Key Points for Utilizing Digital Technologies at Manufacturing and Maintenance Sites

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Many companies are considering the utilization of digital technologies with the aim of improving work quality and acquiring highly accurate condition data at manufacturing and maintenance sites. However, it is not easy to reliably introduce and establish digital technologies at sites, the technologies often fail to fit operations, and such efforts often fail to progress beyond the trial and demonstration period. On-site, continuous improvement (KAIZEN) activities are implemented on a daily basis, and leading companies in industry tend to change operational procedures very often. In addition, work environments and conditions vary site by site. This leads to the need for solution agility to nimbly accommodate differences and keep up with changing on-site conditions. Accordingly, Fujitsu has adopted an approach that realizes applications that can be used continuously by converting business and digital technologies into standard business components that can be combined into design patterns for application at sites. Not only does this approach allow the quick launch of a first trial and demonstration on a small scale but it also enables the people at each site to easily modify applications to match operations after the trial phase. The introduction of new digital technologies drives operational sophistication and further growth. This paper describes key points for utilizing digital technologies at expanding manufacturing and maintenance sites with examples.

1. Introduction

Digital technologies such as IoT, AI, and virtual reality (VR) are rapidly spreading, especially at manufacturing and maintenance sites. As demand for mass customization (individualized mass production) increases, manufacturing sites are increasingly required to enhance work efficiency and labor saving for iterative tasks dictated by the manufacturing process, such as setup changes, part replenishment, visual inspection, and personnel training. Meanwhile, at maintenance sites, smart maintenance is required for the safe and systematic maintenance of a growing number of equipment and devices of various generations and types with limited personnel for failure prevention.

Yet nearly 40% of managers have concerns about the utilization of digital technologies such as IoT and AI for operations, expressing misgivings such as uncertainty as to actual contribution to operations and the high cost of development, and have not yet taken the step of making large-scale investments in ICT.

Nonetheless, interest in digital technology is growing and so is the number of proof-of-concept (PoC) cases documenting the utilization of IoT, AI, VR, or the like at selected model sites. To meet the needs of such customers, Fujitsu offers scalable digital solutions that can be started small without requiring a large initial investment and can be customized in a short period of time. These solutions are based on an approach that realizes applications by converting business and digital technologies into standard business components that are then combined to create design patterns.

This paper gives an overview of the issues in the introduction of digital technologies at manufacturing and maintenance sites, which are continually upgrading, and Fujitsu's digital solution, as well as an overview of the digital service platform to realize this solution and introduction examples.

2. Issues concerning the introduction of digital technologies

The introduction of digital technologies at manufacturing and maintenance sites involves the following

three issues (**Figure 1**).

1) System introduction without ICT administrator

The introduction of digital technologies at manufacturing and maintenance sites is done by the production and/or facility departments, which are the most familiar with site operations, rather than by an ICT administrator who defines requirements and introduces systems. In addition, because constraints in terms of products, facilities, and environment differ for each factory and each base, no investment advantage can be obtained from the definition of requirements and the construction of systems from scratch as in the case of the traditional system integration (SI) business.

A system that allows customers to verify the applicability and effectiveness of digital technology introduction while carrying out manufacturing and/or maintenance work is needed.

2) Flexible response to environmental and market changes

Improvement (KAIZEN) activities are carried out daily out in the field, and the higher up in leadership a company is, the more frequent are the changes it makes to the work content according to environment and market changes. In the same way as renewal and maintenance of equipment and facilities, systems based on the introduction of digital technologies need to be able to be maintained by customers.

Further, given the speed of innovation of digital technologies, new technologies are appearing one after the next. Business continuity cannot be achieved unless new technologies keep on being incorporated as the customer's environment changes.

3) Pursuit of higher added value

One expectation regarding the introduction of digital technologies is the enhancement of manufacturing and maintenance work through the use of data via AI and the like. Besides the replacement of traditional work with digital technology, the creation of new value can be expected. One such new value is the extension of data utilization. Constructing a system for a single purpose as traditionally done and then simply using its actual data is not efficient. In the digital age, various applications are possible depending on the analysis axes applied to the same body of actual production data, including productivity improvement, quality improvement, human resource development, and monitoring of equipment status. However, unless these applications are assumed and designed for, usage scenarios will be limited, and so will the effect of digital technology introduction.

