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Information Systems

Integrated Data Analysis System

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Synopsis :
For the purpose of expansion of data analysis activities, a system for the total management and analysis has been developed for application to daily staff work. This system contributes not only to improvement in efficiency but also to encouragement in displaying creativity in various kinds of staff work. The system is intended to be highly efficient and useful by providing a large amount of data storage in the number of items and volumes collected in offices and production lines, sophisticated software easily accessible by a number of personnel at terminals, and activities for supporting the computer utilization in routine and provisional jobs of the terminal users. The system has been found useful in reducing the workload for data collection and analysis and in improving analysis accuracy. This paper explains, for an example, an outline of the system named "IDEA (Information design aid)" at Mizushima Works.

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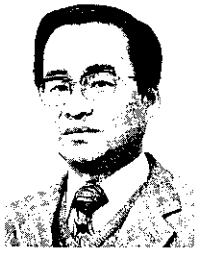

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For the purpose of expansion of data analysis activities, a system for the total management and analysis has been developed for application to daily staff work. This system contributes not only to improvement in efficiency but also to encouragement in displaying creativity in various kinds of staff work. The system is intended to be highly efficient and useful by providing a large amount of data storage in the number of items and volumes collected in offices and production lines, sophisticated software easily accessible by a number of personnel at terminals, and activities for supporting the computer utilization in routine and provisional jobs of the terminal users. The system has been found useful in reducing the workload for data collection and analysis and in improving analysis accuracy. This paper explains, for an example, an outline of the system named "IDEA (Information design aid)" at Mizushima Works.

1 Introduction

Kawasaki Steel Corp. (KSC) has, in accordance with a comprehensive 5-year plan, restructured its sales, production, and distribution control systems, as well as the production control systems in the Works. At the same time, the databases in the company have been examined from the company-wide viewpoint with the aim of improving the work efficiency of personnel. Databases were constructed at the Head Office and the various works, and a database system for analysis purposes was implemented. Free staff access to data is permitted via terminal by way of a company-wide network.

As a comprehensive program, the staff activity support system involves a database which reflects the daily-changing needs of staff and a utilization system, as well as an end-user support organization designed to promote system use. Staff now can make judgments and decisions quickly and can respond flexibly to recent changes in the technical environment through multifacial analyses using broad-ranging data.

This paper describes the history of the staff activity support system at KSC and the integrated data analysis system at Mizushima Works, with particular attention to the aim, functions, features, effects, and future development of the system.

2 History and Outline of Staff Activity Support System

2.1 History of Staff Activity Support System

2.1.1 First period (1970–1973)

The total quality control (TQC) system was developed in 1970. The TQC system is a general-purpose system applied to data analysis processing procedures with which exclusive-use programs were used in the past. The TQC system is a batch system operation.

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2.1.2 Second period (1974-1983)

The technical information system (TIS) was developed in 1974. The TIS system introduced terminals to enable staff to request the analysis of data or obtain analysis results from remote locations.

As data used in such analysis work, data was formerly used in common with the production control system, but data for the exclusive use of the analysis has now been provided.

2.1.3 Third period (from 1984 onward)

The synchronization and continuation of production processes required a broader viewpoint in analysis work than the former regional data analysis aimed at only a narrow fields; consolidated and integrated data analysis, aimed at wide adjoining fields, was needed. Further, as data for analysis, even time series data for equipment control use was included, and enhanced analysis functions such as the statistical analysis, Japanese processing in Japanese graphies, etc., were required.

To meet these requirements, a management and analysis database and staff activity support system were developed, built around a 4th generation language.

The management and analysis database, which controls data as a resource, has incorporated the concept of the relational database in its access method.

The use of the 4th generation language aims at improving the man-machine interface (MMI).

In this way, the company took full advantage of the capabilities of advanced computer technology in response to staff needs and provided a support system for staff use.

2.2 Outline of Staff Activity Support System

The structure of the staff activity support system, as shown in **Fig. 1**, is comprised of computers in the Head Office and the various works, and a network linking these computers.

