CIM Technology for the Process Industry

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1. Introduction

In recent years, the economic and international state of affairs has resulted in changes in corporate environment, a diversification of user needs, and shortening of product life cycle, etc. The market environment has become more competitive. The manufacturing industry has introduced total CIM (computer integrated manufacturing), and FA (factory automation) as a means of achieving corporate restructuring in order to make manufacturing and production systems more efficient and flexible.

FA mainly involves the machining and assembly industry. For the automation of the process industry, there is PA (process automation) which has developed from the introduction of industrial use computers and mini-computers to the application in recent years of a microprocessor based distributed control system (DCS).

In other words, FA is used mainly for discrete processes and PA for continuous processes. In addition, CIM integrates manufacturing management and links sales, physical distribution and shop management systems.

With the basic concepts of TA (total automation), including both PA and FA, Fuji Electric has promoted agressive technology development and system integration (SI) in response to demands for a total CIM/FA system.

The core of this technology is the "EIC integrated control system MICREX". Below the role of the MICREX to the CIM structure in the process industry and its configuration are presented (**Figure 1** shows the basic MICREX concepts).

2. CIM Core: EIC Integrated Control System MICREX

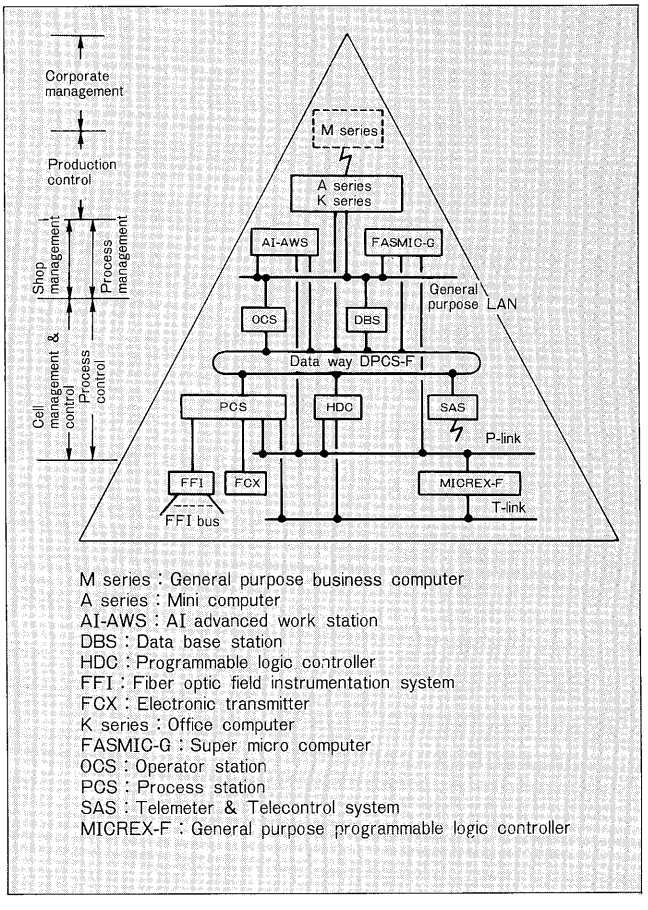
2.1 EIC integrated MICREX control system

The MICREX distributed control system has continued to develop since its introduction in 1975. In 1987, the 3rd generation was the industry leader and developed as the EIC integrated control system. This system consists of the integration of not only instrumentation control (I), but of also electric control (E), computer control systems (C), and a directly connected high speed 10M bits/sec dataway DPCS-F. In this single window system, operation may be supervised from a single operator station (MMI) OCS-1500.

