

Open Integrated Instrumentation and Control System “FOCUS”

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1. Introduction

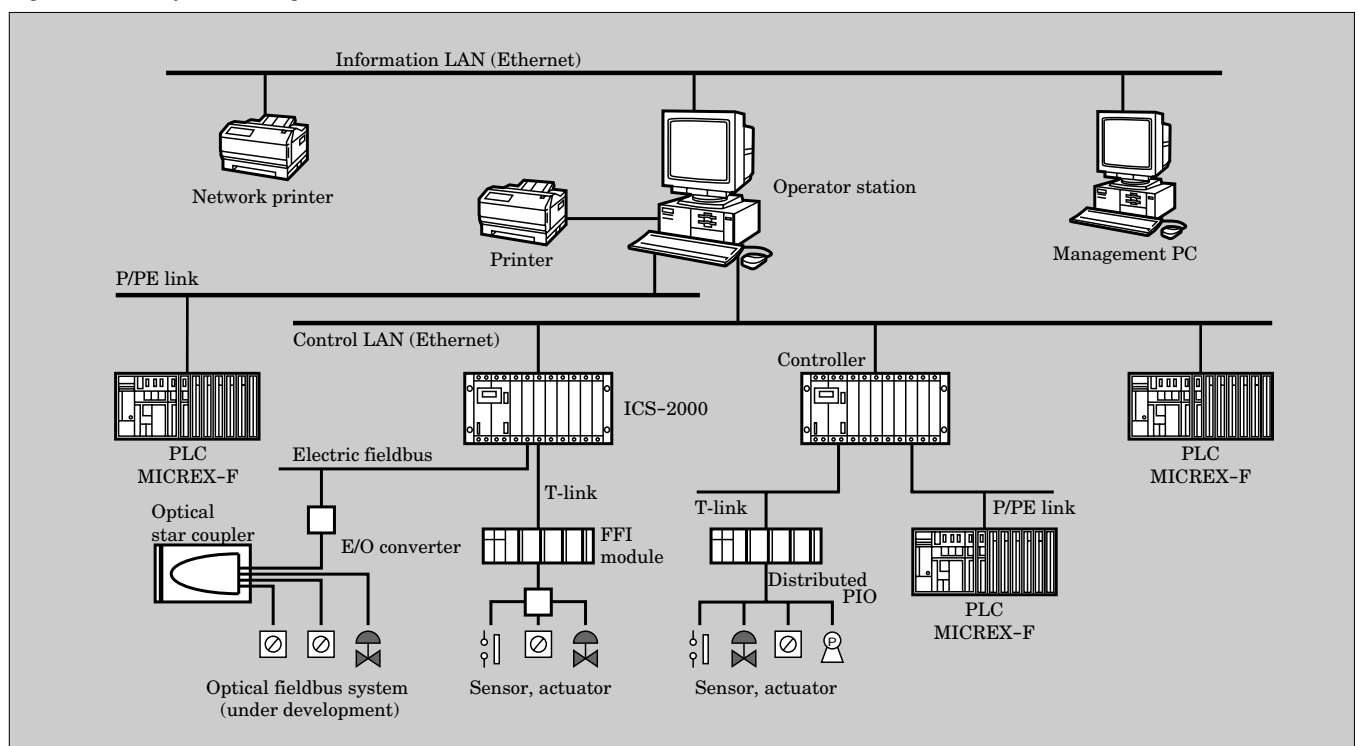
Recently, there have been many advances in plant supervisory control systems. These objective plants are integrated with physical systems, and are constructed to minimize input, the internal flow of substances, and the required energy to obtain the maximum output. Supervisory control systems are required to manage such plants for effective operation and to achieve maximum productivity with a minimum number of operators. Prediction and estimation prior to the commencement of the phenomena and operation based on the operator's knowledge must be tied to the production of excellent results.

For this purpose, the information level must be upgraded to a higher level than conventional plant supervisory control equipment. Furthermore, the system must be constructed at a reasonable price.

Harmony between the scheduling and manufacturing systems as well as the utilization of general-purpose products provides the solution. The role of the vendor is to closely connect people with workplace information and the world inside the computer. At present, owing to the improvement of functions and performance of the personal computer (PC), the utilization of PCs has been spreading rapidly from office to manufacturing workshop environments. Graphical human interfaces that are highly expressive and open information and communication functions have become readily available in the field of instrumentation and control. The introduction of advanced systems has become easy even in spite of the severe economical situation and low investment in equipment.

