EXPLORATION ON THE DEVELOPMENT OF COMPUTER AIDED EQUIPMENT MAINTENANCE MANAGEMENT SYSTEMS[①]

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ABSTRACT Computer aided equipment maintenance management system is an interdisciplinary applied technology combining computer science, equipment maintenance technology and management science. On the basis of the computer-aided equipment maintenance management system of the smeltery at Daye Non-ferrous Corporation, the functional and structural analysis, structural design, the major functions of each module and its programming have been offered.

Key words computer-aided equipment maintenance management system

1 INTRODUCTION

Equipment maintenance management is an essential part of the equipment management in an enterprise and a very complicated link of the management as a whole. To ensure the sound running of modern production equipment for the realization of good economic results, we must carry out our management scientifically. In order to achieve this goal, we must proceed from solid practical work, use techniques of equipment monitoring and breakdown diagnoses and change equipment maintenance management from qualitative to quantitative, from irregularity (or little regularity) to relatively accurate forecasting on standardization and normalization by means of computerized management.

Computer-aided equipment maintenance management system is an interdisciplinary application technology combining computer science, equipment maintenance technology and management science. Many people find it's difficult to develop. This paper is an attempt to offer some of my experience and points of view on the basis of the system of the smeltery in Daye Nonferrous Corporation.

2 FUNCTION ANALYSIS

Like other management system, the fundamental functions of equipment maintenance system are to determine goals, work out plans, organize the execution, monitor feedbacks and perform controls. Realization of these functions requires system to carry out a series of processings through its innate organization structures. Although the scale and form of the organization structure, the depth and range of its processing as well as the size and local tradition in the system may differ considerably from enterprise to enterprise, the basic pattern in this country can be summed up as shown in Fig. 1.

As shown in Fig. 1, the general equipment manager exercises overall control over all departments under him via the equipment management department, and processings in all departments are towards the ultimate goal of the system and feedbacks are sent to the

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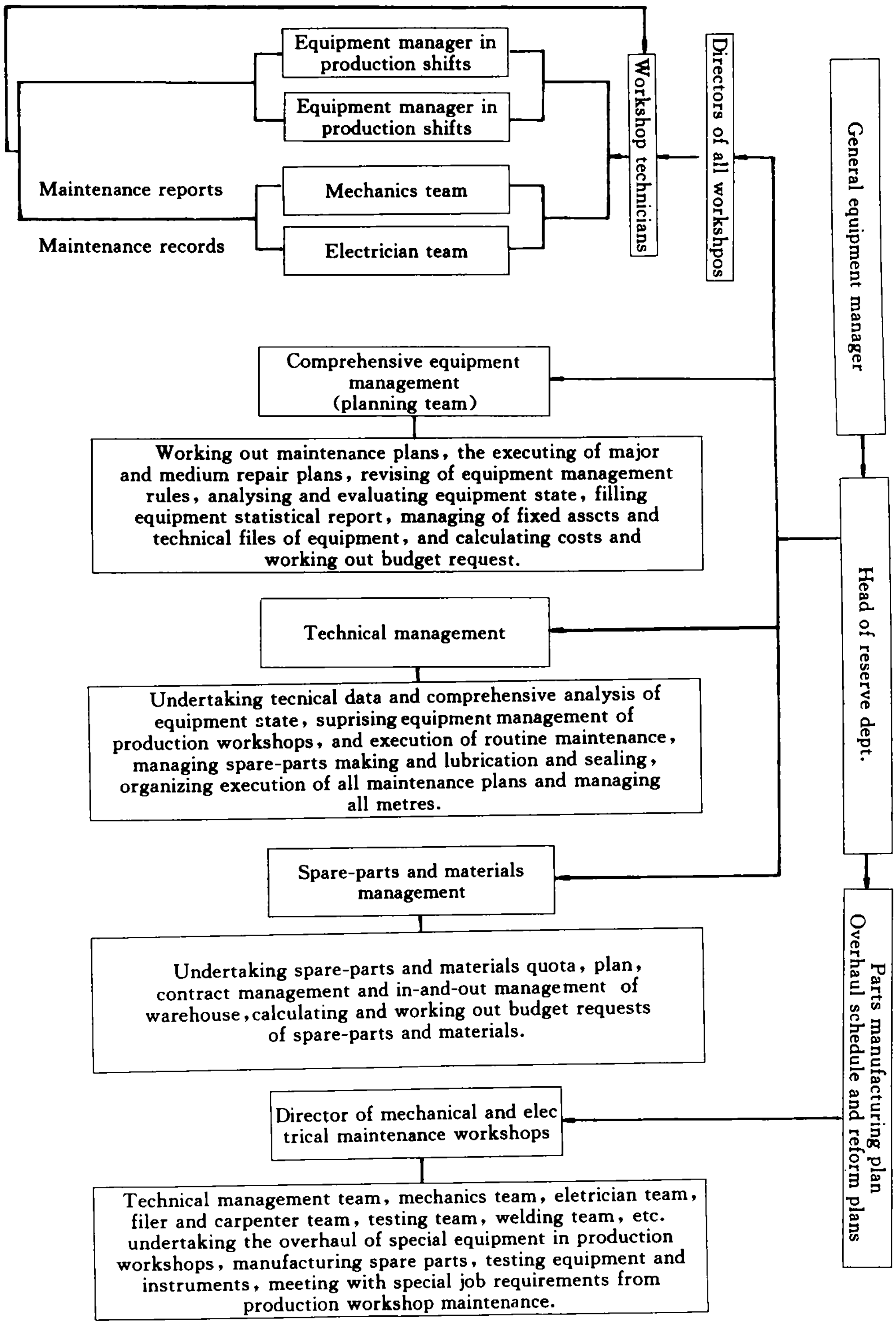

