

AUTOMATIC SUPERVISION AND MANAGEMENT OF CONSTRUCTION SCHEDULE FOR BOT PROJECT

Kuo, Cheng-Dao

*Deputy Chief Engineer and Manager, Project Management Department of
General Consultancy Services to the High Speed Rail Project, China
Engineering Consultants, Inc. (CECI), and*

Wu, Wen-chia

*Section Chief Engineer, Project Management Department of General
Consultancy Services to the High Speed Rail Project, CECI., and*

Chen, Jiunn-Jyi

*Engineer, Project Management Department of General Consultancy
Services to the High Speed Rail Project, CECI., and*

Chang, Cheng-Yu

*Engineer, Project Management Department of General Consultancy
Services to the High Speed Rail Project, CECI.*

Abstract: This paper introduces how an automatic system for supervision and management of construction schedule was established to monitor the High Speed Rail BOT Project in Taiwan. With the application of P3 and PDA through e-mail, field sites, field offices and headquarters can be linked together so that information can be transferred, shared and updated in an economical, simple, instant and correct manner. As a result, the governmental competent authorities may exercise their supervisory functions timely and satisfactorily.

1. INTRODUCTION

The High Speed Rail Project in Taiwan is implemented in the form of BOT -- Build, Operate and Transfer -- which is a new contract model in Taiwan. Contrary to the traditional construction bidding practice, the BOT is expected to urge the Project Company Taiwan High Speed Rail Company (THSRC) bring their productivity into full play and complete the project efficiently. On this basis, the project will be more effectively managed because of its entrepreneur nature, while the competent authority and the financing bankers exercise their supervisory functions to ensure that the project is constructed in accordance with schedule, quality and budget. For this purpose, an effective progress monitoring system is essential to the supervisory practice.

Research of automation monitoring in construction usually involves advanced equipment and development computer program. Higher budget and caliber personnel may be required, but the result achieved may also make much difference. This paper,

based on the experience of High Speed Rail BOT Project in Taiwan, tries to approach from a different methodology for automatic research, and seeks for a new automatic system for supervision and management of construction schedule in accordance with the tender documents of THSRC. Consequently a more practical automatic supervision and management of construction schedule can be achieved.

2. PROCESS SUMMARY

There is no shortcuts for supervision and management of a construction project. At the planning stage, one should first consider the target result, available resources, the degree of detail of a monitoring plan and the frequency for updating. Secondly, they should lay out all the steps and obtain the resources required to carry out those steps. At construction stage, successful project supervision and management requires dedication and constant vigilance to find out what really happened, what

remains to be done, what problems, delays, changes, and obstacles will occur, and who will be responsible for assistance.

Besides the major elements for automatic supervision and management of construction schedule for BOT project as mentioned, several managerial levels can be identified, such as the competent authority, THSRC and the contractors. Taking all the existing management systems in different parties involved into consideration, the planner will be able to decide the management system, the available quantity and type of applications, software and human resource. Consequently, the frequency of feedback can be determined. A summary of the process is shown in Figure 2.0.

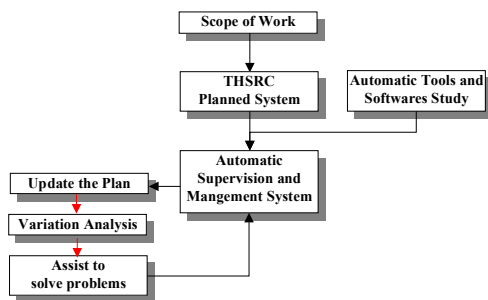


Figure 2.0. Automatic Supervision and Management Process Diagram

3. WHAT'S THE PLANNED SYSTEM OF CONSTRUCTION SCHEDULE FOR TAIWAN HIGH SPEED RAIL CORPORATION

The THSRC planned schedule system consists of four levels: SECTION, PRICE CENTER, MILESTONE and INTERIM PAYMENT SCHEDULE. Through these four levels, responsibilities will be distributed from THSRC down to contractors. Contractors are allowed with sufficient freedom to execute the work and make good use of the resources available to them in order to keep the construction on schedule. On the other hand, THSRC can reduce the number of its site engineers to control the project, and achieve the result more practically. Characteristics of these four levels are defined below.

3.1 Section

Sections of a construction schedule are designed by the THSRC, therefore it is also called Employer-designated milestones. Because this is the most important critical control point, consideration of liquidated damages for delay are included. Section usually is a transition point of time between works by different contractors, i.e., works to be handed over to

track works contractor, station works contractor or core system contractor, and substantially complete contract works. Before the contract tendering, all section milestones should be clearly defined in tender document.