Development of new control system configurations that utilize PCs is also in demand. The range of applications must not only include small-scale systems

Fig.1 FOCUS system configuraiton



but also systems of any size. In the following, the open integrated instrumentation and control system “FOCUS” (Fuji Open Control Universal System) developed based on the concepts of “right sizing” and “right selection” is described.

2. Configuration and Features of the System

2.1 Configuration of the system

Various systems can be configured by combining PC related open components and controllers.

- (1) A configuration of the system is shown in Fig. 1. Systems can be configured from a minimum of one operator station with one controller to a maximum of six operator stations with eight controllers. The operator stations and controllers are connected by the control LAN (Local Area Network) (Ethernet^{*1}). The DCS (Distributed Control System) controller ICS-2000 and programmable controller (PLC) MICREX-F are connected on the same Ethernet and are able to share the control functions. The MICREX-F can be connected to the P/PE link.

The information LAN (Ethernet) enables data links with other systems and allows integration with manufacturing, logistics and maintenance systems. Furthermore, connecting a network printer to the information LAN enables one printer to be shared among multiple operator stations.

- (2) A client server system can be configured with FOCUS at its core. The server and controllers are connected by the control LAN, and the server singularly controls the application program and process data. Multiple client operator stations are connected by the server and information LAN. The application program with singular control enables the supervision and operation of different facilities by multiply operators using the singular control data.
- (3) The remote connection configuration of an operator station is shown in Fig. 2. The local operator stations and remote operator stations are connected by telephone or ISDN lines. The same operation and supervision that are possible onsite can also be performed at a remote office. The supervision of image display from the site monitoring terminal camera as well as the supervision and operation onsite by the terminals are possible using remote connection, mobile computing and wireless techniques.

2.2 Operator stations

- (1) An IBM PC/AT^{*2} compatible PC is used as the operator station. Windows NT^{*3}, having an excellent user interface and high reliability is utilized as the OS (Operating System). FA PCs can be utilized in systems requiring higher reliability. FA PCs are able to withstand

the environment and have been designed for continuous 24-hour operation.

- (2) Input devices can be selected based on system requirements and consist of the following: standard keyboard, mouse, touch panel and application keyboard.
- (3) Console desks are provided so that installation can be performed in a conventional control room without any feeling of disorder.
- (4) Reflecting the experience of DCS, easy to use displays are installed for supervision and operation. The list of supervision and operation displays is shown in Table 1. Display examples are shown in Figs. 3 and 4. The plant display is

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- *1 Ethernet : A registered trademark of Xerox Corp., USA
 *2 PC/AT : A trademark of International Business Machines Corp., USA
 *3 Windows NT : A registered trademark of Microsoft Corp., USA

Fig.2 Remote connection to an operator station

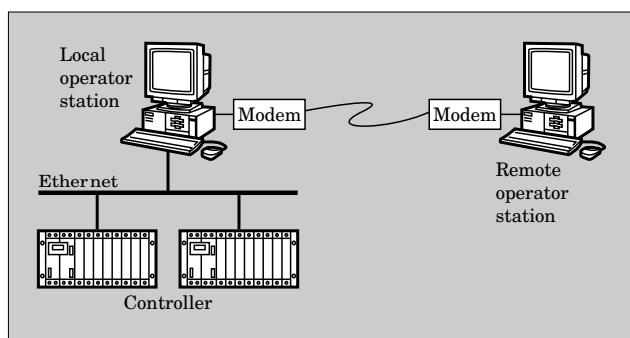


Table 1 List of supervision and operational panels

Plant panel	512 points × 100 pages	Graphic display for piping or electrical diagram of the plant
Group panel	8 tags × 384 pages	Group display for max. 8 instrument modules
Loop panel	1 tag × 2,304 pages	Detail display for each instrument module
Alarm panel	20 points/display page (scroll display 2,000 points)	Alarm message indicating the time of occurrence
Historical message panel	20 points × 100 pages	Historical operation message
Annunciator panel	32 points × 16 pages	Annunciation window display
System condition panel	1 page	System condition display
Trend panel	8 pens × 64 pages	Analog trend display
Logging panel	Daily reports: 20 types Monthly reports: 20 types Annual reports: 20 types	Logging data display

prepared by InTouch^{*4} (an operation and supervision software package of Wonderware Corp.). Instrumentation symbols and parts such as pumps and valves are provided in the software, allowing the efficient preparation of displays. The format for logging data can be created with EXCEL^{*5}. As a result, the processing and graphing of data is easy to implement, and the logging

of data is a visual process.

