Journal of Construction Education
Fall 1997, Vol. 2, No. 3, pp. 222-230

1522-8150/97/$3.00/General Manuscript

Construction Scheduling Specifications

Stephen J. Krone
Bowling Green State University
Bowling Green, Ohio

General conditions found in construction contracts deliberate the managing procedures for construction projects, such as whether schedules are updated and cost loaded. These contract clauses should encourage management participation through a balance between closed specifications with specific requirements and open specifications that allow the parties of the contract to use management procedures that they are comfortable with.

Key Words: General conditions, specifications, schedules, updating, cost loading.

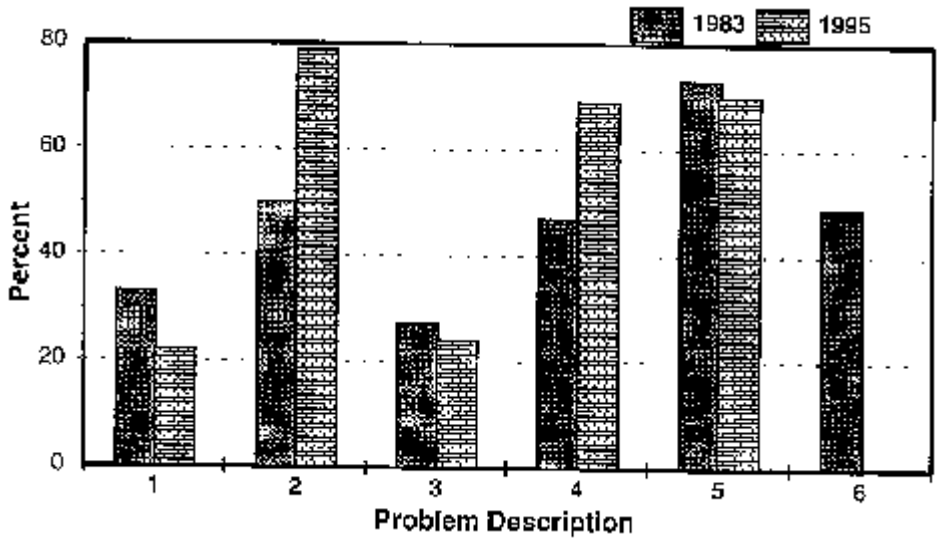
Introduction

Schedules are management tools for planning complex construction projects and coordinating the work of the architect, owner, contractor and subcontractors. Although many contractors develop an original planned schedule, many aspects of a comprehensive schedule such as cost loading, are used less frequently.

This article identifies the contractors' preference level for the requirements found in scheduling specifications. In this study, questionnaires were faxed to 141 contractors to measure the preference for the different types and techniques of scheduling in the construction industry. From the 41 responses, the contractors' preference is compared with responses from an earlier survey and many of the current standard scheduling specifications.

The Schedule's Affect on Delays

The general conditions in the American Institute of Architect's (AIA, A201) paragraph 8.2.1 asserts that "time limits stated in the Contract Document are the essence of the Contract." A 1983 study demonstrated the importance of schedules in relation to completion time. This survey compared projects completion dates when contractors used a schedule and when contractors didn't use a schedule. The survey reported that contractors who used CPM schedules were late on 27% of their projects. For contractors who did not use a CPM, the late project rate rose to 44%. The first set of columns in Figure 1 is from the original survey in 1983. In 1983, scheduling attributed to a 17% increase in completing a project on-time, which is shown in comparing columns 3 and 4.



