Summary Report 1262-1S
July 1993

CONSTRUCTION CONTRACT TIME DETERMINATION(CTDS): NEW MANUAL AND COMPUTERIZED PROCEDURES

PROBLEM STATEMENT

In the fall of 1991, the Federal Highway Administration (FHWA) mandated that all state departments of transportation must have a formal method of establishing contract completion time for all federally-funded highway construction projects. These requirements came in the wake of increasing disputes between the Texas Department of Transportation (TxDOT) and contractors cited for liquidated damages which, they claim, were caused by TxDOT delays. Districts had normally relied, as had most states, on the experience of their senior engineers to set contract duration, with most of the scheduling based on simple prediction techniques or standard production rate bar charts. With the growth of specialized consulting firms who assist contractors and their lawyers in recreating construction schedules that reveal their view of actual job performance, and ultimately, what caused delays, the traditional TxDOT methods often did not hold up. Thus, when FHWA orders came out, the Texas Department of Transportation (TxDOT) had already initiated research in this area.

OBJECTIVES

The Texas Transportation Institute (TTI) conducted study 1262, *Procedures and Data for Determining Project Completion Times*, in cooperation with TxDOT and the Federal Highway Administration to develop a rational procedure (manual and computerized) for determining contract duration and completion dates on different types of highway construction projects. Specifically, the goal was to develop a conceptual Contract Time Determination System (CTDS) that would be

- flexible to accomodate TxDOT's wide range of projects and conditions,
- easily modified and updated,
- based on production rates and work quantities that are common to TxDOT projects, and
- user-friendly, logical, and defensible in contract disputes and litigation proceedings.

Researchers were working toward a *conceptual* scheduling

system, rather than a detailed job schedule, because TxDOT needs only to establish a reasonable period of time to allow for the contract. The *contractor* must develop the *details* of the construction schedule, which encompasses many activities and is highly dependent on the methods and resources used.

Production rate data and any information on determining contract time was requested from all state DOTs, all TxDOT Districts, and 50 major contractors doing work for TxDOT. Twelve DOTs supplied detailed production data, TxDOT Districts provided thirty-five useful responses, and only one contractor gave a full response. Using this information, TTI produced the TxDOT Contract Time Determination System (CTDS) so that schedulers can more logically predict exactly how much time individual construction projects will take.

FINDINGS

Development of the System

Researchers first had to select a project classification system. This places the construction contract into a highway project category. For example, are you widening a freeway, replacing a bridge, or simply laying a seal coat? The system selected is already used for TxDOT's design project management system and allows fourteen categories of highway projects. The miscellaneous category was eliminated for the CTDS, giving it a total of thirteen project categories (see Table 1). Each category then had to be assigned major work items and their relationships to each other. For example, if a freeway is being widened, one of the major work items will be the right-of-way preparation, which will involve such activities as clearing the site, removing old pavement, excavating the earth, excavating the rock, and embankment (placing and compacting the soil). Each one of these acitivities must be complete or partially complete before other work items can be started, so for each work activity, researchers assigned a percentage of the *preceding* activity that must be finished before beginning. For instance, in the category above "Widen Freeway," detour set-up must be 100% complete before right of way preparation can begin.

