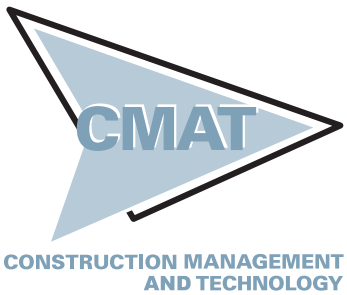
A Comparison of Department of Transportation Progress Scheduling Specifications from Across the Nation

Final Report
February 2024



IOWA STATE UNIVERSITY
Institute for Transportation

Sponsored by
Federal Highway Administration
Iowa Department of Transportation
(InTrans Project 22-822)

About the Construction Management and Technology Program

The mission of the Construction Management and Technology (CMAT) program is to improve the efficiency and cost-effectiveness of planning, designing, constructing, and operating transportation facilities through innovative construction processes and technologies.

About the Institute for Transportation

The mission of the Institute for Transportation (InTrans) at Iowa State University is to save lives and improve economic vitality through discovery, research innovation, outreach, and the implementation of bold ideas.

Iowa State University Nondiscrimination Statement

Iowa State University does not discriminate on the basis of race, color, age, ethnicity, religion, national origin, pregnancy, sexual orientation, gender identity, genetic information, sex, marital status, disability, or status as a US veteran. Inquiries regarding nondiscrimination policies may be directed to the Office of Equal Opportunity, 3410 Beardshear Hall, 515 Morrill Road, Ames, Iowa 50011, telephone: 515–294–7612, hotline: 515–294–1222, email: eooffice@iastate.edu.

Disclaimer Notice

The contents of this document reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the sponsors.

The sponsors assume no liability for the contents or use of the information contained in this document. This report does not constitute a standard, specification, or regulation.

The sponsors do not endorse products or manufacturers. Any trademarks or manufacturers' names appear only because they are considered essential to the objective of the document.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. The FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Iowa DOT Statements

Federal and state laws prohibit employment and/or public accommodation discrimination on the basis of age, color, creed, disability, gender identity, national origin, pregnancy, race, religion, sex, sexual orientation or veteran's status. If you believe you have been discriminated against, please contact the Iowa Civil Rights Commission at 800-457-4416 or the Iowa Department of Transportation affirmative action officer. If you need accommodations because of a disability to access the Iowa Department of Transportation's services, contact the agency's affirmative action officer at 800-262-0003.

The preparation of this report was financed in part through funds provided by the Iowa Department of Transportation through its "Second Revised Agreement for the Management of Research Conducted by Iowa State University for the Iowa Department of Transportation" and its amendments.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Iowa Department of Transportation or the U.S. Department of Transportation Federal Highway Administration.

Technical Report Documentation Page

1. Report No. InTrans Project 22-822	**2. Government Accession No.**	**3. Recipient's Catalog No.**	
4. Title A Comparison of Department of Transportation Progress Scheduling Specifications from Across the Nation		**5. Report Date** February 2024 6. Performing Organization Code	
7. Author(s) Jennifer S. Shane (orcid.org/0000-0002-2612-4269), Andrew Gatto (orcid.org/ 0009-0005-1696-7261), and Kelly Strong (orcid.org/ 0009-0008-5138-5162)		**8. Performing Organization Report No.** InTrans Project 22-822	
9. Performing Organization Name and Address Institute for Transportation Iowa State University 2711 South Loop Drive, Suite 4700 Ames, IA 50010-8664		**10. Work Unit No. (TRAIS)** **11. Contract or Grant No.**	
12. Sponsoring Organization Name and Address Iowa Department of Transportation 800 Lincoln Way Ames, IA 50010 Federal Highway Administration 1200 New Jersey Avenue, SE Washington, DC 20590		**13. Type of Report and Period Covered** Final Report **14. Sponsoring Agency Code** SPR-RE23(009)-8H-00	
15. Supplementary Notes Visit https://intrans.iastate.edu for color pdfs of this and other research reports.			
16. Abstract One of the primary determinants of project success is completion of the project on or ahead of schedule. Owners therefore pay a great deal of attention to schedule progress and timely project completion. This holds true especially for departments of transportation (DOTs), each of which adheres to its own specification requirements for progress scheduling. This project conducted a comparative analysis highlighting the similarities and differences among the specification requirements of multiple state DOTs, including topics such as definitions, float ownership, software requirements, differentiation of project levels/complexity, progress narratives, preliminary schedules, schedule updates, review and resubmit durations, and as-built schedule development. Preliminary findings indicate that requirements for the use of proprietary scheduling software (e.g., Primavera P6) and the use of cost-loaded critical path method (CPM) schedules for payment purposes are potential sources of conflict between the contracting community and DOTs. Researchers can use the findings from this research to assist DOTs in developing specifications that support the DOT's mission but that are not burdensome to project management and the contracting industry.			
17. Key Words progress scheduling specifications—project scheduling methods—scheduling software—state department of transportation specifications		**18. Distribution Statement** No restrictions.	
19. Security Classification (of this report) Unclassified.	**20. Security Classification (of this page)** Unclassified.	**21. No. of Pages** 31	**22. Price** NA

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

A COMPARISON OF DEPARTMENT OF TRANSPORTATION PROGRESS SCHEDULING SPECIFICATIONS FROM ACROSS THE NATION

Final Report
February 2024

Principal Investigator
Jennifer S. Shane, Ph.D.
Institute for Transportation, Iowa State University

Co-Principal Investigator
Kelly Strong, Ph.D.
Institute for Transportation, Iowa State University

Research Assistant
Andrew Gatto

Authors
Jennifer S. Shane, Andrew Gatto, and Kelly Strong

Sponsored by
Iowa Department of Transportation

Preparation of this report was financed in part
through funds provided by the Iowa Department of Transportation
through its Research Management Agreement with the
Institute for Transportation
(InTrans Project 22-822)

A report from
Institute for Transportation
Iowa State University
2711 South Loop Drive, Suite 4700
Ames, IA 50010-8664
Phone: 515-294-8103 / Fax: 515-294-0467
https://intrans.iastate.edu

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGMENTS

The authors would like to acknowledge the Iowa Department of Transportation (DOT) for sponsoring this research and the Federal Highway Administration (FHWA) for state planning and research (SPR) funds used for this project.