Each computer is supported by a database. Databases for staff support vary with the functions of individual sectors.

The head office database is constituted by personnel, labor-administration, financial, planning, distribution, and purchasing data. Activities include demand forecasts based on external data, starting with actual figures for orders and production provided by the Japan Iron and Steel Federation, simulations for financial restructuring, and the drafting of personnel measures aimed at effective utilization of human resources in new business areas and operational diversification.[1)]

On the other hand, the works databases are composed of production data necessary for the administration of the works, product quality data, cost data, process progress data, equipment maintenance histories, and equipment control data. Activities cover a wide range, including study for the drafting of plans for new product production processes, testing and improvement of production equipment control models, analysis of material flow among processes aimed at continuation and integration of processes in an effort to shorten delivery times, and the analysis of equipment maintenance history data for the drafting of new maintenance plans based on equipment diagnosis data in connection with preventive maintenance and data on past repair conditions.[2)]

In this way, 1 500 staff members company-wide have

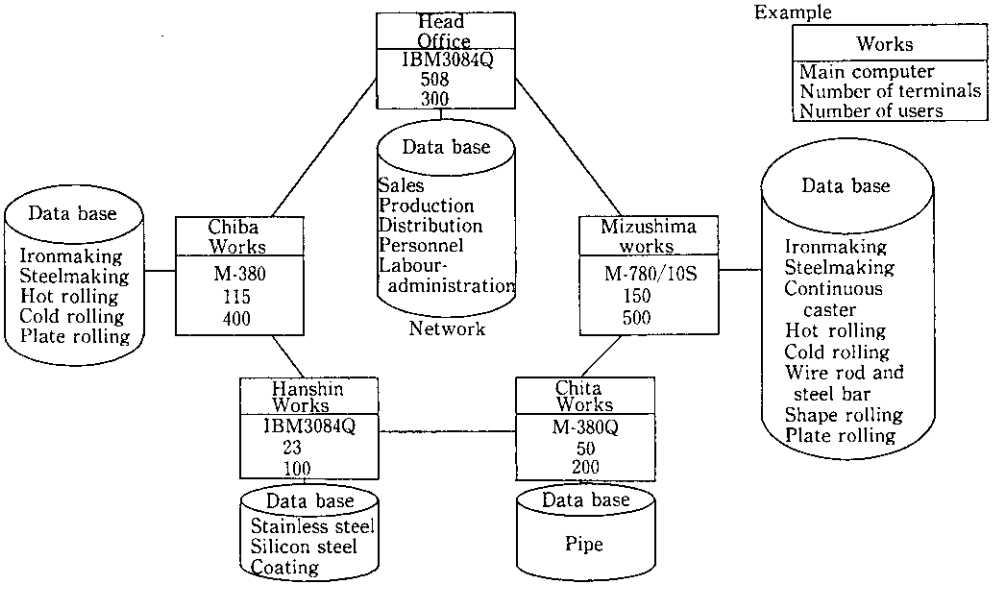

Fig. 1 Outline of system for staff in Kawasaki Steel

access to about 25 000 cases a month through 840 terminals.

In the following, the outline of the staff activity support system is described, focusing on the integrated data analysis system at Mizushima Works.

3 Integrated Data Analysis System at Mizushima Works

3.1 System Outline

At Mizushima Works, the information design aid system (IDEA) is used.[3-5] It took one year to develop the IDEA system, and this staff activity support system was put into service in January 1984.

Data concerning steelmaking, continuous casting, blooming, hot rolling, cold rolling, and the manufacture of plates, shapes, rods, and wires, including all facets of activities at various shops in the works, such as quality, operation, facility history, and machinery and equipment management were systematically sorted out and accumulated in the management and analysis database. The volume of the management and analysis database has now reached 25 gigabytes.