1. Projects completed behind schedule
2. Contractors who use scheduling
3. Contractors who use scheduling
4. Contractors who do not use scheduling and finish job late
5. Poor schedules cause overrun
6. Project late and project dispute job finished late

Figure 1. Scheduling and Project Completion: 1983 vs. 1995

The second set of columns in Figure 1 was generated from the questionnaire taken in 1995. All of the questions except for the sixth question were repeated in the 1995 questionnaire to compare the results twelve years after the original study. It can be seen that the use of scheduling has increased between studies, from 50% to 79%, as shown in the comparing the second set of columns (2). Although this is a significant increase, the introduction of computer technology over those same years is more dramatic. Other trends shown in the study include:

- Construction projects completed behind schedule have dropped by more than 10%. A comparison of the first pair of columns shows that 33% of all projects finished behind schedule in 1983, decreasing to 22% in 1995.
- The pair of columns labeled three show that contractors who scheduled projects but the projects still finished late remains at about 25% over this time span.
- The fourth pair of columns indicate that contractors who do not use scheduling for projects and the projects finish late have increased by more than 20%.
- The results of late projects are shown in columns five and six. Poor schedules cause cost overruns about 70% of the time and late projects result in project disputes about 50 % of the time. The current study found the cost overrun data about the same and did not repeat the disputes question.

Certainly the increase in contractors who use scheduling and the drop in projects completed behind schedule is an encouraging trend. The disturbing trend is the large increase in late project completion for those contractors who do not schedule. This may be due to increased time pressures and the complexity of the projects. This emphasizes the need for construction management to schedule projects. Managers must recognize the need, purchase the software, train their employees, and encourage the use of updated and cost loaded schedules.

Closed or Open Specifications

Rather than leaving the choice to the participants, some specifications dictate requirements for the method of scheduling.

These requirements include the frequency of updating, the use of cost loading, the number of activities, the type of schedule, and even the type of software, just to name a few. These are closed specifications, in that they detail the specific procedures for managing a schedule. The AIA A201 scheduling process has few procedural statements and is predominantly an open specification, which obligates the contractor to derive a schedule (A201, 3.10.1), but leaves the scheduling details up to the contractor. The specification is:

> The Contractor, promptly after being awarded the Contract, shall prepare and submit for the Owner and Architect's information a Contractor's construction schedule of the Work.

Additional scheduling obligations can benefit project control through managerial involvement:

> Detailed clauses attempt to impose a particular scheduling technique or regulate the complexity of the schedule. General clauses permit Contractor flexibility in selection of technique and complexity. The AIA philosophy to take hands off and run away bespeaks the problems its members and its insurers have had in the recent past with construction delays. There is thus some justification for a scheduling clause with greater detail than the AIA's.

On the other hand, many contractors preference for closed scheduling specifications supports the hands off position of the AIA. Figure 2 shows low contractor support for contract clauses that dictate how the contractor prepares the schedule. Eighty-five percent of the contractors surveyed support the specification for an original schedule. However, other detailed scheduling specifications are much less embraced. There is little support for specifications requiring a schedule with progress payments (22.5%) or specified updating procedures (17.5%), and virtually no support for specifying the type of schedule (2.5%) or cost loading the schedule (2.5%). There are many reasons why a contractor may prefer a less detailed schedule. Detailed schedules are more expensive to produce. Proprietary information can be hidden with a less detailed schedule. Also, some contractors circulate early start schedules as a stimulus to subcontractors. History has shown that contractors preference can be changed by adopting closed specifications that direct implementation of better business practices, as exemplified by the Gantt Chart. Henry Gantt, a Maryland management engineer, invented the Gantt Chart to allow foremen to study the performance of their equipment. The chart was adopted by the military, who changed the focus from adjusting machine efficiency to managing the shipment of materials. Before World War II, about 12 companies used the Gantt Chart. After the war, there were about 1200 companies using Gantt Charts as a result of a military requirement to suppliers.

