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LARGE-SCALE DCS APPLICATION FOR EIC INTEGRATION

Satoshi Fujiwara
Tetsuya Koide
Takamichi Suzuki

1. FOREWORD

The steel industry is a classic energy consuming industry that occupies approximately 15% of the total domestic energy demand. Moreover, the energy consumed by a consistent steel mill is in fuel, electric power, steam, compressed air, and other diverse forms. These forms of energy consist of coal, heavy oil, electric power, and other purchased energy (primary energy) and by-product gases which are generated by the production process. However, since these energies have a complex interrelationship and change considerably, it is no exaggeration to say that the biggest point of steel mill operation is how to maximum the use of secondary energy and minimize the primary energy. A center manages these diverse and voluminous energies one-dimensionally and is installed with energy saving, labor saving, rationalization of operation, emergency processing of trouble, and environment management as its main objectives.

Recent energy center trends and an energy center which adopts a large distributed control system and builds an EIC integrated system are outlined.

2. ENERGY CENTER TRENDS

Recently, the power point for improving the functions a steel mill is placed on labor-saving. The trend is aimed at substantial rationalization of operation by replacing conventional instrumentation with digital instrumentation. The system functions are roughly divided into four groups: production (planning, production management), operation (operation management data collection, man-machine interface processing), control (transmission processing, control processing, process I/O processing), and support (software development, system operation). The functions are distributed by corresponding the computer, man-machine interface, controller, work stations, etc. to each and the shift to a distributed control system to centralize information by a hierarchical structure is made gradually.

On the other hand, from the standpoints of improved operability, maintainability, and uniformity, the demand of an EIC unified system, which unifies the three control systems, electromachinery (E), instrumentation (I), and computer (C), conventionally formed as independent systems, is also strong.

The energy center at the NKK Keihin Steel Works introduced here started from central management of the Ogishima region overall power, water, and electric power facilities matched to completion of the Ogishima 1st stage work of 1976. In 1982, the Ikegami energy center was promoted to rationalize operation of the Keihin Steel Works existing region (Ikegami, Watarida, Mizue) power, water, and electric power facility.

This energy facility manages the following items:

(1) Fuel supply facilities ..... BFG, COG, LDG, heavy oil, etc.
(2) General power facilities ... Compressed air, oxygen, argon, CO_2, H_2, steam, etc.
(3) Water facilities .... Clean water, waste water processing, receiving of industrial and drinking water, etc. of each plant
(4) Power substation .... Receiving substation, main stations, etc.
(5) Environment monitoring facilities .... Air and water quality monitoring, prefecture and city data transmission, etc.

However, the energy facilities in the Keihin Steel Works to be managed contained not only the above-mentioned two energy centers but also Ogishima thermal power plant, a large-scale private power plant, and the blast-furnace blower/power-generating equipment; therefore, total management of energy supply and demand and efficient operation were not fully achieved.

To improve this situation, NKK has built an EIC-integrated system based on a large DCS aiming at personnel reduction and optimal energy management, and realized fully centralized control of energy facilities scattered over about 8,000,000 m^2 targeting the following items:

(1) Energy center unification
   (a) Unification of the operation and supervision functions of the Ogishima energy center and Ikegami

energy center and centralization of all functions.

(b) Use of a CRT operation system and simplification of the operation monitoring operation.

(c) Upgrading of the energy management system functions.

(d) Strengthening of the monitoring functions by integration, automation, and remote monitoring of energy center related local facilities.

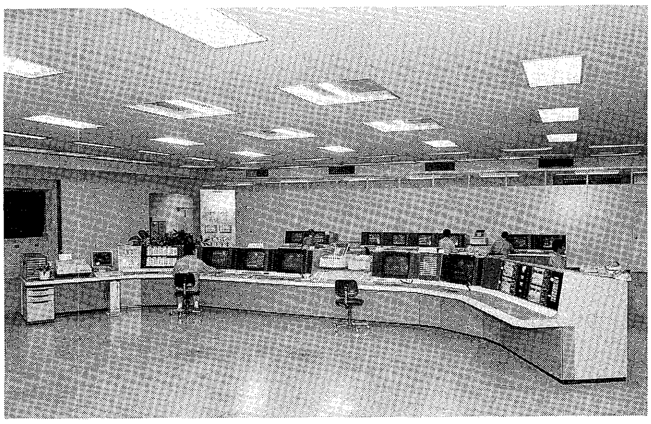
(2) Remove control of blast furnace blower and TRT facility

(a) Centralization of the operation monitoring functions of the blast furnace blower and TRT facility at, and remote control from, the Ogishima energy center.