Fig. 1 Organization structure and major functions of equipment maintenance management system

manager and transfered among the departments through the equipment department. It has three levels of management functions, namely, the routine sub-system, the information management sub-system and the aided decision-making sub-system. The routine sub-system deals mainly with routine work in equipment maintenance and its management, such as lubrication, spot examination, execution and management of heavy and medium and minor repairs, planning and purchese and management of spare parts and materials, organization and execution of spare-parts production, processing and control of cost. The information management sub-system focuses on the management of information like management of technical files,drawings as well as the fixed assets. The third sub-system is mainly applied to carry out decision-making according to the information provided by the routine sub-system and the information sub-system by means of the pre-established models. A widely applied approach has been supplying to leaders through vast quantities of data statistics with some reference data for the decision-making, such as information regarding the reserve quotas, the period and structure of equipment maintenance, failure detection and forecasting, budgeting of all concerning costs, equipment replacing and reforming as well as planning and scheduling of important maintenance projects. Traditional manual report management has a number of disadvantages, which ranges from delay in statistics of the information provided by the first two levels to insufficient use of the information, difficulty in establishing accurate models and considerable artificially imposed interferences, thus resulting in delay and error in decision-making. This is why our computer aided equipment maintenance management system has been set off to develop here.

3 STRUCTURAL ANALYSIS OF THE SYSTEM

The development of the system must begin with system analysis. The most commonly applied approach in this respect is the structural analysis of the system. The first thing to do is to describe as briefly as possible the functions of the system from the top to the bottom, that is, drawing the HIPO of system (see Fig. 2).

Further division of the HIPO will reveal overlapings of some blocks. For example, it is not only related to equipment in operation but also to the state and period of its storage, to draw equipment spot examination plans; spare-parts management is related to equipment maintenance and the state of equipment technology, also to supply and warehouse management. This is what called system information sharing. The interrelationships of the problems involved must be made clear by means of some commonly-used approaches in system structural analysis, such as the routine project analysis diagram, the entity life period diagram and the data flow diagram. Fig. 3(a) is an example of data flow diagram in spot examination operations. It shows not only the transmission of infromation, but also the relationship between spot examination operations and the equipment state, the spare-parts and the financial management.

The computer-aided system is meant to replace the current manual report management system. In the structural analysis, we call the existing system "current system" and the one being developed "target system". So it is necessary to analyse the differences between the two systems and draw the data flow diagram of the target system. Fig. 3 (b) is the data flow diagram of spot examination operations. It is an improvement from Fig. 3 (a). Compared with Fig. 3 (a), the target system has got many more functions, such as spot examination plan forecasting, feedback control (ie. "revision" and "control" in Fig. 3(b)), collection of spare parts, cost and workhour information (not shown in the diagram), and statistics in spot examinations. Moreover, the requirements set in the new spot examination report can not only facilitate the normalization.