EXECUTIVE SUMMARY

The successful completion of projects on or even ahead of schedule is an important factor in project success, commanding the unwavering attention of project owners across various industries. This holds true especially for departments of transportation (DOTs). Each DOT adheres to its own unique set of specification requirements for progress scheduling, shaping the landscape of project management within its jurisdiction.

This report presents a comparative analysis highlighting the similarities and differences among the specification requirements of multiple state DOTs, encompassing critical topics such as definitions, float ownership, software utilization, distinctions among project levels/complexity, progress narratives, preliminary schedules, schedule updates, review and resubmit durations, and the pivotal as-built schedule development process.

The central objective of this research was to provide support to the Iowa DOT in revising specifications that meet its core mission objectives while maintaining practicality and efficiency in project management and for the contracting industry. Early findings from the investigation illuminate two noteworthy areas of potential conflict between the contracting community and DOTs: requirements for the use of proprietary scheduling software, such as Primavera P6, and the use of cost-loaded critical path method (CPM) schedules for payment purposes.

This report offers a glimpse into the intricate landscape of multiple state DOTs' specification requirements, serving as a foundation for further exploration and resolution of challenges within the project management and contracting spheres. By fostering alignment and clarity in these critical areas, DOTs can not only achieve their missions but also bolster collaboration and understanding within the industry, ultimately enhancing project success.

INTRODUCTION

Section 1110 of the Iowa Department of Transportation (DOT) *Standard Specifications for Highway and Bridge Construction* describes the progress scheduling requirements for the contractor (Iowa DOT 2018). Currently, the specification is written prescriptively to favor high-end project enterprise software such as Primavera P6 by Oracle. This is problematic because many contractors and the Iowa DOT do not have expertise in Primavera, nor do they have site licenses for the software. As a result, contractors often must hire scheduling consultants with expertise in and access to expensive scheduling software, and the Iowa DOT must hire consultants to review and comment on the critical path method (CPM) schedules submitted by the contractor. The existing progress scheduling specification results in a system where most contractors and the Iowa DOT cannot even open the schedule files because they do not have licenses for the software used to create them.

Additionally, the current Iowa specification requires the contractor to provide a very high level of detail in each schedule, perhaps more than is needed for effective control of many projects. The high level of detail may be adding time and cost associated with creating the schedule without adding benefit in the form of risk mitigation or schedule control. The same is true for the cash flow projections submitted by contractors. The current Iowa specification requires the contractor to provide units and related costs for every activity in the schedule. Requiring such a high level of resource loading in the schedule is likely to drive up prices due to the increased number of consultant hours required to add unit and cost details for activities that represent a small percentage of the overall project costs. Assuming the Pareto principle holds true, that 20% of work items account for 80% of project costs, scheduling consultants are spending billable hours adding unit and cost information for the 80% of project activities that reflect only 20% of the project costs. The costs of creating cash flow projections can be reduced while still providing relatively accurate cash flow estimates. Simplifying cash flow projections can also make payment schedules tied to CPM schedules much easier for contractors to manage.

Iowa is not the only state facing this challenge. Other states are in a similar situation, and several states have adopted graduated scheduling specifications in an attempt to achieve a good balance between project control, effective risk management, and value-added project cost.

The central objective of this research was to support the Iowa DOT in revising project scheduling specifications that meet its core mission objectives while maintaining practicality and efficiency in project management and for the contracting industry. To achieve this objective, a comparative analysis highlighting the similarities and differences among the specification requirements of multiple state DOTs was conducted. The analysis encompassed critical topics such as definition, float ownership, software utilization, distinctions among project levels/complexity, progress narratives, preliminary schedules, schedule updates, review and resubmit durations, and the pivotal as-built schedule development process.

METHODOLOGY

The authors collected and conducted a content analysis of scheduling specification information from 11 state DOTs, including Alabama, California, Colorado, Idaho, Iowa, New Jersey, Ohio, Tennessee, Utah, Virginia, and Wisconsin. In reviewing the specifications, the authors made note of information regarding the following:

- Software requirements
- Whether definitions are provided as part of the specification
- Float ownership
- Whether levels of complexity are used
- Requirements regarding a project progress narrative
- Frequency of schedule updates
- When preliminary schedules are required
- Schedule requirements for the preconstruction meeting
- How long the DOT has to review the schedule and how long the contractor has to resubmit a schedule if the DOT requests modifications
- Whether a final schedule is required showing the actual as-built schedule

Some of these categories are similar to those used in a study by Gi Han et al. (2022), and some of the same states listed above were also included in that study. However, the present analysis considers additional criteria as well as additional states.

In addition to the content analysis, follow-up interviews were conducted with four states (New Jersey, Tennessee, Colorado, and Virginia) to discuss specific sections of the specifications in greater depth and to understand the actual implementation and usage of the written specifications.

