Trends and Tasks of the Integrated Control System

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1. Introduction

Recently, reengineering has become one of the most popular topics in the field of industry. Through the consolidation of facilities and construction of a highly-effective production system, in which information and control are integrated, costs are reduced and international marketing power is maintained.

The distributed control system (DCS) has been studied as one of the ways to respond to these demanding needs. Advanced technologies which accompany the DCS are large scale, integrated, highly functional and follow trends toward network technology, open architecture systems, downsizing and multimedia.

As a general trend of information and control technology, there have been remarkable advance in systematization, e.g. the field-distributed, autonomously distributed, and open systems, which are closely related to the network system.

Fuji Electric announced the MICREX-IX as a fourth generation distributed control system in October 1992, and has since delivered it to numerous users. Technology has been developed and improved to match the trends and needs of the time, so that users are presented with various solusions to meet their requirements.

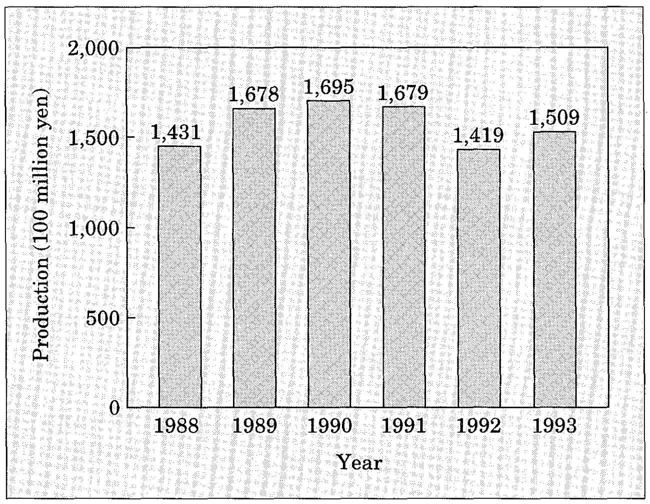
This issue features the recent technological achivements associated with the MICREX. An overview of the trends and tasks of the integrated control system in the field of plant control is presented in this paper.

2. Technological Trends of the Integrated Control System

Technological innovation of semiconductors (LSI, ASIC, etc.) in the computer and information processing field as well as the trend forwards open networks and operating systems has greatly influenced the field of process control.

However, by observing the yearly trends in the production quantity of process supervisory control equipment, it can be seen that the DCS field has apparently reached maturity (see Fig. 1). Therefore, there is a need a new system architecture to establish a highly effective production system.

Fig. 1 Production of process supervisory control equipment



The industry, which has been in recession, has recently begun to pick up with the recovery of the USA semiconductor market. It is anticipated that the DCS market will grow as the active desire for capital investment returns in the future.

The fundamental objectives with which the integrated control system should modernize operation and management as we approach the 21st century, based on market and technology trends and changes in the environment, are presented below.

(1) Because the DCS is a system which handles industrial equipment and has a large influence on society, high reliability and shortened trouble recovery time must be achieved. The system facility is consolidated to share information and integrate equipment.

(2) Individually developed electrical control (E), instrumentation control (I) and computer control (C) are consolidated into an EIC integrated system which shares data by linking the above individual control systems into a network. In addition, the EIC integrated system uses multi-venders and links computers to the controller to implement autonomous and decentralized functionality.

(3) The engineering environment is improved.

Fig. 2 General technological trends of information and control system

Background

(1) Downsizing and open architecture
- ○ Main frame to workstation
- ○ UNIX
- ○ Networking

(2) Modernization
- ○ "3 D" work, short work time, site patrol
- ○ Unmanned night operation
- ○ Periodic repair
- ○ Variable item and variable amount production
- ○ Fault diagnosis, maintenance support, simulator
- ○ Production center

(3) Man-machine cooperation
- ○ Human control
- ○ Professional consciousness
- ○ Safety

Fundamental objectives of information and control system

(1) DCS integration and open architecture
- ○ EIC integration and open architecture
- ○ Networking
- ○ Linking with computer

(2) Field-distributed system
- ○ Fieldbus
- ○ Optical fiber bus

(3) AI
- ○ EXPERT, fuzzy, neuro
- ○ Advanced control

(4) Wide area network
- ○ Linking TM/TC

(5) Multimedia
- ○ ITV, large screen
- ○ Voice
- ○ 3 D (image processing), VR (virtual reality)

Establishing a concurrent engineering environment, realizing user engineering and enhancing its support functions are important topics.