This system is widely used not only for the preparation of routine reporting materials (700 types per month) such as production, production yield, and pass ratio records, but also for the execution of non-routine jobs such as the simulation of material flow in the study of facilities layout when planning new facilities; process analysis and inventory analysis at the various shops, data analysis for preparing the reheating furnace operation model, and claim investigation.

As can be seen from the hardware configuration shown in **Fig. 2**, the IDEA system is used with the central computer (M-780/10S) and is available to 500 staff members, through 150 terminals in the works. The volume of analysis commands programmed by the staff for data analysis has reached 850 000 steps and 4 200 types.

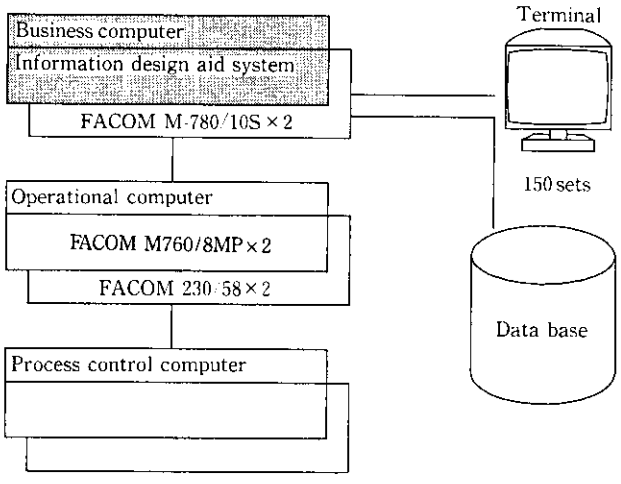

Fig. 2 Hardware configuration of IDEA system

3.1.1 Aims of system development

In the development of the IDEA system, one aim was the active use of computer data and efficient execution of the jobs of collection, sorting-out, and processing of various types of data by individual staff members. The specific goals were to permit each staff member to obtain "required information" "easily" "in the format desired" "at any time."

3.1.2 Concept of system construction

The concept of system construction and the method of realization are shown below.

(1) In this age of rapid technical progress, data required by staff for the execution of work changes daily, and processed information easily becomes obsolete. It is essential, therefore, to accumulate and promulgate original data. At the same time, it is necessary that the system for collecting and accumulating such data be adaptable.

(2) It is necessary that staff have easy access to data at all times. For this purpose, data should be managed as a resource and made easily accessible through a data dictionary.[6]

(3) Data handled by the works is of a tremendous volume.[7] Therefore, while it is important to obtain data quickly, hardware must be organized with consideration to economic restrictions. Thus ingenuity was necessary in creating a hierarchical database and in storing the data most frequently used in analysis in storage media with higher access efficiency.

(4) Further, data must be "easily" processed in the "format desired". This requires highly-advanced processing methods, such as various types of statistical analysis, and visually appealing output, including graphics and native-language output, which in this case means Japanese in character form.

(5) Finally, it was necessary to promote an effective "do-it-yourself" philosophy among staff. For this purpose, an educational system and user support structure were devised.

3.1.3 System configuration

In line with these concepts, the IDEA system was constituted of the following three sub-systems:

(1) Management and analysis database structuring sub-system.

(2) Analysis support sub-system.

(3) Utilization support sub-system.

The configuration of the IDEA system is shown in **Fig. 3**. The functions and features of the respective sub-systems, system operation, educational system, and effects are described below.