2.3 Controllers

The ICS-2000 EI (Electric Instrumentation) integrated controller, which is common with Fuji Electric's DCS MICREX-IX series, and the MICREX-F programmable controller can be used. The most suitable model

Fig.4 Example of FOCUS standard display

*4 InTouch : A trademark of Wonderware Corp., USA
 *5 EXCEL : A product name of Microsoft Corp., USA

Fig.3 Example of FOCUS plant display

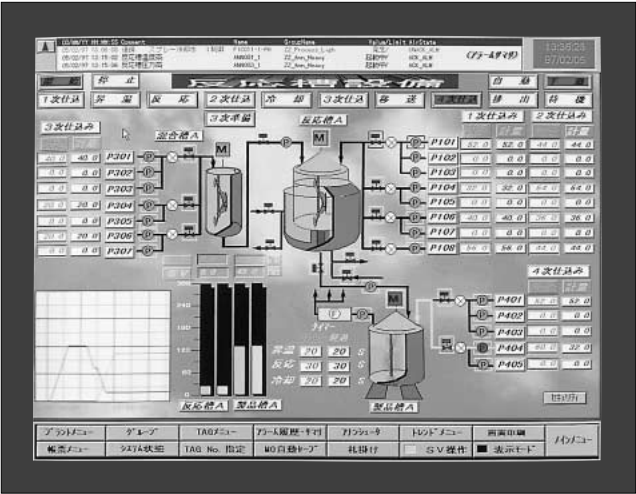
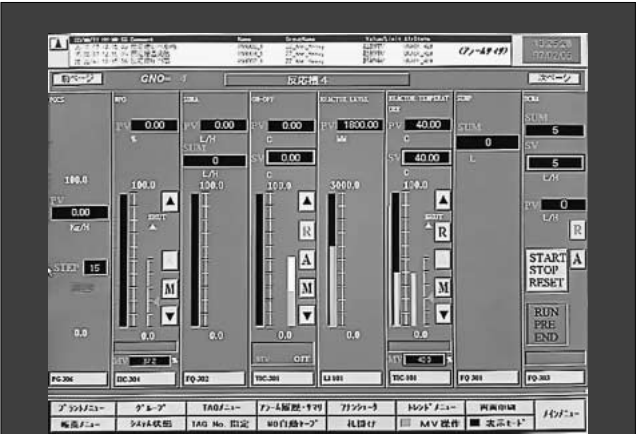


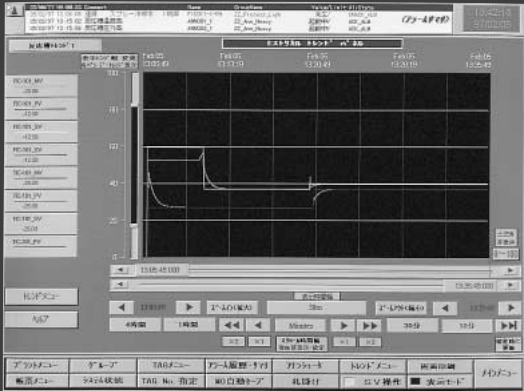
Table 2 ICS-2000 control function specifications

Instrumentation and control	Instrumentation module	288 modules PID controller (position/velocity type), ratio setter, ON/OFF controller, alarm indicator monitor, manual loader, etc.
	Sequence table	64 sequence table
Task management	No. of tasks	5 level, 100
	Interrupt	1ms/10ms, periodic, event
	No. of subroutine	480
Processing speed	Instruction execution time	0.125μs (sequential calculation)
	Calculation period for the instrumentation module	Min. 60ms
	Calculation period for the time chart module	200ms × n times
Memory capacity	Program	256k words
	Data	128k words
No. of I/O points		Max. digital: 8,704 points analog: 2,048 points
Programming method		Ladder, function block, SFC, decision table, instrument loop, time chart
Data type		Bit, word, double word, floating point



