Present Status and Prospects for Information and Control Systems

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1. Introduction

Although the economic prospect for economic recovery is still bleak, as reflected in the low production of industrial information and control equipment of Fig. 1, there has, however, been a remarkable increase in the use of personal computers. Because of computer, network, multimedia, and software technology innovations, society is becoming more information oriented and network applications are rapidly increasing in the form of the Internet.

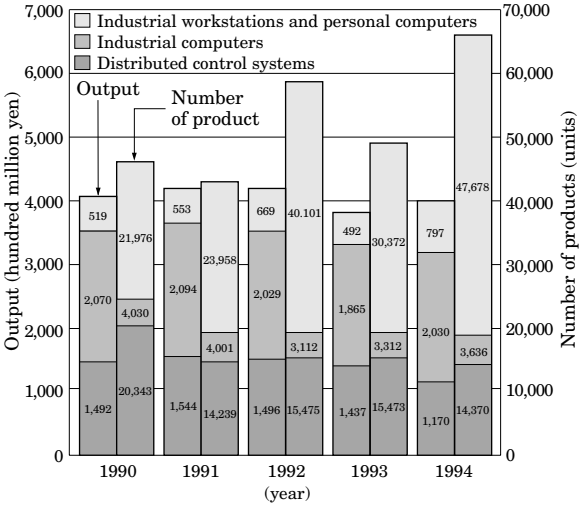
Information and control systems for the purpose of automating production systems, have developed as core devices to perform plant operation, monitoring, and control functions. These information and control systems have been greatly changed by the changing economic and social environment as well as technical innovations. In other words, it is necessary to structure efficient production systems to optimally utilize technical innovations in computer, network, and multimedia technologies at as low a cost as possible. To attain this goal, it is important to consider both sides of production systems: functions represented by EIC (E: electrical control, I: instrumentation, C: computer) and time represented by the life cycle (planning-design-execution-operation-maintenance).

In consideration of the above, information and control systems must be integrated to realize broad management functions, such as product management, process control, maintenance, and equipment management, in addition to conventional operation, monitoring, and control functions.

On the other hand, with regard to the architecture of systems, openness and field distributed control are the keys to system downsizing and flexibility. In this sense, software and network technologies that use international standards and de facto standards are important. In particular, the international promotion of standard specifications and product development for the fieldbus to realize field device networks and field distributed control systems has become an essential systematization technology.

Further, ISO 9000 for quality assurance and ISO14000 for environment management must be taken into consideration when structuring of information and control systems.

Fig.1 DCS and industrial computer production trends



Source : Japan Electronic Industry Association
"Investigation of Japan's industrial computer output in 1994"

Within this setting, Fuji Electric has advanced the configuration of the latest information and control system and has recently developed MICREX-AX[*1], an advanced information and control system to unify information and control.

This special issue reviews the present status and prospects for information and control systems and introduces new MICREX-AX technologies.

2. Information and Control System Trends

Production systems now require flexibility that enables the high quality and high added value production of various products. Total costs now take into consideration the life cycle of a system.

*1: The "AX" in MICREX-AX means Advanced information and control system for the next generation.

In information and control systems, therefore, not only are real-time and reliability critical for control, but information and information processing required for operation and maintenance have also become important. In other words, it is important to have plant-wide or enterprise-wide unified control, intrinsically necessary for production systems, and information for efficient management and maintenance.

The requirements of production systems and technologies to realize them are shown in Table 1. The main trends of information and control systems are described below.

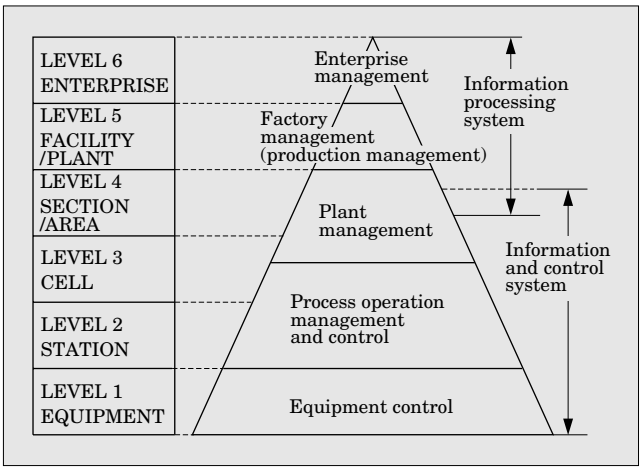
(1) Unification of information and control

Figure 2 shows the positioning of an information and control system for the CIM model in ISO definition. As shown in the figure, fields relating to positioning of the information and control system include equipment control, process operation management and control, and plant management.