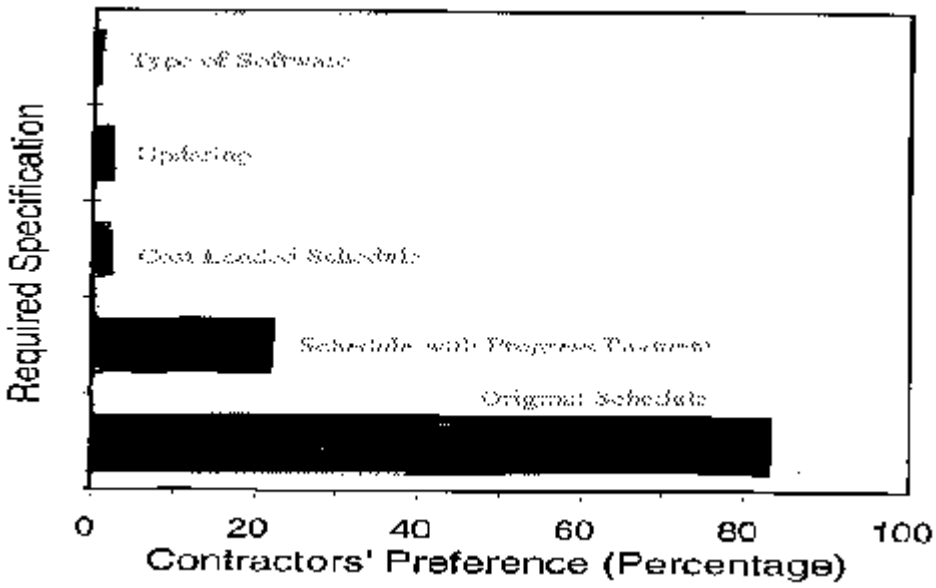


Figure 2. Contractors Preference for Required Scheduling Specifications

Table 1 shows the present circumstances with cost loaded schedules. Although scheduling software provides the technical ease to cost load schedules, only 20 % of all schedules are cost loaded. The low contractors preference of 2.5 % contributes to the low number of cost loaded schedules. One contractor commented that he cost loaded only government jobs because most of them specified cost loading. Since the technology is already in place, it would be beneficial for this company to utilize cost loaded schedules for all projects.

Table 1

Cost Loading of Schedules

Cost Loading Scheduling Situations		
Description of Circumstance	Yes	No
Contractors Preferred	2.50%	97.50%
Specifications Required	7.10%	92.90%
Project Schedules Cost Loaded	20.00%	80.00%

The risk that can be avoided through the use of cost-loaded CPMs with monthly cycles ... are substantial. On the one hand, this technique prevents the parties from putting off a lot of little claims regarding changes and delays until the end of the project. When this is done, many small problems which could have been easily addressed at the time they arose tend to become one big problem, and the owner often ends up in a dispute with the contractor regarding a large overrun of total construction cost.

Scheduling Requirements

Table 2 reveals the inconsistency in the construction industry with regard to scheduling specifications. The documents compared are the *American Institute of Architect's (AIA) Document A201 - The General Conditions of the Contract for Construction*, the *Associated*

General Contractors (AGC) Document 510 - Standard Form of Agreement Between Owner and Construction Manager and 600 - Subcontract for Building Construction, 1988 State of California DOT Scheduling Specifications, Engineers Joint Contract Documents Committee (EJCDC) Standard General Conditions of the Construction Contract, and the *United States Postal Service Specification (Section 01030*.

Table 2

Scheduling Requirements

Document	Original Schedule Deadline	Software or Format Specified	Approval Time and Procedure	Update Requirement
AIA A201	Promptly	None	None	at appropriate intervals
AGC 510 (CM)	In design phase	None	None	Yes, but not specified
AGC 600	Provide Contractor with any requested schedule information	None	If interrupted resume in 2 days	Yes, but not specified
CA DOT	20 days after contract is signed	None	No progress payments until the Engineer is satisfied	within 10 working days of the Engineer's written request
EJCDC	10 days after NTP	None	10 days before first progress payment	to reflect the impact of new developments
US Postal Service	35 days	Primavera	7 days CPM-Cost & Resource Loaded	monthly

Construction contract provisions vary in the specified time periods for administering the original schedules. For the above contracts, the original schedule is required "promptly," "in the design phase," "after 10 days," "after 20 days," and "after 35 days." Any of the mentioned due dates for the original schedule can be met, but the detail and accuracy of the schedule after 10 days may be less than a schedule created after 35 days because of time constraints.

