

# Instrumentation and Control System Solutions for Optimizing Plant Operation

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## ABSTRACT

Required functionality of instrumentation and control systems has been changing depending on such environmental factors as the optimization of plant operation and generational change in operators. Up until now, these systems performed simple monitoring and control, but recent needs have required functionality capable of quickly responding to trouble and ensuring safe and stable operations. In order to meet these needs, Fuji Electric is providing navigation functions for quickly responding to plant abnormalities, functions for supporting enforced settings and simulation functions for training operators. We are also providing solutions that meet the needs of various business sectors, such as chemical plants, gas and oil pipelines and waste incineration plants.

## 1. Introduction

Fuji Electric's instrumentation equipment has about 60 years of history and our instrumentation and control systems have more than 40 years of history since 1975 when the first distributed control system (DCS) was launched on the market. Over these years, Fuji Electric has been providing various solutions in order to solve the issues and meet the requests of its customers.

This paper describes Fuji Electric's latest technologies of instrumentation and control systems for plants and the solutions it provides. The target plant facilities are those of chemical plants, gas and oil pipelines and waste incineration plants.

## 2. Circumstances Surrounding Instrumentation and Control Systems

For plant operation, investments in facility improvement and energy saving have been discussed and made, initially in order to improve production efficiency through automation, and recently in order to address and solve global and regional environmental issues. It is expected in the future that the proliferation of sensors with communication abilities will make it possible to collect information that could not be collected previously, leading to a reform in plant operation.

On the other hand, instrumentation and control systems have been requested to have more abilities for not only monitoring and control but also reliability, scalability and engineering functions for about

30 years since their introduction. Later, along with the development of information technology, the functionality of the entire system has been reinforced through the cooperation with external functions such as manufacturing execute systems (MESs) or product data management (PDM), in order to satisfy various requests from people ranging from top management to workers in the field. Unfortunately, in exchange for the convenience of carrying field data to the outside, security-related problems have arisen. These include unauthorized access from the outside, computer virus issues and the leakage of confidential information through careless data carrying using external media. Consequently, there are increasing needs for ensuring the soundness of instrumentation and control systems. From now on, investments in the Internet of Things (IoT) in instrumentation and control systems are expected to be increased to make efforts to optimize plant operations by means such as having continuous security measures, safe and stable operations and improvements aiming at higher productivity and quality.

## 3. Issues with and New Functions of Instrumentation and Control Systems

### 3.1 Issues with instrumentation and control systems

In a plant, the influence of an operation shutdown may spread over an extremely wide area. Therefore, safe and stable operation is the most important issue. Companies have been addressing and solving this issue by evolving their instrumentation and control systems. They have, however, not yet completely eliminated unexpected troubles and safety risks encountered in the field. Finding ways to address such unexpected troubles and safety risks is important to maintain safe and stable operations. Up until now, unexpected troubles have been addressed flexibly by

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experienced engineers and operators who have know-how accumulated along with the development of DCS. An important issue from now on will be to reinforce the troubleshooting abilities and educating inexperienced engineers and operators. Furthermore, the period of engineering and commissioning tests for system replacement or plant launch, has become shorter, whereas the requirements for quality are becoming severer. Functions supporting these have also come to be required.

### 3.2 Functions addressing failures in plant operation

In recent years, sophisticated and complex operation control has been achieved through the use of instrumentation and control systems, which promotes automation and labor saving of plant operations. On the other hand, there are unsteady operations such as failures due to aging or wear of plant facilities or recovery work from the maintenance of part of a facility conducted during plant operation. As a result, it is essential to provide measures against alarms. There is another possibility of a secondary failure caused by a failed sensor. In case a failure occurs, it is necessary to immediately replace the sensors or take other measures to avoid a secondary failure. A delay in taking actions may lead to serious damage to plant operations. In conventional systems, the identification of the causes of alarms is mostly left to operators who have much experience and knowledge of past cases and the field, which has raised issues of dependency on individual skills and causes problems in further efforts to save labor.

To solve these issues, Fuji Electric's "MICREX-View XX (Double X)" small- and medium-scale monitoring and control system includes a navigation function and a forced setting function. They allow operators to address unsteady procedures occurring during operation by analyzing plant failures or by temporarily avoiding a failure more easily.

#### (1) Navigation function

The navigation function displays a list of relevant functions on the operation screen or engineering screen based on the actuator name used as a keyword. Previously, an operator autonomously moved to and displayed a relevant screen. This function lists only the screens related to the specified actuator, so that the operator can select one of them to go to a necessary screen easily (see Fig. 1).