The 14 Categories of TxDOT Highway Projects

1. SC
Seal Coat

2. OV
Overlay

3. RER
Rehabilitate Existing Road

4. CNF
Convert Non-Freeway to Freeway

5. WF
Widen Freeway

6. WNF
Widen Non-Freeway

7. NLF
New Location Freeway

8. NNF
New Location Non-Freeway

9. INC
Interchange

10. BWR
Bridge Widening/Rehab

11. BR
Bridge Replacement

12. UPG
Upgrade Freeway to Standards

13. UGN
Upgrade Non-Freeway to Standards

14. MSC
Miscellaneous Construction

The initial production rate data collected from the TxDOT Districts was used to calculate base production rates (time assignments) for each major work item in the CTDS. Production rates for construction are difficult to standardize. Because of the many variables such as location, weather, labor conditions, site conditions, traffic, and state of the economy, there are an infinite number of possible work times for every work item in a project. Therefore, researchers incorporated into the system the ability for districts to substitute their own data with the standard rates (time assignments), or to select project specific rates. Production rate adjustments for this conceptual CTDS are based on five common work condition factors that impact most construction projects–location, traffic conditions, complexity, soil conditions, and quantity of work. The user can also modify the condition factors if the defaults do not seem appropriate for a specific job item that needs adjustment.

Researchers also had to select the basic scheduling technique. Which is better?–a table or curve based on time versus cost, a bar chart with or without production rates, the more sophisticated, detailed Critical Path Method, or simpy the judgement of senior personnel? After analyzing the district and DOT questionnaire data, bar charts were selected for TxDOT's conceptual CTDS be-

cause of their familiarity and the ease in development training.

Finally, for the computerized system, the following software packages were selected:

Superproject, version 2.0 (to convert bar chart data into a CPM schedule, and because it has a very good bar chart system already used in other components of TxDOT's Pre-Construction Management System)

Lotus 1-2-3, version 2.0 (to handle the storage and manipulation of productivity data, and because it is a common database/speadsheet system), and

Flash-Up, version 3.05 (to allow Lotus and Superproject to communicate, and because it is already used in the existing design project management system).

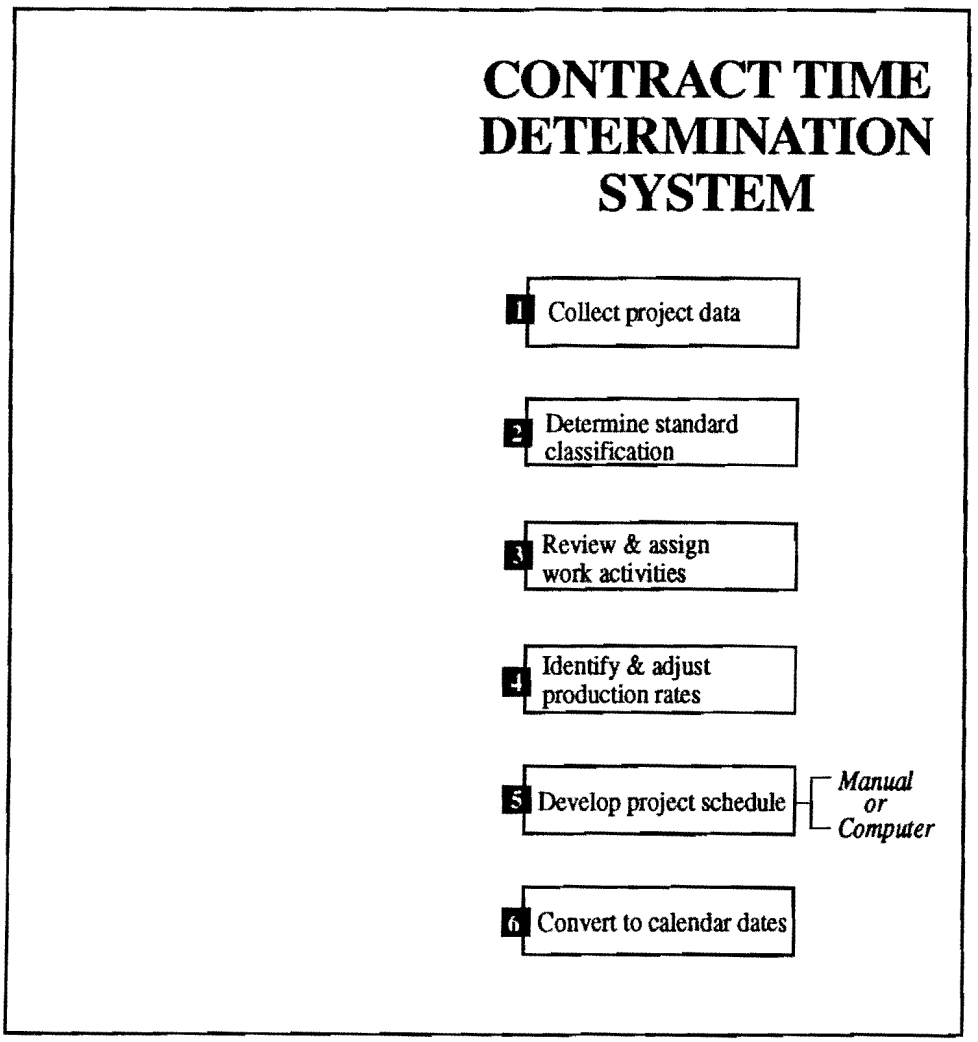
Using the Basic Conceptual Scheduling Procedure (CTDS)

