

Proceedings of the Fifth International Conference on
Railway Technology:
Research, Development and Maintenance
Edited by J. Pombo
Civil-Comp Conferences, Volume 1, Paper 23.11
Civil-Comp Press, Edinburgh, United Kingdom, 2022, doi: 10.4203/ccc.1.23.11
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Establishment of a new unit to promote interlocking systems replacement projects

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Abstract

In this paper, we present our kaizen to accelerate the design procedure and improve the quality of the upstream design by changing the workflow of the projects.

First, we established a new unit dedicating to drawing control diagrams and tables. Our workflow had a time gap between finalizing the design condition and the onset of finalizing the system's specifications by drawing control diagrams and tables. We filled this gap by parallelizing the preliminary design and drawing control diagrams and tables. Also, this parallelization contributes to improving the quality of the upstream design by uncovering problems in design because drawing diagrams require detailed considerations.

Second, we set a technical committee to identify the issues during the upstream stages of the design. This new committee helps us further uncover problems by asking all related departments' opinions.

Third, point cloud data is used to accelerate the design by reducing the frequency of visiting the site.

As a result, we accelerated our procedure by several months while improving the quality of the upstream design.

Keywords: project management, control table, diagram

1 Introduction

East Japan Railway Company (JR East) is one of the largest railway companies in Japan that performs operation, construction and maintenance of equipment. JR East replaces twenty interlocking systems for conventional lines per year on average, and about half of these replacement projects are promoted by Tokyo Electrical Construction and System Integration Office (TESCO). TESCO also promotes signaling system improvement projects to realize a more profitable railway through track layout change and increasing the number of vehicles in one set. In addition, we conduct an investment survey, establish a project plan, carry out detailed design, and perform construction supervision.

Promoting interlocking replacement projects on the replacement schedule is a principal issue for safe, reliable railway operation. The replacement schedule is set based on life expectancy. If we exceeded the replacement time, there would be many failures of electronic components. These failures will degrade the system's reliability, and in the worst case, safety hazards will occur. To prevent such hazardous events, we always do our best to complete replacements on schedule.

The workflow of our signaling system construction design is following (Figure 1).

- (1) collaborate with other departments such as operation and other engineering disciplines to form an agreement on design conditions,
- (2) conduct preliminary design based on the conditions and propose the project,
- (3) receive approval of the proposal by the executive board,
- (4) prepare control diagrams and tables, and hold meetings with other departments to finalize the specifications, and
- (5) conduct detailed design.

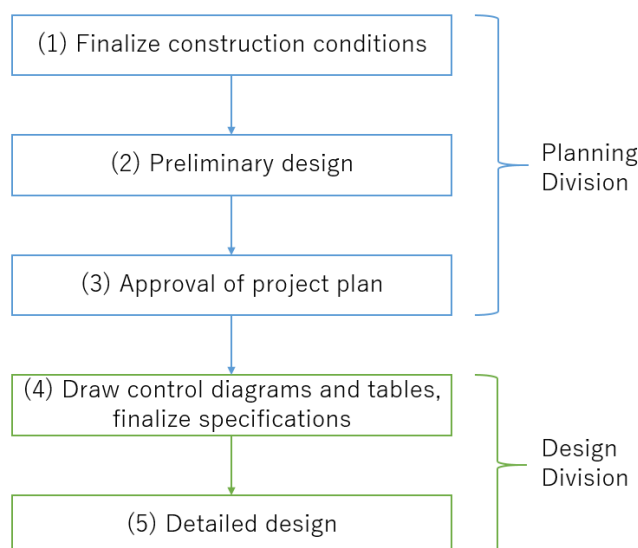


Figure 1: Procedure of designing the signaling projects

In this workflow, the planning division performs (1) to (3), and the design division performs (4) and (5). In (4), control diagrams and tables include interlocking system, ATP, and crossing.

The essence of promoting projects on schedule underlies upstream design. Key points are the following: working closely with other departments on the design specifications and early uncovering potential issues for designing the system. These two key points form a virtuous circle; closely working with other departments leads to uncovering potential issues, and vice versa. Also, this virtuous circle leads to the early finalization of the system specifications. This early finalization helps us promote the project without reconsidering them at later stages, which can be a serious problem about schedule and cost. In order to achieve such a situation, we worked on improving the workflow to finalize the specifications earlier and improve the quality of the upstream design.

2 Methods

We focused on the upstream design to improve the workflow, considering the cost of change [1]. Then, a new unit specializing in designing control diagrams and tables is established in the planning division. In addition, a technical committee is established to identify issues early in the design procedure, and design guidelines are defined to improve the quality. Furthermore, we decided to reduce the construction period by utilizing point cloud data in the design.

In October 2020, a unit specializing in preparing control diagrams and tables, including those of interlocking system, ATP, and crossing, was established within the planning division. The problem in Figure 1 is that there is a blank period between (1) and (4), though it is possible to start (4) once the design conditions are fixed. Therefore, this new unit starts (4) while the other units are working on (2) and (3) (Figure 2).