(b) Introduction of an automatic control function into blast furnace blower starting and stopping operations and simplification of operation.

An exterior view of the energy center control room after introduction of the large-scale DCS is shown in *Fig. 1*.

Fig. 1 Energy center control room



3. OVERVIEW OF UNIFIED SYSTEM

3.1 System configuration

The overall system configuration is shown in *Fig. 2*. A distributed control system MICREX was used as the DCS. This system connects the instrumentation controller PCS and the telemeter telecontrol SAS used as the computer controller to the data base station DBS, the nucleus of the MICREX via a high-speed, high capacity dataway DPCS-F and centralizes the data at the DBS. A system consisting of a energy computer system U-1500II linked to the DPCS-F and a dedicated AI (Artificial Intelligence) work station FASMIC-G500/32 was also built. The system configuration of the energy computer system and dedicated AI work station is shown in *Fig. 3* and *Fig. 4*. Each controller (PCS, SAS), the DBS, and the computer all have a duplicate configuration to improve reliability.

3.2 Features of electromachinery and instrumentation systems

The features of the system are described from the features of the electromachinery control and instrumentation control systems.

3.2.1 Sharing of man-machine interface and data base

Sharing of the man-machine interface and sharing of data are described first.

Conventionally, switching to a relay panel and operation console for supervising and operating remote valves,