3. Steps for the introduction of digital technologies

Based on the above issues, Fujitsu proposes the following three introduction steps for the provision of solutions that support the introduction and establishment of digital technologies at manufacturing and maintenance sites.

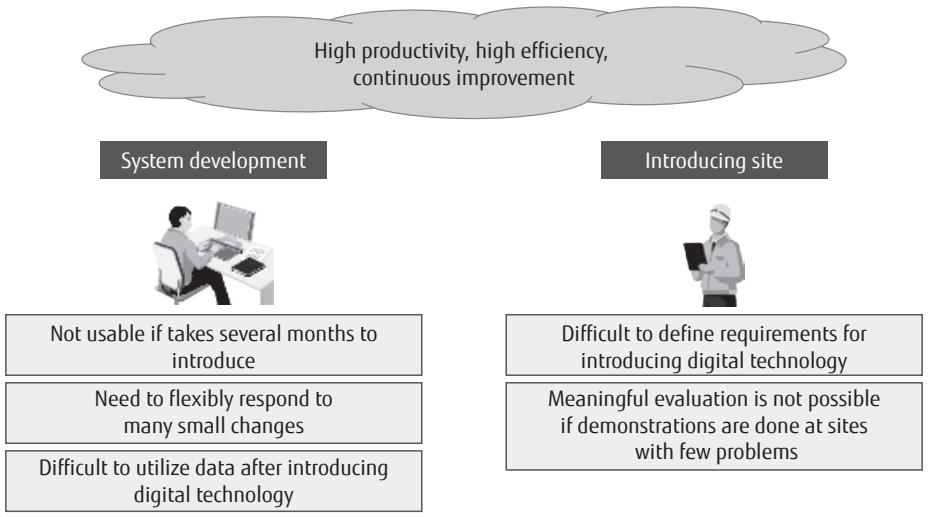

Figure 1
Issues concerning the introduction of digital technologies at sites.

1) Step 1

The first step is to undertake consulting with the aim of obtaining the agreement of the people in the related site departments to the introduction of digital technologies, and the decision to do so on the part of corporate executives.

When introducing digital technologies to a customer, it is indispensable to make the process as burdenless as possible for the customer according to the customer's work environment, work content, and site. Only under this condition is it possible to proceed with verification of the effects of the introduction of digital technologies in terms of management issues and the formulation of management measures. Therefore, as the first step when introducing digital technologies, solutions are to be reviewed at the site through discussion and planning as part of the consulting service. Any introduction effect will remain elusive unless the site departments are brought into agreement regarding the introduction of digital technologies, and further, the inability to convince corporate executives as to the value of such an initiative will prevent commitment to company-wide investment.

2) Step 2

The second step is trial evaluation of the application at a model site to verify the introduction effect. This step starts small, focusing only on the site and operations, and aiming mainly to achieve results that the customer can then use to convince others inside and outside the company. As the initiative at the model site gains recognition both inside and outside the company, it becomes easier to promote deployment to other sites as a company-wide measure.

The key point here is customizing the application to ensure a good fit to the use case at the site. To make this possible in a short period of time, we use the digital service platform shown in **Figure 2**. The application is created by assembling a number of standard business components as design patterns according to the work that is to be carried out. And since the components can be arranged in terms of process flow and content according to business changes, the application will be able to grow as the site does.

3) Step 3

The third step is to utilize data to enhance manufacturing and maintenance site operations.

As the introduction of digital technology progresses in this way, the third step makes it possible to utilize on-site data for further creation of added value. For example, as one surveys the actual conditions of a manufacturing site based on utilization rates of people and equipment, one may conclude that there is no room for improvement. However, visualization of the situation by correlating the flow of goods with the utilization rates of people and equipment makes it possible to identify potential waste, and in some cases, productivity can be dramatically improved in a short period of time.

