Scheduling Specification for the Rehabilitation and Reconstruction of I-235

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ABSTRACT

On behalf of the Iowa Department of Transportation (Iowa DOT), Iowa State University has developed a review process to monitor contractor compliance with the Iowa DOT construction scheduling specification. The process also involved review of schedule updates in comparison to actual work performed. Records of the reviews and project progress photos have been retained using a redundant system of both hard copies and electronic backup files. Specifically, the system has been implemented on the I-235 corridor reconstruction project stretching from the downtown Des Moines area to the north I-35/I-80/I-235 system interchange. This paper provides a case study that focuses on a project having a contract value of approximately $93 million and that is being constructed under an average traffic volume of between 115,000 and 120,000 vehicles per day in peak traffic areas. The paper presents a detailed description of the schedule review system, a discussion on the lessons learned from the implementation of the system, and recommendations for those who may need to institute a similar system in the future.

Key words: construction—I-235—Iowa Department of Transportation—specification compliance—schedule
INTRODUCTION

On October 25, 2005, the Iowa Department of Transportation (Iowa DOT) let its largest contract to date in the amount of $93,118,005.65. It was let as several tied or combined projects, with IM-NHS-235-2(269)7 – 03-77 designated as the prime project. Herein, the project is referenced as (269), the short version of the project number used by most project participants. The objective of (269) was to reconstruct I-235 from Cottage Grove Avenue to East 16th Street in Des Moines, Iowa. The magnitude and visibility of the project prompted the Iowa DOT to develop a Special Provisions for Progress Schedule by Critical Path Method (SPEC), which amends the Standard Specifications, Series 2001. The SPEC states, “The contractor shall submit a progress schedule of construction activities based on the critical path method (CPM) of scheduling….The CPM progress schedule shall be used for coordination and monitoring of all work under the contract, including all activities of subcontractors, vendors, and suppliers. The Engineer will review the CPM progress schedule and forward comments to the contractor” (Iowa DOT 2005).

The Iowa DOT contracted Iowa State University (ISU) to review contractor compliance with scheduling specification and to offer assistance. The SPEC states, “The Engineer’s review comments will neither bind the Contracting Authority nor constitute acceptance of any portion of the schedule” (Iowa DOT 2005). Throughout the duration of the contract, ISU has reviewed the contractor-submitted schedules, compared the schedules with actual progress in the field, and attended regular meetings where scheduling issues were discussed. ISU has developed recommendations for an efficient SPEC compliance review system.

THE I-235 CORRIDOR RECONSTRUCTION PROJECT

The (269) project was part of a multiyear, multiple contract effort to rebuild the entire I-235 corridor through the Des Moines metro area. The corridor includes 13.83 miles of freeway from the east system interchange of I-80/I-35/I-235 to the west system interchange of I-80/I-35/I-235 through the heart of Des Moines, Iowa (Figure 1). From 2002 to 2007, contracts for approximately $429 million of construction will have been completed in this area (Iowa DOT 2007a). Work consisted of the rehabilitation and reconstruction of numerous utilities, bridges, and miles of interstate paving, all of which were constructed under traffic. Currently the estimated traffic count is 115,000 to 120,000 vehicles per day. The purpose of the corridor reconstruction project is to “improve safety, update the facility to current roadway design standards, reduce congestion, and improve mobility” (Iowa DOT 2007b).
SCHEDULE SPECIFICATION

Formal scheduling efforts with the assistance of ISU started in 1999, when a program-level schedule was developed for the entire I-235 corridor (Chen, Jahren, and Canales 2003). The program-level schedule provided information on each construction contract and each major utility conflict as separate activities. Logical relationships between these activities and a schedule were also provided. This process was helpful because it identified projects that were critical for the timely completion of the entire corridor. When such projects were identified, the Iowa DOT took several actions to ensure that the project completion did not delay corridor completion. Possible actions included starting the project early in the corridor reconstruction process, budgeting to accommodate appropriate bids for a tightly scheduled project, and setting up incentive/disincentive schemes. From 2000 to 2005, project-level schedules for each contract were provided by the contractor and reviewed by the Iowa DOT according to Section 1110 of the Iowa DOT Standard Specifications (e.g., see GS 1101, 2006).

