Smart Factory initiatives aimed at achieving highly efficient production sites

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Abstract

As electrification advances, improvement of overall equipment efficiency at manufacturing sites is required for further improvement of cost and quality competitiveness. To do so, further analysis of the primary causes of declining operating rates and shortening of the improvement cycle are necessary. We have therefore promoted the digitization of information. This report describes the development and development of an in-house system designed to respond promptly to changes in the business environment and the needs of each manufacturing site.

1. The Smart Factory JATCO is aiming to achieve

At JATCO, activities to digitize information inside factories to improve overall equipment efficiency (OEE), referred to as Smart Factory activities, are promoted based on the roadmap shown in Fig. 1 and the following three steps.

Step1:Factory that minimizes defects and equipment stoppage time

Step2:Factory that does not pass on defects and does not stop production lines

Step3:Factory that maintains maximum efficiency

Progress as of 2023 is between Step 1 and Step 2. The actual OEE at JATCO is around 80%, and we are aiming to achieve 90% in Step 2 and 100% in Step 3[(1)].

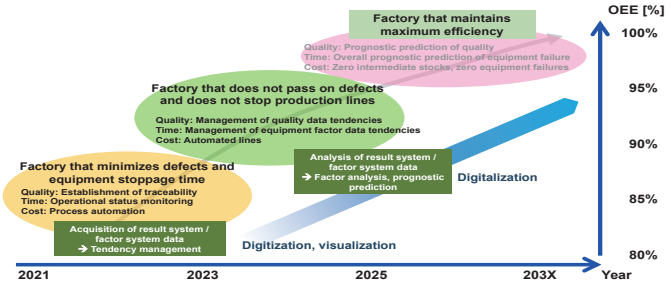

Fig. 1 Roadmap to JATCO's Smart Factory

2. How to promote digitization and visualization

2.1 Necessity of digitizing information at production sites

To improve OEE, it is necessary to share the operational status and changes of production lines, as well as to identify the causes of the declining operating rates and implement countermeasures. For prompt information sharing, a system in which information is digitized and stored so that necessary information can be collected and analyzed without human intervention is absolutely essential.

As an information storage system, JATCO has built EQ_Connect, which is an unified information platform for the entire company[(1)].

EQ_Connect is a platform that supports the visualization of data at sites by consistently carrying out data collection, transfer, storage, and visualization.

This report describes the in-house development of a subsystem to be connected to EQ_Connect.

2.2 Necessity of in-house development of the subsystem

The subsystem was developed for the purpose of flexibly responding to various requirements at each manufacturing site.

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JATCO has manufacturing sites that range from casting and processing to assembly. The information to be managed and analyzed differs depending on each manufacturing site, as each site has different manufacturing methods and unique equipment. Therefore, the optimal input devices differ.

For example, on processing automation lines, tablets or PCs with large screens are required at the end of the lines.

On the other hand, on assembly lines, small portable devices that can be used to input the reasons for the stoppage of individual pieces of equipment without leaving the line are required.

Like this, in order to respond to the needs that vary depending on individual equipment, in-house development is necessary, as person-hours, costs, and lead times would become enormous if they were outsourced.

In addition, as a flexible response, we have carried out in-house development to enable us to respond quickly and precisely through analysis and utilization. This includes changes to collect information that meets the issues in the ever-changing production lines, integration with newer devices, and data collection using new technologies such as AI.

In addition, as a side effect, by gathering software assets and know-how, we were able to shorten lead times for system improvements and make in-house development a possibility.

3. Development methods to maximize merits

In the in-house development of the system, the development was carried out under the following policy in order to maximize the merits.

1)Adopting an agile development process

Agile development is a system and software development method that involves repeating the plan, design, implement, and test development process in smaller functional unit cycles. Detailed specifications were clarified and additional requests were reflected through multiple trials at the manufacturing site from the test stage. In addition, by improving proficiency through tests, we could smoothly transition to the start of operation.

2)Utilization of off-the-shelf software

While utilizing free and opensource software and paid package software (outsourced systems), we have carried out agile in-house development of interfaces between devices and systems without hindering customizability. Our aim is to minimize development person-hours and lead times.

3)Supporting various input devices and sensors

The devices for acquiring signals from equipment were developed in-house from control circuit boards. They have been developed to have degrees of freedom in the quantities and types of signals that can be connected.

4)We developed them using a web-based system at the core, and input has been made possible not only from computers but also tablets, smartphones, and IoT devices. In addition, Wi-Fi and private LoRa communications were adopted. LoRa communication allows for a longer transmission range than Wi-Fi, enabling stable communication while covering the entire factory building. The positional relationship of the devices is shown in Fig. 2.