Fig. 1 Concept of EIC integrated control system MICREX

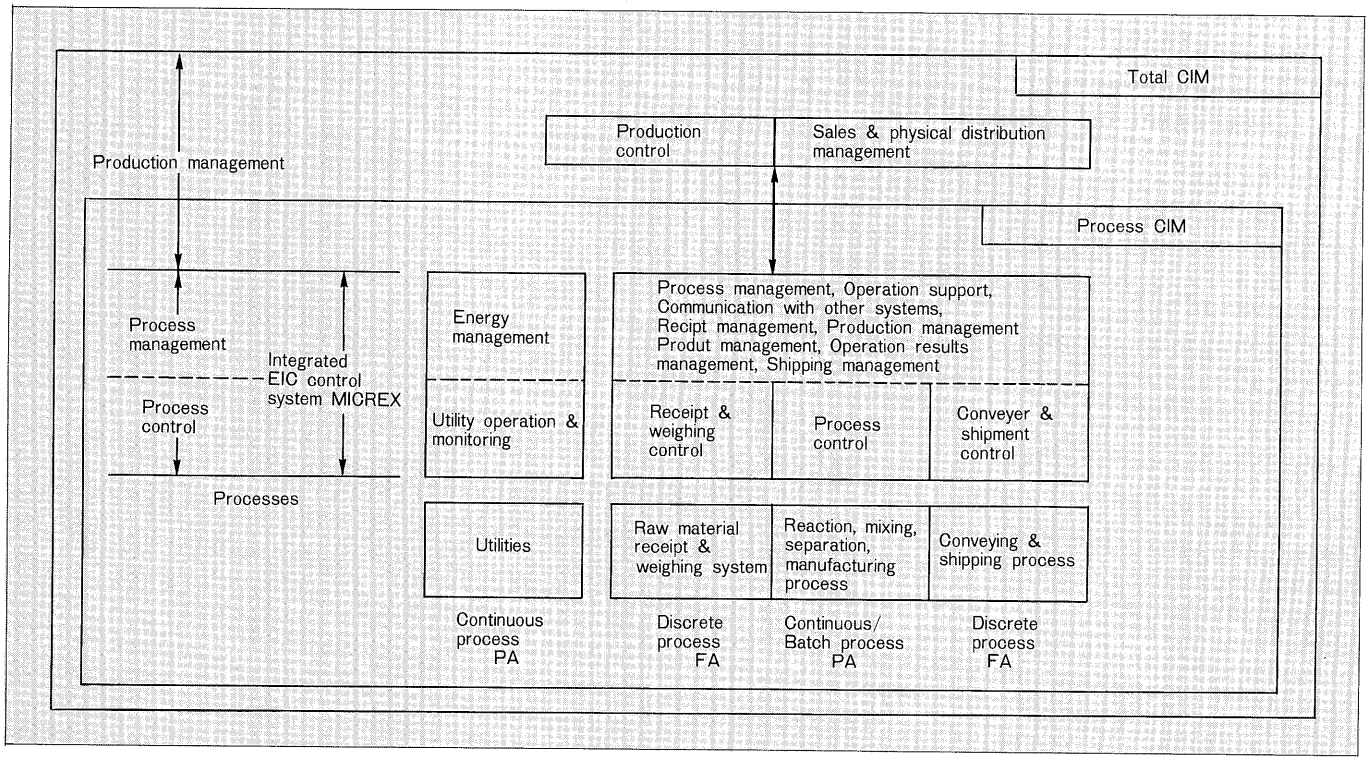
(1) Distributed control and centralized management
(2) EIC integration
Mini EIC
Integrated & open system
Integrated LAN & General purpose LAN
(3) TA(Total Automation) including both PA and FA
Core of total CIM & FA system
Horizontal & vertical integration

Fig. 2 System configuration of EIC integrated control system MICREX



M series : General purpose business computer
A series : Mini computer
AI-AWS : AI advanced work station
DBS : Data base station
HDC : Programmable logic controller
FFI : Fiber optic field instrumentation system
FCX : Electronic transmitter
K series : Office computer
FASMIC-G : Super micro computer
OCS : Operator station
PCS : Process station
SAS : Telemeter & Telecontrol system
MICREX-F : General purpose programmable logic controller

Fig. 3 CIM configuration of process industry



This system integrates and improves the efficiency of all EIC functions and equipment. At the same time, it aims at allowing easy connection to multivendor open system structures. The concept of "integrated and open systems" is fundamental to MICREX.