COMPARISION OF SCHEDULING SPECIFICATIONS

Content Analysis

The genesis of this effort involved concerns about software requirements, specifically whether DOTs and the contracting community have access to the required scheduling software. Of the 11 specifications examined in the content analysis, 6 require the use of specific software, with most requiring Primavera P6 (see Table 1). Through follow-up interviews, it was found that some of the DOTs have had a similar experience to Iowa in that they do not have the in-house expertise or software licenses required to develop or review schedules developed in Primavera P6. Interview participants noted training a few DOT employees to become schedule masters, with a consultant hired to complete reviews and track progress.

Table 1. Scheduling specification content

State	Software	Definitions	Total Float Ownership	Levels of Projects	Project Progress Narrative
Alabama	Not specified	Not given	Shared	Two levels based on duration	Required
California	Primavera P6	Not given	Contractor must put an activity in for owner-owned float	Three levels based on bid and duration	Required
Colorado	Primavera P6 or Microsoft Project	Given	Shared	Not specified	Required
Idaho	Microsoft Project	Not given	Shared	Not specified	Required
Iowa	Not specified	Not given	Not specified	Not specified	Not specified
New Jersey	Primavera P6	Not given	Shared	Four levels based on project construction cost	Required
Ohio	Not specified	Not given	Not specified	Not specified	Not specified
Tennessee	Primavera P6	Not given	Shared	Not specified	Required
Utah	Primavera P6	Given	Shared	Not specified	Required
Virginia	Not specified	Not given	Not specified	Five levels based on project complexity	Required
Wisconsin	Not specified	Not given	Shared	Not specified	Required

One known area of contention between contractors and owners is float ownership. Many of the specifications examined state that float is shared. However, three do not specify float ownership. One state requires the contractor to include an activity for owner-owned float.

Some states require different types of schedules or different amounts of information in schedules for different types of projects. For example, Alabama requires bar graph schedules for projects

that “have a contract time in excess of 90 working days or 180 calendar days” and CPM schedules for projects that “have a contract time in excess of 180 working days or 360 calendar days” (ALDOT 2022). New Jersey defines project levels based on project construction costs, with groupings of less than $5 million, $5 to $15 million, $15 to $40 million, and greater than $40 million (NJDOT 2019). Caltrans (2018) provides different schedule types and progress monitoring requirements based on a combination of bid amount and number of working days. Virginia uses five categories, with different types and amounts of required detail based on project complexity. For example, a single-page bar chart and executive summary are required for basic, short-duration, “straightforward operations.” A moderately complex project, one that spans more than one construction season, requires a CPM schedule. The most complex projects are larger, urban-setting projects, or a program of projects, and require cost- and resource-loaded CPM schedules (Hildreth 2006).

There are varying requirements as to when a preliminary schedule should be provided and the frequency of updates (see Table 2). When specified, the preliminary schedule is often due in relation to either the preconstruction meeting or contract execution. Updates are primarily due monthly to avoid overburdening the contractor with too many requirements and to allow for sufficient review and resubmit timeframes, which also vary by state. If updates are required too often, the schedule may need to be updated before the review and resubmit process for the previous schedule is complete.

Table 2. Schedule provision and update requirements

State	Updates	Preliminary Schedule	Preconstruction Meeting	Review and Resubmit Length	Final Schedule
Alabama	Depending on level. Bar graph level - Major change, time extension, at request of engineer. CPM level - Monthly	Required at preconstruction meeting	Yes	Review - 14 calendar days Resubmit - 7 calendar days	Required
California	Monthly for all levels	Required 10 days after contract approval to be discussed at preconstruction meeting	Yes	Review - 15 days Resubmit - Not specified	Required
Colorado	Monthly	Not specified	Yes	Review - 10 days Resubmit - 10 days	Not specified
Idaho	Monthly	Required at or before preconstruction meeting	Yes	Review - 10 calendar days Resubmit - 10 calendar days	Required

State	Updates	Preliminary Schedule	Preconstruction Meeting	Review and Resubmit Length	Final Schedule
Iowa	Biweekly	Unclear if section 1110.02 is referring to preliminary schedule or updated schedules	Yes, but obscure wording is used	Unclear if section 1110.02 is referring to preliminary schedule or updated schedules	Not specified
New Jersey	First update typically 2 months after baseline approved, then each update at engineer's request.	Required within 15 days of contract execution. Length of preliminary schedule changes depend on size of project	Not specified	For preliminary schedule: Review - 14 days Resubmit - 7 days For schedule updates: Review - 14 days Resubmit - 14 days	Not specified
Ohio	At engineer's request	Required at or before preconstruction meeting	Yes	Review - 14 calendar days Resubmit - 10 calendar days	Not specified
Tennessee	Monthly	Required within 30 calendar days of contract award and have a length of 120 calendar days	Yes	Review - Not specified Resubmit - 14 days for baseline and 10 days for update	Not specified
Utah	Monthly	Required within 14 calendar days of notice to proceed and have a length of 60 days	Can be required	Review - 7 business days for preliminary and baseline, 5 business days for updates Resubmit - 7 business days for preliminary and baseline, 5 business days for updates	Not specified
Virginia	Monthly	Not specified	Yes	Review - 7 calendar days Resubmit - Not specified	Not specified
Wisconsin	Monthly	Bar chart schedule required at least 14 days before preconstruction meeting. CPM schedule required within 30 days after notice to proceed.	Yes	Review - 5 business days Resubmit - 5 business days	Not specified

Many states do not specify a requirement for an as-built or final schedule. This is unexpected given the fact that this schedule is what provides the production rate data that DOTs use to

develop their expected project duration schedules. DOTs do not have crews that perform this work and therefore rely on inspection logs and/or final schedules to develop the projected durations of projects.