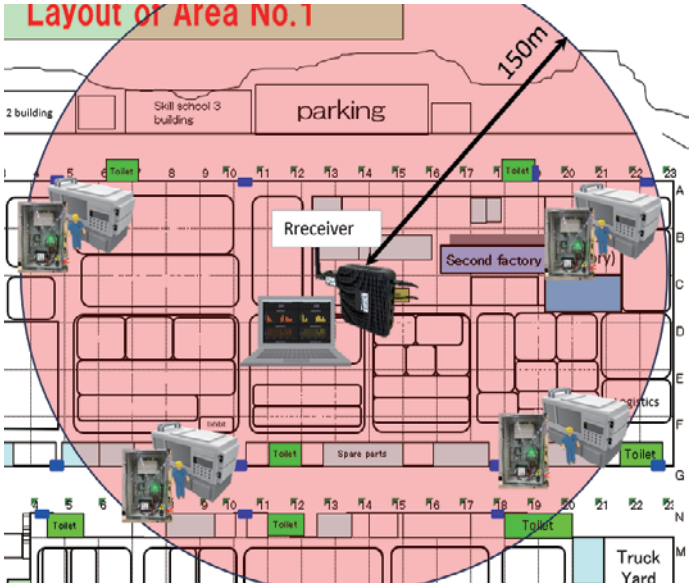

Fig. 2 Visualization of device locations

4. In-house development cases

Cases involving the development policies are shown below.

4.1 Development of JPH Monitor System, a simplified operation monitor

The JPH Monitor System is a system developed in-house that acquires production volumes hourly. It is installed on existing equipment for which it is difficult to automatically acquire operational information.

This time, we designed and created the hardware (base) and developed the software, achieving in-house development of the JPH Monitor System.

An outline of this system is shown in Fig. 3. This system is able to transmit, record, and display equipment production quantities and production times to a database server over a wireless network. It also has the following features.

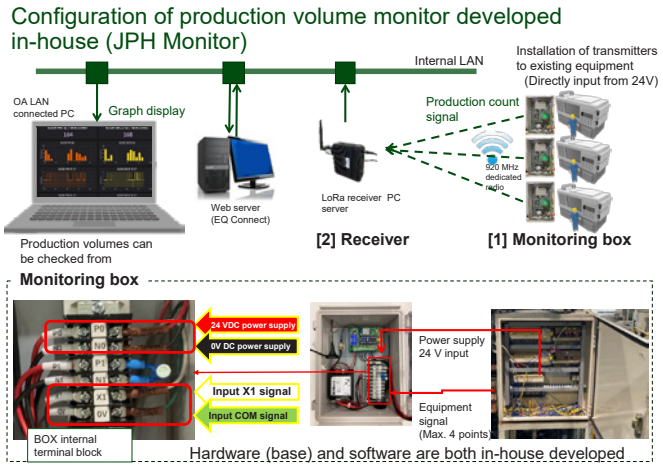

Fig. 3 JPH Monitor System

- It is a hardware that is easy to install as it does not require additional fabrication of wiring, etc. in accordance with the standard specifications of the factory.
- Using private LoRa communication, long range communication is possible even inside the factory, and no additional infrastructures is necessary.
- Using dedicated reception software, data can be acquired simply by connecting a receiver to the server.
- EQ_Connect data can be used.

Since hardware and software are all developed in-house, they can be customized in accordance with the requirements from the production lines. And through additional customization of the software, it was also possible to easily respond to acquisition of equipment error occurrence times, numbers of error occurrences, high cycle equipment data, and analog sensor data.

4.2 Digitization of handwritten daily reports

For information that must be input by production line operators, a system to directly input information via tablets was developed, and the accuracy of input data was improved while reducing the amount of paper used and eliminating losses resulting from copying.

In developing this system, we utilized Grafana as an open-source BI tool. This is a tool that visualizes stored data. Meanwhile, Pleasanter Community Edition was utilized as a low-code application development platform.

5. Measures to encourage establish at production sites and operational management

The quality and quantity of DX personnel were improved and increased to expand and establish digitization at production sites.

- An ICT team with intermediate level digital skill operators was launched in the Company-Wide Management Department to carry out in-house development and provide support.
- DX teams that promote digitization were placed in each factory.
- Skill improvement was carried out by solving problems jointly by each DX team and the ICT team.
- A DX Lab was established in the Production Division, and an environment in which trial and error is possible was constructed. And personnel development was implemented by holding consultation meetings for help solve problems and accepting personnel who wish to improve their skills.

The DX promotion system of the Production Division is shown in Fig. 4.

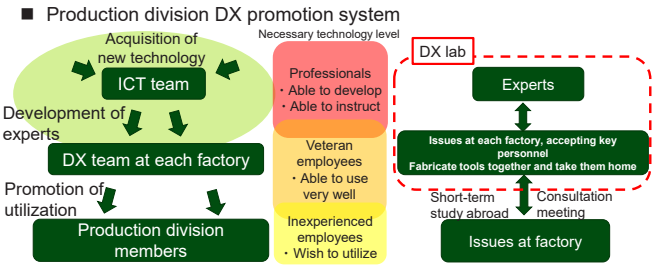

Fig. 4 DX promotion system in the production division

6. Conclusion and future initiatives

Through these activity, we were able to see the prospect of achieving Step 2 of our OEE goal.

And, by increasing the number of DX promotion members and clarifying authority, we were able to expand our system to promote independent digitization.

We want to advance improvements in technologies for collected data analysis in order to achieve Step 2: Factory that does not pass on defects and does not stop production lines.

7. References

(1)Makoto HIROSAKI: Construction of a platform for supporting promotion of manufacturing workplace data digitization and improvement of overall equipment effectiveness, JATCO Technical Review No. 22, pp.111 - 115.

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