3.2 Price Center

Information on all activities shall be grouped within a Price Center for accumulation. Price Center shall be:

- (1) As a minimum, there shall be different Price Centers for each major structure type, i.e., tunnels, elevated structures, special bridges, cut and fill.
- (2) There shall be a Price Center for significant changes in construction methodology.
- (3) Price Center(s) shall not include work that occurs in more than one Section.
- (4) Separate Price Center(s) shall be assigned for the guideway through each station.
- (5) Price Centers shall not contain more than one critical path.
- (6) Price Center shall be grouped so as to make up a Section of the Work.

3.3 Milestone

Milestones shall define significant events and/or reflect certain or significant accomplishments towards the completion of work within each center that can be readily identified without resorting to measurement of quantities. Milestones within the same Price Center shall be numbered sequentially over time.

Milestones shall meet the following requirements :

- (1) There shall be a Milestone no later than the third month from when payment commences on each Price Center.
- (2) There shall be a Milestone three months before the completion of a Price Center.
- (3) Subject to (1), (2) And (7), Milestones for each Price Center shall generally be scheduled at three to six month intervals.
- (4) Milestones shall signify the completion of elements of work that can be readily identified as being completed without resorting to conventional measurement of quantities.
- (5) Milestones shall be related to activities on critical path, where practicable.
- (6) The last Milestone in each Price Center shall coincide with the point on the IPS where the cumulative percentage is 100 percent. There shall be no further interim payment after the last Milestone in each Price Center.
- (7) The month each Milestone is to be completed shall be as shown in the Schedule of Milestones.
- (8) The Employer-designated milestones and Section completion time shall be included in the Schedule of Milestones.

3.4 Interim Payment Schedules

The contractor shall develop and submit the Interim Payment Schedule for each Price Center. The IPS shall cover the entire period of the Contract in monthly increments. The interim payment percentage shown on the IPS shall be reasonably compatible with the progress of work indicated in the Proposed Baseline Programme. "Reasonably compatible" shall mean that the cumulative percentage shown at the quarter points (25%-50%-75%) on the IPS for each Price Center shall be within 5 percent of the cumulative percentage shown on the price-time curve (derived from the Proposed Baseline Programme) for each Price Center.

Developing the IPS shall meet the following requirements :

- (1) The contractor shall distribute the Price Center Value of each Price Center over the period of the Contract to indicated the Contractor's desired payment schedule.
- (2) There will be no advance payment and there will be no payment for mobilization. These costs shall be distributed over appropriate Price Center as activities within the Price Center.
- (3) The sum of the Price Center Values shall equal the Contract Price.
- (4) Determine the monthly cumulative percentage distribution of the Price Center Value over the duration of the Contract for each Price Center. The resulting curve shall be the IPS for each Price Center.
- (5) Prior to the first Milestone in each Price Center the interim payment for any month shall not exceed 5% of the Price Center Value.
- (6) The interim payment before the last Milestone and Price Center shall be no more than 95% of the Price Center Value.

4. AUTOMATIC TOOLS AND SOFTWARE STUDY

Although planning a project is important in the first place, automatic tools and software are essential because even the most carefully thought-out plan will fail unless it is planned with the help of powerful project management software and monitored and updated regularly.

Management software and Personal Digital Assistant (PDA) are widely adopted in automatic scheduling control system recently. Project management software can organize our thoughts and identify potential problems. PDA is a powerful tool for regular site monitoring and progress schedule updating. With the inclusion of these two implements, the procedure for updating can be simplified and the

general existing software is identified to meet the procedure requirements. Therefore, program for computerizing is redundant and no longer required. Project procedures work more efficiently and timely.

4.1 Primavera Project Planner TM

There are two reasons why P3 is chosen as the management software for this project. First, as mentioned before, planning an efficient project supervision and management system considers not only what are needed to be accomplished, but also what planned management systems exists and which part of these systems are suitable to apply. For this reason, P3 is chosen as unique project management software among THSRC contractors. For the purpose of compatibility, P3 is also chosen for supervision and management. Second, with the fact that P3 can be transmitted through E-mail, project progress can easily be updated between the headquarters and site offices. Status of activities can be sent via e-mail to the headquarters without delay.

4.2 Personal Digital Assistant

PDA is a capable assistant on the site. Simply connect PDA to the cradle, which in turn connects to the back of computer, and the information will be ready on demand. PDA simplifies the data transferring process via modem, network, and dial-in server of the company, etc. Thus the headquarters, site office and field site are linked together.

4.3 Another Software

P3 works on PC platform, Windows system, and PDA works on WinCE platform. They are totally different systems. In order to link them, method for formatting data should be considered to make them readable for both systems. PDA software is less popular than PC window system. There is an ancillary software for PDA, XCE format file, which is like MS EXCEL and can be transferred in from TXT format. This discovery solve the problem of data linking for these two implements.