The "Logical Model" of the target system

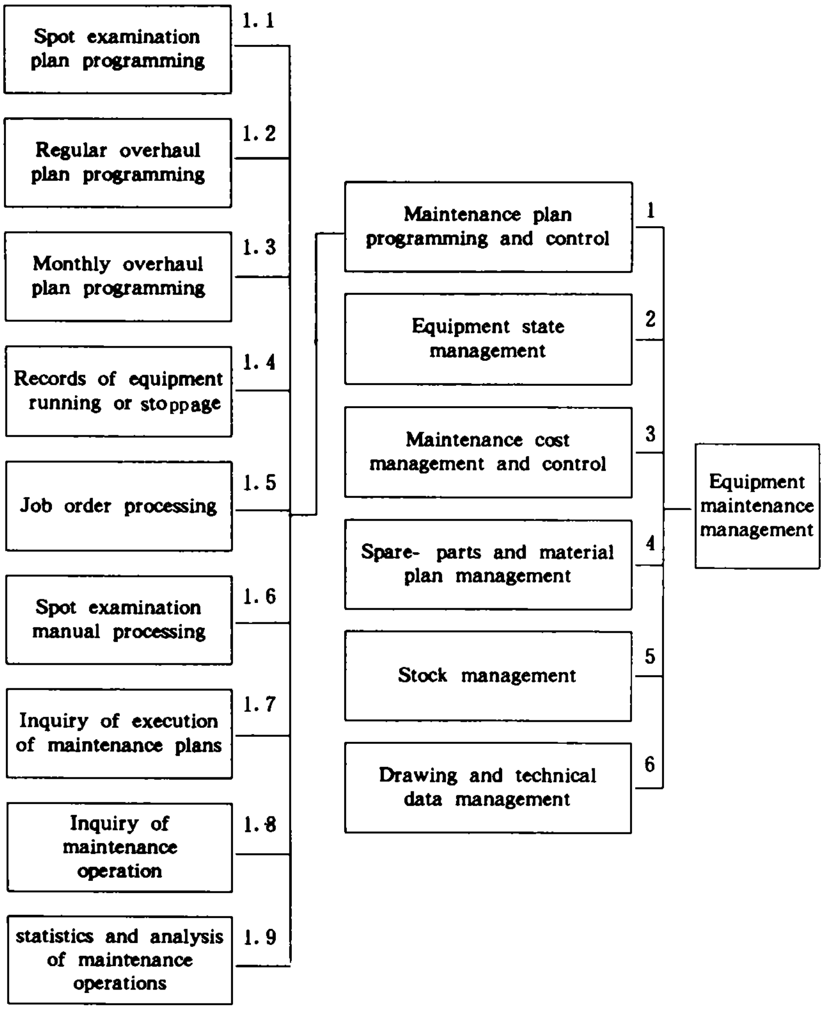

Fig. 2 An example of equipment maintenance system HIPO chart

is established through repeated analyses of this kind. Two points here requires some explanations. First, it is practically impossible to draw all data flows and processings in only one diagram. It must be divided level by level from the very top to the bottom so that the data flow diagram at each level can be drawn. The principle to follow in this respect is that the father diagram must agree with the sub-diagram, namely, the input and output data flow of a certain processing in the former must conform with the corresponding input and output in the latter, and the division may end when each processing has become simple enough. Second, the establishment of the logical model of the system is a rather arduous and complicated task. A successful completion of which requires full support from the leaders and close cooperation on the part of all participants.

In addition, while drawing a data flow diagram, it is necessary to establish a data dictionary which records the definition, structure and variety of a datum in application as well as the related information in order to ensure the conformity in data application. This is also

