ICT and IoT Technology for Further Global Expansion of Production

Kawasaki is promoting the global production of hydraulic equipment and has established a system for boosting manufacturing capabilities with Nishi-Kobe Works and has continued to be a top brand in the field of hydraulic equipment.

In recent years, with the aim of catching up with rapidly changing global customer requirements, Kawasaki has been promoting the visualization of cost and production capabilities and working to realize a production system for local production and consumption through utilizing ICT (Information and Communication Technology) and IoT (Internet of Things) technology.

Introduction

In the construction and agricultural machinery markets, construction and agricultural machinery manufacturers are expanding their production and sales globally to address expanding markets in emerging countries and reduce exchange risk. They are keeping up with this a shift in the market through local production and consumption[1].

1 Background

Because construction and agricultural machinery manufacturers, which are Kawasaki's customers, are expanding their production and sales globally, there is an urgent need for Kawasaki to have a production system that enables local production and consumption in producing hydraulic equipment.

Regarding Nishi-Kobe Works as the mother factory for overseas production bases, Kawasaki has been producing rotary parts only in Japan, thereby remaining competitive in terms of quality and delivery. Rotary parts are used in hydraulic motors and pumps, which require core technologies and are called core parts.

To meet increasingly diverse customer needs and increasing demand, Kawasaki is required to further promote globalization, which means producing finished parts and core parts at overseas production bases with the same level of management.

2 Challenges faced in the core parts strategy and global expansion of production

Under the core parts strategy[2], Kawasaki has been supplying core parts from Nishi-Kobe Works to overseas production bases for differentiation in cost and quality. In addition, Kawasaki has been working to thoroughly eliminate overburden and waste and ensure full use of equipment and manpower by promoting KPS (Kawasaki Production System) in its production sites with the aim of reducing cost and enhancing quality.

However, as the number of production models increase to meet diversifying customer needs, a substantial number of man-hours are needed to modify standard operations for operators. The required production model may change when standard operations have been modified. In addition, because of the increasing demand, it is becoming difficult to meet the customer-required lead time by supplying core parts from Nishi-Kobe Works only. Moreover, Kawasaki has so far remained competitive in quality and price by focusing on managing core parts but will be required to enhance the management level of other parts to strengthen its competitiveness.

To address these challenges, we decided to further expand our production globally. However, we will not start producing core parts at overseas production bases if the conditions are not met, due to the risk of quality degradation or technology leakage even it would reduce the cost or lead time. Taking this into account, we decided to look into the following two specific measures.

① Changing production models flexibly to meet diversifying customer needs and ensuring prompt response to such changes for efficient production.
② Having overseas production bases produce core parts that require relatively easy production and quality management.

3 Importance of ICT and IoT technology in global expansion of production

Changing production models flexibly and producing some core parts at factories other than Nishi-Kobe Works is essential to keep up with customers' globalization. In addition, maintaining superiority in quality is necessary to maintain a high market share and avoid involvement in product price competition.

In further expanding production globally, ICT and IoT technology contribute to achieving the same level of quality and productivity at lower cost and making adequate use of production know-how from the startup of the production line as well as these technologies makes it possible to offer customers the same value from different production bases.

4 ICT and IoT technology for global expansion of production

To expand production globally, we put emphasis on visualization in each production phase using ICT and IoT technology.

(1) Visualization of production plans and results in machining processes

Every production base has machining processes for various parts, and Nishi-Kobe Works has the largest scale of machining processes. Amid the increasing demand, maintaining the equipment operating rate at the maximum level is important to satisfy the customer-required lead time.

In making investments in machining equipment, each production base is required to have a system for efficient use of equipment. Therefore, we visualized the operating condition of machining equipment so that both the supervisor and operator can keep track of the progress of production and also the supervisor can give efficient work instructions.

First, we developed a system for giving efficient work instructions to an FMS (Flexible Manufacturing System), which is shown in **Fig. 1** and has been adopted in several places in Nishi-Kobe Works and keeping track of work results.

An FMS can machine multiple models at the same time. Available machining equipment depends on the model, so if the number of models machined at the same time is large, the output changes depending on the work sequence. In addition, FMSs should be operated in conjunction with the assembly line, so the operators need to perform their work while accounting for the following:
① Accomplishing the instructions given on the production management board.
② Recording work results.
③ Minimizing the operation loss of the equipment each operator is in charge of.

