Plant Operation Support System That Helps Transfer Skills and Improve Productivity

YOSHIKAWA, Yuzuru* WATANABE, Daisuke* INOUE, Akio*

ABSTRACT

In industrial plant operations, major challenges involve transferring skills and improving productivity. To help solve these two tasks, Fuji Electric has decided to redesign its previously developed plant support system to match current monitoring control systems. As a result, The monitoring control system of target facilities can be connected through a general-purpose interface to support operation. This development also makes it possible to share personal operator skills and to standardize operator knowledge and a skill level, helping users to transfer skills. Moreover, standardizing operating procedures and operation that are independent on operators improves productivity.

1. Introduction

Fuji Electric has a history of about 60 years for measuring equipment and released its first distributed control system (DCS) in 1975. Up to now, Fuji Electric has offered a variety of solutions in order to meet challenges and demands of customers in plant operation. However, challenges and demands are changing with the times, and major challenges of today are skills transfer and productivity improvement.

2. Challenges in Plant Operation

2.1 Challenges in skills transfer

Before plant operation was automated, operators had a full grasp of the characteristics of the plant and conditions of devices and operated them manually. This operation is assumed to have caused many problems and errors. Meanwhile, operators were naturally given opportunities to learn the know-how, and control skills relevant to the plant and skills related to plant operation had been transferred in day-to-day operation.

For plant operation, monitoring and control has become systematized by means of PCs and programmable logic controllers (PLCs) along with the development of microcomputers, which has brought about remarkable advancement in automation. Monitoring and control systems are now built as a matter of course, and automatic control has come to be applied to a high level. This has led to a reduction in the problems that occur on site but also reduced opportunities and experience to acquire plant-related knowledge such as unsteady states and the plant characteristics that caused the phenomena.

The challenge of skills transfer has been continuously discussed and 40 years have passed in the meantime. From now on, there is a concern that a shortage of skilled operators will get worse as seen in retirement of the baby boom generation.

2.2 Challenges in productivity improvement

One factor that poses a major challenge in productivity improvement is an environment of plant operation.

In plant operation, visualization on site and data linking have made progress along with the dissemination of information systems such as introduction of a manufacturing execution system (MES), on-site use of tablet PCs and upward linking of site data using bar codes and IC tags. While productivity has improved to enable a small number of people to handle plant operation, the scope of work per operator has expanded and operation has become more complicated and sophisticated.

More efforts are required to deal with labor shortages due to the aging population combined with the diminishing number of children, reduction of working hours and improvement of productivity.

To meet the 2 major challenges mentioned above, Fuji Electric has decided to develop an operation support system by redesigning the one developed in the past to match current monitoring control systems.

3. Overview of Development of Plant Operation Support System

3.1 Purpose of system introduction

There is a need to provide a plant operation mechanism and operating environment to allow skills transfer and productivity improvement. Achieving skills

* Power Electronics Systems Business Group, Fuji Electric Co., Ltd.

