

# CURRENT STATE OF PROCESS INSTRUMENTATION & CONTROL TECHNOLOGY AND ITS OUTLOOK

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## 1 FOREWORD

In Japan, the development of process control technology is based on the passwork "automation" as modernization of industrial facilities, that is, as automation facilities in steel works, new thermal power plants, oil refineries, and so forth, which started during the last half of the 1950's.

Fuji Electric skillfully adapts the economical and social environment (plant needs) and control system technology background (technical seeds) of such an age in this field, and has made numerous achievements by supplying high-performance, reliable, and economical process control systems adapted to each industrial field.

## 2 DEVELOPMENT OF PROCESS CONTROL SYSTEMS

### 2.1 Development of Feedback Controller

We have in early stage practicalized a mechanical pneumatic instrument and controller, and have gradually made it more accurate and smaller. An electrical type appeared at first with moving coil type, and after that with the transition from the vacuum tube to the transistor and IC, it has become the mainstream of instruments.

As we entered the 1970s, advances were made in the practical application of LSI and an distributed digital control systems were announced by various companies and were developed and filled out as the mainstream of processing control systems, which were becoming more diversified and sophisticated.

In the last half of the 1970s, panel mounted type digital single loop controllers having continuity with the existing analog controllers, were practically applied.

Here, the distributed digital control system developed from the centralized type DDC and this single loop controller were technically harmonized and consociated, then a consistent system was realized by combining rack mounting and panel mounting type.

Especially, the distributed digital control system MICREX-PCS, -OCS announced in 1983 fuses close functional coupling of the centralized information and the distributed control by single loop and is echoed from many

customer for the superiority hierarchal system which is closely connected with the U Series and S-3000 Series upper-level process computers.

### 2.2 Development of Sequence Controller

In the beginning, the sequence controller was developed from sequence control by electromagnetic relay combination. Thereafter, as processes became larger and control became more complex, controller having high-speed and high computing processing capabilities and high reliability and RAS functions were practically applied as industrial programmable logic controllers (PLC) with the aim of developing electronic controllers with this sequence control as the main objective.

Fuji Electric made very effort into this field from an early stage and, at the present time, its effort is being displayed at the core of control of all industrial fields as the MICREX-HDC and -PMS.

The development of such Fuji Electric process control systems is summarized in *Fig. 1*.

## 3 TREND OF PLANT NEEDS

In the background in which process control technology is needed and was developed, there are, of course, plant needs which come from changes in foreign and domestic economical, social, and various other environments. These needs change with the age.

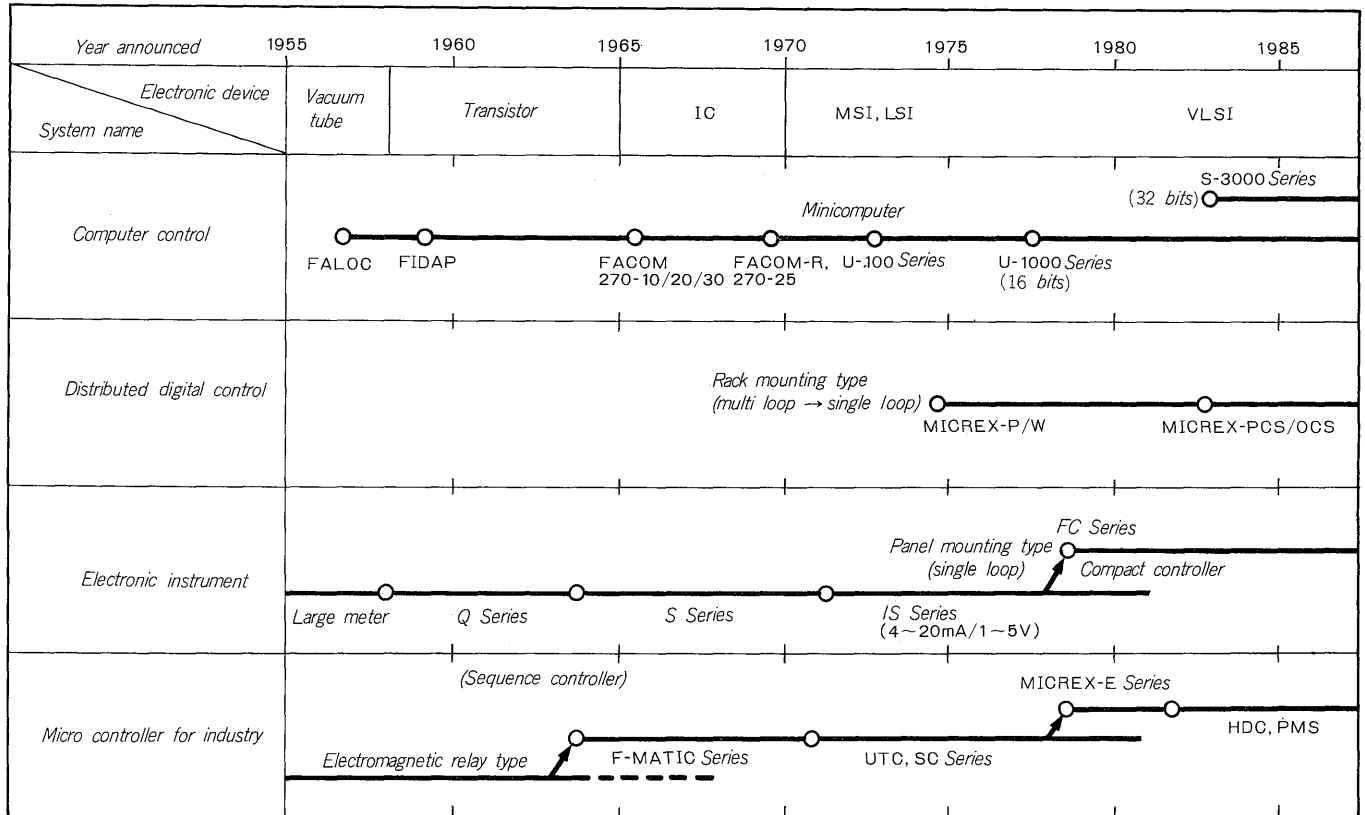
### 3.1 Expansion of Automation and Improvement of Controllability