(4) Maintenance work is made more efficient. For the increasing range and number of objects to maintain having complicated hardware components, the maintenance and inspection work associated with RAS function and shortening trouble recovery time (MTTR) has been improved.

(5) Field-distributed systems are configured using highly functional field equipment compatible with the fieldbuses currently being developed and used widely.

(6) The alarm warning system is configurated through computer linking and AI functions. The AI navigator plan is developed further to relieve the operator's load and ensure stable operation.

(7) Operation training with the simulator reinforces and strengthen the ability to adapt to various turbulence, e.g. an emergency, improving the reliability of the facility equipment.

The above technological trends are summarized in Fig. 2.

2.1 Integrated control system MICREX-IX

The MICREX-IX, introduced to the market in 1992, was developed based on the above trends. The MICREX-IX is a product which was developed to achieve high functionality, high performance, and high reliability in responce to the age of open architecture through adopting the most advanced LSI, ASIC, and display technology and by improving maintainability of the whole system. Considering today's economic situation, the hardware and software resources currently in use have been inherited from the EIC integrated control structure developed in 1987 (the MICREX-PIII).

In addition, the MICREX-IX is a product which has also introduced the latest technology, responded to the open environment, improved service functions and provided a flexible answer to user specification requirements. The system configuration is thus adaptable for the age when coexistence of old and new system is becoming common field.

2.2 Development of the MICREX-IX integrated control system

Figure 3 shows the development of Fuji Electric's MICREX integrated control system in comparison to that of the computer and information processing field.

At first, the DCS was put on the market in 1975 and developed to a single loop controller at 1978. Development of the DCS for integration of EIC functions has since kept step with those of the LSI and ASIC. Originally, its application was intended for a large-scale system, but later extended down to small and medium-scale systems, realizing the openness and downsizing of EIC integration. The DCS has been developed to a flexible EIC integration or an optimized cooperative system of EI and C, depending on the plant, the facility environment, and the worker situation .

3. Tasks of Integrated Control System

Figure 4 shows the position of the integrated control system in the ISO hierarchy model (6 layers). The field where the integrated control system is positioned in the ISO model targets the plant management, the process operation management and control, and the equipment control.

The function and performance necessary for an integrated control system are somewhat different from those of the general information processing field, because the interface between man and machine is involved. Therefore, the following capabilities are expected of the DCS.

3.1 Real-time processing performance

Both sequential control and feedback control play an essential role in the control system, but differ largely in the speed of control. The sequential control needs response performance to be 1 to 10 ms. Feedback control can be used with almost all process controls if a response of about 100 to 200 ms can be achieved. Therefore, an efficient, real-time processing controller compatible with the above-mentioned response is necessary for the EI integration function.

3.2 High reliability

The DCS normally operates 24 hours per day in an environment where manufacturing equipment are set up, much more severe than that of a general office.

To manufacturing a product having a large influence on society requires a system with high reliability. Therefore, it is essential that the DCS establish structure and circuit technology able to withstand severe