Supervisors may create a plan to make full use of equipment but the achievement rate changes depending on the proficiency level of each operator. Many man-hours are needed to efficiently analyze the difference between the plan and the achievement rate.

Therefore, we introduced a work instruction system to

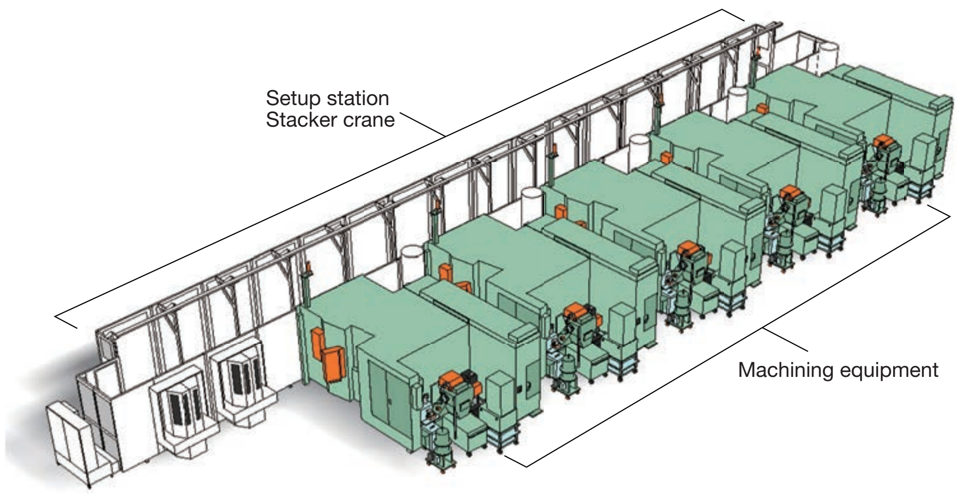


Fig. 1 Overview of FMS (Flexible Manufacturing System)

automatically create the operator's work sequence and equipment operation plan based on the production plan as shown in **Fig. 2** so that anyone can plan and execute the same work sequence.

With this system, the equipment operating rate in hydraulic pump part machining lines has improved by an average of 5 to 10%. In addition, it has become possible to visualize problems even if the equipment operating rate does not improve.

At overseas production bases, in general, one operator is in charge of multiple pieces of equipment. Currently, this system gives work instructions to FMSs but it can also give work instructions to operators with the same concept.

This enables production bases that introduce the system into their lines to perform the same level of improvement activities as the Nishi-Kobe Factory without depending on the supervisor's ability.

(2) Visualization of work in assembly processes

At Nishi-Kobe Works, hydraulic equipment of different types is produced in an assembly line for cost reduction.

In mixed production lines, new operators and experienced operators work together on the same line, so the bottleneck process changes constantly depending on the operator and product. In these lines, the supervisors have difficulty immediately identifying where a problem has occurred and taking necessary actions to remedy it.

To solve this problem, we developed a system that can automatically obtain detailed data on each production process and analyze the progress of production in real time, i.e., visualized work.

Figure 3 shows the process information obtained by this system. This system collects work data in each process from the sensors installed on a production line and displays the obtained data with the BI (Business Intelligence) tool. This has enabled early problem detection with the visualization of line status. In addition, variations in standard time can be minimized by optimizing the sequence of loading products onto the assembly line.

Differences between the assembly plan and result, which are currently analyzed based on the supervisor's ability, depend mainly on the product loading sequence, production model, and operator, so cannot easily be analyzed. The newly developed system is able to quantify the differences by visualizing work and in addition, can evaluate the effectiveness of improvements in the same manner. This system makes it possible to quantify problems in production lines, thereby eliminating management dependent on individuals.

