

OKI's Mono-zukuri Innovations

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Seven years have passed since the National Academy of Science and Engineering (acatech) announced "Industry 4.0" in 2011. Likewise, in the United States, "Industrial Internet" is being formulated led by General Electric and other organizations.

In Japan, many IoT related consortiums have been launched and are active. As of recent, the Japanese government put forth a strategy called "Connected Industries" at CeBIT 2017 held in Hannover, Germany in March 2017, which OKI was also a participant. The strategy calls for the effort to advance connections between people and all sorts of machines in the manufacturing sector not merely from the point of automation and efficiency, but also from the viewpoint of prevention and prediction. Furthermore, the strategy is expected to endow not only large companies, but also small and medium companies with a solution to the growing problem of labor shortage.

Mono-zukuri Initiatives using IoT

IoT has brought remarkable impact to the manufacturing industry, and innovations seen at production sites in recent years have been nothing short of astonishing.

IoT is often said to progress in four stages. They are "Stage 1: visualization," "Stage 2: control," "Stage 3: optimization," and "Stage 4: autonomy." Prior to 2010, OKI's visualization of the production sites allowed:

- Progress of the production line to be viewed at the site's line
- Operating status of each production facility to be viewed on the facility's display.
- Status of stocked components to be presented as a result during the process
- Quality status of the process to be compiled and displayed

As can be seen, the statuses of the production site's assembly lines, facilities and processes can be determined through batch processing.

Currently, the progress and operation status of a process can be confirmed on a PC via a network without making a physical visit to the production site. Additionally, a system can be constructed for monitoring the real-time

status of overseas production bases.

Future approach for production sites is "Can the future be predicted and trouble be prevented?" This is not a standalone effort of OKI's production technology, but currently a co-creation effort with facility manufactures. The ICT Systems Honjo Plant and Mechatronic Systems Plants will be presented later as examples of the approach.

In moving toward "Stage 2: control" and "Stage 3: optimization," the various huge volume of information obtained during "visualization" must be converted using AI to "information that can be controlled" and "information for prediction."

Current Environment of the Manufacturing Industry

Traditionally, the strength of Japan's manufacturing industry has been "on-site capabilities." It goes without saying that elimination of wastefulness and kaizen activities have long supported Japanese mono-zukuri. However, it is said that the situation of maintaining this strength in "on-site capabilities" will continue to be difficult in the future.

Currently, population decline, especially those of the work force, is a problem. The most notable are the service sector that includes accommodation and food services, and the transport sector. In both business sectors, overworking including extensive overtime has been criticized, and it became necessary to shorten business hours, make changes in the offered services, and review pricing due to wage revisions.

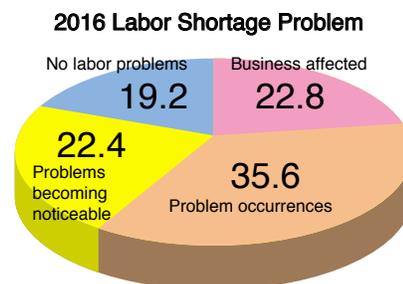


Figure 1. Labor Shortage (Source: White Paper on Manufacturing Industries (Monodzukuri) 2017^{*)})

Figure 1 shows that over 80% of businesses experienced some sort of problem arising from labor shortage in 2016. At the present, the situation is growing worse.

It is the same for the manufacturing industry. Hourly wages for on-site manufacturing workers have risen for five consecutive years, yet labor has not been secured. As shown in **Figure 2**, OKI has production bases in the Kanto, Joshinetsu, Fukushima and Yamagata regions. Securing labor is a common problem at all the production bases. Where there are favorable automobile or large equipment industries in the vicinity, the severity is getting higher.

The problem of securing labor is not limited to on-site workers. As skilled workers who have supported the on-site work grow older, personnel to take over their position is not being secured. Thus, on-site expertise and “master craftsmanship” will be lost. It is feared that this may result in the loss of “on-site capabilities.”

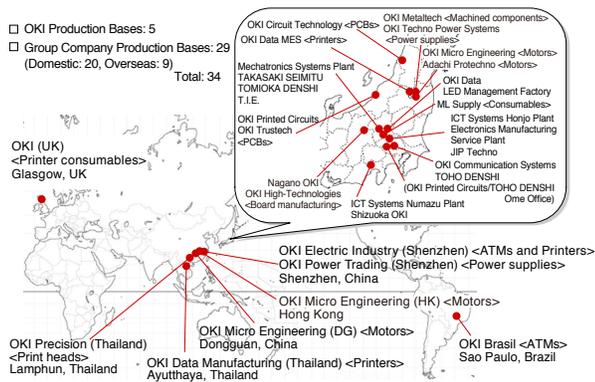


Figure 2. OKI Groups' Production Bases

Mono-zukuri Innovation Approaches

In introducing new technologies and products for mono-zukuri, measures to deal with the problem of securing labor and how to make effective use of “master craftsmanship” are also presented. Some examples are described below.