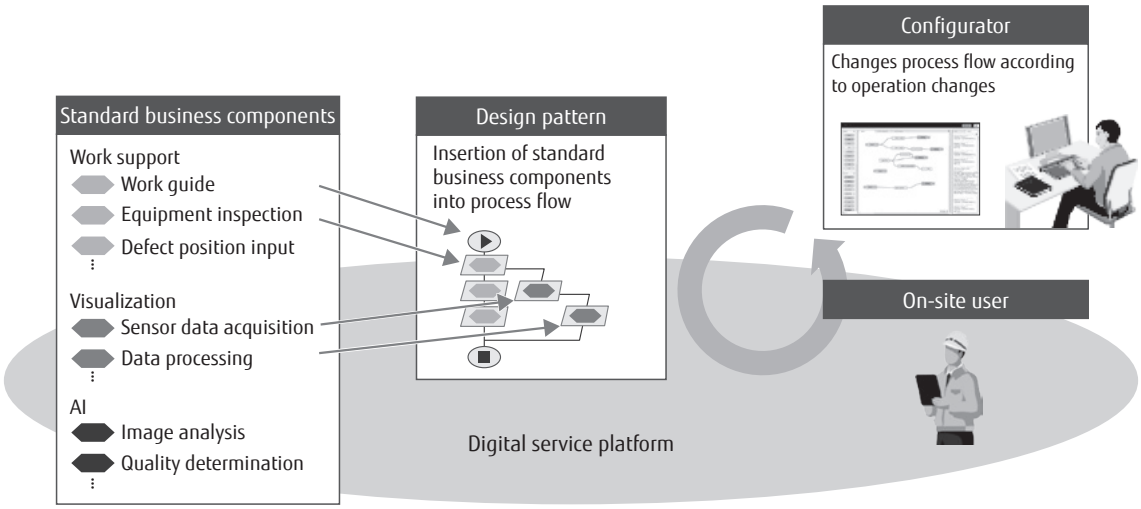

Figure 2
Digital service platform.

4. Digital solutions for manufacturing and maintenance sites

To support implementation of the above-described steps for digital technology introduction, Fujitsu provides digital solutions to grow manufacturing and maintenance sites in the form of a total package that includes consulting services, work support application, and data utilization.

4.1 Consulting service

The consulting service clarifies the actual content of the customer's operations and uses this information to support planning of the introduction of digital technologies. To this end, a consultant with a good grasp of both the customer's business and a wide range of digital technologies is needed. Gaining a good understanding of a customer's site operations is not easy and identifying work issues can rarely be achieved through just one or two on-site surveys. This is because, as mentioned above, site operations change due to daily improvements, and site workers are unlikely to readily reveal on-site issues to an outside consultant with whom they are still barely acquainted. Moreover, the consultant needs to be able to sort issues by priority, not just looking at the issues extracted from on-site interviews, but also from the viewpoint of management indicators such as return on investment (ROI). At Fujitsu, digital innovators well versed in such site operations and with extensive experience of introducing digital technologies in multiple projects are put in charge of consulting. The innovators are familiar with both digital technologies and site operations, and are thus able to plan the introduction of digital technology on a short-term, small-start basis yet with a long-term perspective.

4.2. Work support application

Two examples of applications that solved management issues and/or operation issues identified through consulting through the use of digital technologies are presented below.

1) Digitalization of work procedures

Training through printed manuals and videos showing experts performing given tasks cannot guarantee that still inexperienced workers will perform the required work without mistakes. Examples of such failures at work include mistaking which equipment to operate, misreading a printed manual, and being unable to effectively relay the situation at the site over the phone to an expert at a remote location.

Work Navigation through a head-mounted display (HMD) was offered as a solution. Work Navigation graphically displays the procedure to be performed next on the screen of the HMD worn by the worker and reads out the work instructions. With Work Navigation, even unskilled workers are able to perform tasks without mistakes as they follow the work instructions from the HMD. After identifying the target equipment by the augmented reality (AR) marker affixed to it, the worker operates it and records the operation result as electronic data. If there are any unexpected problems or unclear points, the worker is able to share information on the current state of the site in real time through Remote Support with an expert at a remote location and resolve them.

The result of the work done according to the instruction given via Work Navigation can be stored as electronic data. In addition to the presence or absence of mistakes, this electronic data includes until now difficult to acquire, automatically recorded work logs that cover items such as the execution order and duration of operations.