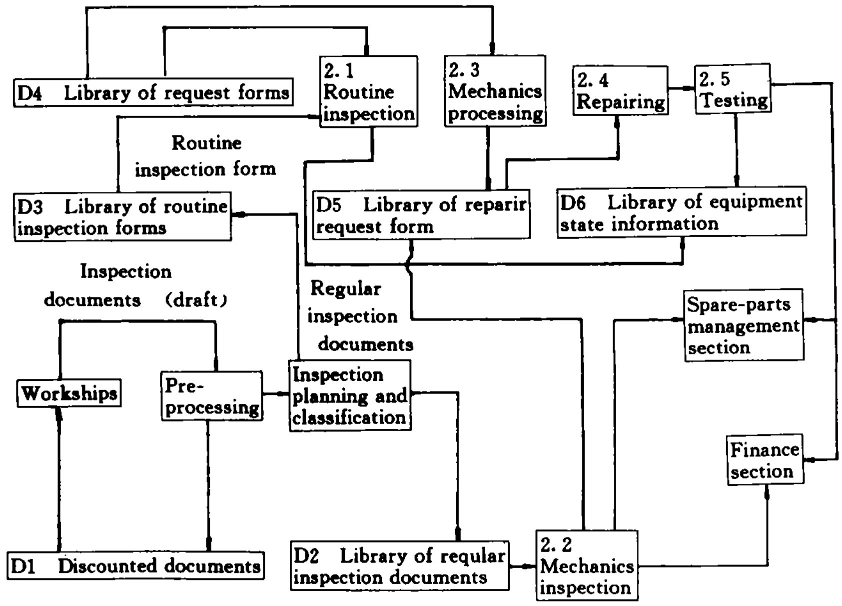

Fig. 3(a) An example of spol examination data flow diagram

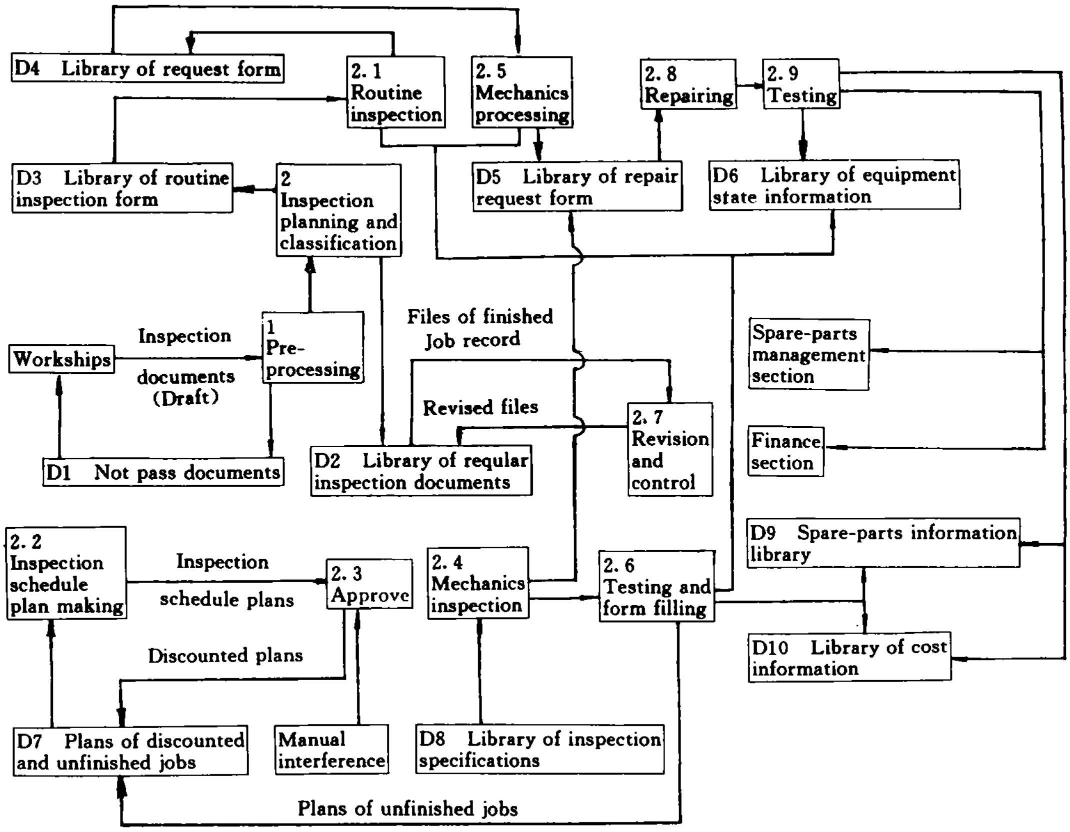

Fig. 3(b) An example of spot examination data flow diagram of target system

necessary in the development of data bases and data storage design.