“Development of a new production system using robots and AI” was the approach taken by the OKI Data LED Management Factory.

In the multiple processes of assembling minute components and performing processing inspections, a robot with AI was utilized enabling unmanned supplying and automation of the entire line. As mentioned previously, labor shortage is a concern. The situation is even more dire for the nightshift. With this approach, if the necessary components are set, supplying of components, setup for the next process and the pickup of the finished product can all be performed automatically, thus greatly contribute to the measures against labor shortage.

“How to support on-site work of remote locations?” was the question tackled by the Corporate Research and Development Center and ICT Systems Numazu Plant. How to transfer and utilize the expertise of skilled workers possessing “master craftsmanship” is the topic currently under study.

Installation and maintenance work of each product must be performed on-site. When troubles occur, wisdom of skilled workers becomes a necessity, but many skilled workers are aging, and the number of those remaining in the workplace is limited. As a solution to that problem, the “possibility to remotely provide on-site guidance using wearable terminals” is being investigated.

“Predictive maintenance of production facilities using sensors and AI” was the activity undertaken by the ICT Systems Honjo Plant and IoT Application Development & Business Promotion Division.

The ICT Systems Honjo Plant mainly handles mono-zukuri of communication equipment. The key to that is the board mounting process. Due in part to the production of high volume products, the operating rate of electronic component mounting machines is high with operation taking place day and night.

At the production site, a continuous line has been built and production from board assembly to final product inspection is performed. Stoppage of the electronic component mounting machine line means the entire product line comes to a stop. For this reason, quickly picking up production facility anomalies, strange vibrations, screeches and other abnormalities to predict and perform preventive maintenance becomes the deciding factor for sustaining the line. This activity is currently proceeding co-creatively with the electronic component mounting machine manufacturer. The manufacturer is also considering the implementation of the activity result to its other mounting machines that are operating around the world.

The topic “How to manage the operation of processing facilities?” being tackled by the Mechatronics Systems Plant is a similar effort. The strength of the Mechatronics Systems Plant is sheet metal processing, and many sheet metal processing facilities are used. Working co-creatively with the sheeting machine manufacturer, a system has been built to study how subtle changes in sheeting machine vibrations can be used to improve the sheeting machine’s operating rate.

So far, these efforts at the ICT Systems Honjo Plant and Mechatronics Systems Plant have in part been sustained by the expertise of FA (Factory Automation) engineers. Using technology to predict that expertise is also an effort that is being undertaken.

OKI Initiative: “Production Reform Awards”

A distinguishing characteristic of OKI’s production departments is that they including affiliated companies fall directly under each business division. Such an organizational structure is liable to give rise to production site egoism or negligence in information sharing. Therefore, the Engineering Support Center (ESC) carries out OKI and its affiliated companies’ cross-departmental activities. At ESC, a select few perform cross-departmental activities covering many production related fields such as production, quality, export control, technology safety, global environment and construction work.

Besides information sharing activities, ESC responds to company-wide issues that include enactment of corporate regulations, measures for various risks, liaison meetings of the entire OKI Group, unfolding of legal regulations/revisions, and reporting to various government agencies/certification bodies among others. The department also solves production related problems.

As one of the cross-departmental activities, ESC has held an annual “Production Reform Awards” event since 2010.

The OKI Group as a whole holds an annual “OKI Group Awards” to announce the results of the year’s efforts. In the past, innovations of the production departments were presented at this event. However, mono-zukuri innovations and new businesses/business viewpoints were deemed incomparable, thus it was decided an independent awards event should be held.

For 2017, the 7th Production Reform Awards was held in December with the president, executive officers, general managers and production site managers as judges (**Photo 1**).



Photo 1. 7th Production Reform Awards

A theme is chosen every time the event is held. The 2016 theme was “Towards Visible, Connected, Living

Production Sites.” For 2017, it was decided the event will return to the basics of mono-zukuri, and the theme “Profitable production sites” was chosen with “Effectively utilize management resources and generate profits from production sites” as the sub-theme.

As a manufacturer, the source of profit lies in the production sites. Going back to this basic philosophy, the competition was to focus on the effective use of management resources for the generation of profits.

The candidates for the 2017 awards were OKI and affiliated companies’ 34 production bases. Preliminary judging was conducted at each department level. This was followed by a secondary judging at the business division level. The eight sites that were selected, including two sites from China, made their presentations at the event.

Presentations at each event were primarily “New Innovation Activity Reports,” but as a new initiative, a special “Homage Award” was established in 2017. Homage is a French word meaning “showing honor and respect for the original while incorporating unique ideas or expressions.”