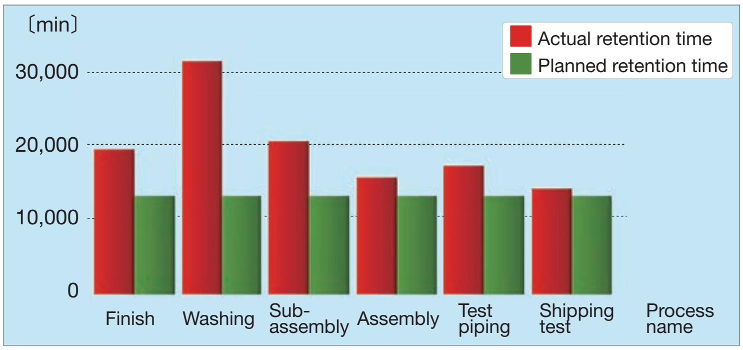
Introducing this system into each production base provides standardized production line management procedures, thereby making it possible to detect problems early regardless of the production volume. This system also provides efficient line improvement with a unified way of thinking in response to requests for cost reduction and lead time reduction.

(3) Visualization of cost

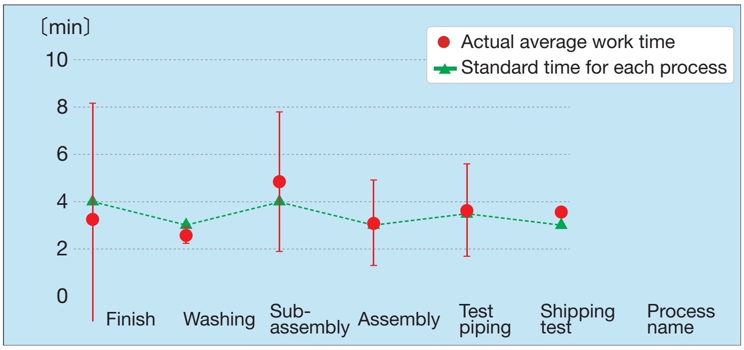
The cost management system currently used in Nishi-Kobe Works is based on the system introduced in 1986 and its operation began in 2006.

After mechanization and automation in 2011, it became

Fig. 2 Overview of operation instruction system



(a) Total retention time in each process



(b) Average work time for each process and variation

Fig. 3 Collected process information

difficult to evaluate cost in a uniform manner due to uneven automation. In addition, labor saving is required for cost calculation and it is better for the actual production volume to be grasped automatically.

These problems are expected to arise at other production bases in globally expanding production, and measures are needed. To solve these problems, we decided to introduce a new cost calculation method and quantify and visualize cost, which changes according to the circumstances, so as to address globally expanded production.

Figure 4 shows the overview of the new cost calculation method. The machine rate, which represents the equipment operating cost per hour, is calculated based on the equipment operation time obtained from machining equipment. If the operator's work time, including assembly and operation, is the dominating factor, then the man rate, which represents the operator's labor cost per hour for each of the processes, is set based on the work time automatically measured by the sensors installed in the production line. By combining those rates, we aimed to obtain more detailed cost information.

Major improvements brought about by the new cost calculation method are as follows:

① The target cost reduction can be clarified by visualizing the details of cost for each product model.

② In rate calculation, the operation time for each piece of equipment is measured and calculated automatically, enabling significant labor saving.

The new cost calculation method enables not only accurate cost control but also strong linkage between management and production line improvement, thereby making it possible to clarify what to focus on for cost reduction. In addition, with this method, it is possible to identify departments responsible for each factor through detailed cost analysis, enabling strong promotion of improvement activities.

Introducing this new cost calculation method into each production base will enable global cost evaluation. Cost is a customer need that customers put particular emphasis on. This method enables accurate decision making through cost comparison for each production base. We think that this will make it possible to formulate appropriate business strategies for the management plan.

(4) Visualization of supply chain

In expanding production globally, global procurement is an important issue as well. With the conventional management method, if a product is purchased nearby, the delivery can be confirmed adequately through close communication, so problems are unlikely to occur. In global procurement, however, suppliers exist worldwide, so