Currently, the Iowa DOT funds approximately $400 million of highway construction per year. This is generally made up of small, rural, standardized projects that are familiar to the construction industry and the Iowa DOT. For routine projects such as these, the risk and consequences of a poor schedule is less in comparison to a large, urban, unique project. The (269) project was sufficiently large enough to possibly draw out-of-state contractors to bid on the project. Therefore, (269) was going to be either constructed by an in-state contractor who had never taken on a project of this magnitude or an out-of-state contractor who was not familiar with Iowa DOT business practices. In either case, a higher degree of project-level scheduling in comparison to past projects was deemed appropriate to ensure smooth and timely progress on the schedule. In addition, (269) had an incentive of $70,000 per calendar day, up to a maximum of $2.1 million for 30 days prior to the final completion date, and a disincentive of $30,000 per calendar day beyond the final completion date.

In addition to the (269) project, other projects were concurrently under construction along the I-235 corridor that had similar levels of importance and that were also conducted under the SPEC. In order to provide focus for this paper, the authors primarily refer to the (269) project. However, it is worth noting that the other important projects existed, because concurrent execution of several critical projects was part of the rationale for using SPEC.
The SPEC states, “The contractor shall submit a progress schedule of construction activities based on the critical path method (CPM) of scheduling….The CPM progress schedule shall be used for coordination and monitoring of all work under the contract, including all activities of subcontractors, vendors, and suppliers. The CPM progress schedule shall include provisions for traffic control, staging, and other events necessary to complete all work involved in the contract. This schedule shall be the Contractor’s intended working schedule and shall be used to plan, organize, and execute the work; record and report actual performance and progress; and forecast remaining work” (Iowa DOT 2005).

After the contractor has turned in a progress schedule, “the engineer will review the CPM progress schedule and forward comments to the contractor within 7 calendar days” (Iowa DOT 2005). The contractor was thus required to develop a computer-generated schedule displaying the following: activity descriptions, durations, dollar values, major crews, and equipment for each activity. In addition, a cost curve showing cumulative expected progress payments vs. time was required.

The CPM progress schedule was also used in construction operations. The contractor was required to “conduct weekly job site meetings with the Engineer to verify CPM progress schedule accuracy” (Iowa DOT 2005). Furthermore, the contractor was required to update the schedule as required, which was determined to be every other week, to reflect the actual progress of work.

REVIEW SYSTEM

The duty of ISU was to develop a system to review contractor compliance with regard to the SPEC. This was accomplished by reviewing the schedule, conducting weekly field visits to compare actual progress with scheduled progress, and attending weekly meetings to coordinate activities. Other services included taking weekly progress photos, providing data backup, and maintaining a project website that was available to the contractor, subcontractor, and Iowa DOT.

Specification Compliance of Schedule

During the initial stages of schedule development, ISU reviewed schedule submissions as the contractor worked to develop a baseline schedule (Figure 2). For each version of the pre-baseline schedule submitted, ISU completed a schedule review checklist (Figure 3). The completed schedule checklist was submitted to the Iowa DOT’s Resident Construction Engineer and the contractor’s project scheduler. In an iterative process, the schedule was revised until it reached compliance with the SPEC, at which point it was accepted as the “baseline” schedule. According to Hinze (2004), “The baseline schedule provides a measuring stick for comparing the as-built schedule. It is used not only as a management tool for determining the accuracy of planning efforts, but also as a basis for any construction delay claims.” The contractor’s project scheduler would then provide schedule updates, typically on a biweekly basis.
Contractors sometime submit post-bid value engineering (VE) proposals to the Iowa DOT in accordance with GS 1105.15 (Iowa DOT 2006). During the process of construction, delays and setbacks are very common. If a VE proposal was submitted, or if a delay or setback occurred, ISU would review the schedule impacts and provide comments. This was helpful for the Iowa DOT when it was necessary to obtain approvals for the changes.
Table 3. I-235 schedule checklist

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<tr>
<th>Item</th>
<th>Y or N</th>
<th>Comments</th>
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<td>Shop drawing submittal &amp; approval</td>
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<td>Fabrication activity</td>
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<td>Responsibility</td>
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<td>Early Start</td>
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<td>Predecessors</td>
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<td>Successors</td>
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<td>Expected Payment, Time curve</td>
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<td>Less than 10 days float</td>
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<td>Work Days, shifts &amp; hours</td>
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<td>Major crane (equipment and # of workers)</td>
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</tbody>
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Reviewed by: ____________________________  (print name)

Date reviewed: _______  Signature: _______  (signature or name)

Weekly Field Visits

After the “baseline” schedule was accepted and a schedule update was submitted, an ISU team member visited the construction site weekly to perform crew checks on critical activities. This was done to compare as-planned crew sizes to observed crew sizes. Additionally, the progress of the work was checked by comparing the updated schedule to the observed progress. A field verification sheet was developed to streamline this process (Figure 4); it was submitted to the Iowa DOT’s Resident Construction Engineer weekly.
During the weekly field visits, digital progress photos of multiple areas of construction along I-235 were taken to document the progress of work in each area. These photos were submitted via CD-ROM to the Iowa DOT’s Resident Construction Engineer on a monthly basis and were utilized on the project website. Photos were also taken prior to and at the end of each phase of construction, where disincentives might be assessed.