It is unusual for specifications to delineate the amount of detail in the schedule. Five of the six specification clauses shown in Table 2 do not specify the type or detail of the schedule. The most prevalent specifications in the construction industry, the *AIA,* the *AGC,* and the *EJCDC s* schedule specifications are not detailed. In contrast, the U.S. Postal Service, and other government agencies such as the U.S. Veterans Administration, uses specifications that include the type of scheduling software, the number of activities, the update frequency, and the type of graphical representation. The format of the schedule is usually based on the personal preference of the contractor. Contractors prefer the bar chart by far, as shown in Figure 3. Although activity-on-arrow and activity-on-node are both formats in Critical Path Method (CPM), CPM was included in the questionnaire as a separate format. The CPM format was included to diffentiate those contractors who included float and critical path in the schedule presentation.

Contractors update their schedules at different intervals. The AIA A201 states that The schedule... shall be revised at appropriate intervals as required by the conditions of the Work... This allows for an open interpretation of when the schedule is updated. Most of the current general conditions follow this open interpretation of updating. Update requirements also are varied, taking place "within 10 working days," "monthly," or "to reflect the impact of new developments." The CA DOT requires a notice requirement in updating, within 10 days of Engineer s written request as compared to the US Postal Service s monthly requirement.

Specifications are needed on construction projects to maintain feedback to management in this interactive process, and a balance must be struck between providing an adequate amount of information and updating too frequently.

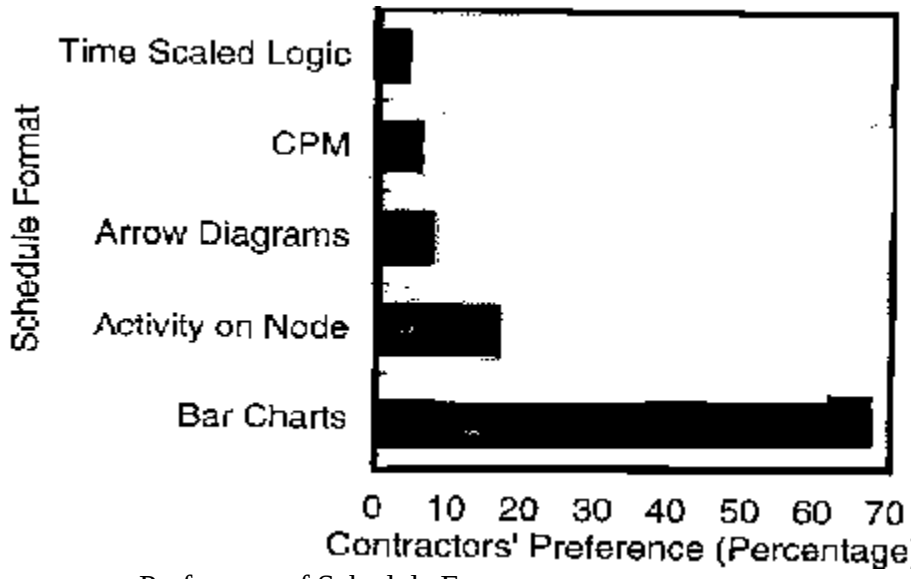


Figure 3. Contractors Preference of Schedule Format

From the faxed questionnaire it was found that almost half, 48.8%, of the contractors updated monthly as indicated in Figure 4. Other contractors updated their schedules at more frequent intervals; 27.9% weekly and 18.6% bi-weekly. Only 5% updated less often than monthly.