Fig. 3 Development of MICREX and information and control system

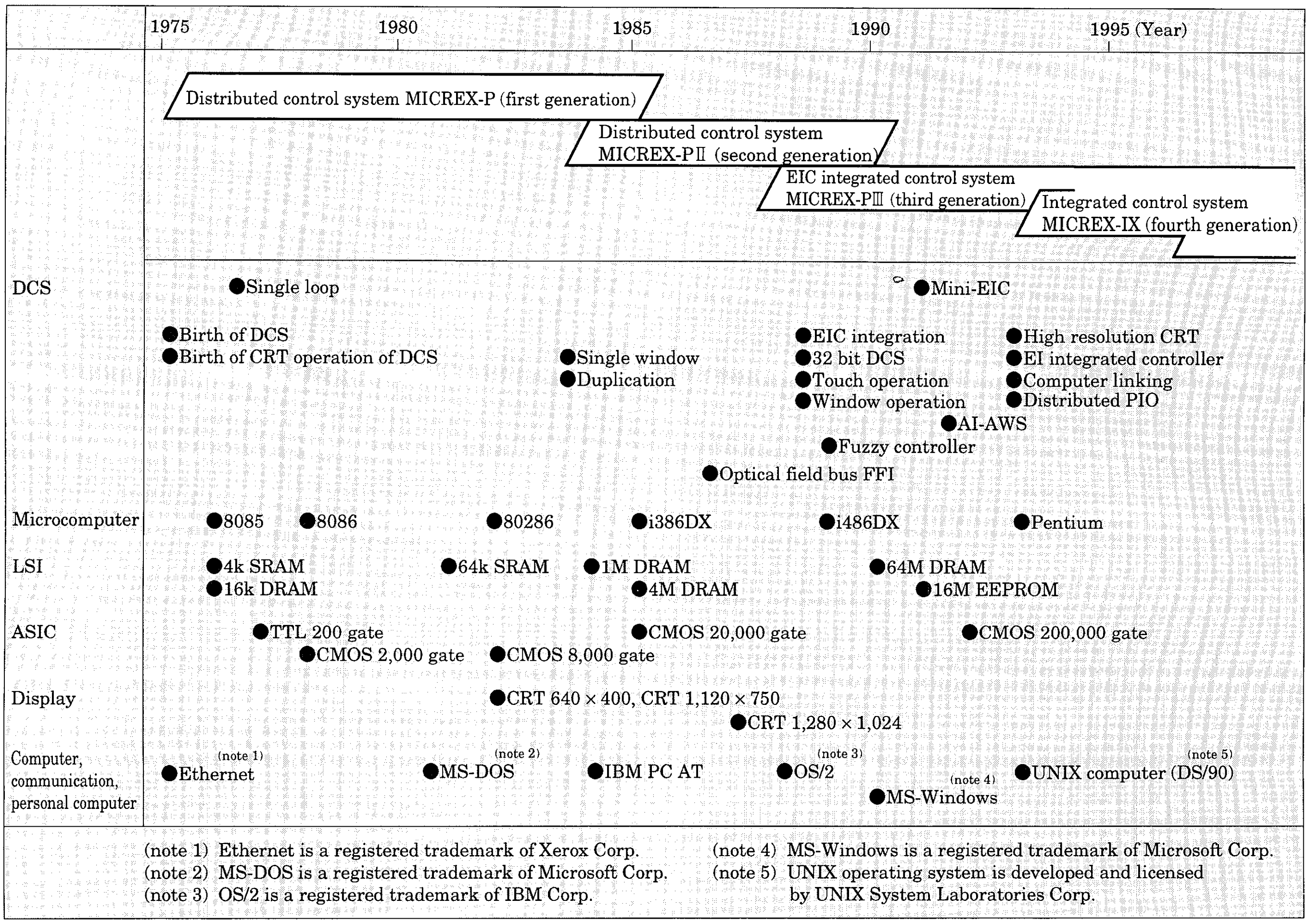
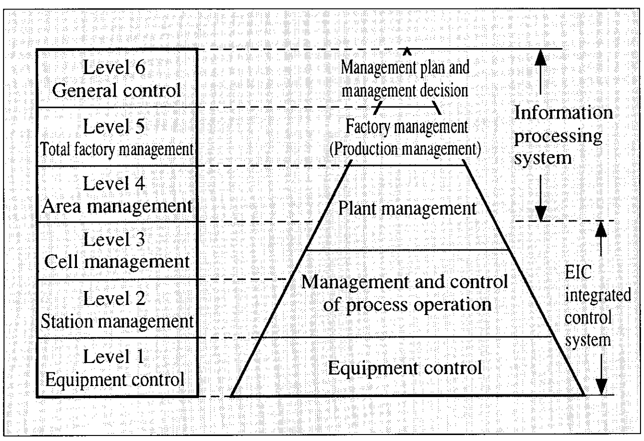


Fig. 4 CIM model and EIC integrated control system



environments in order to avoid the occurrence of breakdowns.

Moreover, the use of redundancy, either duplex or threefold, in the system configuration to avoide loss of operation for the important process has been studied.

3.3 User-friendly operation

Substituting for the operation of meters or panels, the DCS has established its position by functioning as an information terminal in the plant operation.

However, the current DCS has not discarded the conventional operation method out of consideration for the capability of elderly operators and those who may fear monitoring and operating a black box with new advanced methods.

As a solution, it is important to adopt a pointing device such as a touch screen or track ball hardware which may be operated with ease. Hierarchical operation is also useful to solve the problem of operating a black box.

Moreover, monotonous monitoring work causes mental fatigue and often causes misjudgement and misoperation by the operators. It is therefore important to put the AI navigator system to practical use. This system incorporates an intelligent alarm function to inform the operator when an alarm is generated in a form corresponding to the process status. The AI guidance function indicates the optimal operation and procedure.

3.4 Flexibility for system expansion

The movement in the industrial field towards re-engineering aims at the consolidation of facilities and collective management. The elimination of the conventional system of individual E, I, and C and the promotion of the information-based collective management of the industrial facility is a natural trend for DCS development.

As the integration of EIC progresses, the DCS requires a system structure which can flexibly respond to the expansion of the plant and the flexible hardware component. In addition, it is desired that each hierarchical layer of the DCS use the software and hardware which meets international standards.