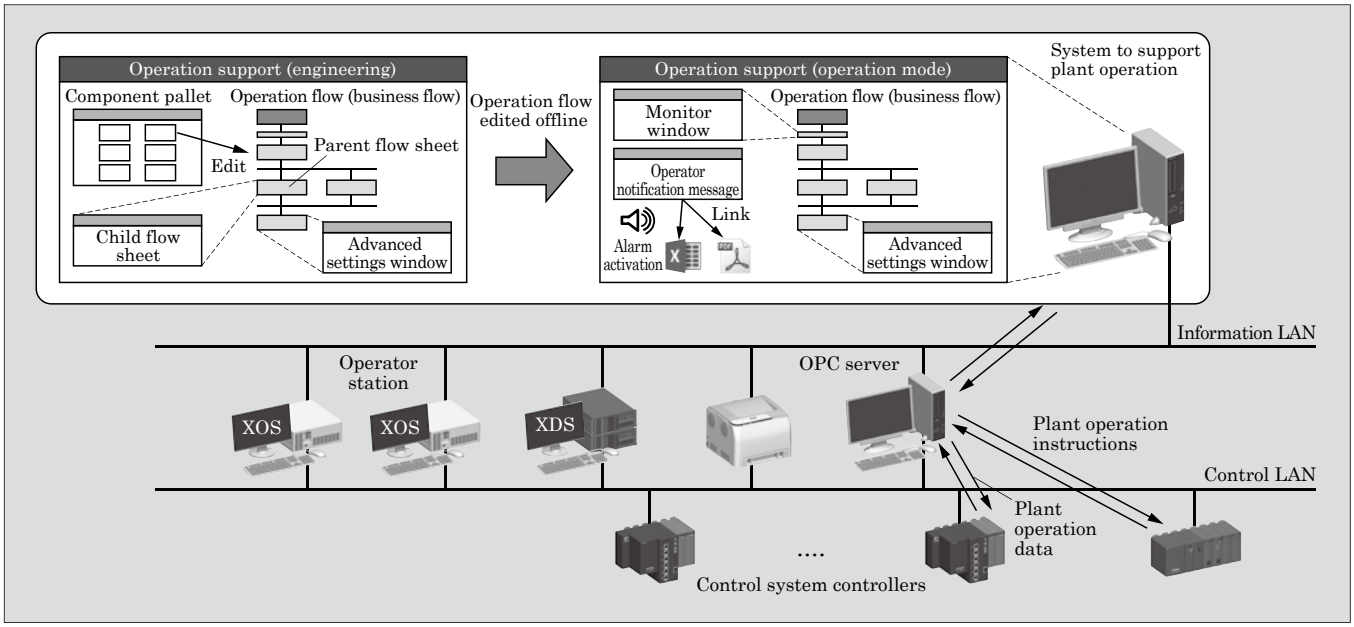

Fig.1 System configuration

transfer requires the sharing of operation skills that depend on the individuals and standardization of operators' know-how and skill levels. Productivity can be improved by establishing and standardizing procedures and operations independent of the operators. By realizing these mechanisms with the system, the following 4 effects can be expected.

(a) Resolution of difference in competence between skilled and novice operators
(b) Transfer of operation know-how
(c) Equalization of quality by breaking away from dependence on individuals
(d) Reduction of waste and excessive burden in operation

3.2 Concept of system development

Even if we build a system that resolves challenges in plant operation, it is not easy to apply the system to the other sites and allow it to be used on site for a long time unless we consider construction characteristics and operability. To meet this challenge, we have developed the present system, adopting the concepts of ease of system construction and versatility for plant operation. Based on this concept, Fuji Electric has developed a new plant operation support system on the basis of existing one developed in 2005.

This system employs the OPC interface, which is an open interface, to connect with Fuji Electric's previous generation systems and different series products, as well as other manufacturers' systems. The plant operation support function, which depended on the model in the past, is now available regardless of the model used.

Figure 1 shows the system configuration of the plant operation support system. Introducing this system makes the following possible.

(a) Creating operation flow diagram from operation procedure defined by a user
(b) Tracing of operation procedure and operation notification by guidance
(c) Recording of steps and alarms during operation

4. Functions of Plant Operation Support System

This chapter describes the functions implemented in the system to support plant operation.

4.1 Creating operation flow diagram from operation procedure defined by a user

The system provides the following functions for creating a flow diagram for the plant operation support system from an operation procedure.

(1) Structure of operation flow diagram

An operation flow diagram is composed of process parts to execute operation management or processing and condition parts to transition to the next task. The process and condition parts are designed to create easily by using provided components. An operation flow diagram makes it possible to involve 2 layers of parent and child flows.

(2) Creation and editing functions

To create a new operation flow diagram, a flow diagram can be prepared and components dragged and dropped out of the component lists corresponding respectively to the process and condition parts (see Fig. 2). The editing function is provided for actions such as moving a selected group of components and copying, which is useful for iterative processing.

(3) Tag linking

To define tags for the process and condition parts, they can be selected out of the list of tags provided by the operation support system. To link tags via a versa-

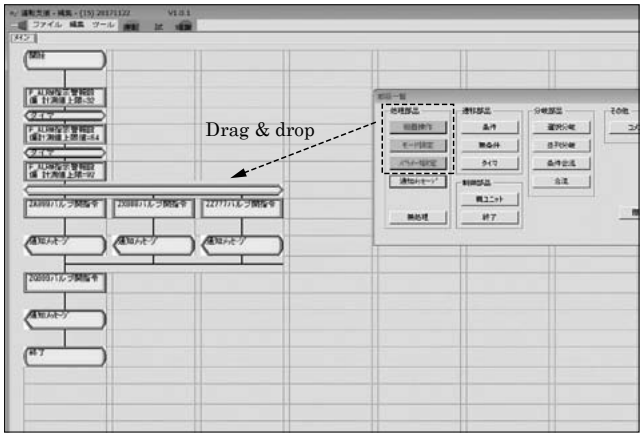

Fig.2 Example of operation flow screen

tile interface, tags of a target system can be imported using the comma-separated value (CSV) format without linking the database of a specific system.