Achieving the navigation function requires search information across systems (cross reference) for which data names or memory addresses are used as key data. MICREX-View XX generates a cross reference automatically from the data that a user entered on the supported utility screen of an engineering tool.

When an abnormality occurs, even an inexperienced operator can identify the cause of a failure or an alarm easily by using the navigation function. This ensures quick response to failures and thus minimizes

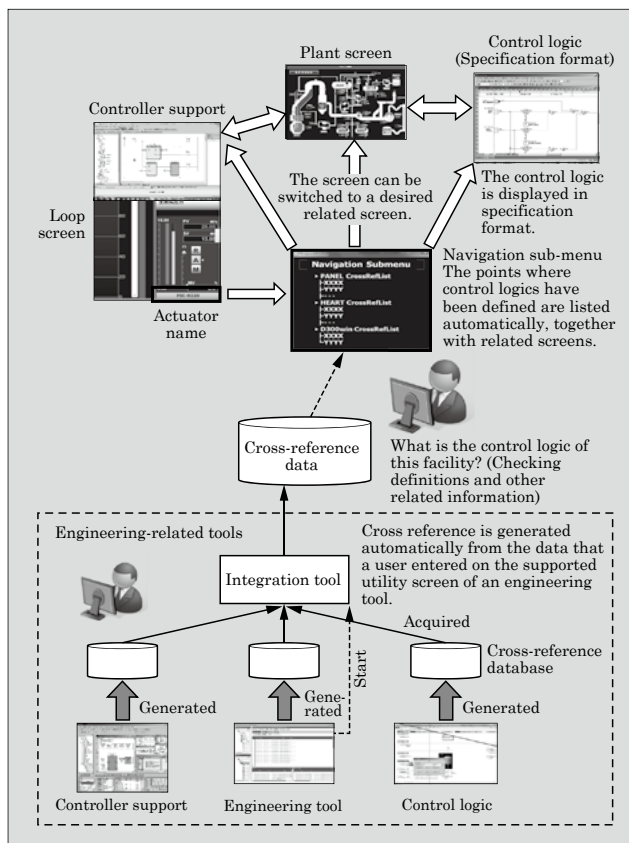


Fig.1 Navigation function

the influence on the plant.

#### (2) Forced setting function

The forced setting function is intended to temporarily avoid an abnormality from occurring during plant operation or to avoid a secondary failure. It forcefully blocks writing to the memory activated by the control logic that uses the value measured with an abnormally operating sensor and then continues opera-

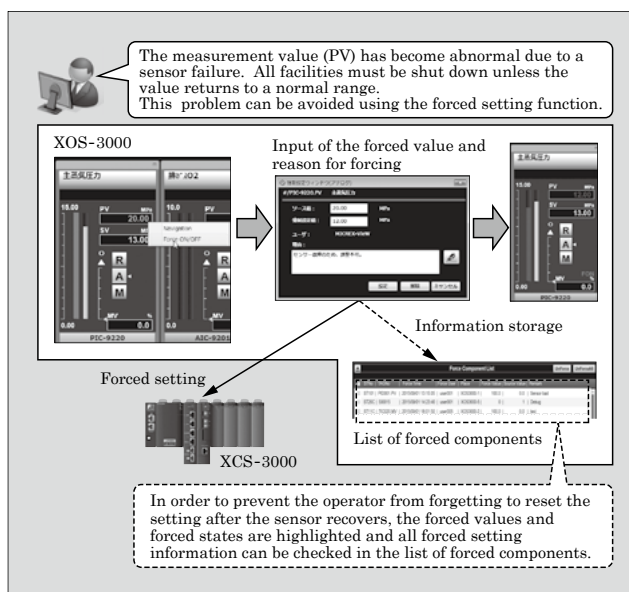


Fig.2 Forced setting function

tion by using a substitute value specified by the user (see Fig. 2). This allows the system to avoid a failed state temporarily without a need for changing the application software in case of sensor abnormality.

Moreover, the operation history stored in the database can be viewed online. In case an abnormality occurs in a plant, the operator can quickly determine the condition and identify the cause using the navigation function described above, and then the operator can use the forced setting function according to their judgment. This can avoid any unnecessary plant shut-down.

### 3.3 Advanced functions for plant operation optimization

As the competition among plant businesses is heating up, further improvement of productivity and quality has been demanded. For this purpose, all data concerning the life cycle of the plant should be put under unitary management with a database so that the relevant divisions can share them. For example, using these data in a plant simulator can improve the quality of an automatic control program before it is tested in an actual plant.

Fuji Electric provides the DCS “MICREX-NX.” Furthermore, we first started providing the plant simulator SIMIT\*<sup>1</sup> with the aim of offering the plant management tool COMOS\*<sup>2</sup>. Figure 3 shows the digitalization and product lineup of plant engineering.