For this reason, a layered structure with the main dataway DPCS-F, as a integrated LAN, and a general purpose LAN (Ethernet*1 for example) are used for the system architecture. This "integrated and general purpose LAN" system structure later evolved into the common structure for other DCS. (**Fig. 2**)

In 1989, the industry's first small-scale application of EIC integration was announced, "the mini EIC integrated system MIREX-MS".

2.2 MICREX in the CIM system for process industry

The CIM structure for the process industry (process CIM-CIP/computed integrated process automation) is shown in **Fig. 3**.

The process industry has not only continuous and batch processes, but also discrete processes. In addition to simply automating continuous processes, it is also neccssary to have total automation and control within CIM.

With the development of CIM in the process industry, the EIC integrated system is used at the process control field level.

Compared to EIC integration, which had "horizontal cooperation and integration" as its goal, the MICREX system also achieves "vertical cooperation and integration" within CIM.

This is the PA, FA and TA that Fuji Electric has been advocating for the past 5 or 6 years.

With MICREX, the control of continuous, batch, and also discrete processes may be integrated with a process control computer within CIM.

2.3 PLC for MICREX system

The Programmable Logic Controller (PLC) system is used mainly in FA discrete processes and electric controls. In contrast to other systems where the PLC is simply coupled to the DCS, in MICREX system the PLC is integrated as a component common to the same system (Refer to **Fig. 2**). In other words,

(1) the high performance programmable logic controller HDC-500 in the upper level MICREX system

(2) the compact HDC-250 in the MICREX-MS system

are completely supported as components common to the instrumentation controller and process station PCS-500/PCS-250 (support is the same for hardware and software). HDC-500 is for high performance electric controls; HDC-250 has the same box-type structure as the general purpose PLC. In addition,

(3) individual general purpose PLC MICREX-F series (F120/F80 etc.)

are connected directly to each controller through a high speed link (P-link).

*1 Ethernet: Registered trademark of Xerox Corp.

3. Computer Functions

The main use of computers in manufacturing factories is for ① production management and ② advanced control.

A typical recent EIC system structure is shown in **Fig. 4**.

The function, positioning and trends of a computer in this system are shown in **Fig. 5**. With DCS, conventional controls and operation support can be sufficiently realized, but there is a need for more sophisticated controls (advanced controls) and greater managerial functions (CIM).

Multi-vendor, open systems have also developed, and as shown in **Fig. 4**, it is necessary for the total system to be connected to a different type of upper level production management computer or other process computer. For the planning, structure and maintenance of such a system, standardization independent of machine type, high functionality, low cost, and short delivery time are demanded by users.