Table 1 Production system requirements and necessary technologies

Requirements	Necessary technologies to satisfy requirements
Flexibility Scalability	◦ Open system ◦ Network technology ◦ Autonomous decentralized system, field distributed system ◦ Shared information and control data system ◦ PA, FA, and OA integration technology
Improved productivity	◦ High-speed control, real-time control ◦ Redundant system, fault tolerant system ◦ Preventive maintenance, Equipment diagnosis, remote maintenance ◦ Integrated engineering, concurrent engineering
Improved product quality	◦ AI (fuzzy, neuro), GA ◦ Modeling, simulation ◦ Intelligent sensor ◦ Quality control system (ISO9000)
Human beings and environmental consideration	◦ Object-oriented system, Agent-oriented system ◦ Multimedia ◦ Environment-friendly system (ISO1400)

Fig.2 Positioning of information and control system in the CIM model



To operate systems efficiently, there is a growing necessity to enhance information processing functions and to unify information and control even at the level of equipment control, which was formerly specialized.

(2) Openness

Open systems aim to freely combine characteristic products from different manufactures to construct an optimum system.

The key to open systems is the use of a standard operating system (OS), network, and database. The popularity of Windows[*2], UNIX[*3], and Ethernet[*4] has had a great influence on the openness of information and control systems and has resulted in their wider use. On the other hand, there are many problems in the reliability and real-time characteristics of open systems in control application. It is necessary to use the right system in the right place.

Fuji Electric is promoting open systems with the belief that further progress in hardware, improvements in operating system functions, and the innovation and spread of internet technology will advance information and control systems toward increased openness.

(3) Cost reduction and right sizing

The right sizing concept is to realize a system with appropriate (right) functions and performance of as low a cost as possible.

Fuji Electric achieves right sizing with its line of products that correspond to the scale and function of the system application and its line of packaged solutions for individual fields.

(4) Advanced operator interface

As systems become more sophisticated and complicated, their operation (monitoring and handling) becomes difficult. However, to hold down rising labor costs, operation by few operators or without an operator is demanded.

This requires visual interfacing with multimedia technology and operation support with AI functions.

Fuji Electric has attached user-friendly concepts to human engineering considerations to develop desk designs, picture coloring, and operation.

In addition, Fuji Electric has developed an intelligent alarm that uses AI functions to give guidance in case of emergency and a scene-based interface which integrates on-site pictures, audio, and process data on the operator station using multimedia technology to monitor and operate the system.

(5) Integrated engineering support

The ratio of engineering cost to construction cost of an information and control system has rapidly increased and is a dominant influence on system cost.

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*2 Windows: A trademark of Microsoft Corp., USA

*3 UNIX : A registered trademark of X/Open Company Ltd.

*4 Ethernet: A registered trademark of Xerox Corp., USA

In an EIC-integrated system where many different types of functions are closely linked, and in large-scale systems requiring group engineering and concurrent engineering by several members, integrated engineering support over the life cycle of the system is required.

On the basis of the above thinking, Fuji Electric has developed and applied an integrated engineering support environment having a unified integrated engineering database and a descriptive language for automatically generating controller programs from operation procedures, piping and instrumentation diagrams.

(6) Fiber-optic fieldbus and field distributed control

The fieldbus is both a network technology that realizes digital communication and openness on the field device level and also a systematization technology that changes the configuration of information and control systems. That is to say, the fieldbus can form a field distributed control system in which a combination only of field devices with control functions, such as AI/AO (analog input and output) and PID will form a control loop. Figure 3 shows an example of a field distributed control system with a fiber-optic fieldbus.

By providing diagnostic and maintenance functions to field devices and communicating through the fieldbus, a unified information and control system can be constructed.

Fuji Electric developed the optical fieldbus according to international standard specifications based on FFI (fiber-optic field instrumentation) and is using the Fieldbus Association to promote openness. MICREX-AX is being prepared to be compatible with these electrical and optical fieldbuses.