The procedures are the same for manual and computer systems except for steps five and six. Figure 1 shows the basic steps. Schedulers must first examine any available information about the specific project, such as design drawings, specifications, quantity take-offs, construction site conditions, etc. This step is important because details and special conditions might effect the overall project duration. Following the second step–selection of a project classification from TxDOT's already established thirteen highway project categories–the scheduler will have a standard schedule with pre-established work activities and production rates. He or she must then determine if there are any work acitivities that need to be added or removed for the particular project. If special activities are added, appropriate sequencing relationships and overlap information must be included. If the project requires phasing, then work activities should be identified for each phase of the project and the phases linked sequentially as they are to be built in the field.

The last step before the actual scheduling, is to check the standard production rates for the work activities. Here the scheduler must draw from experience in deciding whether or not the rates are realistic for the particular project being estimated. If the scheduler is not satisfied with any of the standard production rates, preferred rates should be used. Also, he or she can make necessary adjustments using the five correction factors.

The last two steps of the basic procedure–developing the project schedule and converting to calendar dates–can be done manually or with the computer system developed. TTI research report 1262-1F contains detailed instuctions and documentation of both the manual and computerized processes. The computerized system should be more convenient for most projects.

Having obtained an estimate for the total project duration, the scheduler should check the number of working days assigned to see if the total appears reasonable. Depending on the project conditions and constraints, it might be feasible to reduce or add more time to allow for con-



tingencies. If the time period appears short, this should be noted, checked, and emphasized in the bid documents before going out for bids, so the bidders can plan accordingly. *The time should be emphasized, not presented as unreasonable.*

Once the final schedule has been determined, a bar chart or CPM diagram will be produced for the project files and for use by the project management team. Contractors should be required to submit their own detailed construction schedule for the project and should not use the conceptual schedule since it is only for setting a feasible contract time.

CONCLUSIONS

TxDOT has implemented the manual procedure as policy in the form of an administrative circular. Training sessions have started for selected division and district employees. The next step toward optimizing the study results is to obtain the software and computer equipment necessary for implementing the computerized procedure. Also, in order to narrow the standard production rate ranges, researchers recommend that district study teams review the standard work items and relationships, the proposed production rates for these items, and the optional job condition factors to see how they relate to the actual work environment. Modifications can then be made to the CTDS to make it more compatible.

The districts also need a mechanism to collect and synthesize production data from their construction projects, so they can regularly update and develop new individualized production rates and/or job condition factors for CTDS. Finally, large or complex projects cannot be standardized such as those in CTDS and must be handled by in-house personnel with construction planning and scheduling expertise or by consultants. Additional training for in-house personnel and additional computer software may be needed in these cases.

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The information in this summary is reported in detail in TTI Research Report 1262-1F, "Construction Contract Time Determination," Donn E. Hancher, William F. McFarland, and Rifat T. Alabay. The contents of the summary do not necessarily reflect the official views or policies of the FHWA or TxDOT.