5. PLANNING THE SUPERVISION AND MANAGEMENT SYSTEM

5.1 Work Breakdown Structure for Supervision and Management System

Based on the responsibility of Competent Authority and THSRC planned system, the scope of work can be divided into 6 levels, as shown in Figure 5.1.

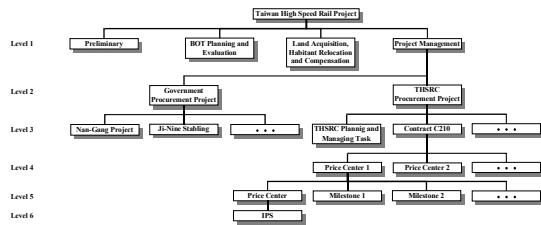


Figure 5.1 Work Breakdown Structure for Supervision and Management System

Level 1: Four components of the project control for the competent authority reporting to the Executive Yuan.

Level 2: The category is divided by the administration works for different parties in the project.

Level 3: It related to the independent procurement contracts and management tasks of different parties.

Level 4: Independent procurement contracts should be divided into 60 to 100 price centers for grouping activities and providing sufficient detail to monitor and evaluate the progress of the project. As mentioned in 3.2.

Level 5: Activities for controlling purpose, such as Price Center, Milestone, as mentioned in 3.2 and 3.3. It is also called control level.

Level 6: IPS is assigned to each activity for calculating the progress in this level.

5.2 Planning in Primavera Project Planner

In line with the features of Primavera Project Planner, the WBS structure is divided into 5 divisions for the purpose of easy supervision and management:

- (1) Master Project: Considering the interface of the competent authorities and THSRC, the whole project is monitored by the Master Project. It will be authorized to manage and manifest problems of the project.
- (2) Subproject: Corresponding to level 3 of WBS structure as mentioned in paragraph 5.1, subprojects are composed of independent procurement contracts and management tasks of different parties. Using the feature of subproject in P3, subprojects can be controlled by respective contractors. See Figure 5.2 for Tree Directory for Project and Subproject.

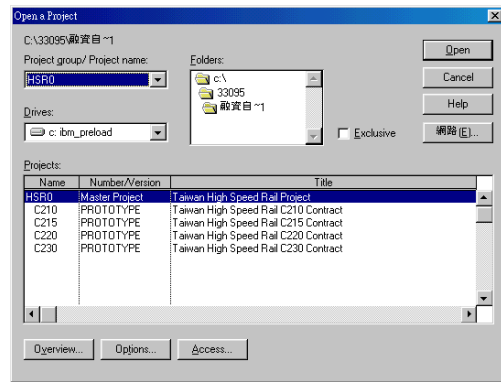


Figure 5.2 Tree Directory for Project and Subproject

- (3) WBS Structure: For easy linkage of project structure and subproject's management system, WBS structure is planned in a simplified manner. The First level corresponds to subprojects and second level deals with Price Centers. See Figure 5.3.

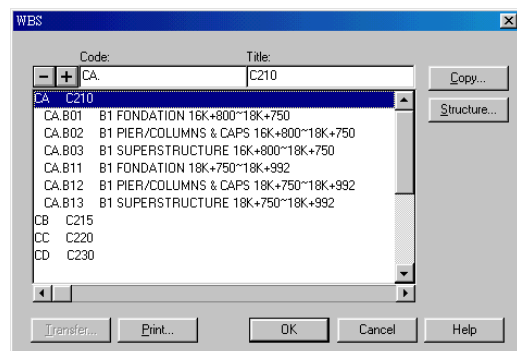


Figure 5.3 Designed WBS Structure in P3

- (4) Activity: There are two kinds of activities in a Price Center. One is equal to price center planned in WBS structure, called Price Center activity. It is the major item for supervision and management. The other is Milestone activity. This is a no duration activity for controlling the schedule and reflecting the completion of work within each Price Center.

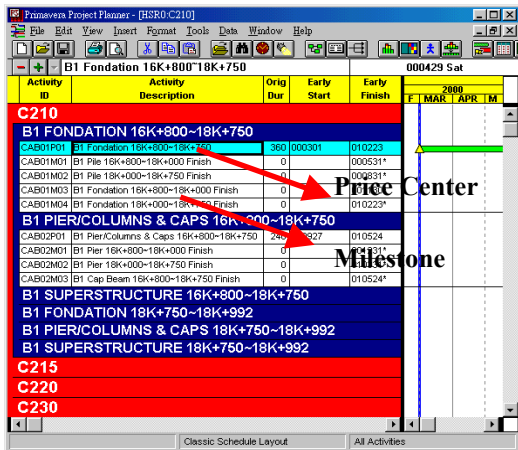


Figure 5.4 Designed Activities in P3

- (5) Resource: For Civil contract, there is no resource for Milestone activity, but Price Center activity has a one-to-one resource. It links with IPS for progress calculation purpose. For Core System contract, on the contrary, there is no resource for Price Center activity, but Milestone activity has a one-to-one resource.