3.5 Open architecture

It is only natural in an age where the EIC integrated control system monitors and controls the manufacturing facility, that it is required to be integrated with the production control system. However, when processing speed and function are compared, the large difference between the production control system and the plant control system becomes apparent. The coexistence of the EIC integrated control system and the production control system will become an important topic in the future.

In responce, the MICREX-IX acts as a data link between process data and management data through its connection to the open network TCP/IP.

To implement the "EIC single window monitor function in DCS" with the MICREX-IX, the management data display speed is improved by down-loading the monitor and operation display, generated by the workstation, to the MMI (man-machine interface device) of the DCS.

As the open architecture environment has become widespread, apprehension of multi-vender system configurations has increased. The most important point in the configuration and operation of multi-vender system is the trouble-shooting method. Since each manufacturer makes the system a black box, locating the source of trouble becomes more and more difficult for the user. The user is forced to make a large investment of both labor and money in operator education.

3.6 Downsizing

In consolidating the control facility, the latest monitor and operation equipment are often installed in the space where the old equipment they are replacing had resided. Moreover, the user also has a desire to secure space for amenities in the existing building, and to improve the work environment which is often called "3 D" (demanding, dirty and dangerous).

It is therefore crucial that equipment be downsized and functions upgraded, and that the necessary functions of the EIC equipment are integrated to a light weight and compact size unit for right sizing.

Figure 5 shows the space saving of the MICREX-IX.

3.7 Simulation function

Remodeling and renewal of the plant are demands of the day. Therefore, the DCS should be a system in which the control, monitor and operation functions can be easily remodeled or replaced. An enhanced simulation function of the DCS is necessary to secure reliability during remodeling or renewal.

Fig. 5 Space saving of control

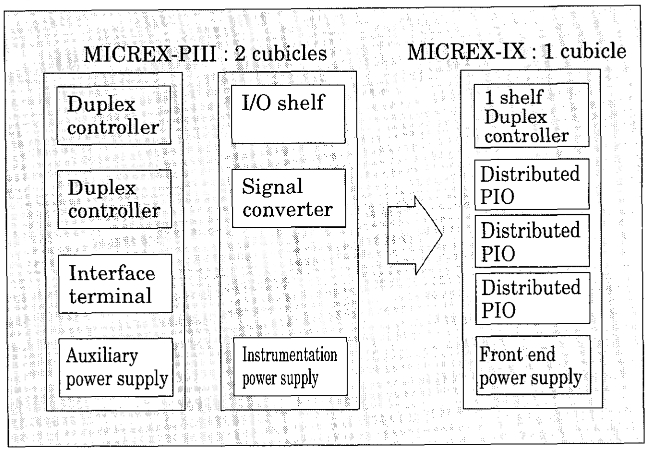
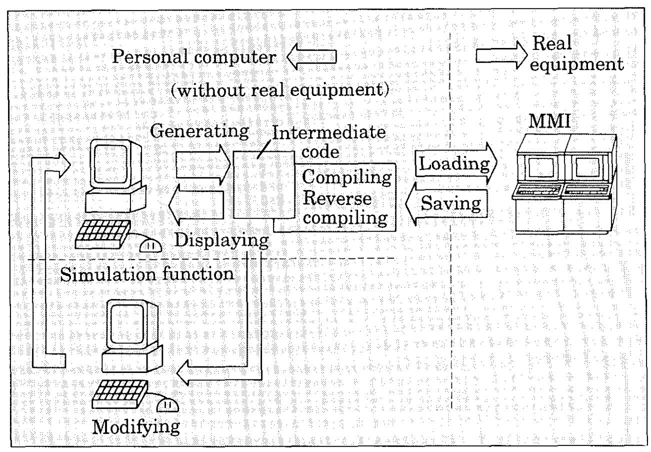


Fig. 6 Use of a personal computer to generate a plant panel



These simulations should be performed on equipment anyone can use.

Figure 6 shows the method of making the plant panel in the MICREX-IX system using general-purpose personal-computer.