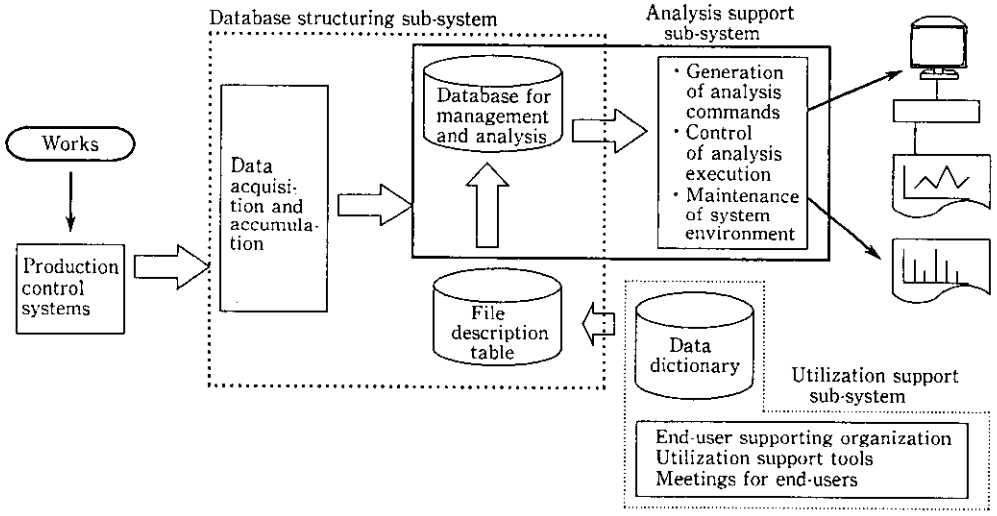

Fig. 3 Structure of IDEA system

3.2 Management and Analysis Database Structuring Sub-System

This sub-system accumulates data collected from the production line in the various shops and furnishes this data to the management and analysis detabase via the process computer and on-line computer.

3.2.1 Mechanism of large-capacity data handling

A conceptual diagram of the management and analysis database is shown in **Fig. 4**. Data for the preceding day, amounting to 130 000 cases, collected by the production control systems are added daily early in the morning to update the original data file. At the same time, frequently used data is updated and added to the public file. In addition, to improve access efficiency, provision is made for a summary file for long term storage of data for specific purposes, a private file for short term storage, and a temporary file which stores, maintains, and analyzes data which occurs on an intermittent basis.

The original data file accumulates data for an average of six months. Data stored for more than six months is moved to the permanent file and stored for two years.

Depending upon the use frequency of these files, the public file, summary file, private file and temporary file are stored in the direct access storage device, the original data file in the mass storage system, or the permanent file on magnetic tape.

In this way, ingenuity is used in selecting the storage medium most appropriate to use frequency, and in permitting efficient access to most needed data from among the large volume stored.

At present, 388 types of original data files and 195 types of public files are available.

3.2.2 Optimization of data layout in database

To match the database to use needs, data switching

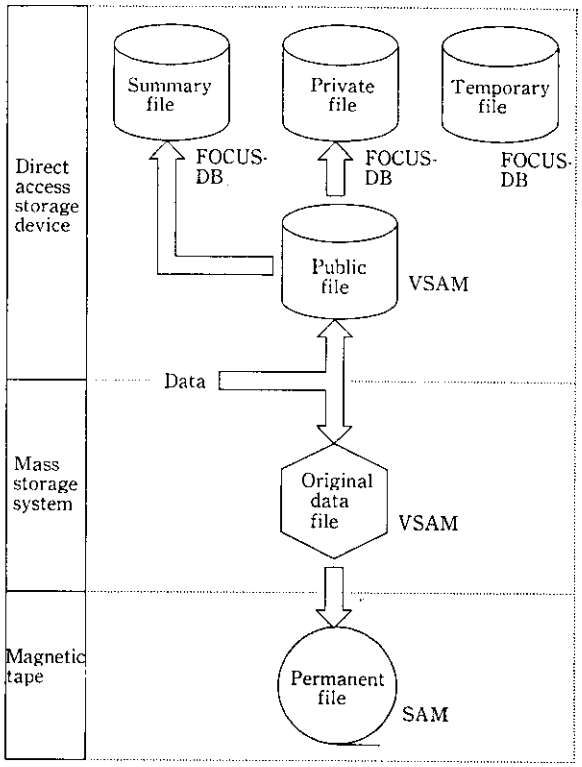

Fig. 4 Hierarchical structure of database for management and analysis

inside the database is necessary, and such system changes must be easy and quick. Changes are accomplished by the following methods, using automation tools described in the following section.