Work Navigation uses four standard business components of the digital service platform to define design patterns based on site operations (**Figure 3**). As work components, Work Navigation provides a function that shows operation procedures (Work Instruction), and a function that records work results (Result Input). As technology components, it provides a function that specifies equipment through AR technology (AR Equipment Identification), and a function that provides work support through Remote Support technology (RS Remote Support).

2) Digitalization of equipment inspection check sheets

While paper check sheets are handy for recording daily inspection results on-site, they are far from practical for carrying out business analysis and making changes based on utilization of the inspection results. For example, enormous effort is required to analyze trends in collected data if one has to hunt for past records in file storage boxes or spend a long time digitalizing results recorded on paper check sheets by inputting them into Microsoft Excel spreadsheets.

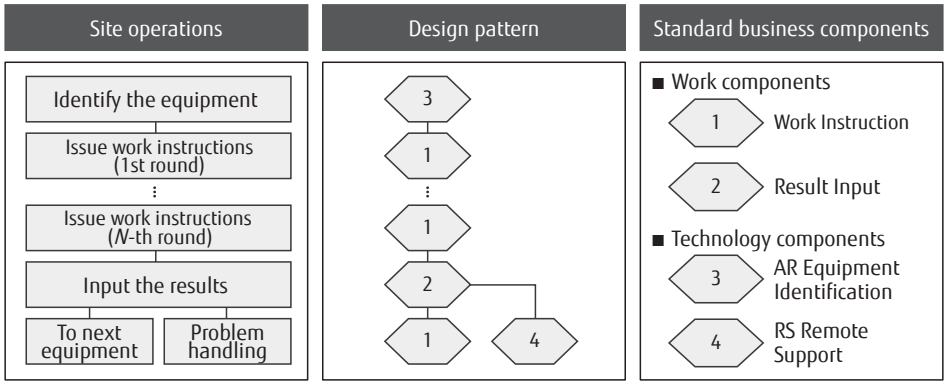

Figure 3
Definition of Work Navigation.

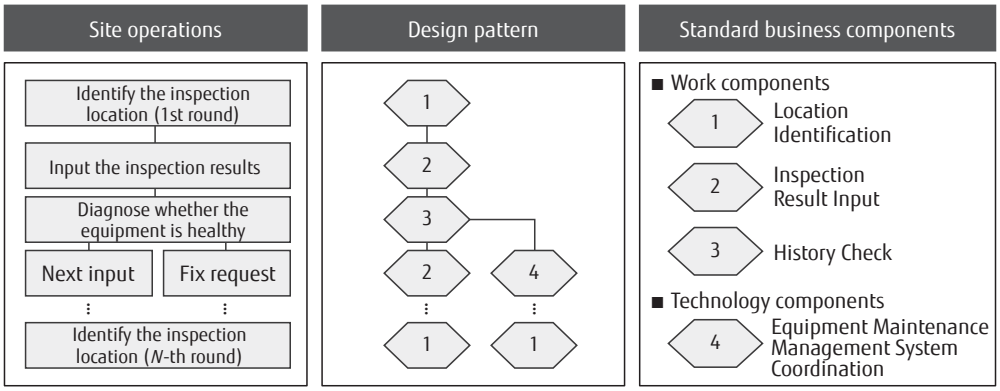

Figure 4
Definition of Inspection Information Sharing and Utilization Service.

Therefore, Fujitsu offers the Inspection Information Sharing and Utilization Service, which is used on smart devices. The Inspection Information Sharing and Utilization Service accumulates various information on pins placed on plans that are used daily at the site, such as floor plans and flow charts, allowing information to be managed visually. Further, it can display past records on graphs to check for changes in values at the site, and it can output recorded data as reports in prescribed formats.

The Inspection Information Sharing and Utilization Service thus makes it easy to utilize inspection results without any effort. Locations can be readily known by looking at the map displayed on the smart device, and inspection result input and equipment health checks are continually performed. In the event of a problem, a fix request is issued to the equipment maintenance management system, and the problem is fixed according to the maintenance plan formulated based on the fix request.