5.3 Progress Calculation Method

When it comes to calculating schedule, it takes thousands of superintendents on site checking in such a large project. Also will be many disputes concerning how many progresses updated to date. Therefore the payment system of THSRC is transferred into the scheduling system, called 0% vs. 100% system. First, before achieving Milestone activity, the monthly progress is equal to the estimated progress at the same month no matter whether it is delayed, on schedule or beyond schedule. Second, when the progress reaches a Milestone activity, there are two conditions. One is the Milestone is accomplished, the monthly progress becomes the estimated progress; the other is the Milestone is not accomplished, the monthly progress is equal to zero. See illustration in Figure 5.5.

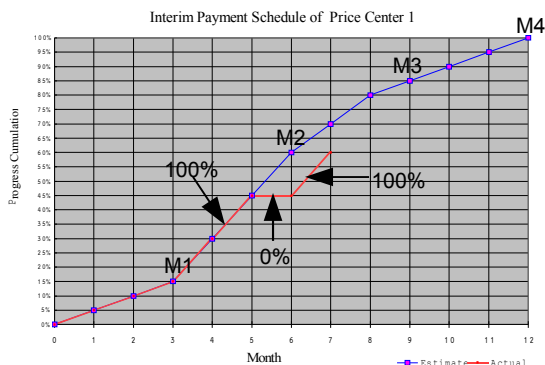


Figure 5.5 0% vs. 100% system

5.4 Automatic Schedule Updating

When the 0% vs. 100% system is adopted, the progress updating becomes easier. Site Engineer just collects information on milestone, and transfers it to headquarters via E-mail. This new automatic procedure saves much works in collecting and dealing with the information required for updating the schedule. The procedure is shown as Figure 5.6 and detail steps are described below.

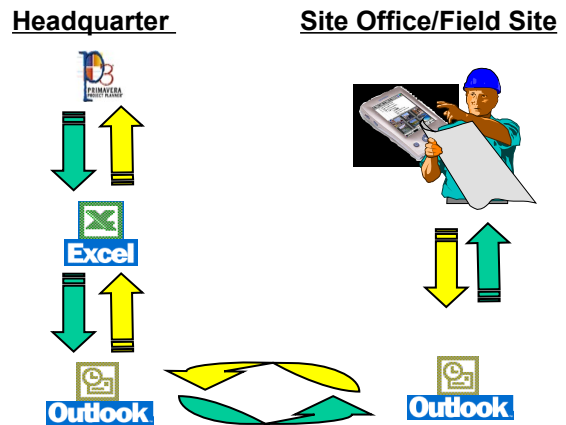


Figure 5.6 Automatic Schedule Updating Procedure

- (1) Set up project in P3: Setup a master project in p3 and transfer individual projects into subproject to constitute an integrated project.
- (2) Send activities for updating: Use P3's Send Mail feature to create selected activities from project and send to site engineers who are not equipped with P3 software.
- (3) Transfer P3 Format, PRD, to TXT Format: Before sending selected activities to site engineer, it is better transferred P3 PRD format to PDA readable format, TXT format. MS EXCEL is chosen for transferring software, because PRD format is similar to EXCEL format. The procedure on site is simplified and the headquarters will take care of the jobs for site engineers.
- (4) Mail the TXT file to Site Engineers.
- (5) Connecting PDA and PC on site office: When site engineer receives activities from the headquarters for updating, he should save the file into PC synchronic directory, then connects PDA to the cradle, which in turn connects to the back of PC. This allows site engineer to update the

information between PDA and computer by using synchronizing technology.

- (6) Site Engineer carries PDA to field site to record new data.
- (7) Site Engineer connects PDA to the PC cradle again. It will update the information in the synchronic directory of computer automatically.
- (8) Using E-mail system, Site office sends the updated information to headquarters.
- (9) Headquarters use MS EXCEL to open the updated activities from site office and save them to the original P3 PRD file.
- (10) Updating in P3: Use P3 Receive Mail feature to merge updated activities into project in P3.

6. CONCLUSION

A successful automatic project control system not only apply new advanced equipment and program for computerizing, but also takes the whole system into consideration, including tender document, contractor's management system, supervision system, etc. Keeping the whole system in mind, a convenient way of construction schedule control can be transferred to achieve the automatic goal.