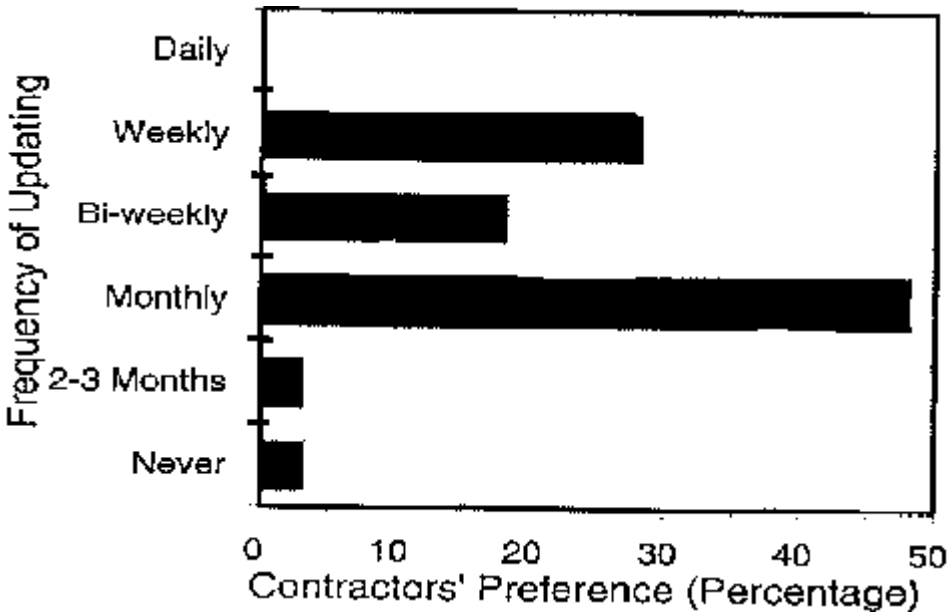


Figure 4. Frequency of Updating

Perhaps specifications need to become more specific when evaluating the effect of changes to the schedule. The Corps of Engineers, who stipulate simple bar charts in their contracts, employ network analysis for a more detailed identification of the impact of changes. The complexity of

the project may be a determining factor to scheduling administration specifics, such as the updating frequency.

Obligations and Opportunities

Scheduling provisions are both an obligation and an opportunity. The contractor is obligated to prepare the schedule. The schedule is submitted to the architect or owner, establishing that project performance was agreed upon by all parties. For a contractor who schedules a two-year project for one and a half years, he forecasts a one-half year float. This scheduled finish date exhibits the contractor's intention to complete the project early and substantiates the right to receive prompt payment upon early completion. Federal law grants contractors the right to complete the project earlier than the contract completion date and the schedule forewarn the owner of an obligation for early payment.

In the case of Pathman Construction Company (Pathman Construction Company v. United States, ASBCA 14285, 71-1 BCA Par. 8905, 1971), the project's schedule was accelerated based on a government representative's statement of urgent need along with the revised schedule verifying the accelerated performance of the change claims. The revised schedule was submitted, in response to the representative's statement, with an early completion date. This request, coupled with a threat to access liquidated damages, constituted a request for accelerated performance and the need to compress selected project activities to reduce the project's duration. The court relied on the schedule and found for the contractor.

The failure to grant time extensions in a timely manner can compromise an owner's position. Fortec Constructors submitted a claim for cost and time extensions to the Corps of Engineers (Fortec v. United States, 8 Cl. Ct. 490, 1985) for unilateral modifications on an aircraft maintenance facility. The court found that the Corp's denial of the cost and time extension was improper because the Corp had based its decision on an original schedule. Control of the project is hindered when the schedule is not current.

Construction management has become much more sophisticated with network analysis of updates easily incorporated into computer schedules. Extended durations and changed conditions are recomputed in minutes. With an interactive scheduling procedure, the project's time and the effect of changes to the project are instantly updated. The revised "what if" schedule predicts the consequences of significant changes to the as-planned "original" schedule. "What if" schedules are easy to generate with today s software, and managers should directly encourage interactive analysis as the construction norm.