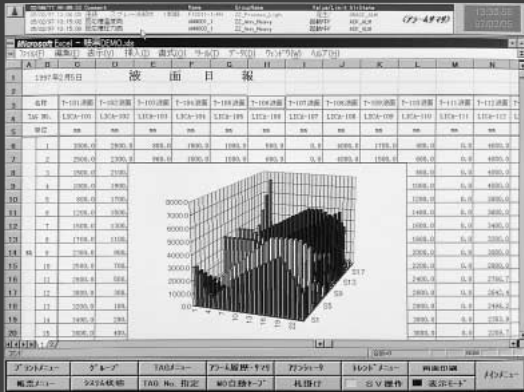
Group panel

8 instrumentation modules introduced from tag menu panel are simultaneously monitored and operated.



Trend panel

Analog trend display with various time scales and measurement ranges.



Data logging panel

Each daily, monthly and annual report is displayed with an EXCEL sheet. Manual input is also available.

can be selected depending on the requirements. Furthermore, the supervision and operation of both ICS-2000 and MICREX-F can be conducted from the same display. Feedback can be controlled by the MICREX-F, and in this case, the instrumentation symbols for both the ICS-2000 and the MICREX-F can be indicated in the same display.

2.3.1 ICS-2000 EI integrated controller

Specifications of the ICS-2000's control functions are shown in Table 2, and its features are described below.

- (1) This controller is common to the MICREX-IX, and is able to execute EI integrated control and fuzzy control that organically combines high-speed sequential control and regulatory control similar to conventional DCS, even in a PC instrumentation system.
- (2) Since this module structure is able to withstand the environment, it does not have to be installed in a custom locker.
- (3) The individual type PIOs (IPUs) are connected by the field LAN (T link). IPU's have a module structure of one point unit and can be installed at distributed sites. The FFI (fiber-optic field instrumentation system) can be connected. Optical field bus compatibility is currently under development.

2.3.2 MICREX-F programmable controller

A system that mainly executes sequence control can be configured at minimum cost. PID control is possible by the PID module or the single loop controller with a T link connection. Furthermore, a software module is provided to perform PID control by software.

2.4 Peripheral devices

Since commercially available peripheral devices for PCs can be used, a system can be configured at a low price as described below.

- (1) Printers, such as a color ink jet printer for alarm printing and a laser printer for data log printing, can be used selectively.
- (2) A CD-ROM (compact disc read only memory) device for the rapid installation of software packages and an MO (magneto-optical) disk device for backing-up and saving the application program and trend data can be used.
- (3) Voiced annunciation can be output from the sound board of the PC.
- (4) Monitoring of the site is possible by capturing the video display via the video capture board.

2.5 Redundancy

Reliability can be improved through utilizing redundancy for the components that configure the system, depending on the application as described below.

- (1) Operator stations are provided in parallel. Even if one station is down, supervision and operation can be continued by another station.
- (2) The ICS 2000 controller is duplicated according to

the required shelf. This system, in which two MPUs execute identical control independently of each other, is called the warm standby system. Data is copied from the operating MPU to the standby MPU at all times, and control is continued by the standby MPU if the operating MPU is down.

- (3) The Ethernet cable can be a duplex cable.
- (4) The T link cable can be a duplex cable.
- (5) The PIO for each I/O module unit can be duplex.