Weekly Progress Meetings

The Iowa DOT conducted weekly progress meetings with contractors and subcontractors involved in the I-235 project. ISU attended each progress meeting and offered comments on the schedule. The meeting served as a time for ISU to exchange compiled data with the Iowa DOT and receive schedule updates from the contractors. The weekly progress meetings allowed all participants to become better informed of the following: traffic, utility, and environmental impacts and any contract modifications, change orders, extra work, and activities happening in and around Des Moines that could impact the project.
Data Backup

All project information obtained by ISU including the following: plan sets, staging scrolls, specifications, schedules, meeting minutes, progress photos, schedule reviews, field reviews, and any correspondence between ISU, the Iowa DOT, or the contractors. This information was backed up electronically every week and was stored in hard copy format immediately. Hard copies and electronic copies are stored in separate areas of the building in case of fire. The redundant backup system has been in place since October of 2005.

Project Website

ISU has developed and maintained a secure website for multiple projects of the I-235 project (ISU 2007). The website was password-protected to allow access only to project personnel. The website has been updated on a weekly basis and contains the following information: preliminary schedules, baseline schedule, schedule updates, project contact information, plan sets, staging scrolls, specifications, addendum letters, progress photos, meeting minutes, and VE proposals. A screen shot of the project website is provided in Figure 5.

![Figure 5. Screen shot of project website](image)

STAKEHOLDER INTERVIEWS

During June 2007, the second author conducted interviews with project participants to obtain information about how the schedules were used, what parts of the scheduling process went well, and what parts could be improved. The results are still being analyzed. However, the following preliminary observations can be shared at this writing:
The schedule was used primarily by higher level managers for the Iowa DOT, prime contractors, and major subcontractors.

Most respondents reported the following:

- A more complete planning effort was undertaken with greater communication amongst stakeholders as a result of applying the SPEC to this project.
- Including the schedule as an agenda item in the weekly progress meetings encouraged effective communication and problem solving on scheduling issues.

Iowa DOT respondents indicated the following:

- The schedules allowed them to quickly and confidently respond to questions on the schedule from public officials, utility companies, and concerned citizens. It was especially helpful for providing updates to and answering questions from upper level managers.
- The process of schedule updating encouraged contractors to reexamine and refine their plans on a regular basis.
- The information from the schedule provided justification in an efficient manner to obtain necessary approvals for contractor-generated VE proposals.

Contractors reported that the schedule provided a basis for agreements amongst subcontractors on when to work overtime and extra shifts in order to meet schedule commitments.

It was challenging to develop agreements regarding the amount of detail necessary and how to represent logical relationships, especially the first time that a contractor group submits a schedule to the Iowa DOT. Maintaining the balance between providing required information to the contracting agency and allowing the contractors to use their own means and methods for planning and scheduling required considerable effort.

Some scheduling tasks that were perceived as useful to the Iowa DOT were not perceived as useful by the contractors

Some scheduling tasks that were contemplated as necessary and useful at the beginning of the project turned out to have limited usefulness during the project.

RECOMMENDATIONS

The knowledge gained by project participants in using this scheduling process may be used by others wishing to implement a similar system on future projects. Based on the experiences described in this paper, the following recommendations are made:

- Continue to use the SPEC on challenging projects where schedule compliance, coordination, and stakeholder communications are deemed especially important.
- Prioritize tasks required by the specification in terms of benefits to project stakeholders and consider adding or deleting tasks. On future project, modify the specification according to the needs of the project.
- Plan to expend considerable effort at the beginning of the scheduling effort to communicate contracting agencies’ needs and contractors’ preferences regarding the scheduling effort.
- Develop standard procedures to monitor scheduling efforts and retain records or refine the ones described in this paper.
ACKNOWLEDGMENTS

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REFERENCES