Follow-Up Interviews

As previously discussed, interviews were conducted with four DOTs to gather further insight into the effectiveness of each state's scheduling specification. Highlights from each state that was interviewed are listed below.

New Jersey

- The New Jersey DOT (NJDOT) originally used Primavera P3 in-house, but when Oracle switched to P6, NJDOT had to hire a consultant to assist with scheduling.
- Projects above $2,000,000 require a P6 schedule, while all projects under $2,000,000 use a bar chart.
- NJDOT has had multiple complaints from contractors when contractors have been asked to provide a P6 schedule. Most contractors hire a consultant to help build their schedules.
- The engineer inspects the baseline schedule submitted by the contractor, then the engineer has the consultant review the schedule. At the preconstruction meeting, the schedule is reviewed with the contractor. Once the schedule is approved, construction can start.
- The P6 schedule is not resource or cost loaded, but NJDOT requires planned resources in the notes for each critical activity.

Tennessee

- The Tennessee DOT (TDOT) has provided training to several employees on how to use P6.
- TDOT has three tiers of projects. The lowest tier projects, those with a duration of less than 90 days, require no schedule, just a written plan. The middle tier projects, those with a 90-day to 24-month duration, require a bar chart. The highest tier projects, those with a duration of over 24 months, require a P6 schedule.
- Contractors have raised concerns about the use of P6 schedules. TDOT has addressed these concerns by adding a bid item for CPM schedules.

Colorado

- The Colorado DOT (CDOT) requires P6 schedules, and CDOT hires a consultant to review the schedules.
- CDOT expressed interest in moving away from requiring P6 schedules.
- Contractors and CDOT frequently disagree about what should be required for projects in terms of schedules.
- CDOT requires a written narrative for critical path or near-critical path activities.
- Estimated draw schedules are required every month for contractors to get paid.

Virginia

- The Virginia DOT (VDOT) uses three levels, similar to Tennessee. The lowest tier projects require a written plan. The middle tier projects require a bar chart. The highest tier projects require a CPM schedule.
- VDOT suggested the use of two to three levels for project tiers. These tiers should be based on complexity, duration, time impacts, and risk.

Discussion with Iowa Personnel

An in-person discussion was also held between the Iowa DOT personnel, contractors, and Institute for Transportation staff. Highlights from that meeting are as follows:

- Contractors emphasized that a key aspect of a project schedule should be an approved baseline that updates are based on.
- Contractors asked for tablet-friendly scheduling software as well as user-friendly software to allow for easier phasing.
- Contactors stated that Microsoft Project is user-friendly and can be incorporated into tablet-friendly software like Procore. However, some Iowa DOT employees do not believe that Microsoft Project is sophisticated enough for complex projects.
- Schedule updates should be monthly for all levels of complexity, and three-week lookahead schedules should be required at each project meeting for middle tier projects. Projects with the highest levels of complexity should also require monthly updates, with the updates required to include a recovery schedule or narrative if the project experiences significant delays or falls behind by two weeks. Seven days to review and seven days to revise the updated schedule should be the standard review and resubmit timeframes. Some revisions may not require resubmittal for lower tier projects.
- Contractors stated that they preferred draw schedules over cost-loaded schedules.
- The consensus was that there should be three tiers of projects, similar to Tennessee and Virginia. The lowest tier projects should only require a written narrative. The middle and highest tier projects should require a CPM schedule.
- The highest tier projects should require written resource requirements for critical path activities, but a full resource-loaded schedule should not be required.

DRAFT SCHEDULE SPECIFICATION

Based on the comparative analysis and discussions described in the previous chapter, a draft specification was developed and is presented in this chapter.

Definitions

Activity (Task) - A portion of the project that requires time or resources to complete. An activity has a description, start date, finish date, duration, and one or more logic ties. A critical activity is an activity on the Critical Path.

Activity ID - A unique, alphanumeric identification code assigned to an activity that remains constant throughout the project.

Baseline Schedule - The original, approved Project Schedule before the project begins with no progress.

Calendar - Defined Work periods and No-Work periods that determine when project activities can occur. Multiple calendars may be used.

Constraint - A restriction imposed in a schedule that fixes a value that would otherwise be calculated within the schedule. Examples of values that can be fixed by a constraint include start date, end date, completion date, and interim milestones.

Critical milestone - Milestones that are identified in the contract that are traffic critical.

Critical Path Method (CPM) Scheduling - A logic-based planning technique using activity durations and relationships between activities to calculate a schedule determining the minimum total project duration and the interdependencies of all activities.

Critical Path - The longest logical path through the CPM network, driven by calendars, constraints, and activity logic. It consists of activities that determine the shortest time for project completion and the sequence of activities such that a delay to any of the activities on the Critical Path will prolong contractual project milestones, such as project completion.

Data Date - The starting point from which to schedule all remaining Work. It can also be considered the cut-off date wherein all Work before this date has actual starts, actual finishes, or both.

Duration - The estimated amount of time needed to complete an activity.

Free Float (Free Slack) - The amount of time an activity can be delayed without delaying the Early Start or Early Finish of its successor activity or activities.

Gantt Chart - A time-scaled graphical display of the project's schedule.

Lag - A time value assigned to a relationship.

Logic - Relationships between activities defining the sequence of Work (See also predecessor activity and successor activity).