Data use frequencies of original data files and public files are compiled every month. On the basis of this use frequency information, the data layout on the file is reviewed by managers of the using department and the

Systems Department. According to the results of the review, the data layout is optimized by discarding unnecessary data in the public file and by moving frequent-use data in the original data file up to the public file in an operation called "database dynamic tuning." Database dynamic tuning has already been executed several times to prevent obsolescence of the database.

3.2.3 Automated development of management and analysis database structuring system

Development and optimization of the database requires system development operations such as volume calculations, preparation of a job control language, and the various environmental definitions necessary for database updating, startup, and testing of the data.

The database structuring system automatic generation tool carries out these operations according to the basic necessary conditions of database structuring, which include record layout information, number of cases of records, and storage period.

The menu screen of the tool for automatic generation of the database structuring system is shown in **Fig. 5**. System development operations, amounting to 38 types, can be accomplished easily, accurately, and quickly through the use of the automatic generation tool.

3.3 Analysis Support Sub-System

The analysis support sub-system conducts analyses using the menu screen, automatically generates analysis commands, and supports analysis execution processes such as requests for analyses, investigation of the execution status of analyses, and outputting of analysis results. The sub-system also maintains and manages analysis commands programmed by the staff.

Analysis methods such as periodic and reserved analyses are available, and analysis results can be output at any terminal in the system. Periodical checking and deletion of obsolete and unnecessary analysis commands is also provided.

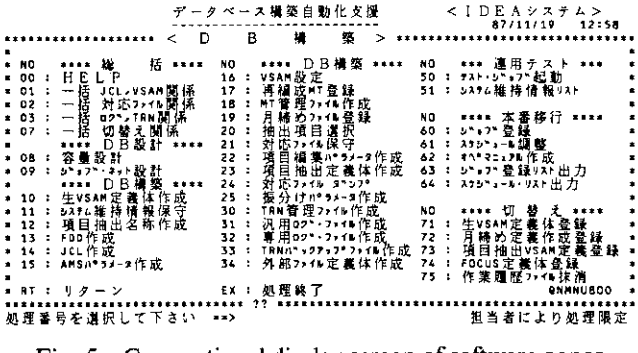

Fig. 5 Conventional display screen of software generators for database structuring

3.3.1 Conductive-type analysis support using menu screen

To allow staff to easily perform data analysis of the management and analysis database, a menu-conductive-type system is provided, enabling even users not familiar with computer operation to perform data analysis operation without difficulty.

3.3.2 Analysis command automatic generation through simplified input

Because it is difficult for the beginner to programme commands for data analysis, a simplified input function was provided to relieves the burden of command programming with respect to basic table/graph output patterns. Through this simplified input function, even the novice who does not know the grammar of the analysis language can easily carry out data analysis simply by designating necessary conditions such as the file name and field name of the object of analysis and the type of analysis desired.

3.3.3 Ample analytical functions

By adopting a 4th generation language, only a single language is necessary for data analyses which were possible in the past only by linking plural language for data processing use and graph drawing use. Processing operations such as the combination of plural files, data stratification, and sorting can now be performed easily. Tables such as detailed tables, summary tables, and cross summary tables, as well as business graphs including circle and bar graphs and simple statistical analysis processing are also possible. Examples of data analysis output are shown in **Fig. 6**.

3.3.4 Data analysis by personal computer

An access and analysis tool linking the host computer and personal computer and fully utilizing the simple operation of the latter permits free analysis based on access to necessary data in the management and analysis database of the host computer via personal computer.

3.4 Operation Support Sub-Systems

To maintain smooth system operation, a periodic indication of system condition is provided.

3.4.1 System utilization

This sub-system outputs the user list classified by department and section, analysis terminals control ledger, terminal work condition table, and analysis command registration state table, indicatig the utilization of the system.