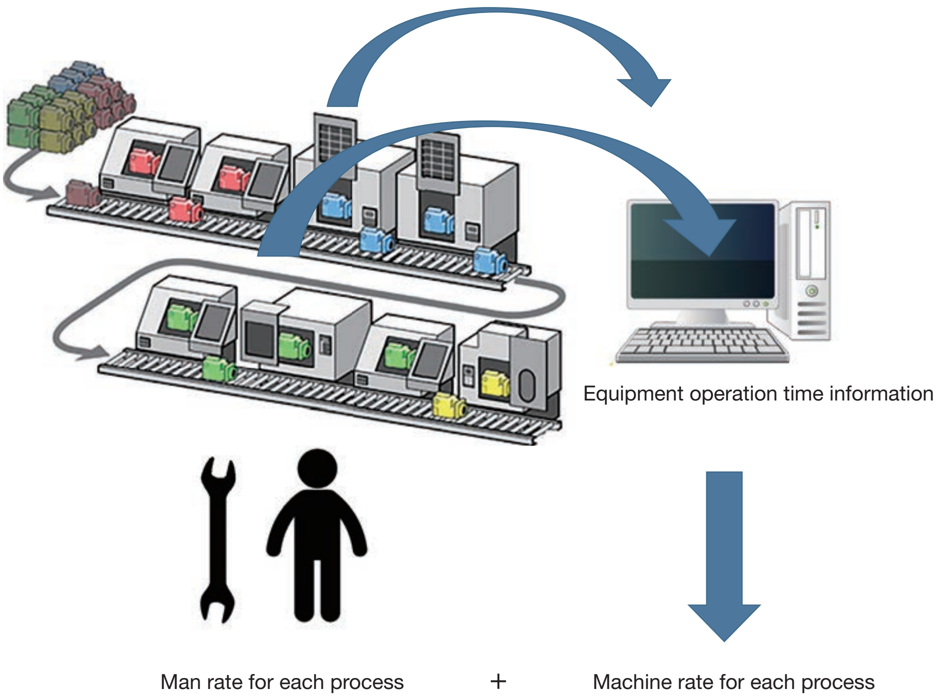


Fig. 4 Overview of new cost calculation method

several additional items must be considered.

Taking hydraulic pumps as an example, even they consist of over 40 kinds of parts (which is a relatively small number) so even if production activities are managed properly within the factory, a delay in the delivery of even one part will result in a failure to meet the delivery date required by the customer. Globalized procurement requires complicated delivery management for purchased products.

To address this problem, we decided to visualize the supply chain. More specifically, the production management workflow used in Nishi-Kobe Works, as mother factory, is used as a model so that it can be used by suppliers as part of the production management system. This makes it possible to share the basic concept of production management with suppliers.

Figure 5 shows an overview of the modeled production management procedure. The current operation workflow consists mainly of equipment capacity estimation,

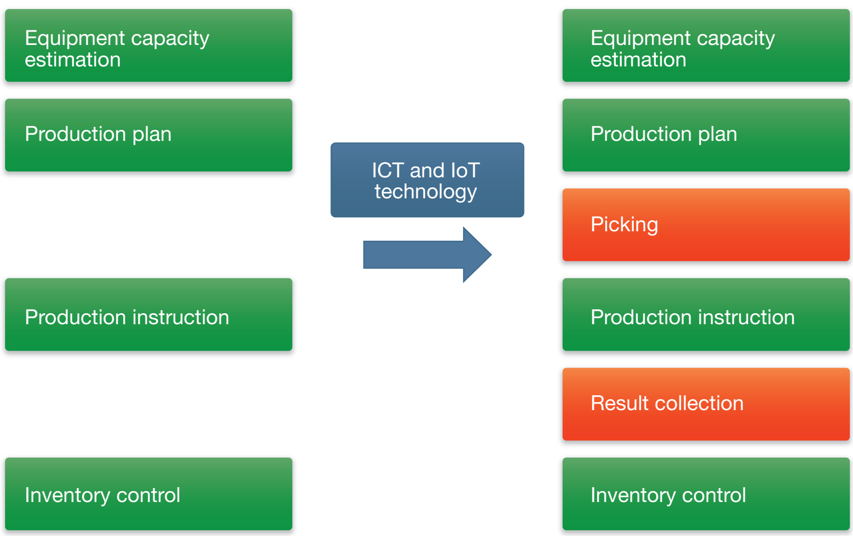


Fig. 5 Modeled production control method

production planning, production instruction, and inventory management. A new production management system will be established by adding picking and result collection using ICT/IoT technology to the workflow.

This production management system enables borderless delivery and inventory management even under a globalized production system.

Conclusion

In order to meet global customer needs, we established a foothold for expanding our production globally with the same management level as Nishi-Kobe Works through promotion of visualization using ICT and IoT technology. This has allowed us to promote a production system for local production and consumption.

We will be working to establish a flexible production system that can respond to varying customer needs and promoting technical innovation as a top brand in the field of motion control.

Reference

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