#### (1) Integrated data platform

In the life cycle of an entire plant, inadequate engineering and adjustment may lead to a decrease in quality and capacity utilization, resulting in serious negative effects on the cost and time required for the operation and maintenance of the plant.

A commissioning test, in particular, is an important task that may greatly affect the subsequent safe and stable operations of the plant. Most of the time required for it is taken for testing and adjusting the automatic control. Most software bugs found in this

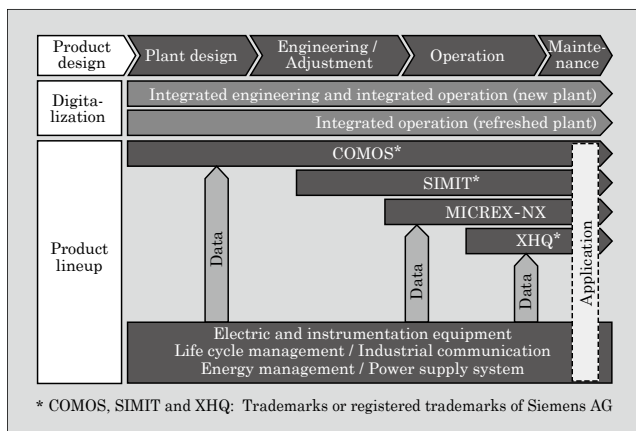


Fig.3 Digitalization and product lineup of plant engineering

\*1, 2: COMOS and SIMIT: Trademarks or registered trademarks of Siemens AG

phase are made during the engineering period.

Moreover, once the plant starts actually operating, it is difficult to educate operators about unsteady state conditions. In the present circumstances, the operators are not sufficiently educated about the operations assuming plant accidents. Once the plant enters an unsteady state, the influence of insufficient education is great and seriously affects safe and stable operations. A measure to avoid such situation is to incorporate a simulation that replicates an actual plant as closely as possible into the system architecture in every process from specification determination to plant operation. This can significantly reduce unnecessary engineering costs and time.

Such a measure can be achieved by using an integrated data platform that performs unified management of the data related to engineering and operation of the plant.

#### (2) COMOS plant management tool

COMOS is a tool for having integrated management of all data related to a plant life cycle (such as electric and instrumentation facility, control flow, and facility and piping flow). It can seamlessly operate with MICREX-NX and SIMIT. It can thus provide a digital engineering solution that optimizes the life cycle of an entire plant from design to operation (see Fig. 3). Specifically, based on the data created with COMOS, a simulation model for SIMIT to be used with the control program of MICREX-NX can be generated automatically.

#### (3) SIMIT plant simulator

SIMIT is a tool that allows engineering through a simulation (see Fig. 4). The major functions are as follows:

- (a) Controller simulation function
- (b) I/O signal simulation function
- (c) Modeling and simulation functions for I/O devices such as sensors, valves and motors
- (d) Modeling and simulation functions for entire control targets such as a plant and machinery

Using SIMIT makes it possible to test and adjust the entire facility in a project under conditions similar

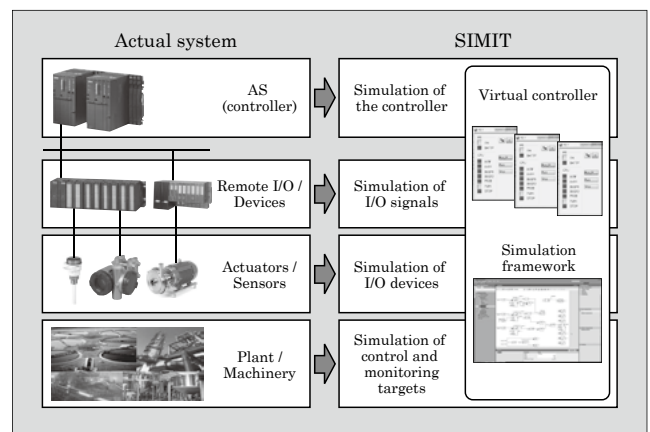


Fig.4 System image of SIMIT

to the actual plant as closely as possible in advance in an office. Therefore, the actual commissioning test can be completed within a shorter period without problems.

Moreover, when SIMIT is combined with a virtual controller (controller emulation tool of SIMIT), it can be used as a training system for operators. You can use the commands of SIMIT (initialize, start, stop, pause, snapshot, etc.) to check the operation in a simulation and then reproduce the process or adjust the simulation speed. By creating the behavior of a plant in an unsteady state on the simulator, this function can be used to educate operators about steps including emergency response.