4 SYSTEM STRUCTURAL DESIGN

Based on the logical design and with the help of the data flow diagram, the data dictionary and a set of standard design forms, the structural design approach aims at the gradual division of the system level by level into a number of easily realizable modules with proper size, specific functions and considerable independence, thus transforming a complicated system design into very simple module design.

The major means of structural design is the structure diagram (also called the control structure diagram). Each square in the diagram stands for a module; the arrow pointing to another square shows the call relationship of one module with the following one and the small arrows besids the call arrow are used to represent the data transmission between two modules(Fig. 4).

To effectively draw a structure diagram from the data flow diagram is a fundamental technique in system structrual design. The whole system should first be taken as one module and then be divided level by level. The module to be divided must be made to do several tasks. Take the "equipment maintenance planning and control" module for instance. The tasks include spot examination planning, regular overhaul planning, monthly overhaul planning, spot examination report planning and writing and input of job information in the spot examination task report and job order. A call module should first be built. All jobs to be processed are put in the modules at the next level, which are called by the upper module according to the types of operation, When the function of the modules to be decomposed is composed of several smaller sequential function executions, the module processes the same kind of operations and can be processed according to the data flow diagram in these stages input, processing, output, etc. With the structure diagram, programming can be carried out.

Of course, system design involves more than the drawing of a structure diagram. We must carry out a series of physical designs, such as code design, interface design, database structure design, data storage design, table design, privacy measures, etc.