Milestone - An activity with zero duration used to represent an event.

Near-Critical Activity - An activity with a total float of five days or fewer, or as defined by the Engineer.

Open-Ended Activity - An activity that does not have a predecessor activity and a successor activity or that only has a start-to-start as a predecessor or finish-to-finish as a successor.

Planned Completion Date - The date that the schedule shows Work is planned to be completed.

Predecessor Activity - An activity that is defined by schedule logic to precede another activity.

Relationship - The interdependence between activities.

Successor Activity - An activity that is defined by schedule logic to follow another activity.

Time-Scaled Logic Diagram - Gantt chart that illustrates logic links depicting both schedule logic and the times at which activities are performed.

Total Float (Total Slack) - The amount of time between the earliest date an activity can start and the latest date an activity must start, or the earliest date an activity can finish and latest date an activity can finish before the activity causes a delay to the time specified in the Commencement and Completion of Work special provision.

Float

Float within the Baseline Schedule or any other Project Schedule is not for the exclusive use or benefit of either party but is a project resource available to both parties as needed until it is depleted. Do not use float suppression techniques, such as preferential sequencing (arranging the Critical Path through activities more susceptible to a Department-caused delay), special lead/lag logic restraints, zero total or free float constraints, extended activity times, manipulated calendars, or constraint dates other than as required by the Contract. Negative float may be shown, as long as it is not on the Critical Path.

Level 1

Level 1 projects are those that will span one or more seasons with straightforward operations. These projects have very few components. They are typically constructed in rural areas, where impacts to travel and commercial activity are negligible.

Schedule risks for Level 1 projects are minimal. Delay on the project and the resulting impacts are minimal. Typically, the only scheduling constraint will be fixed completion date.

Minimal scheduling submissions will be required for this type of project due to the limited risks associated with Level 1 projects. The submittals for Level 1 projects should include a plan of operation with sufficient detail to show the sequence and location of operations and the period of time required for completion of the portion of the Work under each item or group of like items. The Engineer will use a straight-line plot to determine progress. The baseline narrative should be submitted at the preconstruction meeting. The narrative should be updated at the Engineer's request. No as-built schedule will be required at the end of project. If the project is out of working days, the Engineer may request a plan of operations stating the manpower and general type of equipment required to handle the remaining Work.

Level 2

Level 2 projects are projects completed in two (2) or fewer seasons. These projects consist of a sizable number of components and pose a moderate amount of risk. The potential for delay is average or greater.

General

Ten days before the preconstruction meeting, submit a baseline bar chart to the Engineer for review. Submit a hard copy and an electronic copy in the native file format in which the bar chart was generated. The baseline bar chart progress schedule shall include the following:

1. Activities that describe the essential features of the Work, activities that might delay Contract completion, and controlling activities;

2. The planned start and completion dates for each activity, the duration of each activity in workdays, and the calendar (number of workdays per week, holidays, number of shifts per day, and number of hours per shift) as described in the narrative. No activity should have a duration greater than twenty (20) workdays, unless approved by the Engineer;

3. The sequencing of all activities, including predecessor(s) and successor(s). If scheduling software is used to create the bar chart schedule, submit related reports such as a predecessor and successor report, a sort by total float, and a sort by early start;

4. Dates related to the procurement of materials, equipment, and articles of special manufacture and dates related to the submission of working drawings, plans, and other data specified for review or approval by the Department;

5. Dates related to key Department inspections;

6. Dates related to specified activities by the Department and third parties; and

7. A schedule timeline broken down into weekly time periods with a vertical line to identify the first working day of each week.

Project Narrative

Include as part of the schedule a project narrative listing the following:

1. The quantity and estimated daily production rate for controlling activities;

2. A calendar describing the number of workdays per week, holidays, number of shifts per day, and number of hours per shift;

3. The planned number and types of crews;

4. Lists of Contractor's expected equipment, Subcontractors, and each Subcontractor's expected equipment; and

5. A number of anticipated adverse weather days for each month (for calendar day or completion date contracts). The Engineer and Contractor will review the draft Baseline Schedule at the preconstruction conference. The Engineer will accept the Baseline Schedule, provide review comments, or request additional information. Allow seven (7) days for the engineer to review the schedule. As necessary, make appropriate adjustments or provide additional information within seven (7) days. The Department may withhold payments until the Engineer accepts the Baseline Schedule. The Engineer's acceptance is based solely on whether the schedule meets the requirements of Section 1110. Review comments made by the Engineer on the Baseline Schedule will not relieve the Contractor from compliance with the Contract.

The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with Contract requirements. The cost of preparing and updating the schedule is incidental to all Contract items.

Updated Schedule

Conduct periodic project site meetings with the Engineer monthly or as required by the complexity of the Project to assess progress. Submit an updated schedule on a monthly basis. Include the actual start and finish of each activity, percentage complete, the original duration and remaining duration of activities started and ongoing, and a summary of schedule changes necessitated by changes to the Project directed by the Engineer or resulting from changes in the Contractor's planning or progress of the Work. Include with the monthly schedule update a cover letter that:

1. Identifies and explains any schedule revisions since the prior monthly update;

2. Includes a general description of the progress of the Work since the prior monthly update; and

3. Identifies any items of special interest.

The Engineer reserves the right to reject any such revisions. Submit the schedule updates to the Engineer for review within forty-eight (48) hours after the project site meeting. If the Contractor fails to provide monthly schedule updates by the stipulated due date, the Engineer may withhold up to 10% of the monthly progress estimate payment until such time as an update has been provided and accepted in accordance with this provision.