Tags and comments used in such plant operation support systems are typically not easy for operators to understand. To solve this problem, we make it possible to separately define the tags to be displayed on the plant operation support system.

(4) Tag search

If a large number of system tags are imported, selecting out of the list of tags is difficult. Accordingly, a function is implemented to allow the creator to narrow down tags to be defined by using tags and comments.

4.2 Tracing of operation procedure and operation notification by guidance

(1) Monitoring function

When switching the operation flow diagram to the online mode, an operator can monitor the progress of a process by detecting a signal change in linked systems and migrate conditions (see Fig. 3).

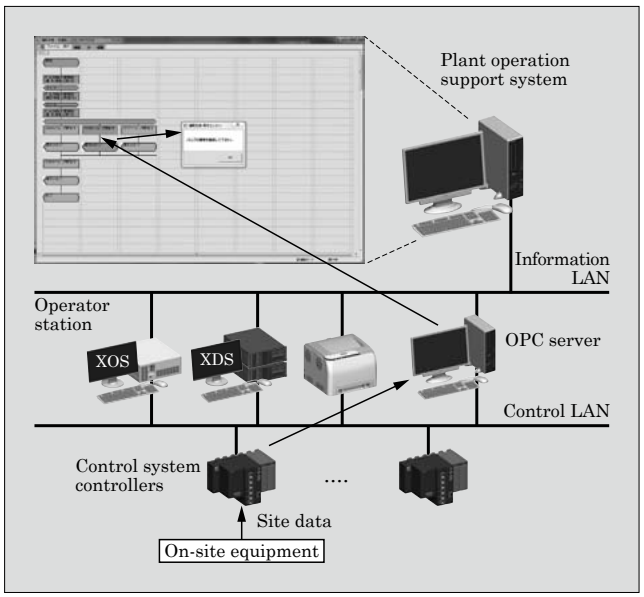

Fig.3 Example of operation and commissioning mode screen

Fig.4 Example of operation and alarm history screen

(2) Guidance function

The guidance function, which notifies an operator of operation instructions according to the change of the state of a signal sent from linked systems, includes the following 3 types:

(a) Comment notification using a pop-up window
(b) Notification to prompt the operator to make a judgment and input the result of the judgment
(c) Audible guidance notification

(3) Operation and commissioning modes

There are 2 online modes: operation and commissioning. Operation mode is used in actual operation. In commissioning mode, message notifications are given to confirm output timing in a target monitoring control system, but actual instruction signals are not output. It can verify whether operation flows perform as intended by the creator, in actual plant operation.

4.3 Recording of operations and alarms during operation

(1) Recording function

The operation and alarm history shown in Fig. 4 records the history of the operation of operators and the results of system processing. This recording function can help review past operation history to improve and revise operation procedures. The operation and alarm history information can also be output in CSV format, which allows easy analysis of operation procedures using general-purpose tools.

(2) Search function

Operators can search operation and alarm history with following conditions:

(a) Search period
(b) Operation flow name
(c) Tag and comment

Any problem that occurs during operation can be investigated efficiently by using occurrence period and a keyword to extract the operation and alarm history managed in lower systems.

5. Case Example

We have delivered this system to a certain factory. It is applied to 2 monitoring control systems: a system delivered by Fuji Electric and another system

Fig.5 Plant operation support system that has been delivered

delivered by another company. Monitoring control is already carried out in these systems. Fuji Electric has built a operation support system to integrate 2 different systems via the respective OPC servers. Figure 5 shows the operation support system that we have delivered.

6. Functional Enhancement for Future

Fuji Electric plans to further enhance functions as follows for systems that employ the Internet of Things (IoT) technology:

(a) Functions that support high-mix, low-volume production plants
(b) Linking function for tablets and other mobile information devices
(c) Management function for operation history and result data

7. Postscript

This paper has described a system to support plant operation that contributes to skills transfer and productivity improvement. Many packages related to operation support are on the market. Accordingly, we focused on future extensibility in the present development and designed a structure that allows easy addition of any new function developed to the existing ones. For additional development in the future, we intend to further improve and enhance the functions to provide customers with systems that are even easier to use.

Fuji Electric

Innovating Energy Technology