To beat the competition at stable economic growth, production having cost competitive force must be realized, for the purpose productivity must be increased at high efficiency with little raw materials and energy, and at the same time, product quality must be maintained and improved.

raw materials and energy and production having cost competitive force must be realized and, at the same time, product quality must be maintained and improved.

For this reason, the range of automation is being expanded, and high reliability control systems which are more accurate and faster are being pursued.

Fig. 1 Development of Fuji Electric process control systems



At the same time, this means that systems are being made gigantic and are being distributed over a large area.

### 3.2 Control System with Flexibility

The age of mass production and mass consumption under a high growth economy ended with the oil shock and the sense of value of consumers is becoming more diverse and discriminating in the trend toward individuality and high quality mind.

If this is viewed from the standpoint of production, the production items must be increased, production lot become smaller, and fast response of production line changing is necessary.

For this reason, a control system with which permits flexible and simple production line reconfiguration is being pursued.

### 3.3 Simplified Operation Supervision and Maintenance

The aging of the labor force and the reduction in the experienced labor force is accompanied by a strengthening of the trend toward finding good working conditions and environment by necessity.

For this reason, the demand for automation and mechanization of production facilities is increasing and along with it, operation supervision and control of entire complex and large systems is fast exceeding the limits which only on the human judgement. A system in which a safer system construction and the serviceability of the entire system are taken into account, and with which operation supervision

and control are easy, is desirable.

### 3.4 Coping with Internationalization

With the internationalization of products and the increase in plant exports, products and system which conform to international standards and which simple to handle, are desired. At the same time, arrangement of documents and display on a CRT screen, etc. for overseas, are also desired.