5 MAJOR FUNCTIONS OF MODULES AND PROGRAMMING OF DAYE SYSTEM

5. 1 *Maintenance Plan Programming and Control Module*

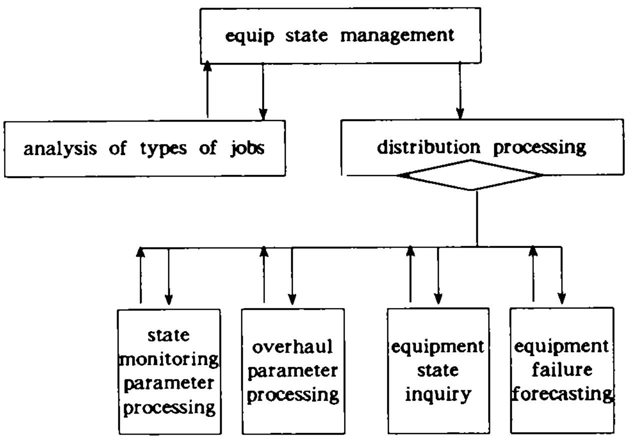

Fig. 4 A structural diagram

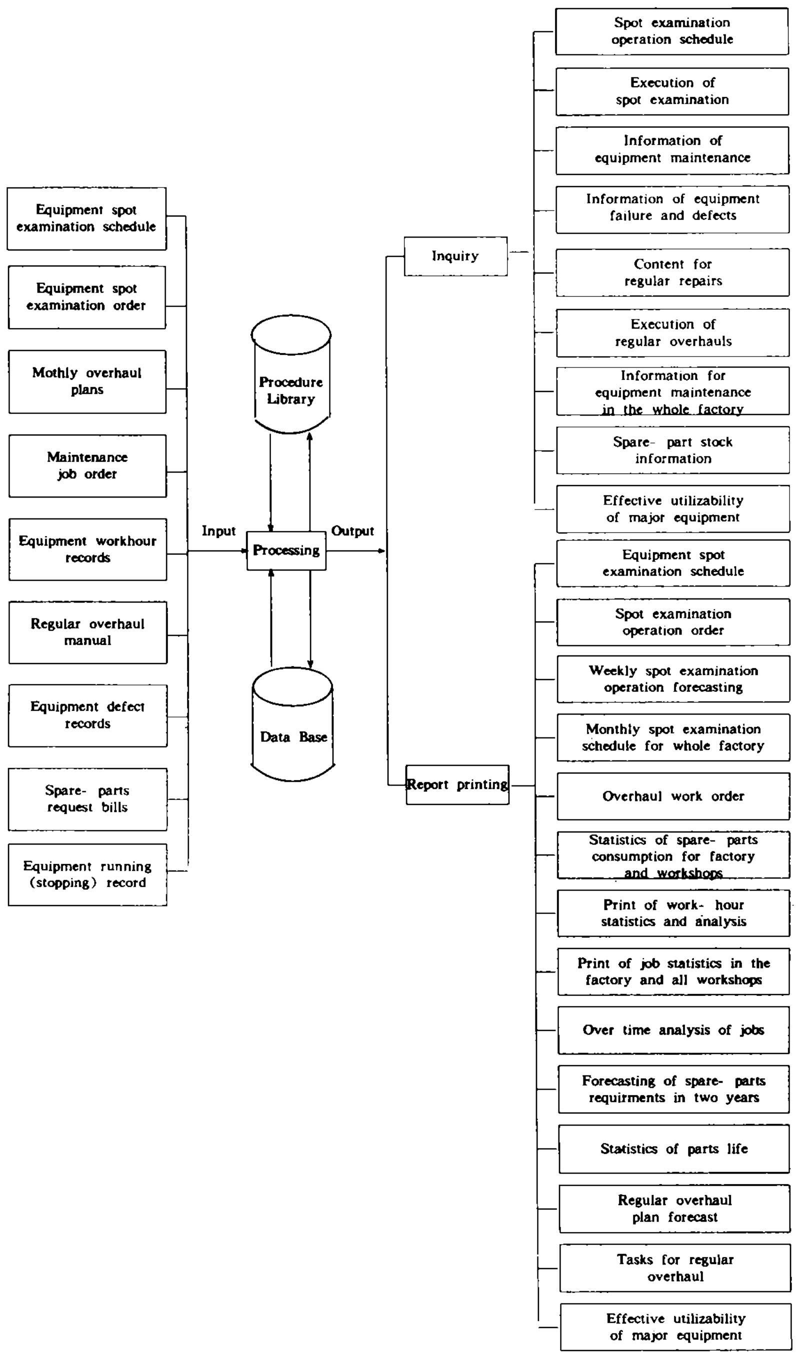

Fig. 5 Major input and output of maintenance plan programming and control

The major function of this module (Fig. 5) is slightly different from those in Fig. 2 because the target system is required to be networked. With the previous computer spare-parts management system as the computer spare-parts management system is developed prior to the equipment maintenance management system. These functions are: programming and printing all kinds of overhaul and spot examination plans, forecasting spot examination operations and regular overhauls, input and processing data of equipment maintenance, spare parts, and potential troubles of equipment, analyzing and summarizing the operations of the factory as a whole, forecasting the lifes of spare parts and required numbers in next two years, inquring the examination of various maintenance plans and related information, inquiring all previous overhaul information of production equipment and changes of spare parts, and finally, recording the operations of equipment and figuring out automatically the utilizability of equipment. This module consists of nine functional modules. The major input and output programmings were illustrated in Fig. 5.

5.2 *Equipment State Management*

By measuring and inputing the equipment state monitoring data, the overhaul parameters and the related information for the purpose of carrying out failure statistics, failure analysis, failure detection and forecasting, and inquirying into the current state and previous files of the equipment. This module provides the personnel concerned with the evidence and information regarding the current state of the equipment, overhaul plan programming, decrease of unexpected breakdowns and avoidance of serious accidents, thus enhancing the utilizability and improving performance of the equipment. It is made up of a parameter control module, a failure analysis forecasting module and an overhaul file inquiry/printing module. The main input and output programmings are shown in Fig. 6.

5.3 *Maintenance Cost Control*

Maintenance cost control is an important part in equipment maintenance management. This module, proceeding from the actual situation of the worksite, performs the statistics and analysis of workshop maintenance cost and overhaul repair costs. Considering the close relationship between equipment overhaul plans and the budget and final accounts, the overhaul repair plan programming are included in this module. This module is composed of four submodules, whose input and output programmings are illustrated in Fig. 7.