Software

If scheduling software is used to create the schedule, the Contractor will be required to use scheduling software compatible with Aurigo Masterworks. The file type must be .mpp.

Level 3

Level 3 projects are large, complex projects typically constructed in an urban setting and requiring more than one construction season. These projects consist of a large number of components that require complex operations and are considered traffic critical. The potential for delays and associated schedule impacts is significant.

Software

Develop a Critical Path Method (CPM) project execution schedule and subsequent updates as required or as specifically requested by the Engineer. Generate the CPM schedule using scheduling software compatible with Aurigo Masterworks scheduling software. The file type must be .mpp.

General

1. Lookahead Schedule Requirements: The two (2) to three (3) week lookahead schedule should be provided and updated weekly unless the project meeting frequency is reduced. A bar chart should be prepared for the three (3) week lookahead schedule each week and should include details on the immediate week (specifically regarding impacts on the Highway Helper program, emergency vehicle access, etc.).

2. CPM Schedule Submission Requirements: Include with all schedule submissions to the Engineer one hard copy and one electronic copy of the schedule. Provide the following items with each schedule submission:

    a. Electronic schedule file in .mpp format;

    b. Gantt chart in PDF file format fit to 11x17 inch paper and showing the Activity ID, Activity Description, Original Duration, Remaining Duration, Total Float, and Calendar ID. The Gantt charts to be included are as follows:

        i. The project Critical Path sorted by early start;

        ii. All uncompleted Work activities as of the data date sorted by area and early start;

        iii. Sixty (60) day lookahead sorted by early start;

    c. Project Narrative report in PDF file format fit to 8.5x11 inch paper and including the following:

        i. Detailed approach to sequencing the Work, including assumptions and restrictions considered in development and updates of the schedule;

        ii. Description of the Critical Path;

        iii. Description of the Near-Critical Paths, defined as those activities not on the Critical Path with a free float less than twenty (20) days of the total float;

        iv. Identification of potential conflicts that may affect the schedule and how they might be mitigated;

        v. Identification of submittal approvals necessary for the Work to proceed as shown;

        vi. Description of the calendars, including identification of workdays per week, holidays, number of shifts per day, and number of hours per shift;

vii. Description of how the schedule accommodates adverse weather days for each month; and

viii. Description of the execution plan, including number and type of crews, a list of Subcontractors' crews, and expected equipment, but not limited to large equipment transport and delivery, transportation permits for oversized/overweight loads, and availability.

Preconstruction Scheduling Conference

Hold a preconstruction scheduling conference with the Contractor, relevant Subcontractors, and the Engineer within fifteen (15) days after Contract approval. The Engineer conducts the conference and reviews the specifications for a Level 3 CPM schedule with the Contractor. This scheduling conference will be held separately from the preconstruction meeting.

Initial Project Schedule

Within thirty (30) calendar days after the Contract Award, submit an Initial Project Schedule (IPS) to the Engineer for review and acceptance. A detailed plan shall be completed as described in the Baseline CPM Schedule, for all Work contemplated for the first one hundred and twenty (120) calendar days after the Work Order is issued. The IPS shall begin with the date of Award and include all other Work thereafter in sufficient detail to identify the Critical Path and identify all contractual milestones.

Submission of the IPS shall be in accordance with the requirements of this subsection. The IPS will be reviewed at the Preconstruction Conference. IPS schedule must be accepted prior to Contractor beginning Work.

Baseline CPM Schedule

Within ninety (90) calendar days after the Effective Date, submit a draft baseline CPM schedule to the Engineer and hold a meeting to review. Define and sequence activities to accurately describe the Project and to meet Contract requirements, the scope of Work, phasing, accommodations for traffic, and interim, milestone, and project completion dates. Use working days to create the schedule, beginning with the date of Award. The baseline CPM shall include, in their entirety, the detailed activities representing the entire duration of the Project. Ensure that the CPM schedule identifies and includes the following:

1. Planned start and completion dates for each activity;

2. Alphanumeric coding structure and activity identification system;

3. Duration of each activity (stated in working days, and with no activities of more than twenty (20) working days, unless approved by the Engineer);

4. Relationships among activities, excluding Start-to-Finish relationships, without leads or lags, unless otherwise approved by the Engineer;

5. Interim, milestone, and project completion dates specified in the Contract as the only contractual constraints in the schedule logic;

6. The Critical Path identifying the controlling activities of the Work;

7. The project identification number, which shall remain the same for the entire duration of the Project;

8. Activities related to the procurement of materials, equipment, and articles of special manufacture;

9. Activities related to the submission of working drawings, plans, and other data specified for review or approval by the Engineer;

10. Activities related to Department inspections and approvals; and

11. Specified activities performed by the Department, Subcontractors, suppliers, and third parties such as utilities and railroads.

The Engineer and Contractor will review the draft baseline CPM schedule at a meeting specifically held for the review of the schedule. The Engineer will accept the draft baseline CPM schedule, provide review comments, or request additional information. Make appropriate adjustments or provide additional information within seven (7) calendar days. The Department may withhold payments until the Engineer accepts the baseline CPM schedule. The Engineer's acceptance is based solely on whether the Baseline Schedule meets the requirements of Section 1110. Review comments made by the Engineer on the initial schedule will not relieve the Contractor from compliance with the Contract. The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with the Contract requirements. The cost of preparing and updating the schedule is incidental to all Contract items.