2.6 Engineering

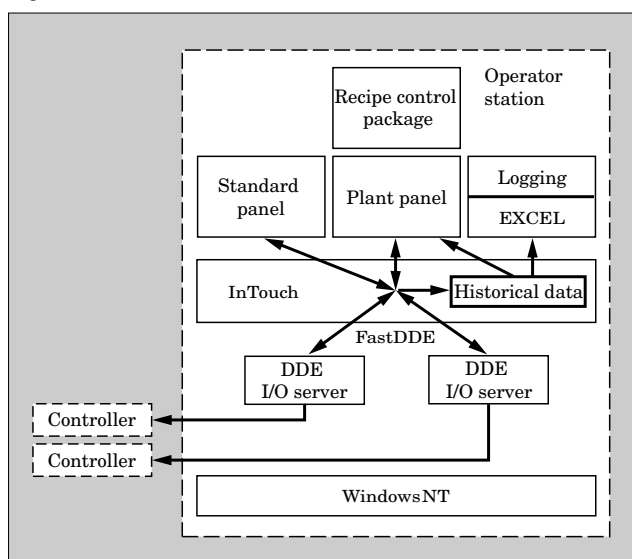
- (1) An intuitive display can be drawn easily on the plant supervision display using graphical animation with InTouch.
- (2) Data display and setting, as well as the variation of shapes and colors depending on the data can be performed without programming.
- (3) The controller program can be created and tested on a PC.
- (4) Programming with various data types such as ladder diagrams, function blocks, SFCs (sequence flow charts), instrumentation loop diagrams, time charts, etc. are possible.
- (5) The defined tags are developed for the tag database of the operator station to increase engineering efficiency.

3. Software Structure

The software structure of the operator station is shown in Fig. 5.

The DDE I/O server executes the transfer of data with controllers. The DDE I/O server uses DDE (Dynamic Data Exchange) to interface with the data. DDE is a transmission protocol developed by Microsoft Corp. to enable the mutual transfer of data between

Fig.5 Software structure



applications running in the Windows^{*6} environment. The transfer of data is possible not only with InTouch but also with other software packages, so it is easy to link data. With InTouch, the DDE I/O server transfers data by Fast DDE, a high-speed DDE.

Data transfer via the Ethernet is possible with the DDE interface. This is an easy means to link data with other systems such as management PCs. Also, a client server system can easily be configured by interfacing DDE through the network.

Various DDE I/O servers are commercially available, and can be connected to PLCs made by other manufacturers.

The standard and plant panels are supported by InTouch, and data can be displayed and set by the tag name without the need to specify the controller address.

Regarding data logging, a macro process in the EXCEL sheet format captures historical data to display and print process data, calculated values and graphs.

4. Examples of System Applications

FOCUS is being introduced into various fields such as chemical, food, pharmaceutical, cosmetic, steel, boiler, incinerator, etc. The motive for these applications is in the features of FOCUS, that is the application of a platform having an open environment to HCI (human communication interface), the use of a controller fitted to system requirements, engineering that is easy to operate, economical merit, short delivery time, and high reliability that is selectable depend-

ing on the application.

Since being introduced, this system has received favorable reviews from users. Several application examples are described below.

4.1 Small-scale EIC systems

The construction of large-scale plants has been decreasing while the construction of mid or small-scale plants, as well as partial modifications, has been increasing in the present market. In the past, small-scale EI control systems were integrated using a DCS such as the MICREX-IX series.

With the introduction of FOCUS, advanced control systems can be realized at a lower cost. The easy to use graphical interface and powerful data management enable highly reliable and safe operation to be guaranteed. System configuration examples using the DCS controller and the PLC MICREX-F are shown in Fig. 6 and Fig. 7 respectively.

In both systems, several hundred PIOs are connected to one controller and high-speed calculation and control is performed. Operation guidance, supervision and operation of the utility, and supervision and operation of the plant are carried out on two sets of HCI. Furthermore, logging of the daily report, monthly report, quarterly report and annual report, and logging of the various control data and the test report are documented based on performance calculations of the plant. Logged data is output by connecting a laser printer for OA (office automation) to the printer port of the information LAN or a PC. The hard copy is output using a general-purpose ink jet printer.

*6 Windows: A registered trademark of Microsoft Corp., USA

Fig.6 Configuration example of a FOCUS small-scale EIC system (DCS controller)