## 4 PRESENT STATE OF PROCESS CONTROL TECHNOLOGY

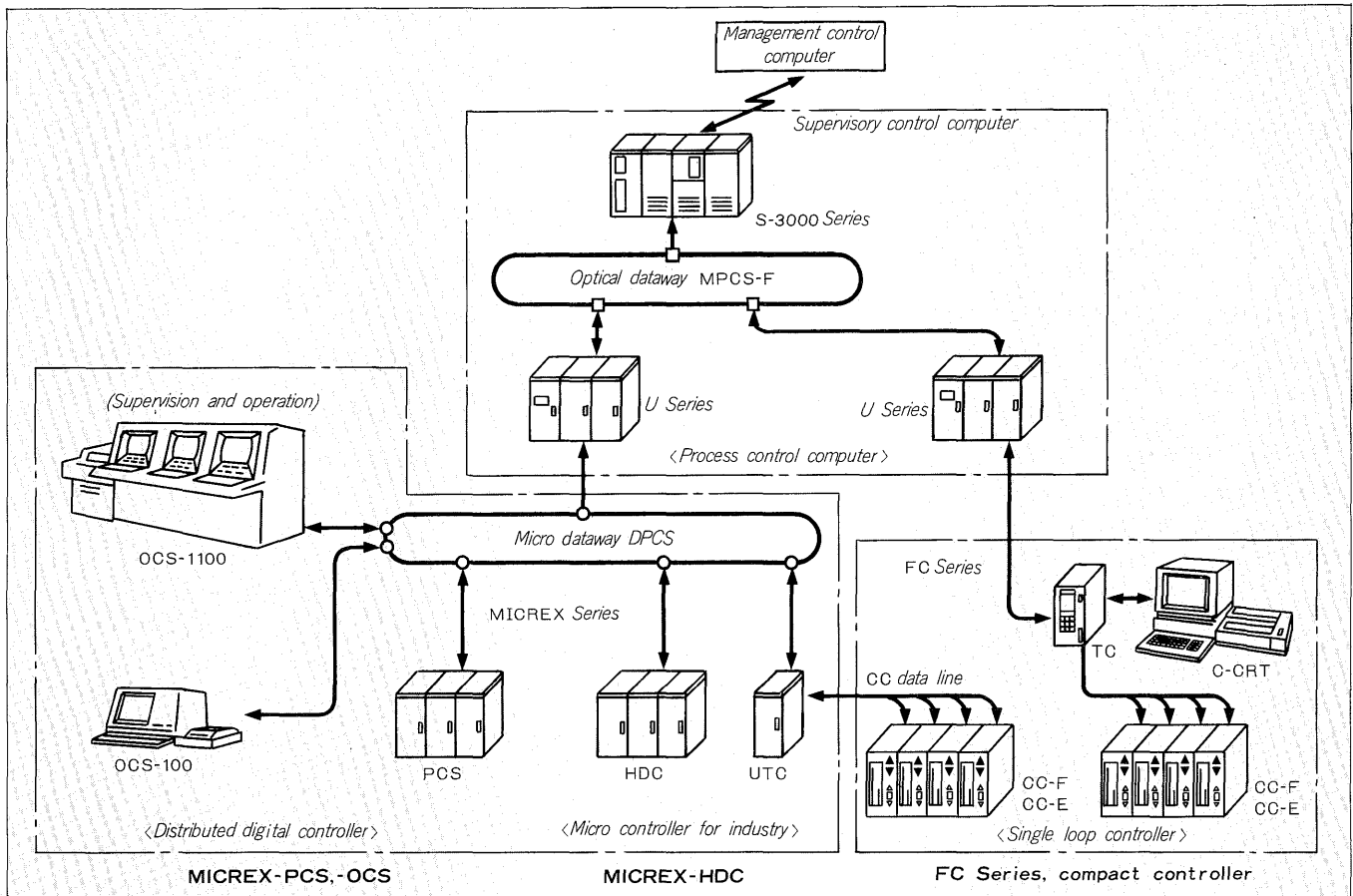
The Fuji Electric total system configuration for process control constructed with such needs as the background, is shown in Fig. 2. Each field is outlined below.

### 4.1 Total System for Process Control

This system has a construction which skillfully harmonizes the centralized information and distributed control concept. That is, it is a total system constituting a same architecture which includes a network system which organically couples everything from the super minicomputer for supervisory control to various controllers at the process control level and a CRT display and other man-machine interfaces.

It is a system in which coordination with an upper-level general purpose computer for management data processing is also planned and which amply utilizes the various merits of the Fuji Electric group. Of course, this system configura-

Fig. 2 Fuji Electric total system configuration for process control



tion has been given flexibility in selection of its combination by system scale, kind and so forth. This is especially beneficial from the standpoint of selection of the optimum functions, expandability, economy, and so forth for control systems in which the application process is various type and various purpose.

#### 4.2 Process Computer Control System

The higher functions and larger scale of process control systems promotes improvement of the performance of the upper-level computer.

Lately, efficiency has been improved by using computers not only in the process control field, but also up to the so-called FA, LA, and OA fields.

Even in this new trend, the S-3000 Series super mini-computer of a new dimension which was completed by concentrating the newest system architecture and technology was announced early 1983.

The S-3000 Series has a 32 bit architecture. Maximum 16M bytes main memory capacity, use of a multiplex virtual memory system, and so forth, improve processing capacity and fill out the realtime functions. It has superior features provided with high reliability functions as a system by the extensive use of mainly a 2000 gate high-speed bipolar logic LSI, and so forth.

Abundant package software is also available for application to not only the process control field, but also to the

FA, LA, and OA fields, and for system development and further completion of Japanese language processing, and so forth.

For a various system structure, connection to a upper-level FACOM M Series by flexible system link (FSL) and communication line, etc. is also possible.