(7) Sophisticated applications

There are demands for sophisticated applications in various fields such as multivariable control, model prospect control, and neuro control in the field of control, plant operation support and plant simulation in the monitoring and operation fields, and schedulers in the process control field.

Fuji Electric has developed various algorithms to meet the demands of these sophisticated applications, and also offers various packaged solutions with engineering support functions.

Fig.3 Example of an optical field distributed control system

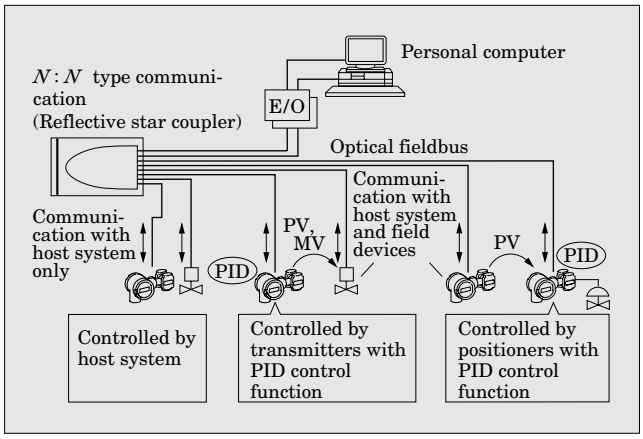
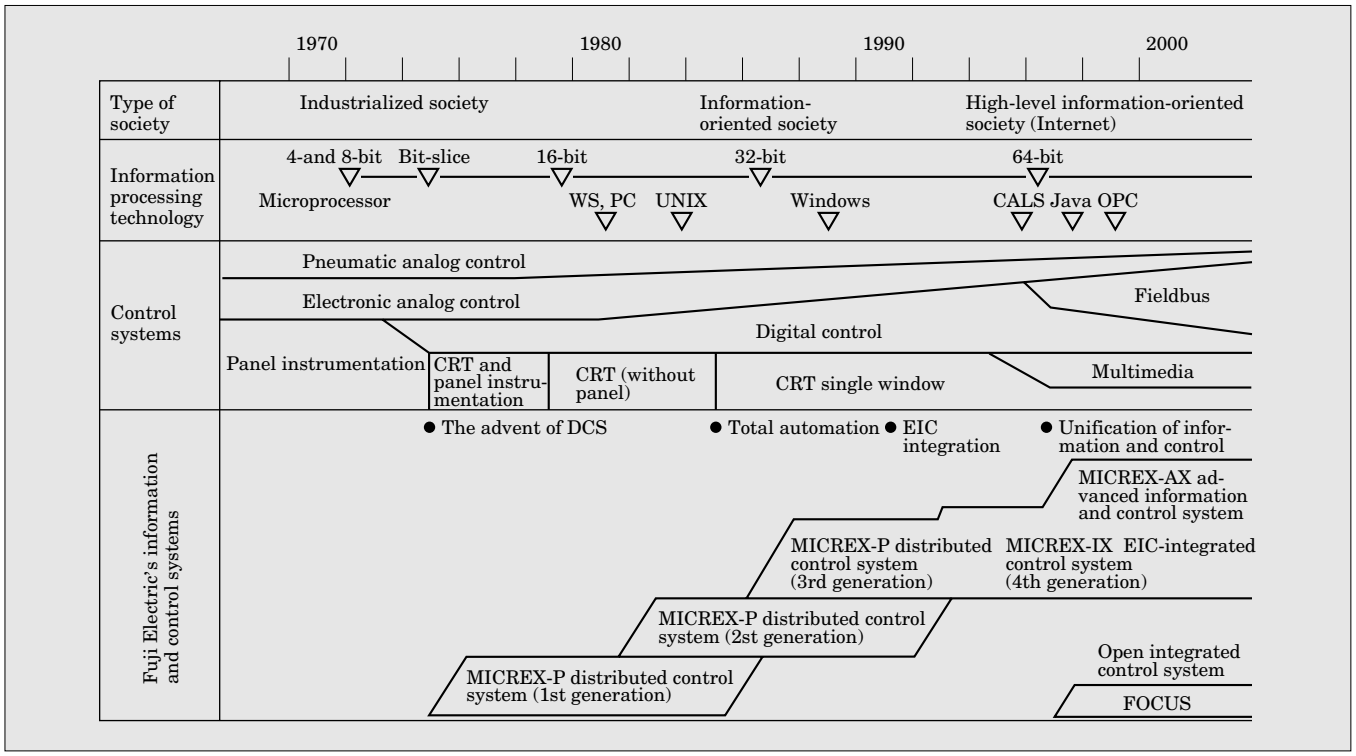


Fig.4 History of Fuji Electric's information and control systems



3. Fuji Electric's Development Information and Control Systems

As shown in Fig. 4 since the advent of the DCS (distributed control system) in 1975, Fuji Electric has always developed products ahead of other companies.