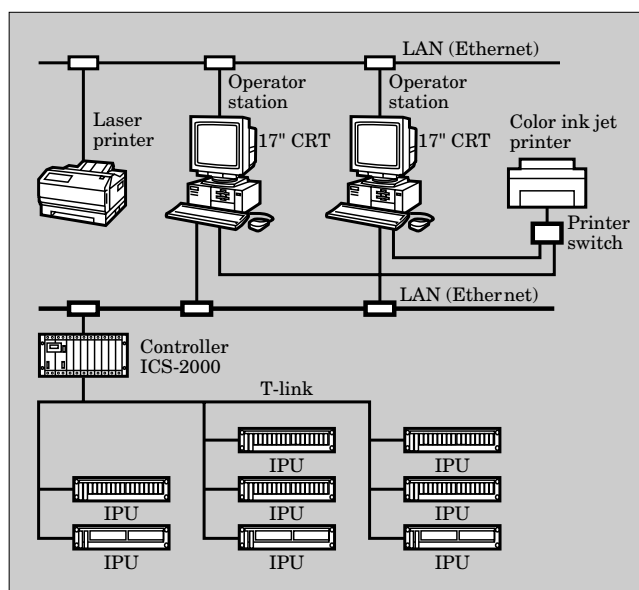


Fig.7 Configuration example of a FOCUS small-scale EIC system (using PLC)

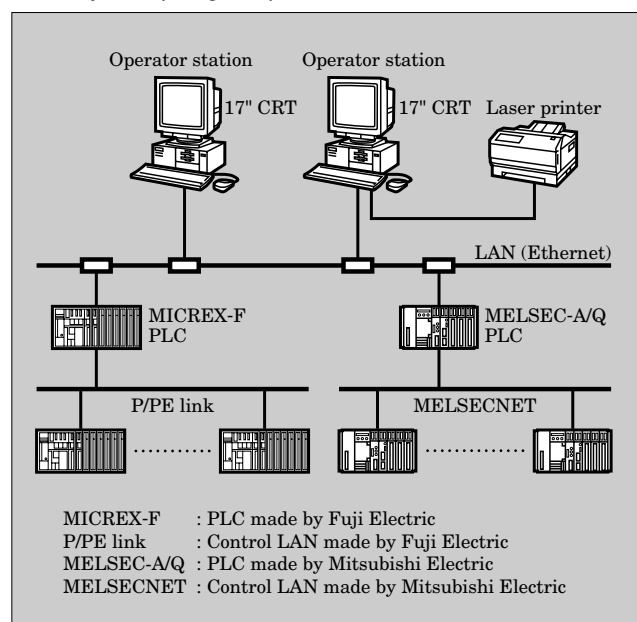


Fig.8 Configuration example of a FOCUS client server system

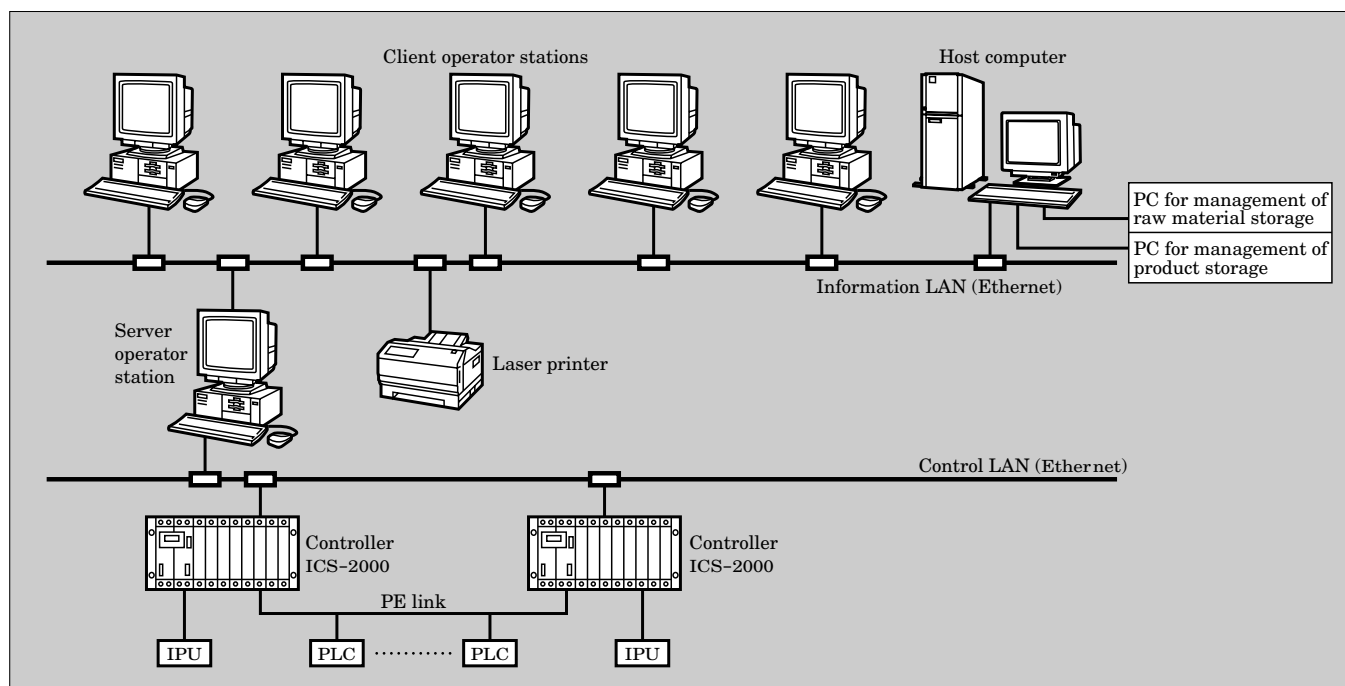
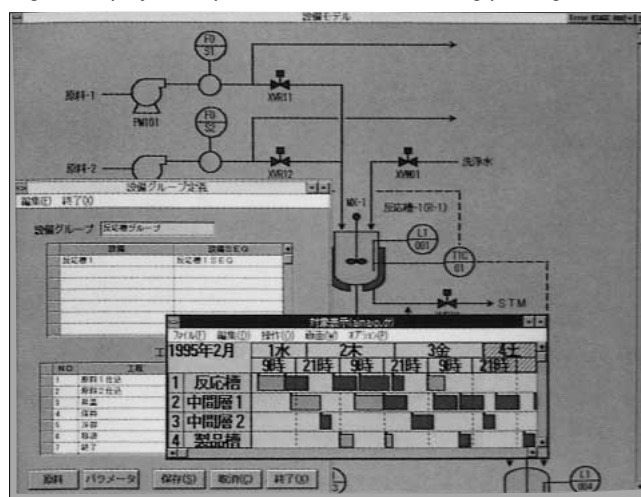