Fig. 2 Overall system configuration

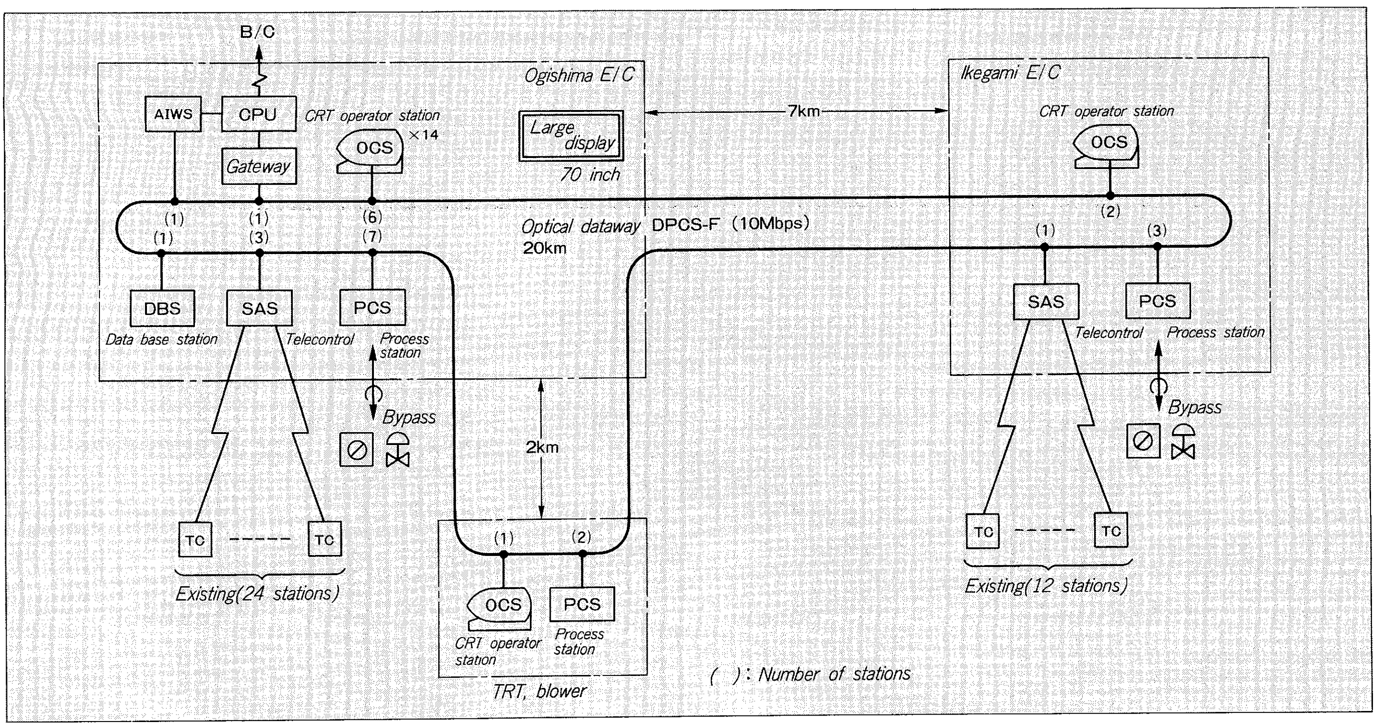


Fig. 3 Energy computer system configuration

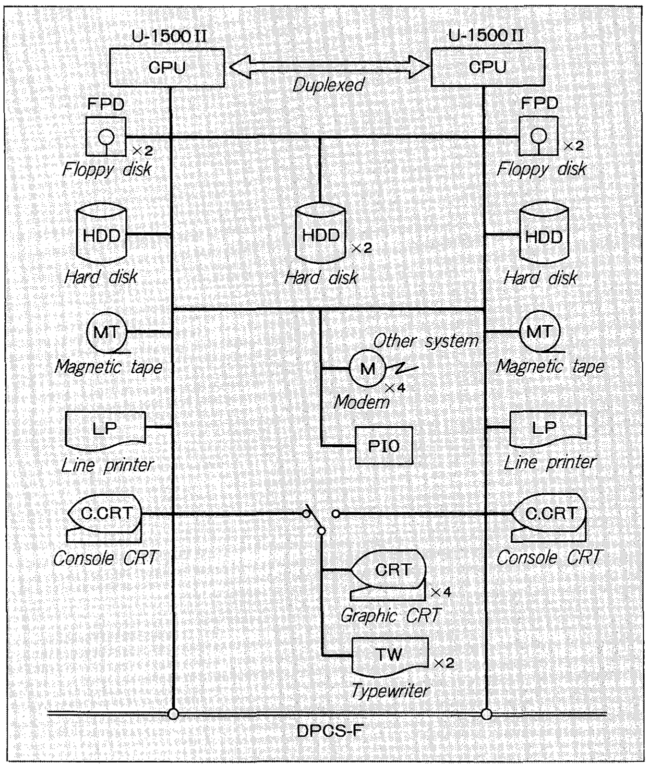
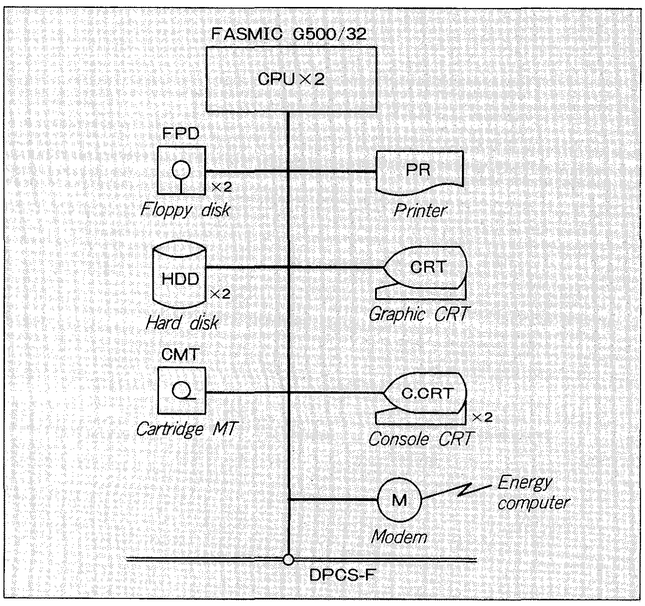
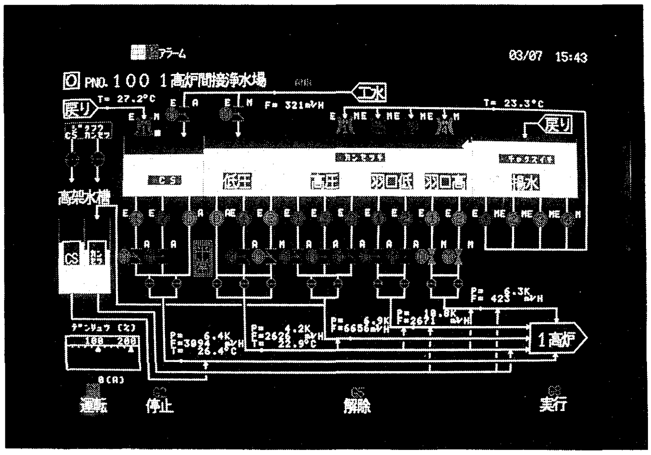