#### 4. Fuji Electric's Solutions in Various Plants and Facilities

In order to solve the issues of its customers, Fuji Electric provides the MICREX-View XX Small- and Medium-Scale Monitoring and Control System<sup>(1)</sup> as well as the MICREX-NX DCS. MICREX-View XX provides a function for data cooperation with external systems, as well as the functions of conventional distributed control systems including excellent visibility and operability, electric and instrumentation control integration, high speed and high reliability, highly efficient engineering and high inheritability, especially designed for small- and medium-scale plants. This allows cooperation with an advanced operational support and facility maintenance management system utilizing big data to ensure optimum plant operation (refer to "Evolving of Monitoring and Control System 'MICREX-View XX (Double X)'" on page 186).

Furthermore, the supervisory control and data acquisition (SCADA) functionality has been adopted to provide a system that can help to optimize operations depending on the facility scale or required functions of the customer.

##### 4.1 Chemical plants

In the business sector of chemical plants, as the demands for system replacement increase, business operators have a greater awareness of the need for continuous energy saving. This leads to the optimum use of equipment based on predictive diagnosis of the facility or to the study of introducing safety instrumentation regarding facility safety. Investments leading to the IoT have also been sought.

As a mechanism leading to the IoT, Fuji Electric has developed a solution package for electric, instrumentation and computer (EIC) integration. In the chemical industry, a facility is normally divided into instrumentation control system and drive control system. The solution package for EIC integration has achieved monitoring and control of instrumentation and a drive on a single platform by utilizing Fuji Electric's component technologies and network technologies. This means it can also be applied to the field of

drive control that requires high-speed control. As a result, time synchronization of field data can be assured easily between instrumentation control and drive control. In addition to the ability to build the foundation for collecting field data, which is important for the IoT, the integration of instrumentation and drive systems will streamline the data flow between facilities, which had conventionally required installation of hard wires or gateways to interface different systems. Furthermore, when the platforms are unified, a common contact person can handle engineering inquiries from customers, providing optimum solutions in consideration of the entire plant.

##### 4.2 Gas and oil pipelines

For gas and oil pipelines, the operation requires central control to efficiently and accurately collect pieces of data to be monitored that have dispersed over a wide area. The requests from customers, however, for communication infrastructure used for data collection have been diversified and it is difficult to use a unified communication infrastructure or protocol to collect all data.

Fuji Electric supports various communication infrastructures by using SCADA such as "MICREX-View PARTNER" to collect data dispersed over a wide area (refer to "Equipment Monitoring System 'MICREX-View PARTNER' Easily Cooperating with Integrated EMS" on page 193). The demand for field data collection is expected to increase to invest in the IoT in the future. Consequently, we will provide optimum plant operations which transparently handle communication methods and media through a system that satisfies customer needs. Table 1 shows application examples.

##### 4.3 Waste incineration plants

The operation in waste incineration plants has been increasingly outsourced to external entities under a package contract (operation management and maintenance management). Up until now, the data acquired during plant operation were only the data

Table 1 Application examples in sector of gas and oil pipelines

Facility	Communication method	Communication medium
Pipeline for fuel transportation	Tele-metering and tele-control (distance monitoring and control) with analog communication	Communications cable
Pipeline for natural gas transportation	Ethernet* communication	Preferred line of telecoms company, dedicated line for satellite communication (for backup)
City gas grid	Ethernet communication	Dedicated wireless network, dedicated line for telecoms company, Mobile Virtual Network Operator (MVNO)

\* Ethernet: Trademark or registered trademark of Fuji Xerox Co., Ltd.

required by municipalities. As the number of cases of package contract increases, it is expected that the external outsourcing entity will collectively collect and manage not only the data requested by municipalities but also the data required for efficient operation of individual waste incineration plants. This will promote the establishment of an IoT environment for optimum monitoring, analysis and operation.

As the first step toward centralized management, Fuji Electric has introduced an EIC integration system for achieving data cooperation between the headquarters mechanism of the outsourcing entity and the waste incineration plants. It also has established an environment for transmitting data to the headquarters mechanism through a public line. This has allowed the headquarters mechanism of the outsourcing entity to analyze the collected data and plan an optimum opera-

tion model.

## 5. Postscript

This paper reviewed the history of instrumentation and control systems and described the present issues being faced, the latest technologies of Fuji Electric and the solutions for respective sectors. Fuji Electric is determined to continue making contributions to optimum plant operations for its customers.

## References

- (1) Shobayashi, N. et al. Instrumentation and Control System Solutions to Support Stable Operation, Energy Efficiency and Environmental Conservation. FUJI ELECTRIC REVIEW. 2014, vol.60, no.1, p.10-15.





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