Fig.9 Display example of the batch scheduling package



4.2 Client server system

Since production in chemical, food, pharmaceutical and cosmetics plants varies in product type and quantity, production control information and recipe control information must be transferred to the plant supervisory control equipment so as to ensure that smooth production is continued. Also, the recipe control information must be scheduled suitably based on the production situation.

Figure 8 shows an example of a production control and manufacturing control system configured with the FOCUS client server system.

The on-site process information is singularly controlled by the PC server. Supervision and operation are conducted from the client via graphic display,

group display, annunciator display, historical message display, etc.

The product scheduling system and manufacturing control system, including the raw materials warehouse and products warehouse, are connected by the information LAN. Instructions from the product scheduling system are transferred to the manufacturing control PC server and are then transformed into process instruction values by the AI batch scheduling package and the recipe control package (FLEX-BATCH) integrated into this server. Thus, smooth production is carried out.

Figure 9 shows an example of the batch scheduling display.

The AI batch scheduling package has the following features.

- (1) High-speed scheduling is possible according to the manufacturing order.
- (2) Simulation based on actual result data is possible with the Gantt chart.
- (3) Scheduling close to the actual operation is possible by considering the actual manufacturing results obtained by the link with the FLEX-BATCH.
- (4) An estimation of the trends for each lot can be obtained.
- (5) Optimized recipe data can be automatically prepared for every lot.
- (6) Intelligent alarm output is possible.

By applying these features, the following user benefits can be obtained.

- (1) A shift to operation that matches the delivery time and the manufacturing capability
- (2) Cost reduction by means of equalizing manpower

and utility loads

- (3) Real time, dynamic investigation of the effect on product schedule and actual results due to unexpected accidents
- (4) Singular control of manufacturing information and engineering information

5. Conclusion

The fundamental systems and application examples of FOCUS have been described. FOCUS combines the open techniques related to PCs and the successful DCS techniques to provide a solution for various

control systems. Fuji Electric offers a system that allows the synthetic integration of various control systems and computing by the end users.

Fuji Electric will endeavor for further improvements by applying novel techniques such as OPC (OLE for process control : the communication standard between the control application, field equipment and office application), clusters (a system in which multiple computers, connected via a network, process information while linked to distribute the load and allow substitution in the event of a malfunction), and the Internet to extend the application range, improve reliability and integrate unrestricted systems.





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