Fuji Electric's latest efforts for information and control systems as well as the MICREX-AX advanced information and control system are introduced below.

3.1 Basic concept of MICREX-AX

Plant facilities equipped with information and control systems are maintained for 10 to 20 years. The information and control systems must be capable of long-term operation and must also be flexible to allow expansion and remodeling of the equipment. On the other hand, technical innovations cause new products to be developed every three months. Information and control systems must also be capable of incorporating technical innovations and providing timely solutions to user requirements.

With a policy to develop flexible systems that utilize advanced technology, Fuji Electric has developed the new MICREX-AX information and control system in which the concepts of total automation and EIC-integrated control system have been expanded upon.

To realize the above, the network, database, and data interface belonging to the infrastructure section that forms the base of the system, the computer, workstation (WS), personal computer, HCI (human computer interface), controllers and field devices are clearly separated and defined as components that evolve independently at short intervals.

As a result, as long as the specified data interface is maintained, each component can evolve independently.

Although the principle is not new, this technique is characterized by using advanced technology with the concept of unified information and control, to realize an open infrastructure section and interface in which the control performance does not suffer.

In addition, the system is scalable from medium to large systems and flexible to facilitate the expansion and remodeling of plants.

3.2 System configuration and component functions

Figure 5 shows the MICREX-AX system configuration.

MICREX-AX consists of a computer (DS/90), WSs, personal computers, an advanced multimedia HCI (AOS-3000), advanced controllers (ACS-3000), a telemeter and telecontrollers, and field devices, which are organically linked by an advanced information and control LAN (ANS-3000) and a database (installed in the HCI).

MICREX-AX is supported by an advanced engineering support system (AES-3000). Functions of each component are listed Table 2.

3.3 Changing requirements

Fuji Electric developed the MICREX-AX system with consideration of the following changing require-