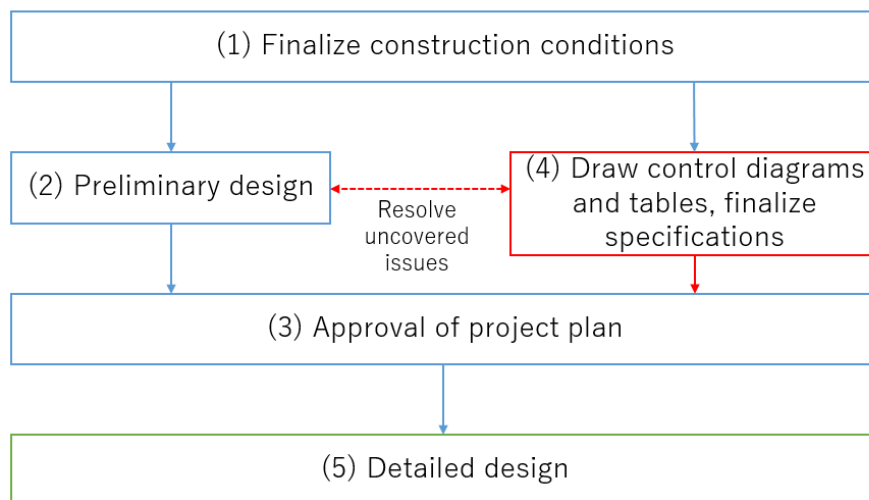


Figure 2: Improved procedure of designing the signaling projects

This parallelization will speed up finalizing specifications. Also, it is possible to find design issues earlier than ever. As a result, the design division will be able to prepare for detailed design while the new unit prepares diagrams. This early preparation of the detailed design also contributes to the speed-up of the process. In addition, the establishment of this new unit is also aimed at improving the technical capabilities of the entire organization by accumulating and horizontally deploying know-how on technical issues found in the upstream stages and the preparation of control diagrams and tables.

The technical committee identifies the issues at the upstream stage while units are working on (2) and (4). One of the reasons for the delay of the schedule and the increase in construction cost is that, as a result of taking into account the station's exceptional circumstances of the station; new functions have to be developed. To prevent such issues, uncovering potential problems at the upstream stage is effective. The technical committee uncovers issues from a broader range of perspectives by asking for opinions from all related departments. In addition, we clearly defined the items to be implemented in the preliminary design in the document to improve its quality.

Furthermore, point cloud data is used to reduce the construction period. The field survey is inefficient since it must be performed within a few hours at night, out-of-service hours. Point cloud data would significantly reduce the frequency of visiting the site.

3 Results

At the time of writing, in December 2021, eight staff members are working on drawing the control diagrams and tables of thirty-four stations.

These thirty-four stations have different design conditions such as the number of routes, types of ATP, and the number of crossings involved. In addition, there are seven stations for which meetings with other departments have been held to finalize the specifications. Also, preparations are underway for the others.

In terms of improving the accuracy of the preliminary design, we are preparing control diagrams and tables for three stations (Ikebukuro, Iwaki, and Tsurumi) in parallel with the preliminary design. Also, we are holding technical committee meetings for two of these with many routes (Ikebukuro: 129 routes, Iwaki: 94 routes) to identify issues. The issues identified at the meeting are considered in preparing control diagrams and tables and in the preliminary design. For example, in the case of Iwaki Station, we discovered issues that had not been verified because there had been no similar cases. The minimization of the impact on the schedule is made possible by relying on the technical committee to verify the issues at an early stage, which results in having more time to consider other means.

In terms of sharing know-how, we compile information as it becomes clear through creating control diagrams and tables and sharing it with the entire office. In addition, meetings are held every two months with the employees in the design division to exchange opinions, and the meetings are used as an opportunity to collect information

about problems in the design division and solve them together. At the meetings, we share information on charts and technical matters that are prone to errors to improve the entire organization's technical skills.

Concerning the utilization of point cloud data, we are trying to get rid of the situation where we have to go to the site for the survey by acquiring the data during the preliminary design or preparation of control diagrams and tables. We are also developing functions to utilize point cloud data to be applied to the survey of balise positions for ATP.

4 Conclusions and Contributions

The signal division of the TESCO had been implementing a scheme in which the planning division formulated the project plan, and the design division carried out the detailed design. However, we had room to improve our workflow by filling the time gap between finalizing the design conditions and specifications. Filling this gap would compress the time required to promote projects.

Then, to ensure the steady progress of the project, a unit specializing in preparing control diagrams and tables was established. This new unit aims to finalize the specification early and improve the preliminary design's quality, which is the upstream stage of the design. The unit has been working on preparing control diagrams and tables rapidly so that the design specifications can be determined early. The group has started designing thirty-four stations in the past year and has held meetings about specifications with other departments for seven stations. In terms of improving the accuracy of the preliminary design, three stations are undergoing preliminary design in parallel with the preparation of control diagrams and tables, and two of these stations have been able to quickly resolve problems by identifying more issues at technical committee meetings. For the other stations, the preparation of control diagrams and tables and diagrams started before the preliminary design.

The new unit also has other roles to play in improving the organization's technical capabilities by accumulating know-how. For example, it held productive meetings with the design division to discuss their issues and share our know-how.

Since decision-making at the upstream of the design process determines the course of the project, we will continue to work to finalize the design specifications early so that the preliminary design can be carried out with high quality. In addition, we will continue to incorporate advanced technologies such as point cloud data to speed up the design process.

Acknowledgements

The authors would like thank to everyone who contributed to change the workflow; establishing a new unit, new meeting scheme and introducing point cloud data. Thanks to their thoughtful observation of our work and bold decision to put more power on the upstream design, the new elements are now functioning well.

References

- [1] Project Management Institute, “A Guide to the Project Management Body of Knowledge (PMBOK Guide). 7th ed.”, Project Management Institute, Chapter 2, 80-92, 2021.