Fig. 4 Configuration of EIC integrated control system

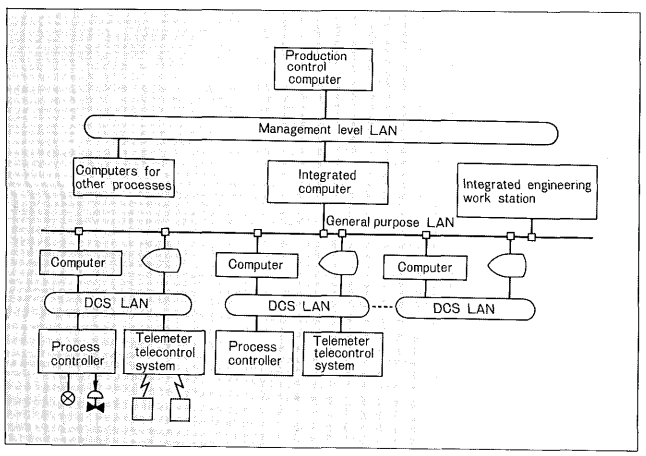
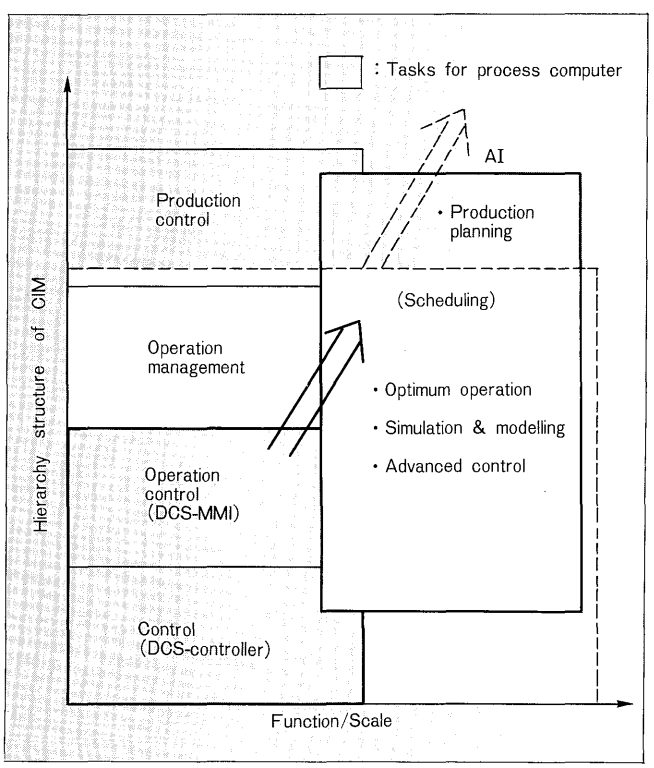


Fig. 5 Function, positioning and trend of computer control



3.1 Production management system

Fuji Electric has supplied the "FA UFAS computer system" which uses a FASMIC-G super micro-computer or an FA personal computer FMR/FA for FA manufacturing management. UFAS makes MICREX-F, etc. a part of the system and is used for FA cell level control. A system for upper level production management is constructed using the "K series" office computer or the "A series" mini-computer. This production management system contains a production data base and is responsible for planning, the dispatch of manufacturing orders, and result management.

Fuji Electric's FA computer and production management system has had many good results and has production planning, manufacturing preparation, daily schedule adjusting, dispatch of manufacturing orders, result management, etc. as standard production management packages.

