CONFIGURATION OF AN ADVANCED INDUSTRIAL CONTROL HIERARCHY FOR COPPER MANUFACTURE[1]

Xie. Changyan
Department of Automatic Control Engineering,
Central South University of Technology, Changsha 410083, China

ABSTRACT

The proposed hierarchical arrangement of the copper plant control is presented. The hierarchical control in copper manufacture and the recent computer advances in this area are discussed. It is also described how a hierarchical computer network can provide a means for effective integrated central control in this article.

Key words: hierarchical computer network copper manufacture

1 INTRODUCTION

An extensive computer control system which constantly monitors and adjusts thousands of process control variables is necessary for production automation in a modern copper plant. The development of effective control strategies is requisite to correct the process through time. These process control correction must often be made in real time to realize the benefits proposed by schedulers. The utilization of a hierarchical computer network configuration enables management to obtain order status in real time, thereby obtaining maximum benefit from on- line control system. Such a network would not only be arranged in a ring structure but linked at their respective levels. The hierarchical computer network would best satisfy the requirements of reliability and coat saving for the modern copper manufacturing facility.

2 THE MEANING OF HIERARCHY

There are three properties common to any hierarchy; namely, vertical decomposition, priority of action and performance interdependence. Vertical decomposition means that the entire system can be broken down into areas of inputs and outputs where each set of inputs and outputs represents a subsystem, which can be used to process the inputs effected on the outputs, and after decomposition change occurs at what would be thought of as the lowest level. Priority of action indicates that the operation at any level is directly and explicitly influenced by higher levels. performance interdependence can be viewed as feedback responses to associated interventions. Fig. 1 shows the three concepts and their relationships.

3 HIERARCHICAL ARRANGEMENT OF COPPER PLANT CONTROL

Since production areas of modern cop-

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per manufacture are distinguished by different physical inventories, we can divide the basic sample copper plant into three production areas. The proposed hierarchical arrangement of the copper plant control is shown in Fig. 2. The layout of the actual computer control system is then dictated by physical process constraints rather than predetermined process control function. The computer hierarchy layout is thereby installed by the actual layout of the plant rather than specific computer capabilities.

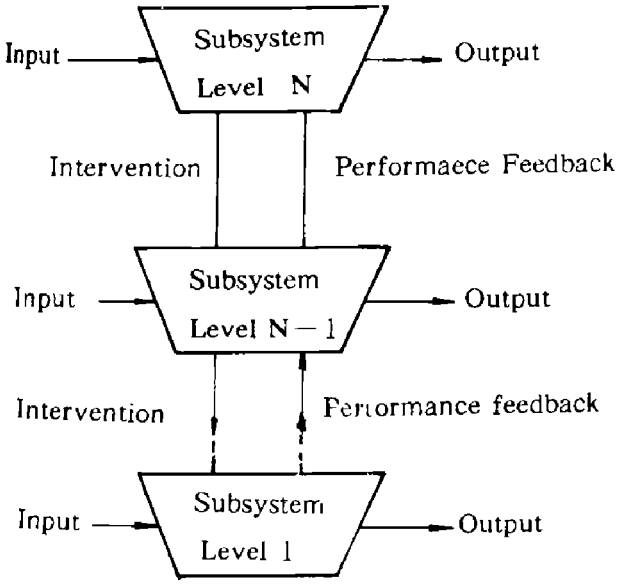

Fig. 1 Basic characteristic of a multilevel system

The management structure in a modern copper plant was also developped around the plant's physical structure, so the architecture of the computer system is coincident with the today's management structure.

The basic control system is composed of a distributed set of small and cheap computers which provide redundant communication links to avoid potential shutdown due to system failure. The lowest levels of the hierarchy will comprise micro-computers monitoring and contolling the production.

A primary function of the top level (4A) scheduling computer in the proposed hierarchy is the production and maintenance of the overall plant production schedule. This computer will be a large, fast mainframe computer capable of performing the necessary production control calculations in a very short time and permitting the plant to operate in a real time. The computer at this level(4A) carries out the master production scheduling tasks to make a dynamically changing system maintain high productivity coupled with low production cost.

Level (3B) computer must take aggregate schedule developed by level (4A) computer and turn it into heat- ingot- slab requests which must also be feasible on a facility by facility basis and should be determined in an optimal fashion. This disaggregate schedule will be given to the next lower level where detailed sequencing is performed.

· The system architecture described incorporates several small computer subsystems in a hierarchical control configuration. Fig. 3 shows the resulting hierarchical structure.