Fig.5 MICREX-AX system configuration

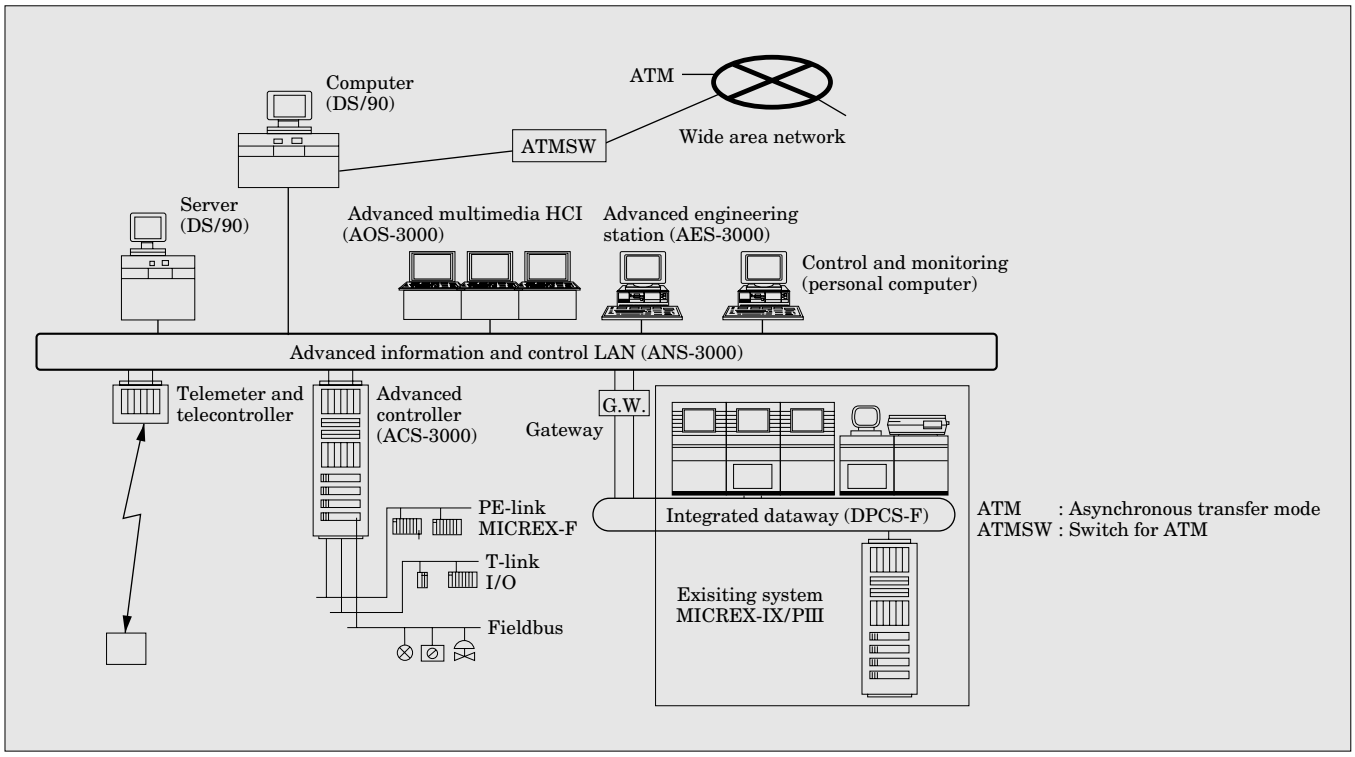


Table 2 Information and control system component functions

Function \ Component		Computers C	HCI	Engineering support	Controllers I	Controllers E	Controllers T	Field devices
Planning and management	Production planning	◎						
	Production management	◎						
	Quality control	○						
	Plant and equipment management	◎						
Operation	Operation control	◎	○					
	Operation data collection	◎	○		○	○	○	
	Operation support		◎	◎				
	Monitoring and operation		◎					
Communication	Transmission	○	○	○	○	○	◎	○
Control input and output	Control				◎	◎	○	○
	Process input/output				○	○	○	◎
Others	System maintenance	○	○	○	○	○	○	○
	AI	○	○	○	○	○		○
Fuji Electric's typical products		DS/90, PC	AOS-3000	AES-3000	ACS-3000			ACS-3000, DS/90, PC

◎: Main function ○: Sub-function -----: Linking function I : Instrumentation E : Electrical T : Telemeter and telecontroller PC : personal computer

ments for new information and control systems.

(1) System changes

One problem of DCS is the lack of flexibility. Each individual manufacturer has promoted its own standards and it is difficult for the mature products to accept new user requirements.

In MICREX-AX, the key to attaining flexibility is considered to lie in openness, and openness is realized in the network, HCI, data interface, and engineering support tools.

(2) Control device changes

Innovation in microprocessor and communication technology has made field devices intelligent and enables the transfer of control functions to lower level devices and the addition of information for maintenance and monitoring. For this reason, the role of controllers has changed to perform integrated control functions and some of the information processing functions formely implemented by computers.

The ACS-3000 advanced controller for MICREX-AX enables a mutiprocessor configuration that closely links control processors and computing processors on the same system bus.

(3) Monitoring and operation device changes

The AOS-3000 monitoring and operation equipment for MICREX-AX integrates the computer system and DCS with open materials on the WS platform (DS/90 or SUN) and can monitor and operate the field conditions according to multimedia information.

(4) Network changes

Information and control systems have come to handle not only conventional control information but also a large quantity of operation support and maintenance information. Therefore, the system's backbone LAN (local area network) is desired to be an integrated network that can handle both control and information systems.

MICREX-AX uses the international standard FDDI (fiber distributed data interface) 100Mbps optical LAN that can handle multimedia information, to realize a unified information and control LAN. Also it is possible to connect to an ATM (asynchronous transfer mode) network. Optical fieldbuses are mainly being used to realize low-level open networks.

4. Conclusion

This paper has introduced the MICREX-AX advanced information and control system newly proposed by Fuji Electric and based on the present status and prospects for information and control systems at this turning point of changing requirements.

The concept of MICREX-AX is unified information and control, which coordinates human beings (information) and systems (control).

It is our goal to change former systems that rely too heavily on humans for system control and to rethink optimal control, operation, handling, monitoring, and maintenance methods.