3.4.2 Database utilization

The management and analysis detabase summary table, detailed table of files used for analysis, detailed

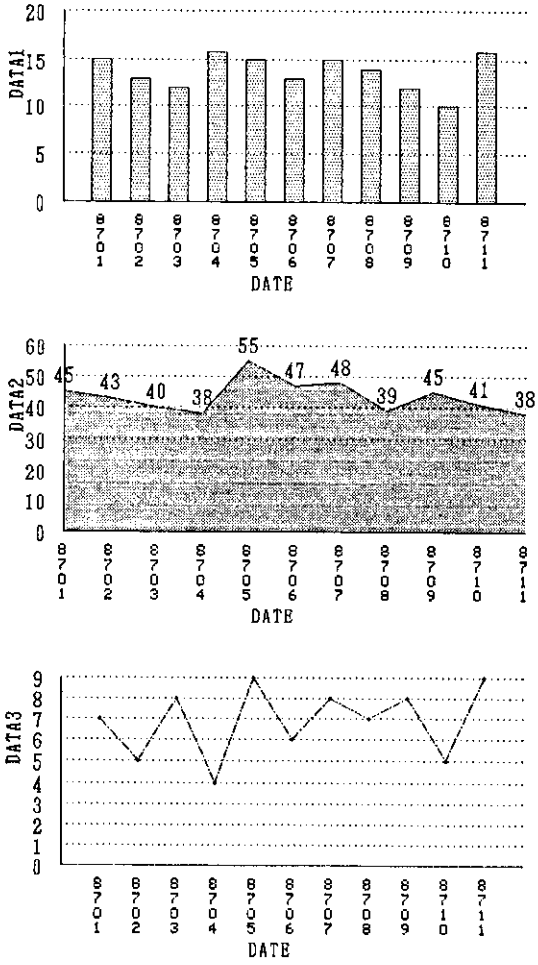

Fig. 6 Output samples of business graph

table of items used for analysis, and analysis command/analysis file relation table are output periodically.

3.4.3 Computer resource utilization

Use state tables for the magnetic tape, mass storage system and direct access device, as well as the computer use record table classified by department and section are output periodically. Utilizing the computer operation expenses calculated on the basis of output result and the effective monetary amount supplied by users, effect calculations are executed.

3.5 Operation and Education System

To promote computer-based data analysis, provision of an organization as well as the improvement of tools is important. Therefore, user departments and the Systems Department made a joint effort to set up an organization for data analysis support. This set-up is called the "end-user support organization." A conceptual diagram is shown in **Fig. 7**. Open windows which were dispersed over the System Department in the past, have now been unified, and open window has been provided.

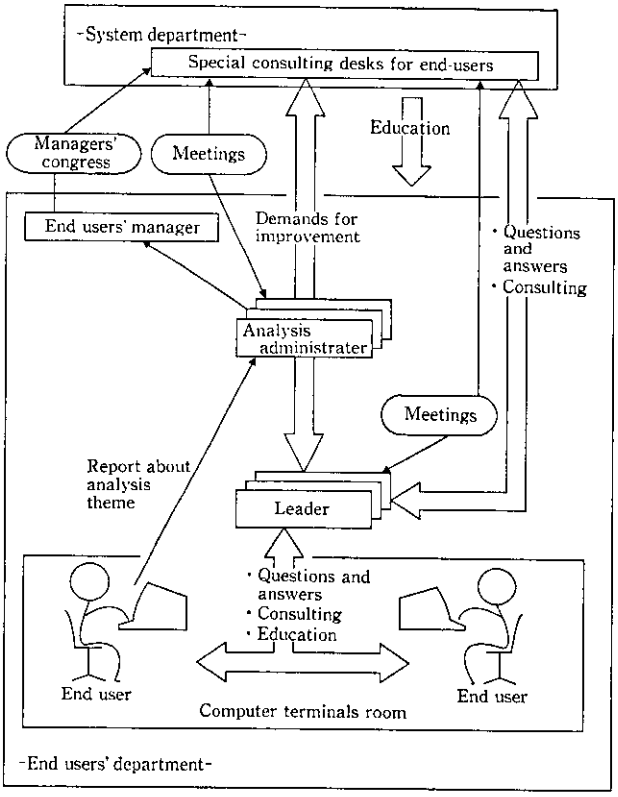

Fig. 7 Concept of end-user supporting organization

In user departments, a manager, analysis administrators, and leaders in charge of analysis have been appointed for each department. Both sides attend liaison meetings held once two months to promote information exchange on topics including optimization of the database and improvement of the analysis support system.