Fig. 6 Function List of AI advanced work station

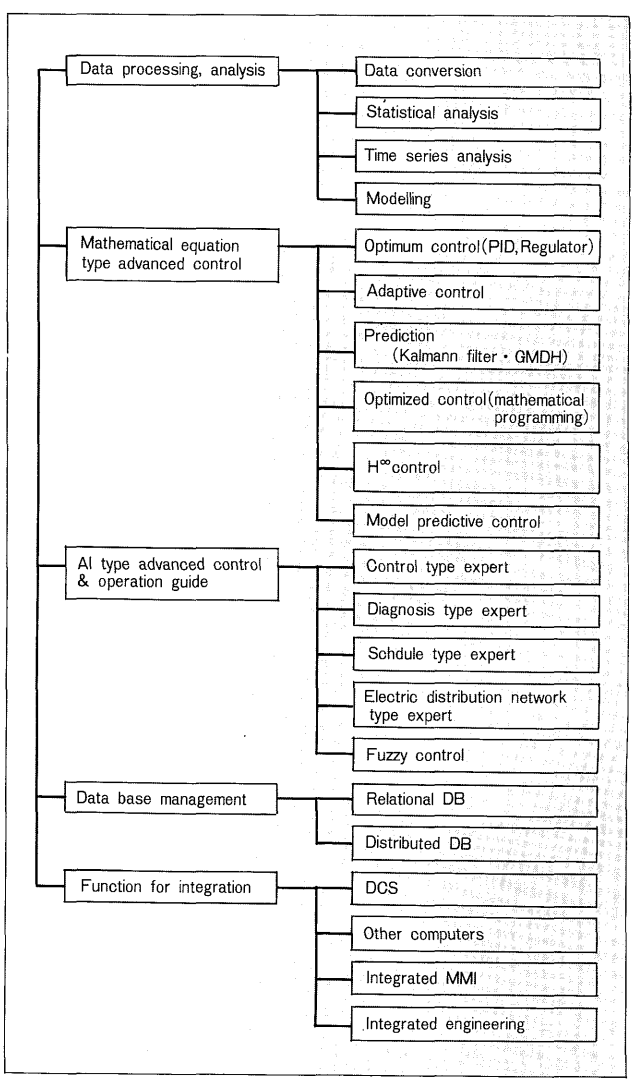
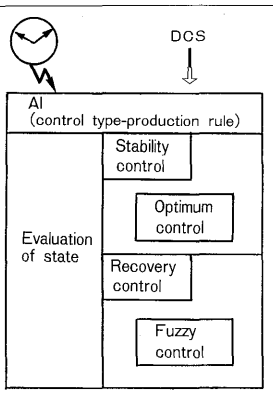
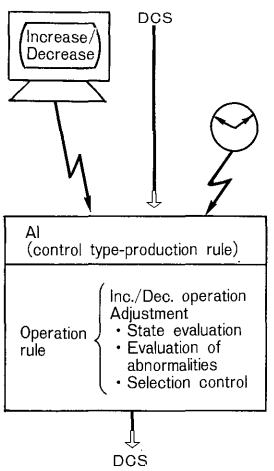
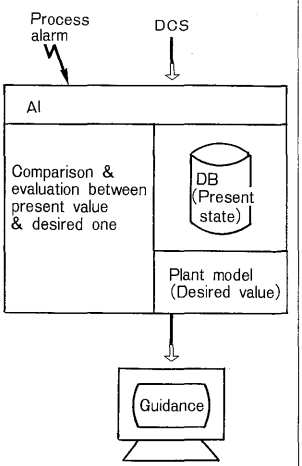
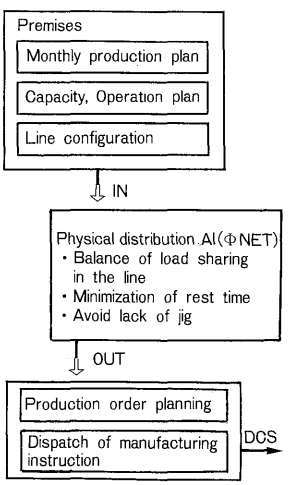


Table 1 Function of computer control in process industry

Application	Cement kiln control	Oxygen plant automation	Evaluation of abnormalities in automatic operation system	FA (machining & conveyor line)
Features of process	Chemical reaction, Thermal process	Distillation by boiling point difference, Thermal process	Distillation, Thermal process	Job shop type production (variable products & amount)
Process variables	Temperature, Electric power, Pressure	Gas flow, Gas purity	Flow, Purity	Line configuration, Machining time, Capacity
Objective of control	Operation stability	Automatization (man power saving), Operation stability	Abnormality diagnosis in DCS system	Line balance, Minimum rest time
Method of control	Optimum control by AR model, Fuzzy control Coordination between AI argorithms	AI (control type-production rule)	Process model + AI	Network model (Petri net)
Configuration				

3.2 Advanced control function

Fuji Electric has put much effort into the research and development of knowledge engineering AI and advanced control technology. Results have been applied to a line of workstations. This latest addition, the "AI advanced workstation AI-AWS", has an online function whereby the LAN for the MICREX control system is connected directly.

In other words, the AI-AWS is an AI workstation which, through superior real-time processing, possesses the functions of planning, control, diagnosis, etc. for the PA field in the process industry.

The functions:

(1) optimized controls such as advanced control
(2) fuzzy control
(3) expert function for control and diagnosis

are combined with Fuji Electric's experience in many fields and built into a workstation package.

A chart of functions is shown in **Fig. 6**.

3.3 DCS-AI cooperation implementation examples

Table 1 shows some example structures of AI systems coupled to DCS which have achieved good results.

4. Conclusion

Fuji Electric's EIC integrated systems were present above within the framework of CIM. With considerations for internationalization, increased information, diversification, etc. CIM and integration is being studied for the integration of strategic information systems.