program generation eliminates human errors.
- Makes compliance with coding guidelines easy (MISRA C(note 2)).
- Simulations allow unrestricted verification.

By adopting this model base development approach, we aim to significantly shorten development periods and improve product quality compared to conventional development methods.

We also addressed the heat generation issue in servo amplifiers by introducing thermal simulations. During the expansion of the *SANMOTION G* servo amplifier lineup, we optimized the heat dissipation design and adjust the cooling fan angle using simulations, promptly resolving the issue.

In the future, we will expand the application of model base development to include motion control systems in addition to servo control systems, while further enhancing product quality and development efficiency. Through these initiatives, we aim to motivate ourselves, advance our technologies, and contribute to higher levels of economic productivity, aligning with the goals of the SDGs.

(note 2) MISRA C: Guidelines For The Use of The C Language in Critical Systems

4. Sustainable Manufacturing

To "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation" as outlined in the SDGs, we are committed to automating production lines and introducing systems that improve production efficiency. By consistently providing SANMOTION products that benefit society, we contribute to creation of a sustainable society.

This chapter presents our specific sustainable manufacturing initiatives for production systems and automated lines.

4.1 System for increasing production efficiency

4.1.1 Introduction of production guidance system

We employ production guidance systems in our manufacturing processes. Production guidance systems aim to standardize operations by displaying work procedures in digital format for operators, as shown in Figure 7. These systems enable efficient, error-free work and help stabilize quality and reduce resource waste, regardless of the operators' skill level.

Furthermore, these systems allow inexperienced workers to quickly learn the operations, significantly shortening training periods.

The stored operation history in the database can be analyzed to identify time-consuming or complex processes, supporting quality improvement activities. These include enhancing work efficiency and reducing defect rates by preventing errors.

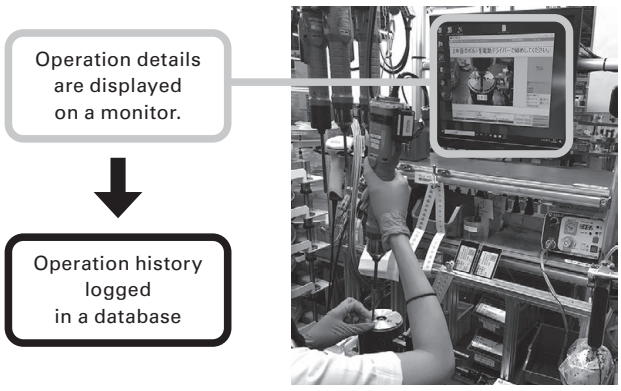

Fig. 7 Production guidance system

4.1.2 Building operator guidance systems(note 3)

In conventional operations, when a single operator managed multiple devices during production, it was the operator's responsibility to decide when to switch between the devices. However, poor timing often led to wait times, lowering productivity.

To resolve this issue and allow efficient workflows, we have built an operator guidance system.

(note 3) Patent application being processed

As shown in Figure 8, this system uses guide lights to signal when operators should switch between devices. When it is time to switch, the guide light blinks, prompting the operator to move to next device. Simultaneously, the guide light on the previously operated device turns off, and the device is locked to prevent unauthorized operation.

By introducing this system, operators can now switch between devices at the optimal time, eliminating wait times. As a result, production efficiency has improved by 42%, thereby optimizing the use of both energy and resources.