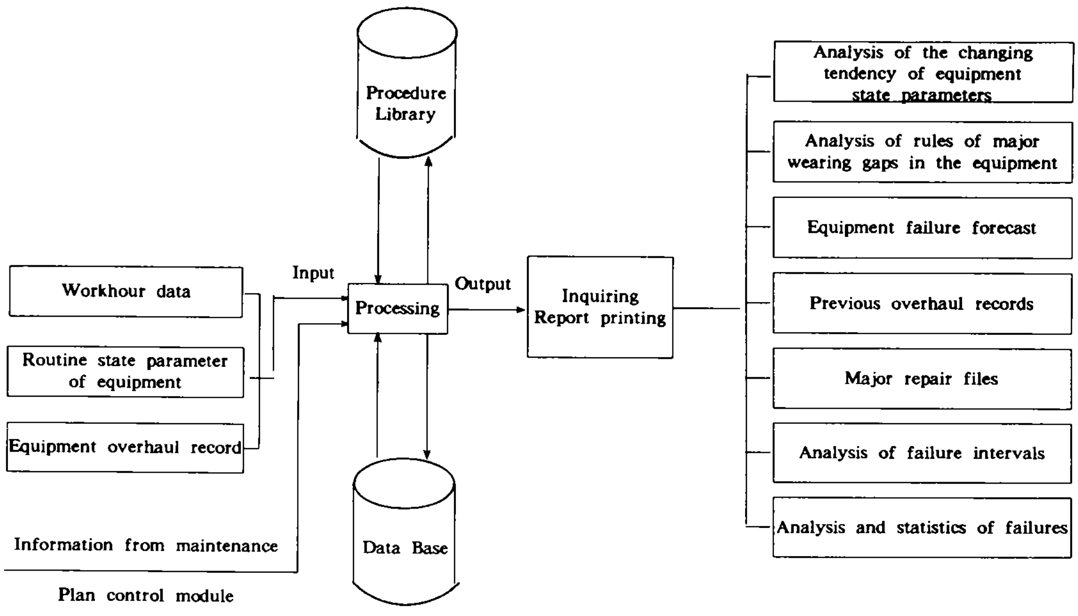

Fig. 6 Major input and output of equipment state management module

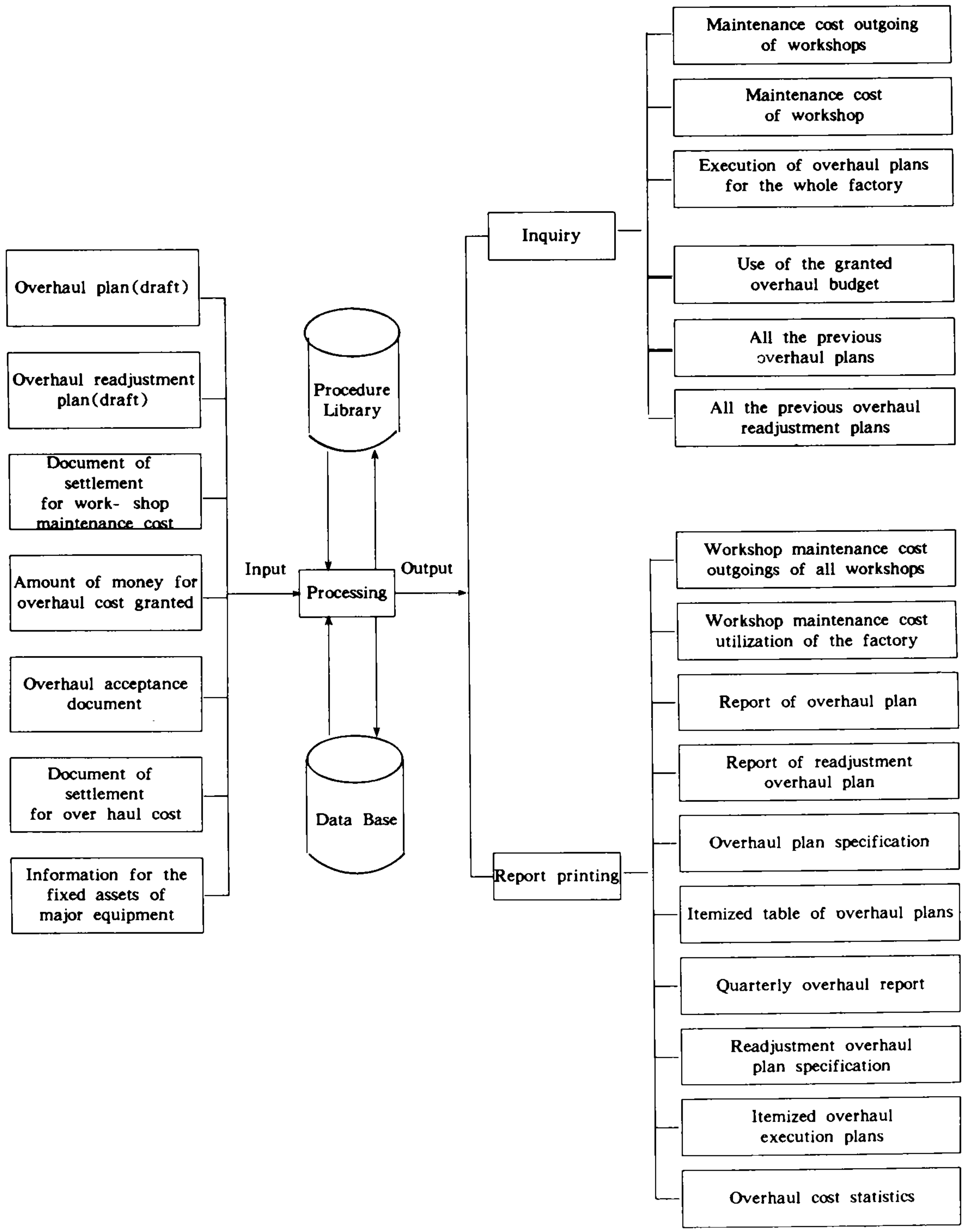

Fig. 7 Input and output of cost control module

5. 4 *Spare-parts and Materials Management Module*

This module mainly carries out the management of the in-and-out connected with the warehouse management of spare parts and materials. Its major input and output designs are shown in Fig. 8.

Owing to the limited capacity of the computer and related media, sub-systems for spare-parts making management, drawings and technical data