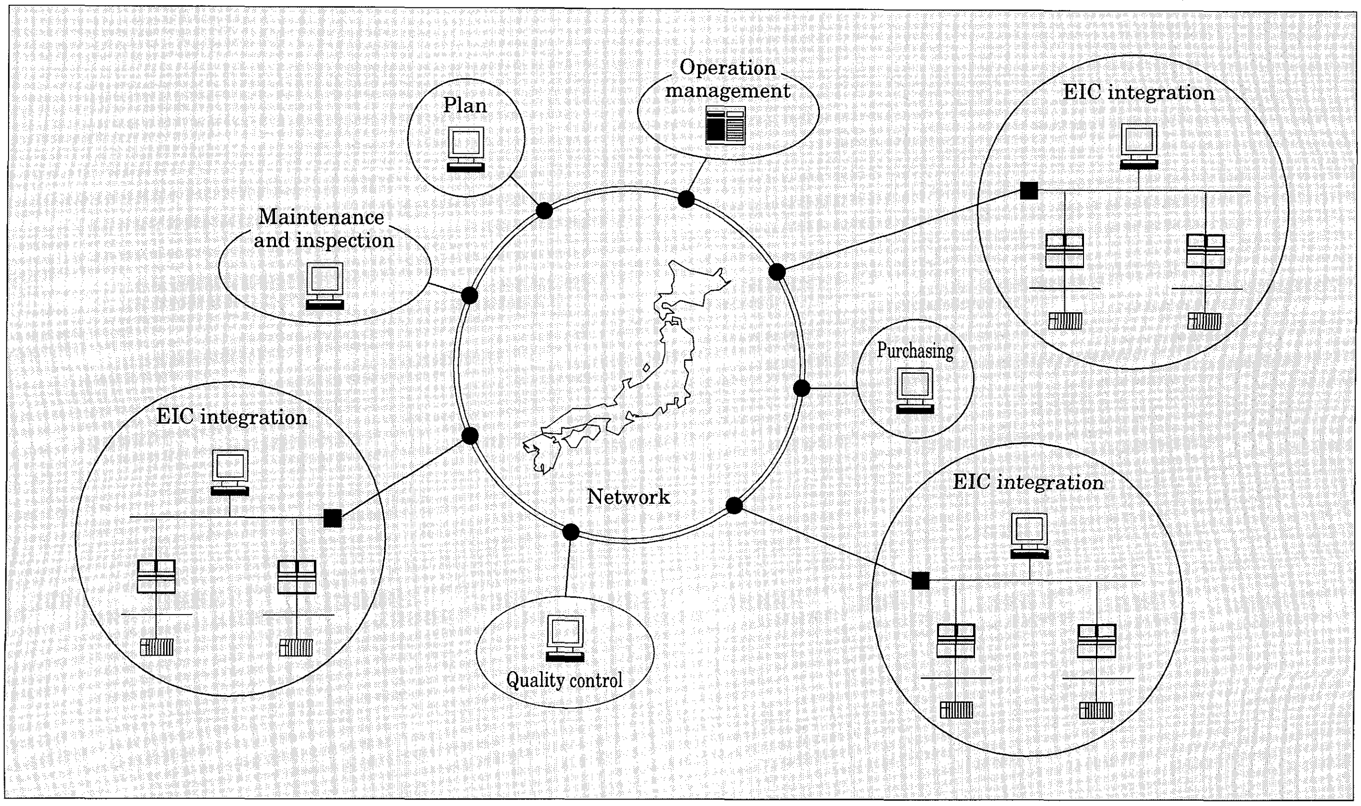
The simulator system is also important for education and training as well as for efficient debugging work.

The trends of the integrated control system and their conditions have been described above.

The promotion of reengineering in responce to changes in the industrial environment will inevitably accelerate EIC integration. However, it is not necessarily good policy to construct a new production center with excessive capital investment to promote such integration.

The concept of the distributed production system is as follows. In a plant operation system, the EIC integration system operates in each facility unit (equipment group); the instrumentation and operation rooms as well as the staff functions (inspection, maintenance, management, and technical section) are distributed in the factory. These functions are linked through a network and integrated into one operation and manage-

Fig. 7 Distributed production system (plan)



ment center, which can control and manage entire plants (within a factory, within the country or in any part of the world)

Figure 7 shows the concept of the distributed production system.

4. Conclusion

Accompanied by the general information processing technology trends toward network technology, open architecture, downsizing, and multimedia and the development of the fieldbus, integrated control systems are making outstanding progress.

These developments may bring about large changes in system construction methods and equipment configuration in industrial fields.

In promoting automation, it is important to make a system in which "an individual with a technical background can control the system", or in other words, to realize a system which will "sufficiently utilize operator knowledge of the plant". This feature will be an important factor in differentiating the technical superiority between systems.

Additional important tasks for the DCS are the improvement of safety, prevention of human error, and to review the cooperation between automatic operation (by computer or controller) and manual operation (human control).

Fuji Electric will continue to manufacture advanced systems as long as environmental changes and the need for these systems contributes to users' profit.

The authors will be grateful for any suggestions or guidance from those related to this subject.