# (IV－9) Development of the conceptual structure for a proposed computer-aided operation adjustment system in Chinese Railway Network

Gong Liying, Student Member, the University of Tokyo
Ieda Hitoshi, Regular Member, the University of Tokyo

## 1. Introduction

In China, the influences of many factors make it difficult to operate trains according to the schedule. Therefore, we need to make the stage plan to adjust the train operation every three hours. It is known as "3 hours' plan". But, until now, it has been done manually, which takes a lot of labor and time and has become one of the main causes of delay in the development of Chinese railway. Compared with the developed countries, Chinese situation is about 50 years behind. However, in China, there are freight trains and passenger trains which have different speeds and requirements to be operated in the same line. According to this complicated situation and economic limitation, in order to achieve the railway modernization and to improve efficiencies, it is necessary to build the computer-aided system in the first place. In this paper, the proposed conceptual structure is mainly discussed. In China, this is the first time to touch this field.

## 2. Conceptual structure

Firstly, the conceptual structure of this proposed computer-aided operation adjustment system in Chinese Railway Network is shown in Figure 1.

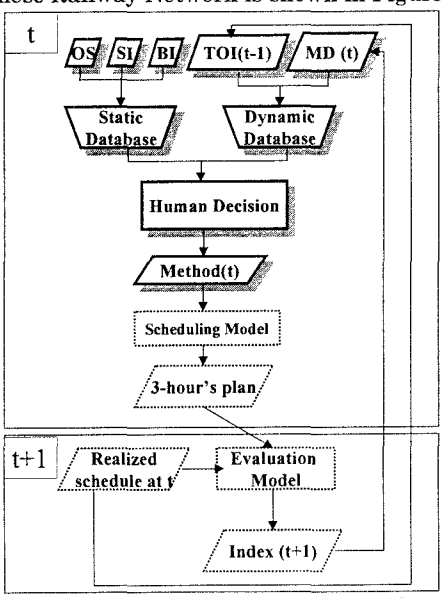


Figure 1 Conceptual structure of computer-aided system

This conceptual structure can be simplified into three parts: Human Decision, Plan Formulation and the Evaluation of the Plan. Input has been divided into dynamic state and static state information. During the development of the original computer-aided system, static information such as OS (original schedule), SI (station information) and BI (Block information), required as input in the static database. However, Dynamic information is in different situation. TOI (train operation information) at the period( t-1~t) is collected from the daily train operation. In method database (MD), the adjustment methods and their suitable situation are stocked. Then, based on these two database, Train dispatchers can decide which method is adopted, and thus, through the scheduling model a "3 hours' plan" for the period (t~t+1) can be obtained. Until the time reach t+1, the realized schedule at the period (t~t+1) can be applied. Finally, through the Evaluation Model, comparing between "3 hours' plan" and realized situation, the quality of this plan can be evaluated. Thus it can be concluded that what kind of methods are suitable for different situations. This evaluation then serves as feedback to improve the method database. By this a good operation cycle can be obtained. At the same time, realized schedule at the period (t~t+1) becomes the basis of next "3-hours' plan", and thus the work will be continued. In this system, the part of figure 1 which has the shadow has been completed. This part is the foundation of the whole system, and it is the focus of this paper.

## 3. Dynamic and Static Databases

### A Dynamic state information database

In Chinese railway system, every railway bureau has a dispatching office to be responsible for formulating "3 hours' plan". In this office, the dynamic information can be collected by train dispatchers who have the main responsibility for making this plan. The schematic view of dynamic information flow is shown in Figure 2, which shows train dispatchers get the dynamic information, like train actual schedule, from other dispatchers, like passenger and freight dispatchers. Every train dispatcher also has the closed connection with each other. As every dispatcher is responsible for one block, they need

Keywords: China, train schedule, operation adjustment, Computer-aided system
〒113-8656 東京都文京区本郷 7-3-1 東京大学大学院工学系研究科社会基盤工学専攻交通研究室 (03)3812-2111 (ex.6118)

to exchange information about upward and downward going trains between them.

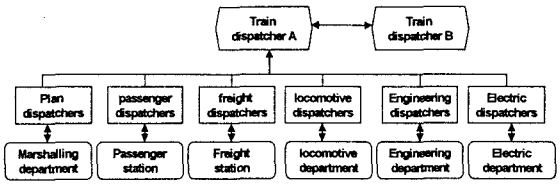


Figure 2 Dynamic information flow

**B. Static state information database**

There are 4 types of static state information such as vehicle information, station and block information and original schedule.

Table 1 Static state information

| | |
|---|---|
| Vehicle information | Train number, train quality, locomotive style, train length, train weight, limitation of train width |
| Schedule | Original schedule, long-term maintenance schedule |
| Station information | station name, location of the station, the type of station, the number of station track, the direction of line, junction connection, signal type, platform type, the slope of railway, overtaking interval time standard, the crossing interval time standard, technical working time, and so on. |
| Block information | Block name, closed style, geography situation, the number of track, signal style, the name of block terminal, the highest allowed speed in the block, and so on. |

## 4. Adjustment methods

In this computer-aided system, the main procedures can be accomplished through the adjustment methods and human involvement.

During the period of investigation in Shanghai Railway bureau and Nanchang Railway bureau, working methods have been closely observed from the train dispatchers and some questions were put forward, such as "what kinds of situation will disrupt the operation of the train?", "what are the current adjustment methods?", and so on. It has been found through these observations and questions that many factors cause the disruption of train operation, such as the insufficient stocks in stations, the loading and unloading delay, fuel quality, and so on. However, two direct consequences have been identified from the investigation: delayed train and disrupted organizational form. To simplify the computer-aided system, the adjustment methods have been classified into two categories as follows:

**A. Speed adjustment methods**

The purpose of adjustment is to organize the train to operate on schedule and to accelerate the handling speed. Speed adjustment methods are used to recover from the confused train operation by improving the travel speed. These methods are mainly adopted when delay occurs, which is one of the main reasons causing disruption of train operations.

(1) Increasing technical speed $V_0$: The allowable speed on the line should be taken full advantage of, and $V_0$ is increased.

(2) Decreasing the time in station $T_S$: Organizing quick and parallel operation; Decreasing the operation time in the station; Choosing reasonable crossing and overtaking station; For steam locomotion, the stations which supply water can be changed.

**B. Organization form adjustment methods**

These methods are mainly used in special situations, such as maintenance, disasters, accident, and so on.

(1) Reverse operation: In double line, when one direction line is broken off or when the vehicle density in one direction is much larger than the other's, the reverse operation can be applied.

(2) Combined operation: This method can be used in following situations: Train density is very large and the passing ability is not enough; The departure and arrival lines in marshalling station are not enough. The trains, which have less wagons, can be put into combined operation.

Train dispatchers are expected to input the actual situation of disruption of train operation and choose one of adjustment methods, then the computer can change the schedule automatically. The principle to choose adjustment methods is that less change from the original schedule is better.

## 5. Future

In this paper, a conceptual structure for a proposed computer-aided operation adjustment system for the Chinese Railway Network is presented. However, the later parts have not yet been completed and further study is expected. Later, when this computer-aided system is applied to the Chinese railway system, the efficiency could be greatly improved.