Schedule Updates

The three (3) week lookahead schedule should be updated weekly unless project meeting frequency is reduced. A bar chart should be prepared for the three (3) week lookahead schedule each week and should include details on the immediate week (specifically regarding impacts on the Highway Helper program, emergency vehicle access, etc.).

Update the schedule on a monthly basis to show current progress. Include the following with each update:

1. Actual start and finish dates of each activity or remaining durations of activities started but not yet completed;

2. "Out of Sequence Progress" activities that have posted progress without predecessors being completed, which are not allowed without written approval of the Engineer;

3. The updated Critical Path; and

4. Narrative report including the following:

    a. Sources of delay, with a detailed history of the delay, corrective action, and schedule adjustments to correct the delay;

    b. Lookahead schedule;

    c. Pending change orders; and

    d. Changes made to the CPM schedule. Changes include additions to, deletions of, or revisions to activities due to the issuance of a change order, changes to an activity duration, changes to relationships between activities, or changes to the planned sequence of Work or the method and manner of its performance, including any schedule changes due to changes in the planning or progress of the Work.

Submit the updated schedule electronically to the Engineer in accordance with the requirements of this subsection. The Engineer reserves the right to reject any schedule updates because of changes in relationships between activities on the Critical Path, inadequate or inaccurate narrative updates, or other deficiencies in the schedule updates as required in this subsection. If the Contractor fails to provide monthly schedule updates, or address the Engineer's comments regarding the monthly schedule update, within seven (7) calendar days following the progress estimate pay period cutoff date, the Engineer may withhold up to 10% of the monthly estimate payment until such time as an acceptable update has been provided.

Schedule Revisions

The Engineer will determine the progress of the Contract by either the time versus money straight-line method or the schedule updates submitted by the Contractor. If actual construction falls behind the plan of operations or schedule by more than 15% or sixty (60) calendar days, whichever is less, request approval of a revised schedule that reflects timely completion. Otherwise, the Engineer may request a revised schedule. Circumstances that may lead to such a request include the following:

1. A delay (actual or projected) to scheduled milestone or project completion dates 15% or more behind schedule;

2. A difference between the actual sequence or duration of Work and that depicted in the schedule; and

3. The issuance of a Change Order that alters the planned sequence of Work or the method and manner of its performance by adding, deleting, or revising activities.

Prepare and submit the revised schedule within seven (7) calendar days after the Engineer's request. The Engineer may accept the revised schedule, reject the revised schedule, or request additional information. Address the reasons for rejection or submit the information requested no more than ten (10) calendar days after the Engineer's request.

If the Contractor cannot justify the unsatisfactory progress, the Department may remove the Contractor from the Department's list of qualified bidders. In addition to the Contractor, any affiliated or subsidiary companies, companies in which the Contractor holds a significant interest, and companies in which officers or stockholders hold a significant interest may be removed from the Department's list of qualified bidders. The Department will give appropriate written notice to the Contractor.

The Department will not reinstate a Contractor disqualified from bidding until the Department considers the progress satisfactory or until the Contract(s) is completed and accepted, whichever occurs first. The above sanction will remain in effect until rescinded by the Department.

Do not stop prosecution of the Work without the written consent of the Engineer. If the Work is stopped, give 24 hours' notice to the Engineer before resuming operations. Unless provided for in the Contract, conduct nightwork only with the Engineer's written permission.

Final Updated Schedule

Submit a final updated as-built schedule with actual start and finish dates for the activities within thirty (30) days after Work completion. Submit a written certificate with this submittal signed by the project manager or an officer of the company stating the following: "To my knowledge and belief, the enclosed final updated schedule reflects the actual start and finish dates of the actual activities for the project contained herein." An officer of the company may delegate in writing the authority to sign the certificate to a responsible manager.

Anticipated Draw Schedules

Large projects that are program funded may require the Contractor to submit an estimated draw schedule to assist the Department with cash flow planning. The estimated draw schedule is not considered part of contractual project controls but is requested as an essential part of program

management by the Department and may be required as part of preconstruction submittals along with the Project Schedule and Resource Narrative. Estimated draw schedules should be prepared as Excel documents with anticipated monthly draws calculated at (+/- 10%) and submitted via email to the Project Management Office and the Resident Construction Engineer. It is understood that anticipated draw schedules will be dependent on weather, materials ordered prior to the start of the project (stockpile), and unanticipated delays. Cost-loaded schedules and updated anticipated draw schedules will be required quarterly. Due dates will be on the first workday of December, March, June, and September.

Resource Loading Narrative

Projects will require a Resource Narrative to be provided to the Project Management Office and the Resident Construction Engineer prior to the start of construction. The Resource Narrative should include a brief description of the Work sequence, resource commitments for major activities (e.g., Critical Path activities, traffic impact activities, and long-duration or significant cost activities), standard Work times (days and hours), identification of Critical Path activities, and third-party interfaces that require integration into the Work. The Resource Narrative should identify anticipated production rates and crews, durations of major activities, and general types of large equipment. The Resource Narrative should be consistent with the Project Schedule and the anticipated draw schedule.

EXAMPLE PROJECTS

To understand the implications of the proposed specification for actual projects, the research team examined three current Iowa DOT projects to identify how each might be categorized in terms of level of specification.

Dallas County Bridge Replacement

The Interstate Road System Dallas County Bridge Replacement project was Bid Order 001 in the August 2023 letting. The project featured a proposal guaranty of $1,500,000, meaning that the estimate was between $22,500,000 and $30,000,000. This is a complex project spanning three years and involving two separate bridge replacements, with additional grading and portland cement concrete (PCC) pavement construction required for the new bridges. This project includes a high cost, long duration, high complexity, and high risk. Given all this information, this would be a Level 3 project.