management, warehouse management, overhaul network technology for large-scale equipment and its management have not yet been developed for the time being.

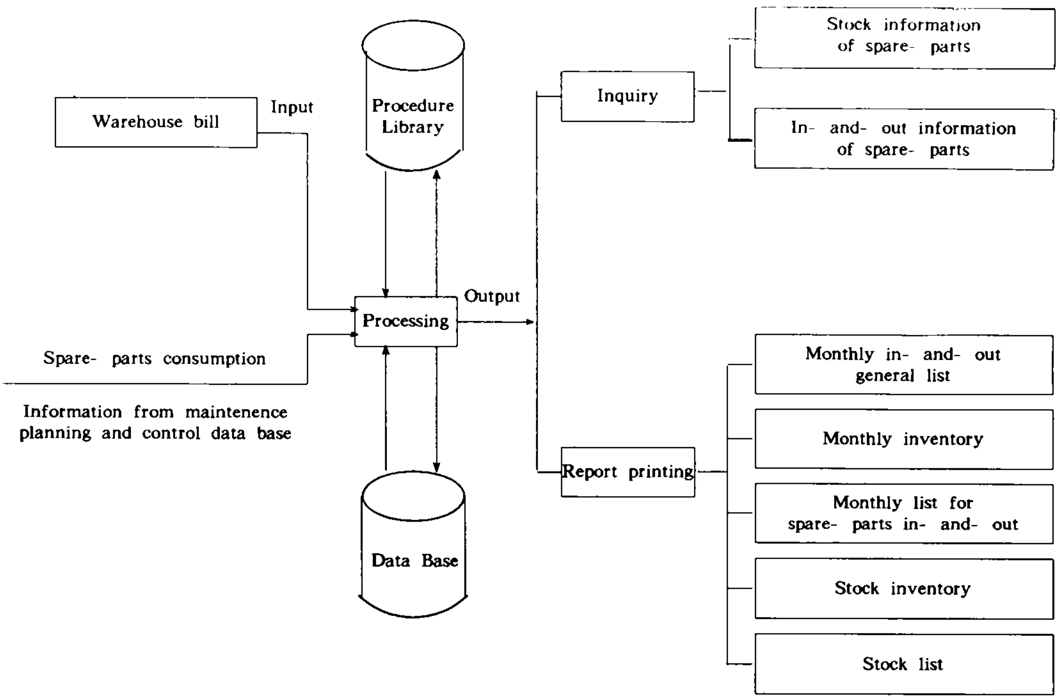

Fig. 8 Input and output pragramming of spare-parts management

REFERENCES

1 Flegg P, Prout R. In: Proceedings of National Conference on Maintenance Management by Computer, 3rd edition. London, 1980.

2 Xia Genfu. Equipment Management and Maintenane(in Chinese). 1993, 3.

3 Kanter J. Management Oriented Management Information System, 1977.

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