4 CENTRAL PLANNING AND TOTAL AUTOMATION IN COPPER PRODUCTION

In the above section, configuration of the hierarchical control in copper manufacture was described. This section gives an overview of automation in copper production systems. High-temperature blooms are transported by computer-controlled vehicles from the casting plant (Area 1)to the billet mill(Area 2).

Control using sophisticated process control models is carried out in the reheating furnaces and rolling mills. The line is provided with on-line sensors to detect flaws and measure the shape of products in order to assure quality. It is also equipped with efficient robots that perform marking and labelling.

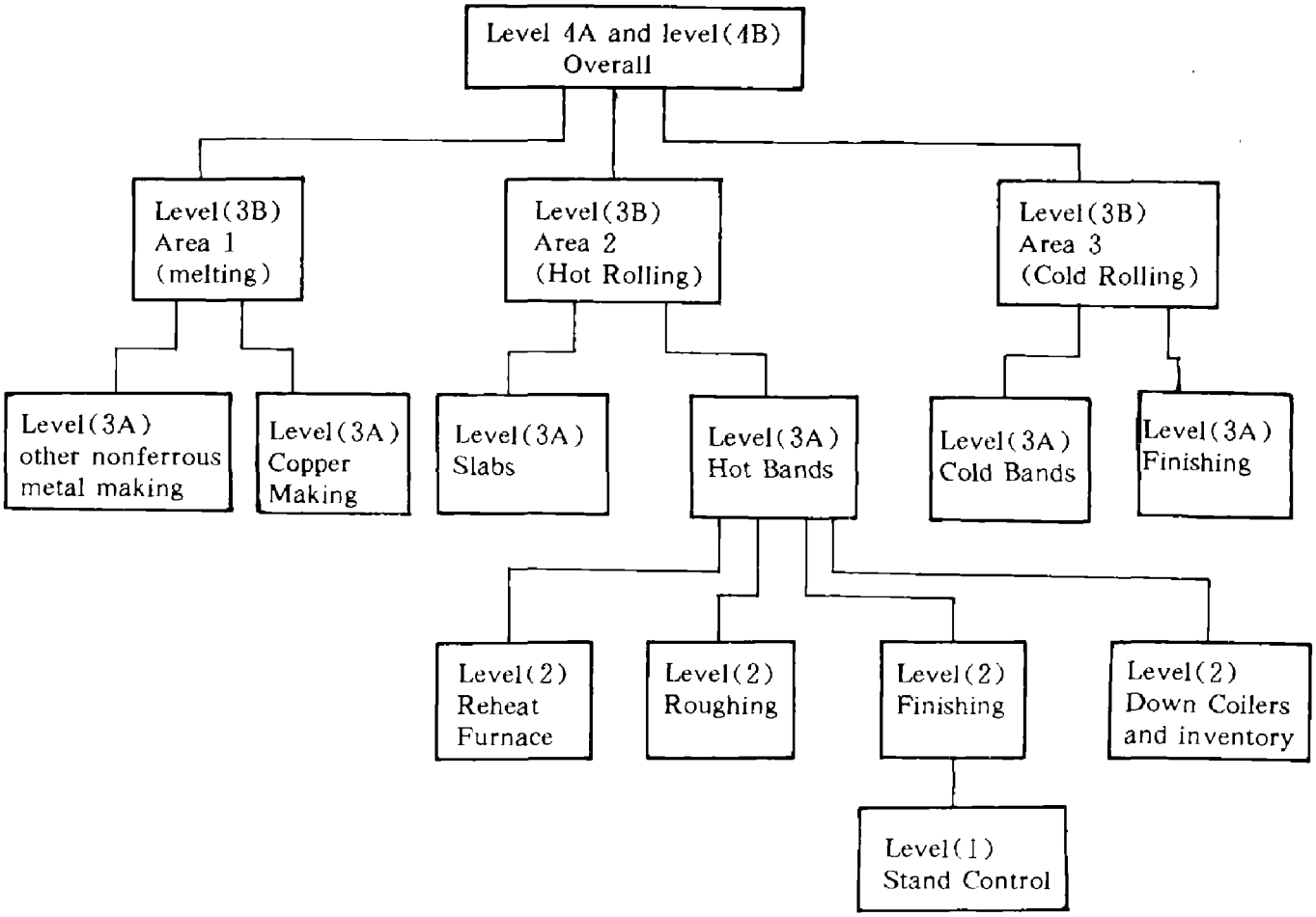

Fig. 2 Hierarchical Arrangement of The Copper Plant Control

Multiple local optical data ways in loop form are installed to provide lateral data transmission among the process computers, microcomputers, sensors and robots.