On the other hand, software packaging of the U-1000 Series computer, which has made many achievements as a process computer, is proceeding. It have been improved and outfitting as a high performance process computer system —“UPOS” (Universal Process cOMputer System). That is easy to operate and has a wide range of applications and is also designed for serialization according to the system scale level.

And overall processing supervision, control and maintenance function encompass not only the process control field, but also the factory management field.

#### 4.3 Distributed Digital Control System

Regarding distributed digital control systems announced by Fuji Electric and also various companies in 1975, the distributed concept is being developed and the number of control loops per process or is advancing from multi-loop to single loop (1 loop).

Contemplating the advent of one loop, which is the extremity of this distribution, in 1983 Fuji Electric an-

nounced the new MICREX system PCS and OCS Series oriented CRT-operation with substantial function level improvements. These series have received extremely high praise from all quarters.

This new MICREX system fuses the single loop distribution concept and multi-loop tight function coupling, and has a system configuration which realizes high reliability, easy application and operation.

That is, the controller (PCS) has simply and flexibly built a system by realizing a multi-loop compound control function in the hardware sphere and by a wafer connection (software functional block connection) system which does not recognize a programming language, and a problem-oriented language (POL) in the software sphere. Unit redundancy and duplication, self-diagnosis function, various RAS functions, and so forth are filled out, and a highly reliable system can be built.

Besides, the CRT operator station (OCS) has more complete one-touch operation by hierarchal panel and back-up operation by CRT and support function by various graphic panel, as a result panelless operation by CRT has been made possible. The function of the micro dataway (DPCS-E) which also allows optical fiber transmission at high speed in data transmission between these controllers and man-machine device is displayed in this total system configuration.

Moreover, advanced control functions so called auto-tuning, simulation etc. can also be applied with this MICREX system. Optimum PID parameters setting is possible even with complex processes and it serves in system optimum control.

#### 4.4 High-speed Sequence Control System for Industry

In 1978, Fuji Electric announced the MICREX-E Series microcontroller for industry having high-speed and high computing processing capability by high performance microprocessor and high reliability RAS functions, and so forth, and has made many achievements in this field since then.

Functions have been further completed and improving as a MICREX-HDC, PMS with advanced easy application has been newly performed.

Regarding this MICREX-HDC, since a distributed control system, duplex system, various transmission systems, etc. flexible system configuration according to the control objective is possible by multicontrol system which can connect multiple controllers by a multicontroller bus (MC bus) and remote I/O (CIO, EIO) system which permits distribution of inputs and outputs, its power is displayed as the core of control in all industrial fields.

A man-machine controller PMS with complete CRT functions is also available for plant supervision and control with this system.

The biggest feature of this Fuji Electric system is that a system configuration with the sequence controller and loop controller intergrated at the same level is possible. That is, connect to the same high-speed dataway (DPCS-E) HDC Series microcontroller for industry and PCS, OCS

Series distributed digital control system, is possible. Therefore centralized operation, control and maintenance by CRT display are possible, and a system with the motors control and instruments mixed and integrated can be easily constructed.

#### 4.5 Single Loop Controller

In 1979, Fuji Electric was the first in the industry to announce a single loop controller digitalized by microprocessor, while continuing the external functions, operability, input/output conditions, etc. of panel mounted type conventional analog controllers, as the electronic control system FC Series "compact controller".

These compact controller has abundant computing and control functions and data transmission with a upper-level system, and tremendously improves other conventional functions and contemplates intelligentization. The all kind of setting value and inner connections can be easily realized by wafer (software function block) connection by setting unit key operation. A special software knowledge and loader, etc. are unnecessary.

This has a deep significance in that the freedom of selection of abundant computing and control functions can also be opened to the user.

### 5 FUTURE OUTLOOK

Recent electronic technology developments are following the amazing advances made in microprocessor technology. Improved device integration – steady growth of VLSI – and improved reliability are the result. This means that the performance and reliability of information processing machines will be substantially improved in the future.

Data transmission by optical fiber technology is expected to have an impact as one more basic technology.

These two big technological impacts will prompt the further development of a hierarchy network system based on the centralization of information and distribution of control. This means that, at the same time, the importance of software will steady increase. Moreover, this means that the demand for improved operation and supervision functions is high, and advances must be also made in the man-machine interface. Completion of CRT display function improvement will advance not only by transmission and exchange of video information or input/output of data by voice, etc. sense of sight but also further by sense of hearing and sound.

### 6 CONCLUSION

As described up to here, Fuji Electric process control technology has exerted its power in responding to the trust and demands of our customer by hardware technology reflecting plant needs and the newest technology, and by system technology accumulating abundant experience. Will continue to put all out power into serving out customers. This special issue introduced one end of this technology.