Developing Schedule Specifications

Scheduling is a form of programmatic goal setting and feedback, which can increase productivity by up to 20%. Open scheduling specifications, such as the two paragraphs in the AIA specifications, allow flexibility to the contractor. But at the outset of the project, parties should clearly specify how performance will be measured, including the type of scheduling software,

the number of activities, the update frequency, and the type of graphics. Experience has shown that the more detailed the specification, the better the chance to eliminate misunderstanding. For large complex construction projects, scheduling software is of immense value as a planning tool, reducing uncertainty in managing the project. Similarly, closed specifications standardize administrative procedures and reduce heated debates resulting from unplanned events.

Insisting on a closed specification that dictates the updating requirement may be found by contractors to be annoying and meaningless. The Veterans Administration s Network Analysis System (Section 01311) is over a dozen pages long. Many construction projects do not require this amount of detail. A balance must be struck between more information versus more paperwork. It is not complex but efficient scheduling that reduces confusion, lessens conflict between the parties, and maintains focus on the project's completion.

Clearly defined administrative procedures promote smooth contractual resolution, just as construction scheduling promotes harmonious project flow. Scheduling specifications should address not only the format, updating, and cost loading; but procedures for justification of time extensions, float utilization, involvement of subcontractors, and remedies for noncompliance. Lack of specified administrative procedures can exacerbate the project efficiency, whereby contract administrators may generate excessive correspondence, meetings, delays, claims, or lawsuits.

Conclusions

It is difficult to establish standard specifications for use in the construction industry. Despite advances, more effort is needed to shift preferences towards employing scheduling technology. Scheduling software aids in the effective daily decision-making on projects, predicting time problems encountered when altering the scope of work. No single industry scheduling procedure is applicable for all projects, however, the procedure for reaching timely scheduling decisions should be established prior to its demand. Contractor preferences for updating, cost loading, and formatted reports effect the success of the project. Specifications for these scheduling issues should be agreed upon by all parties prior to construction and included in the contract's supplemental conditions.

References

American Institute of Architects. 1987. AIA Document A201, *The General Conditions of the Contract for Construction*.

The Associated General Contractors. 1987. AGC Document 510, *Standard Form of Agreement Between Owner and Construction Manager*.

The Associated General Contractors. 1987. AGC Document 600, *Subcontract for Building Construction.*

Callahan, M., and H. Hohns. 1983. *Construction Schedules.* Virginia: The Michies Company.

Callahan, M., Quackenbush, D., and Rowings, J. 1992. *Construction Project Scheduling*. New York: McGraw-Hill, Inc.

Engineers Joint Contract Documents Committee (EJCDC). 1983. *Standard General Conditions of the Construction Contract*.

Goldbloom, J. "Summary Report of Questionnaire on Specifications (Contractor Returns)," ASCE Committee on Specifications; Journal of the Construction Division, Paper 14001, September 1972.

Goldfarb, N. and Kaiser, W. *Gantt Charts and Statistical Quality Control; The Dissemination of New Business Techniques,*Hofstra University, New York.

Krone, S. 1993. *Containing Construction Change Orders With Computers.* Computing in Civil and Building Engineering: Proceedings of the Fifth International Conference. Anaheim, CA.

Krone, S. 1994. *Iterative Scheduling Through Construction Specifications.* ASC Great Lakes Regional Conference.

Lamb, R.W. 1993. *Managing Risks with Cost-Loaded CPM s.*Construction Business Review, Vol 3, No 2, March/April.

Locke, E. A., and Lathan, G. P. 1990. *A Theory of Goal Setting and Task Performance*, Prentice-Hall, Inc., Englewood Cliffs, N.J.

A Report to Wagner-Hohns-Inglis, Inc, Opinions Research Division, Fleishman Hillard, Inc., September 1993.

United States Army. *Modification Impact Evaluation Guide,* Department of the Army, Office of the Chief Engineers, EP-415-1-3 at 3-2 (July, 1979).

Wickwire, J., Driscoll, T., and Hurlbut, S. 1991. *Construction Scheduling: Preparation, Liability, and Claims,* John Wiley & Sons, New York.