Fig. 4 AI dedicated work station system configuration



pumps, circuit breakers, and other devices and the increase in the volume of operator information and expansion of the management range was accompanied by the use of the microcomputer and minicomputer and CRT operation to save labor and space. However, the microcomputer and minicomputer used here are dedicated electromachinery control system devices, and are independent from the instrumentation system at which CRT operation was ad-

Fig. 5 Remote supervisory and control system CRT screen example



vanced separately. Here, a man-machine interface which shares the electromachinery and instrumentation data was realized by mounting a remote supervisory and control system called a packaged TCC (Telecontrol Controller) to the OCS, which is the electromachinery and instrumentation common interface. An example of a CRT screen using a TCC package is shown in *Fig. 5*.

"TCC package" is a tool for supervision and control of various local facilities by CRT operation from the center via a telemeter and telecontrol system. The supervisory and control functions are realized by the following operations (*Fig. 6*):

(1) The device is selected by touching the symbol of the device to be operated.
(2) The device selection frame is flickered by feedback of the selection complete signal from the telemeter and telecontrol system.
(3) The operation command symbol (start/stop, on/off, etc.) corresponding to the device is displayed according to the selected objective (pump, circuit breaker, etc.)
(4) The operation command is output to the telemeter and telecontrol system by touching the operation command symbol.
(5) The color of the symbol is switched to the color of the corresponding status and the symbol is flickered by the reaction of the device.
(6) Flickering of the symbol is stopped and operation is terminated by reset command.

The change of the operation symbol is shown in *Fig. 7.*

The following points were considered in establishing the flow above:

(a) The flow must not give the operator a strong sense of differnrce from conventional operation accompanying the shift to CRT operation.
(b) Since it is different from the conventional hardware sequence in that all processing is performed by software, ample safety and reliability must be considered.
(c) Versatility must be improved for packaging.

Telecontrol control (remove supervision and control)