The Inspection Information Sharing and Utilization Service also defines design patterns using standard business components (**Figure 4**). For example, as work components, a function to specify inspection locations (Location Identification), a function to input inspection results (Inspection Result Input), and a function to check inspection history (History Check) are provided. As technology components, the Inspection Information Sharing and Utilization Service provides a function to consolidate maintenance data through coordination with the equipment maintenance management system (Equipment Maintenance Management System Coordination).

To further improve inspection work efficiency,

Fujitsu is also working to offer additional technology components, including an automatic reading function for analog and digital meters (Meter Reading), and a function for capturing measured values from specific nondestructive inspection devices and sensors (Inspection Data Capture). The effects of newly provided components can be quickly verified simply by incorporating them into the design pattern in accordance with improvement of the on-site operations.

4.3 Data utilization

With regard to data utilization, enhancement of manufacturing and maintenance operations through the analysis of collected data and the introduction of AI technology is expected.

Here, ground design that envisions more diverse applications is important. Ground design is design that assumes from the start a number of analysis axes to allow use of the same body of data for various purposes. In the manufacturing industry, the 5 Ms (Man, Machine, Method, Material, Measure), for example, may be used as analysis axes. By designing such ground designs from the start, a single body of production results data may be used for a variety of purposes, such as human resource development, determination of equipment utilization rates, line balance optimization, quality traceability, and the introduction of AI technology.

Fujitsu has know-how gained from its experience introducing digital technology at various sites for this kind of data utilization. By utilizing this know-how, we can propose optimum ground design combined with optimal technology in accordance with the customer's data usage situation.

5. Examples of introduction and its effect

This section describes a case of introduction of digital technology for a staff support system at the Lake Biwa Development Integrated Operation & Maintenance Office of Japan Water Agency (JWA).

1) Background

The Lake Biwa Development Integrated Operation & Maintenance Office of JWA faced issues with the operation of equipment required for emergencies such as sudden heavy downpours and typhoons. The organization has fewer staff than needed to operate all the required equipment in times of disaster and periodic personnel changes often result in the unavailability of persons with experience in disaster prevention. Therefore, it was necessary to ensure that even non-technical staff and inexperienced staff would be able to carry out disaster prevention without fail. Fujitsu solved this problem with Work Navigation.[2)]

2) Consulting

We visited the customer's site and consulted with them about what kind of instructions would allow even non-technical staff to perform the required tasks. Based on printed manuals and the knowledge we gained from the site visit, we created a storyboard of the kind of design pattern to be constructed, and had multiple meetings with the customer. Then, at three representative sites out of the organization's 14 drainage pumping stations, following two reviews carried out over three weeks after the site visits, we formulated the flow of site operations to be implemented following digitalization.

3) Work support application

We then designed the design pattern of Work Navigation along the flow of site operations. First, by having the customer use the proposed solution as is, we were able to confirm its usability at the site in as little as one week.

On the customer's request, we added "pump activation date and time records" as a site operation item. By developing standard business components and adding new ones to the service flow, we were able to implement this addition in just a few days. In this way, we successfully responded to the customer's wishes for additions and changes to site operations.

4) Introduction effect

Lastly, as an operation verification test, non-regular assistant clerks were asked to perform pump operation using Work Navigation and a printed manual for comparison purposes. We found that operation time using Work Navigation was 31% shorter compared with use of the printed manual. Not only that, with Work Navigation, the clerks were able to carry out, without any omissions, procedures that they failed to carry out in their entirety in the case of the printed manual because they could not correctly interpret the text.

By combining Work Navigation with the Inspection Information Sharing and Utilization Service, we were able to reduce by 89% the amount of reporting work

caused by the difficulty of reliably producing work records under heavy rain.

6. Conclusion

This paper described the issues and effectiveness of the introduction of the latest digital technologies for Fujitsu's digital solutions.

The standard business components and design patterns developed for the cases introduced here by no means can handle the variety of issues presented by sites of all kinds. Going forward, as Fujitsu itself grows, we will continue to enhance the services we offer and strive to contribute to businesses by providing digital technologies that assist the growth of manufacturing and maintenance sites through the synergistic effect of a variety of digital solutions.

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