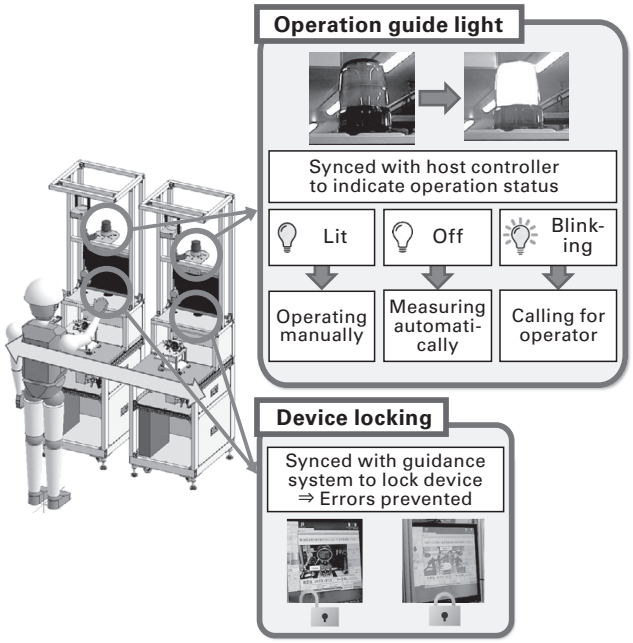

Fig. 8 Overview of operator guidance system

4.1.3 Development of measurement value monitoring system

We have developed a system for real-time monitoring of measurement values in the adjustment and inspection processes for encoders.

This system, shown in Figure 9, allows users to graphically display changes in measurement values by selecting the monitoring period, device, and criteria.

Previously, when a defect occurred, the personnel had to perform multiple tasks, including collecting measurement values, comparing them with standard values, and analyzing changes in measurement data before and after the defect to identify the root cause.

With this system, the time required for defect analysis has been reduced by over 80%, enabling more efficient solution and countermeasure development.

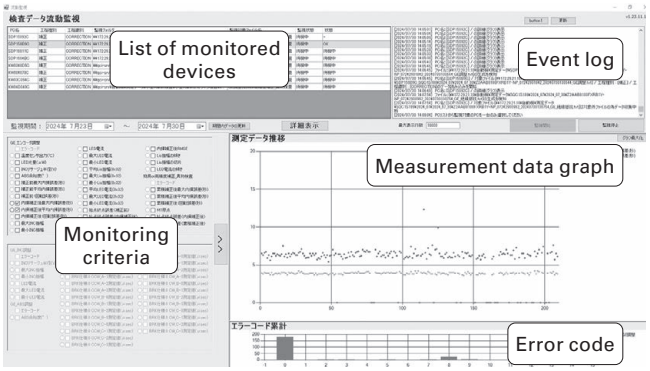

Fig. 9 Measurement value monitoring system

Additionally, we accumulate and analyze data to identify opportunities for process improvements. The system also supports trend analysis of measurement values to enable preventative measures, such as detecting deterioration in inspection equipment and jigs.

Through these initiatives, we reduce waste and environmental impact to promote sustainable manufacturing.

4.2 Building automated production lines

To realize efficient production and optimal personnel allocation, we have built automated production lines. In the automated production line for DC servo motors shown in Figure 10, individual stations for loading and inspecting workpieces are arranged in a single row, enabling automatic transport of products using pallets and automatic connections to inspection equipment.

In this line, product serial numbers serve as keys to retrieve product data from a database, automatically setting the standard inspection values and inspection details for each model.

This automation integrates transportation and inspection processes into a seamless workflow. This enhances production efficiency in high-mix, low-volume manufacturing and optimizes the use of both energy and resources.

Fig. 10 Automated production line for DC servo motors

5. Conclusion

This article has presented three initiatives involving SANMOTION products that align with our corporate philosophy and support the achievement of the SDGs:

(1) We introduced a proposal for a broccoli harvesting robot, a type of agricultural equipment designed to address the labor shortage in agriculture and contribute to stable food supplies.

(2) We showcased efforts such as utilizing the new wing of the Technology Center, joint development with the Design Department of SANYO DENKI PHILIPPINES, INC., and leveraging simulation technology. These initiatives have fostered fulfilling workplaces, enhanced employees' skills, and strengthened design and development capabilities.

(3) We detailed examples of automated production lines and introducing systems to efficiently manufacture SANMOTION products. These efforts support sustainable manufacturing, allowing us to continue providing socially valuable products while promoting sustainability.

As described above, we aim to keep the SANMOTION products closely tied to the SDGs, contributing to the realization of a "sustainable and prosperous society." Our goal is to create servo system products that contribute to a "society in which all people achieve happiness."

Reference

Yasushi Misawa and 15 others: "Development of the *SANMOTION G* AC Servo Systems"

SANYO DENKI Technical Report No. 54 pp. 45-56 (2022.11)

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