Lansing Bridge

The Lansing Bridge project on IA 9 over the Mississippi River was Bid Order 001 in a special letting on August 1, 2023. The engineer's estimate was roughly $127.5 million. This project started on September 11, 2023, and the contract allows 550 working days. This project includes demolition and replacement of the bridge as well as the construction of new pavement. Similar to the Dallas County Bridge Replacement project, this project includes a high cost, long duration, high complexity, and high risk. Given all this information, this would be a Level 3 project.

US 34 Pavement Reconstruction

The US 34 Pavement Reconstruction project was Bid Order 106 in the December 2023 letting. This project involves the reconstruction of US 34 from the East Nishnabotna River Bridge to County Road H34 in Montgomery County. The initial concept estimate was priced at roughly $14,00,000. This project has a late start date of April 1, 2024, and the contract allows 150 working days. This is a fairly straightforward project, with a high cost, medium duration, low complexity, and medium risk. Given this information, this could be considered a Level 2 or 3 project depending on the engineer's discretion.

CONCLUSION

Many states continue to require Primavera P6 for project schedules, either explicitly through prescriptive specifications or implicitly through requiring a level of schedule complexity that can only be achieved with high-end, enterprise-level software such as P6. However, a high level of schedule complexity and the costs associated with it may not be providing good value to DOTs, especially for projects that do not require high-end scheduling to effectively manage schedule-related risk.

The adoption of graduated scheduling specifications will allow DOTs to match scheduling requirements to project needs. Graduated scheduling specifications represent a cost-effective way to provide high-end control of project scheduling when necessary without adding an unnecessary administrative burden on projects that will not benefit from high-end scheduling control.

During the DOT interviews and the discussion with Iowa DOT personnel and contractors, several industry professionals stated that scheduling software packages such as Microsoft Project or Aurigo Masterworks are not capable of producing reliable schedules. However, interviews with contractors and pilot testing of more readily available software programs do not support this assertion. As a result, DOTs could reduce costs and the administrative burden on projects with low or moderate complexity by giving contractors the option to use schedule development processes other than those requiring the use of Primavera P6, including simple narratives, Microsoft Excel bar charts, Microsoft Project CPM schedules, and Aurigo Masterworks project control platforms.

REFERENCES

Works Cited

ALDOT. 2022. *Standard Specifications for Highway Construction*. Alabama Department of Transportation, Montgomery, AL.

Caltrans. 2018. *Standard Specifications*. California Department of Transportation, Sacramento, CA.

Gi Han, B., J. Son, N. Khwaja, and J. W. O'Brien. 2022. Developing assessment criteria for state DOTs' standard specifications on contractor schedules. *Construction Research Congress 2022: Project Management and Delivery, Controls, and Design and Materials*. American Society of Civil Engineers, Reston, VA. https://www.doi.org/10.1061/9780784483978.042.

Hildreth, J. C. 2006. *Schedule Submittal Requirements*. TR-06-02. Virginia Polytechnic Institute and State University, Blacksburg, VA.

Iowa DOT. 2018. Section 1110. Progress Scheduling. *Standard Specifications for Highway and Bridge Construction*. Iowa Department of Transportation, Ames, IA.

ITD. 2018. *Standard Specifications for Highway Construction*. Idaho Transportation Department, Boise, ID.

NJDOT. 2019. *Standard Specifications for Road and Bridge Construction*. New Jersey Department of Transportation, Trenton, NJ.

Additional Resources Consulted

CDOT. 2021. *Standard Specifications for Road and Bridge Construction*. Colorado Department of Transportation, Denver, CO.

FHWA. 2002. *FHWA Guide for Construction Contract Time Determination Procedures*. Federal Highway Administration. https://www.fhwa.dot.gov/construction/contracts/t508015.cfm.

Ohio DOT. 2019. *Construction and Material Specifications*. Ohio Department of Transportation, Columbus, OH.

TDOT. 2021. *Standard Specifications for Road and Bridge Construction*. Tennessee Department of Transportation, Nashville, TN.

TxDOT. 2018. *Contract Time Determination*. Texas Department of Transportation, Austin, TX. https://ftp.dot.state.tx.us/pub/txdot-info/tpd/project-portfolio/contract-time-determination-guidance.pdf.

UDOT. 2022. *Standard Specifications for Road and Bridge Construction*. Utah Department of Transportation, Salt Lake City, UT.

VDOT. 2018. *Project Tasks and Scheduling Guide*. Virginia Department of Transportation, Richmond, VA. https://www.virginiadot.org/business/resources/project_tasks_and_scheduling.pdf.

VDOT. 2020. *Road and Bridge Specifications*. Virginia Department of Transportation, Richmond, VA.

WisDOT. 2023. *Facilities Development Manual.* Wisconsin Department of Transportation, Madison, WI. https://wisconsindot.gov/rdwy/fdm/fd-02-20.pdf.

THE INSTITUTE FOR TRANSPORTATION IS THE FOCAL POINT FOR TRANSPORTATION AT IOWA STATE UNIVERSITY.

InTrans centers and programs perform transportation research and provide technology transfer services for government agencies and private companies;

InTrans contributes to Iowa State University and the College of Engineering's educational programs for transportation students and provides K–12 outreach; and

InTrans conducts local, regional, and national transportation services and continuing education programs.

IOWA STATE UNIVERSITY

Visit **InTrans.iastate.edu** for color pdfs of this and other research reports.