The open window support the education and analyses necessary for data analysis and issue a monthly newsletter to convey to users the latest information for end-user computing.

Training of user departments is executed systematically by means of graduated courses, which include basic, elementary, and intermediate-level classes, and above. Basic and elementary training are given in the user department by the analysis administrator or the leader in charge of analysis. Training from the intermediate-level upward is performed through open window of the System Department.

3.6 Effectiveness

Operation of the IDEA system commenced in January 1984. The number of cases of system utilization has increased yearly, to a current level of about 10 000 cases a month. Utilizing 150 terminals located throughout the site, individual employees are making use of computers, enhancing the efficiency of operations.

Increased efficiency has been realized in data analysis operations, where a great deal of labor is required, free-

ing time to "think and decide", which is an essential element in staff work. In addition, the level of analysis has been upgraded through the use of systematically improved databases, allowing multifacial analyses and greatly contributing to the qualitative improvement of staff work.

For instance, the IDEA system has been used in realizing a quality control system for synchronized and continuous operations aimed at the rationalization of steelmaking, continuous casting, and hot rolling.[8] In addition to the quality design and acceptance/failure judgment system in the production management system, the IDEA system has also been used in quality data analysis to form the type of management cycle proposed by Deming. When an abnormal phenomenon is detected by quality data analysis, the staff carries out an analysis using the integrated database and locates the problem facility. It is also possible to analyze the equipment control data from various facilities and carry out simulations to determine how the control model of the facilities can be improved.

Viewed from a different stand-point, analysis commands programmed by user departments have reached 850 000 steps, as mentioned earlier, which corresponds to 8.5 million COBOL steps. The DIY philosophy is one method of efficient system structuring, and serves, in a wider sense, to improve the productivity of the system.

4 Future Tasks

In Sec. 3, the integrated data analysis system at Mizushima Works was described. This section will discuss future tasks from the company-wide viewpoint.

In addition to the above-mentioned systems, staff support systems such as a system which accumulates and provides access to various technical reports in the company, a technical information system which gives access to a database concerning economic trends outside the company, and a TV conference system connecting the Head Office and the works are already in active use.

In the future, it is important to merge these systems to improve productivity and take full advantage of staff creativity. To achieve this, a unified new approach and the latest computer technology will be required.

For instance, in staff job improvement activities, as well as in the decision-making and managerial judgment processes, it is important to grasp the essence of any given problem and formulate the task accordingly.

The process of task-formulation is the human thinking process itself. In the future, it will be necessary to establish an effective support system for human thinking and judgment through the active use of new knowledge processing techniques which are matched to the human thinking process.

5 Conclusions

This history and outline of the computer system which supports staff job improvement activities at KSC and the information design aid (IDEA) system at Mizushima Works have been described. The main points can be summarized as follows:

(1) A management and analysis database was constructed and hierarchically stores a large volume of data; the database is constantly improved, in terms of both content and structure, to better meet staff needs.
(2) Through introduction of a 4th generation language, a menu-screen conductive type analysis support system was provided.
(3) The end-user support organization was unified for the improvement of the system.
(4) As a result, computer utilization by individual personnel has improved, greatly contributing to the efficiency of operations.

To realize the company strategy, it will become increasingly important to use data resources effectively. In parallel with this trend, a higher expectations will be placed on the staff activity support system. Thus it is essential to positively absorb new computer techniques and provide a staff activity support system of a still higher level.

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