Computer-assisted Train Diagram Planning System

Abstract
The computer-assisted train diagram planning system which features, the sharing of tasks between humans and computers, assists train diagram preparation work, as well as rolling stock and crewmember scheduling by applying a simulation technique. It increases planning efficiency and at the same time reduces labor and costs associated with planning work. The end result of applying this system is the provision of more convenient train schedules for passengers.

1. Introduction
Train diagrams are planned to provide passengers with more convenient time schedules whenever new types of cars are introduced, and when train speed or services increase. The computer-assisted train diagram planning system developed by JR Kyushu in September 2000 assists train diagram planning work, and rolling stock and train crewmember scheduling (from here on to be known in general as transportation). The task of transportation planning has until recently fully relied on manual work at individual train operator depots, with computers partly introduced to assist with train diagram planning tasks. However, in the new system developed by JR Kyushu, data and information contained within the train diagram planning databases are completely stored within EWS (engineering workstation(s)). By applying a simulation technique to the data and information, the system can efficiently compile optimal rolling stock and crewmember schedules. The main theme of the system is the sharing of tasks associated with transportation planning between humans and computers in order to achieve maximum efficiency and results from the planning process. Flexible operation is ensured not by fully computerizing JR Kyushu's complicated rail diagram system, but by introducing ultimate human judgement and decision making into the human planning processing.

2. System Outline
The workflow for transportation planning after the system introduction is shown in Figure 1. The task of transportation planning formerly depended fully on manual operation at individual train operator depots. However, carrying out planning work at a central location has the advantage of maximizing the use of limited and valuable resources, such as rolling stock and crewmembers. For example, there may be spare capacity in one depot whilst resources may be short in another depot. Therefore, a balance in the utilization of resources within JR Kyushu's vast network is the prime objective of the centralized transportation planning system.

The computer-assisted train diagram planning system has the function that performs simulation to produce the most effective schedules for the allocation of rolling stock and crewmembers. The system's most distinguishing characteristic is the automation of both static and dynamic planning activities. Moreover, local terminals are installed at all the branch location so that the system can make effective use of the crewmember know-how at individual train operation depots. Information can be exchanged between the central planning location and the terminals located at the branch locations.

The system configuration is shown in Figure 2. The train timetable preparation system, the rolling stock and crewmember scheduling preparation system, and the planning data management server are installed in the central location. The train timetable data are stored in the planning data management server. The train timetable data is extracted from the planning data management server by the rolling stock and crewmember
scheduling preparation system. The train timetable, rolling stock scheduling and crewmember scheduling data are managed under a general-purpose database. The planning data management server also performs in parallel the task of the transportation planning.

The data from the computer-assisted train diagram planning system is then presented to the Electronic Data Processor system (EDP), in a general-purpose format after having considered the data provided to the system, which will be able to be introduced in the near future.

The workflow of the transportation planning
3. System Function

3.1 Train Timetable Preparation System (DIAPS)

Train timetable preparation system has been nicknamed DIAPS. DIAPS is a reliable system, which has gained widespread usage. This feature of DIAPS is fully utilized with the addition of the following enhancements.

1. The train timetable data is made available to rolling stock scheduling preparation system, crewmember scheduling preparation system and EDP. The train timetable data used in this way is an effective and efficient approach to allocate rolling stock and crewmember resources to satisfy the passenger carrying demand.

2. A convenient user operation interface and function has been added to DIAPS in addition to the existing user interface and functionality.

3. It is possible to output data in user definable data formats or mask certain data in the output (only showing those, which are relevant).

3.2 Rolling Stock and Crewmember Scheduling Preparation System

The editing screen samples of rolling stock and crewmember scheduling preparation system are shown in Figure 3. Work is carried out by editing the contents of screens in accordance to the working process shown in Figure 4 and Figure 5.
The editing screen samples of this system
The working process of rolling stock scheduling

4. Introduction of Rolling Stock Scheduling Simulation
Rolling stock scheduling simulation is the function, which automatically creates a transition from one train to the next train in a manner which satisfies limiting conditions such as the minimum interval time and so on. The main principal of rolling stock scheduling simulation is the FIFO rule, First-In First-Out rule (refer to Figure 6). The rule is that the departures of the trains are all related to the departure of the first train after the minimum interval time. In general, if the interval time is shortened, we can effectively use rolling stock with this scheduling. Therefore, the application of the FIFO rule is the most appropriate for rolling stock scheduling simulation, and concise simulation logic can be built by the utilization of the simple FIFO rule.

Moreover, scheduling such as inspection and cleaning is also made automatically by utilization the minimum interval between train returning to depot and having to leave for commercial service.

The FIFO rule applied to rolling stock scheduling simulation
5. Introduction of Crewmember Scheduling Simulation
Crewmember scheduling simulation is the function, which automatically creates links for crewmember duty from one train to the next train satisfying crewmember working regulations such as duty time, continuous drive time, meal time, rest time and sleeping time. This algorithm flow is shown in Figure 7.
6. Conclusion

Many benefits can be gained by the introduction of the computer-assisted train diagram planning system. Some of the benefits derived from the application of the system during the train timetable revision in March 2001 are listed below.

(1) The system can carry out transportation planning at the same time integrating the database of train diagram, rolling stock scheduling and crewmember scheduling.

(2) The system can efficiently carry out transportation planning work in the central section due to the realization of rolling stock and crewmember scheduling simulation.

(3) The system is built in with all working items, which are necessary for transportation planning work.

(4) Analysis and evaluation of transportation planning can be easily performed with the broad viewpoint, due to the information presented on the various editing screens. Moreover, the mileage of rolling stock and duty time of crewmember is calculated in real time as editing is being performed on the user interface. The most appropriate results are obtained from the transportation planning system by much simulation iteration on the data and information in the planning data management database.

(5) Transportation planning can be achieved efficiently and results presented for checking with little time and effort. Furthermore, human effort for tasks such as diagram and rolling stock mileage table generation is drastically reduced.

Thanks

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