The operation control system permits the synchronization of the billet mill and the casting plant. The central computer (level 4A) prepares the optimum plans based on the product specifications and manufacturing instructions from the head office for, for example, lot combination and process schedule. Information on manufacturing instructions is transmitted to process computers via optical data ways transmitting between the upper and lower levels in a hierarchy which controls production facilities. Operation results on the other hand are transmitted from the lower to the higher level and the central computer forms operation data bases.

The computers at the head office (Level 4A and 4B) has a sales and production control system that controls the whole cycle from receiving orders to production and delivery. The basic function of this system, such as business negotiation, receiving orders, quality design, Production scheduling, delivery and collection of bills, are executed on these data bases.

In general, central planing and control provides a framework for control that can be effectively aided with a hierarchical computer network. The computers help direct all the activities of the organization in a coordinated manner that strives to achieve the goals established by management. Feedback information, such as the production performance and productivity, flows upward to the central computer. The central computer

then reacts through its control algorithms and sends the appropriate control instruction downward to the lower level computers.

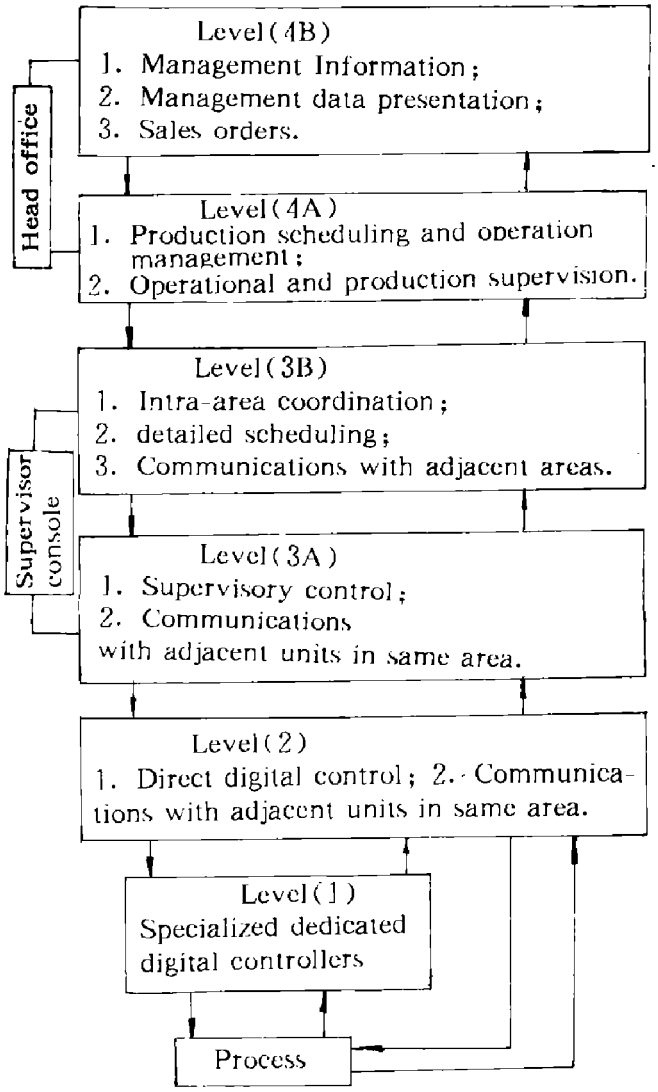

Fig. 3 Hierarchy Structure

5 CONCLUSION

The object of this article is to elucidate the outline of a hierarchical computer control in copper plant.

Since computer has come to light, one can implement more complex and advanced effective control strategies, such as adaptive control, selfstudy control, robot control, application of artificial intelligence, to improve the product quality and to stabilize the operation of the plant close to optimal operating conditions. Control systems using microcomputers and minicomputers have been constructed in rapid succession. Mathematical models based on rolling theory, metallurgy and thermodynamics and control algorithms based on control theory are incorporated in these systems. As a result, model algorithms have been gradually replaced by those based on theory. This will become increasingly marked in the future. Large-scale system in which a control system and a business computer are connected have been developed at integrated metallurgy works. These systems permit the production of high-quality products at low cost while rapidly coping with orders for many items in small lots. This tendency will become increasingly prominent in the future. The functions of hierarchical computer control system will be further developped in copper industry and more production systems for computer-integrated manufacturing constructed.

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