Fig. 6 Supervision and control flow

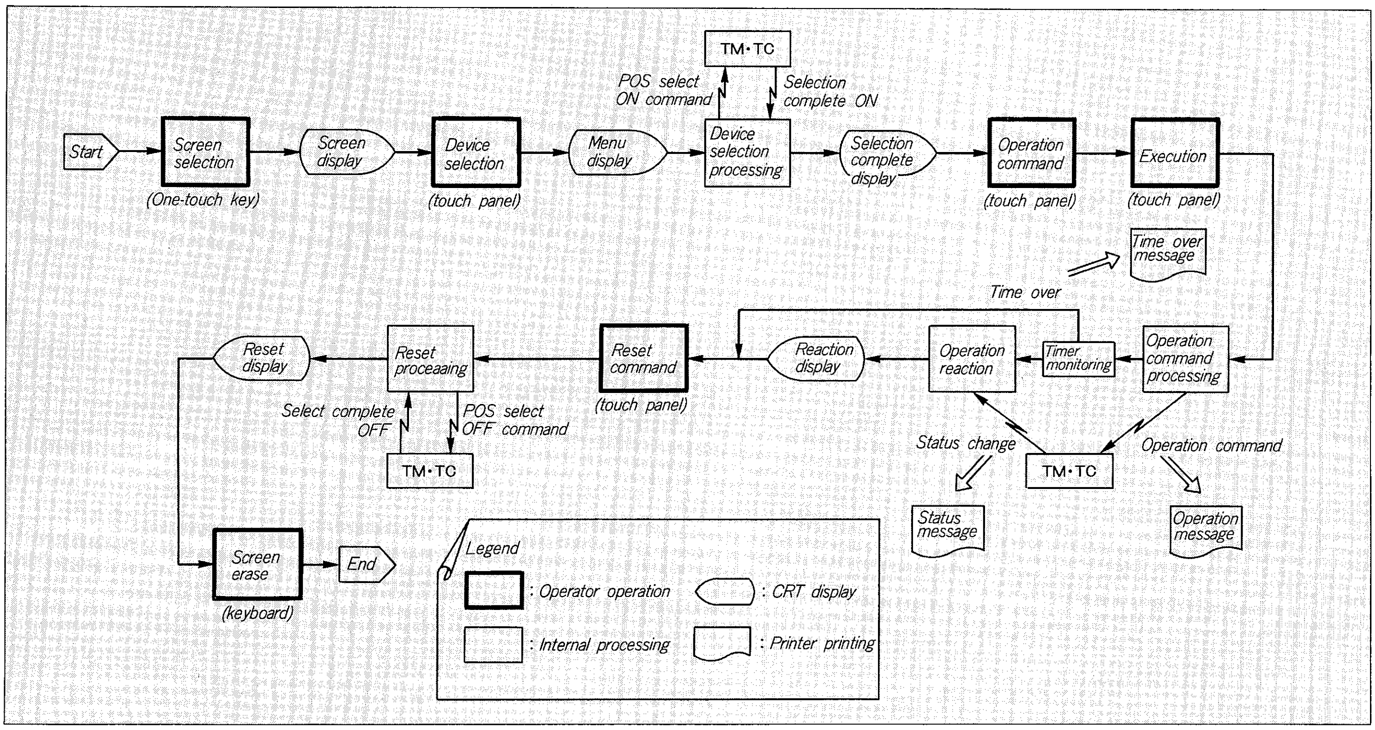
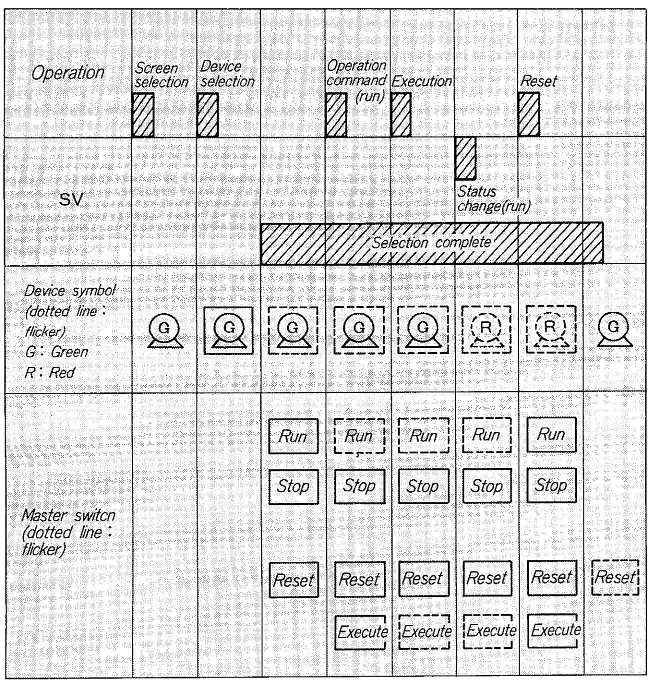


Fig. 7 Operation symbol change



and loop control (remote instrumentation control) from the same screen of the same CRT were realized by development of the TCC package described above.

3.2.2 Large display

The second feature is installation of a 70 inch projection type display with the shift to panel-less CRT operation. Since all the vast information is displayed on a CRT, the main purpose of this was expanded display of the OCS screen as a function which replaces the conventional graphic panel and simultaneous transmission of the same data to multiple operators.

3.3 Features of computer system

As described above, the MICREX is a electromachinery and instrumentation (EI) integrated DCS centered about a DBS. A computer system was fused with this DCS and DCS direct-coupled automatic control system was developed jointly with NKK by the introduction of AI and labor-saving was planned.

3.3.1 Fusion of "C" with unified "EI"

EIC unification conditions are a common architecture, one-dimensionalization of data management, and sharing of MMI. Realization was started with one-dimensionalization of data management, one of these conditions with the most beneficial unification effect, as the first target.