For production sites, this means “theme realized by incorporating arrangements to one’s base using innovations of other bases as examples.” One cannot keep from looking at new mono-zukuri innovations, but this Homage Award is in agreement with the production site activities’ basic philosophy of “Effectively utilize management resources and generate profits from production sites.”

The 2017 Homage Award honors went to Nagano OKI/OKI High-Technologies’ “Deployment of Projection Assembly System (PAS) to the Board Assembly Process.”

This was the application of the Mechatronics Systems Plant’s PAS, which won the previous year’s Production Reform Award. Arrangements were incorporated into the PAS and deployed to the post-processing of the board assembly, which is Nagano OKI’s specialty.

PAS is a system that uses a projector and projection mapping method to project images that instruct workers the picking place and the quantity of the components to be used for assembly. It also projects the assembly’s work instruction manual on to the workbench (**Photo 2**). The system was created by the members of the Industrial Engineering Department at the Mechatronics Systems Plant. In addition to the projections, the system detects hand movement with an USB camera and checks whether a worker has taken a wrong component.

This not only prevents mistakes in mounting the components, but it makes preparatory work such as

supplying components set, preparing work instruction manual and filling out check sheets more efficient. The actions are also recorded and kept as data, which can be used for traceability management. Furthermore, the actual work time can be analyzed to provide source data for work improvement, and without doubt, it can be used as an educational tool for newly assigned employees.



Photo 2. PAS System

Nagano OKI has added new value called component-setting instruction to Mechatronics Systems Plant's PAS. Unlike casing assemblies, components for the board's post-processing are small and often difficult to distinguish. Therefore, Nagano OKI incorporated a mechanism in the PAS that reads the barcode of a component and determines which shelf to set the component.

Incorporating one site's innovation into another department to achieve results is an important role in the ESC's cross-departmental activities, and the activities will be continued in the future.

The PAS has been made into a packaged product for wide use outside of OKI. It is a new OKI product born from the manufacturing department.

Couple of overseas initiatives not included in this issue but worth mentioning is introduced below.

"Packaging Innovation for the Chinese Environment" is Mechatronics Systems China Plant's initiative to reduce the number of cardboard boxes used in the delivery of components. The environmental regulations in China are becoming severe, and the price of cardboard boxes and the cost of its disposal are getting higher. Moreover, labor is required to remove the components from the cardboard boxes and set them up for supply to the assembly line. The labor cost in China is spiking with the minimum wage doubling in just five years. In addition to labor costs, human handling introduces quality risks.

To respond to the problem, the local Chinese staff took center stage, and derived an idea of a returnable box. China, in a sense, has a culture that promotes self-optimization. In such a culture, this activity collaborated with the component manufacturer, found favorable points for both companies, built a win-win scenario and realized a solution. It may have been a modest activity, but it was an activity not previously seen in China. Through this activity, the environmental, cost and quality problems were all solved. This year, OKI group as a whole underwent review to transition to the 2015 version of ISO 14001. This packaging innovation activity proved to be a great contribution to OKI's environmental activities.

The other overseas initiative is the "Automation of Soldering Process Disliked by Workers" at OKI Micro Engineering China Plant, which manufactures industrial motors. Activities at overseas bases have mainly centered on transferred Japanese staff, but now they are stepping up to activities centered on local staff.

Future Production Department Activities

When production site innovation is mentioned, attention is usually drawn to IoT and new hardware related to production technology such as new systems, technologies and equipment /measuring instruments /automation. Although it may be the same for the recent quality issues, it is often said technology at the production site has improved, but the skill has fallen. The presentations at OKI's "Production Reform Awards" are increasingly on new technologies and new approaches as well. New technologies are important. However, for one-second/one-step, the spotlight should be focused on the simple and honest activity of innovating for site improvement. In order to realize this, a plan is in the works to divide the next "Production Reform Awards" into the areas of "New Technology Initiatives" and "One-second/One-Step Involvement in Site Innovation." There is "No End to Improvement/Innovation Activities" and "Source of Profit Lies in the Production Sites."

Conclusion

The previous mono-zukuri feature²⁾ issued three years ago, introduced initiatives centered on OKI's major domestic production sites.

In this issue, the introduction of new technologies and products has been shifted outside the framework of production sites to a viewpoint of what kinds of activities are being conducted.

There are many more innovation and improvement activities taking place at each production site other than the ones introduced in this issue, and a great number of them are eagerly eyeing the next “Production Reform Awards.”

Readers with interest in the activities taking place are welcome to give OKI’s production sites a visit. ◆◆

■ References

- 1) Ministry of Economy, Trade and Industry: White Paper on Manufacturing Industries (Monozukuri), June 2017
- 2) OKI Technical Review Issue 225, Vol.82 No.1, May 2015

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TiPO [Glossary]

Returnable box

Box used for delivering products and components to client. Instead of a single delivery, the box can be repeatedly returned and reused.