Since the computer and DCS specifications are different (industry data value internal data format and data transmission capacity), versatility was pursued and, basically, standardization was planned by considering and absorbing high-speed, accuracy, and versatility at the computer side from the policy of not installing individual processing at the DCS.

Moreover, to use the process data collected by the DBS at the computer, a dedicated processor was installed at the DBS and data management was one-dimensionalized by installing transmission software with an industry value data transmission function at this processor.

The points which were given special consideration in this one-dimensionalization of data management were:

(a) All data transmission requests must be at the com-

Fig. 8 One-dimensionalization of data management

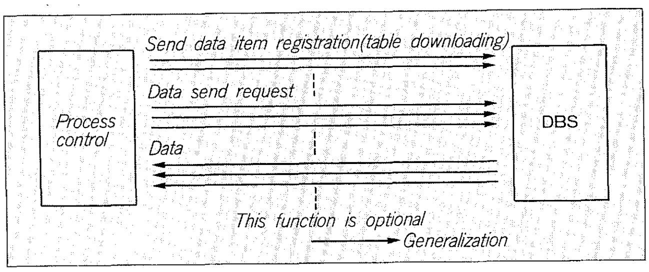
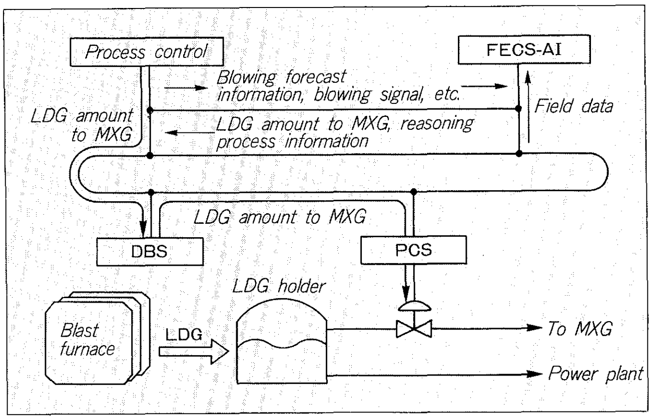


Fig. 9 Expert system data and signal flow



puter side.

(b) All modification of send data items, etc. must be performed at the computer side. (Table downloading method) and versatility efforts were made. This is shown in *Fig. 8*.

3.3.2 Realization of automatic control by the introduction of AI

Conventionally, in gas demand and supply management at a steel mill, efficient operation of the basic oxygen converter gas which is generated with converter blowing depended on the experience and operation know-how of the operator. Besides the vast amount of data on which operation is based, when the capacity of the gas holder is small for the amount of gas generated, the time expanded for judgment is short. Since its frequency is also high, the operation method, operation amount, number of operations, etc. vary due to individual operator error and faulty adjustment may occur, depending on circumstances.

We improved on these problems by developing a high efficiency system by automation of converter basic oxygen gas supply and demand control. In realizing this system, an intelligent energy management system (FECS-AI) fusing our energy management technology and energy management system and AI (Artificial Intelligence) was introduced. This system is realized as an expert system which is executed by driving a reasoning engine from a stored knowledge base with control logic as the operating rules. It is an online, real time control system which performs reasoning once every 30 seconds and outputs the set value.

This expert system is built by using the Fuji Electric process control AI tool "EIXAX".

FECS-AI is positioned as a dedicated work station and is linked with the DBS via DPCS-F and with the energy computer via a modem and incorporates various field data and blowing refining forecast data. The data and signal flows are shown in *Fig. 9*.

4. RESULTS OF INTRODUCTION

The automation of LDG amount regulation for M-gas feed has achieved labor saving, and also the more precise and efficient management of energy has realized saving in expenses for electric power and heavy oil and reduction in operators. Moreover, the TCC package has simplified monitoring and operating methods, and package application has enhanced reliability and expandability and shortened the delivery time.

5. CONCLUSION

The EIC integrated system based on a large scale DCS real plant application example was introduced above.

At the present time, at which electromachinery and instrumentation system and computer system data base unification was realized, unification is developed farther and unification of the man-machine interface which meets the various demands required of EIC component devices, which are a kind of hardware, and realization of the so-called single window is considered a large topic theme of the future.

Finally, the authors wish to thank the concerned parties for their tremendous guidance and cooperation in the development of this system and its application to a real plant.