

A Comprehensive Practice of Total Float Pre-Allocation and Management for
the Application of A CPM-Based Construction Contract

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ABSTRACT

Many construction contracts require contractors to use the Critical Path Method (CPM) scheduling technique as a management tool. In such projects, many participating parties commonly attempt to appropriate float time shown in the CPM schedules in order to advance their own interests. Under current scheduling practices, float time is considered “free” and therefore does not belong to any one party in the construction process. As a result of this conception, when a project delay occurs, float ownership and its utilization can become a major source of dispute.

This ambiguous interpretation of total float ownership can be clarified by improving contract language with regard to scheduling specifications in the area of total float management. The purpose of this research dissertation is to introduce a comprehensive practice of float pre-allocation and management terms, for the application of scheduling specifications in the CPM-based construction contract. The proposed concept for managing “total float” involves pre-allocating a set amount of total float on the same non-critical path of activities to the two contractual parties—owner and contractor. For the sake of equity, this research adopts an *equal (50-50) allocation* concept, which allocates to each party one-half of the total float.

This new concept for pre-allocating and managing “total float” involves recommending contract clauses to direct its use and to explain the manner in which responsibility for any resulting delay will be assigned. Six examples of factual situations are provided to illustrate the assigning of responsibility for delays. The features of proposed concept are then compared to those of other theories presently being used. Such a comparison provides insight as to which features have not worked well in the past—and how those of the proposed concept can change this.

A Delphi survey is used to validate the total float pre-allocation concept of *equal allocation*. The survey shows that the concept could significantly increase involved parties’ awareness of total float consumption and thus help resolve any potential disputes regarding it. This dissertation considers suggestions obtained from the survey and recommends them for future study. The simple step of inserting new scheduling language into the construction contract documents assures that all participants will become more aware of the fact that when they consume floats, they introduce the potential of increasing project completion times.

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CHAPTER 1

INTRODUCTION

As a management tool in construction projects, the Critical Path Method (CPM) scheduling technique is well known and widely accepted. In fact, many construction contracts—especially those written for large public and private projects—require contractors to submit and routinely update CPM schedules showing critical and non-critical activities. In such projects, another occurrence is also commonplace: many participating parties often attempt to appropriate float time shown in the CPM schedules to advance their own interests.

Since time is a critical element in the construction process, owners and contractors risk incurring additional and substantial costs when construction projects are finished beyond the contractual completion dates (Schumacher 1996; Householder and Rutland 1990). When a project's completion time is delayed, the owner may suffer delay damages—such as losses of property use, revenues, and interests—which can increase contract costs by millions of dollars. By the same token, the contractor can suffer monetary reversals caused by the delay, including extended overhead or liquidated damages. When this occurs, it is difficult but necessary to determine which party should be held responsible. Determining the identity of the responsible party is even more complicated when there is more than one event causing the delay.

Under current scheduling practices, float time is considered “no cost” and does not belong to any party in the construction process (Wickwire, Driscoll and Hurlbut 1991). Today's widely accepted method identifies float as an expiring resource available to the parties on a non-discriminatory basis (Wickwire, Warner and Berry 1999). Due to the dynamics of schedules, however, an activity that originally has float may later have zero or negative floats; and as a result of delays to preceding activities, it can become critical. Should this happen, a party who delays this then-critical activity can be held responsible for the delay regardless of its earlier performance. When such project delays occur, questions regarding float ownership and its utilization often cause major disputes (Householder and Rutland 1990; Pasiphol and Popescu 1994; Ponce 1986; Wickwire, Driscoll and Hurlbut 1991).

Ponce de Leon (1986) identifies the common scheduling interpretation of “total float” as the number of days an activity may be extended or delayed without delaying the completion date shown in the schedule; however, this interpretation has proven ambiguous, leaving unanswered crucial questions regarding such issues as schedule management and delay claim resolution. For instance, such an interpretation does not expressly define contractors’ rights to time extensions as a result of delays that merely decrease available float time. To reduce such ambiguities, the issues of float ownership, treatment, and use should be addressed and explicitly provided for in the contract documents. By following such a recommendation, both the owner and contractor know from the beginning their measure of the shared float—a “promise” on which they can rely throughout the project.

1.1. RESEARCH QUESTIONS

In an attempt to develop a new practice of total float management in CPM-based construction contracts, the following research questions have been developed:

- 1) How does total float correspond to the CPM scheduling techniques in today’s construction world? What are the legal bases and applications of the CPM scheduling techniques?
- 2) What is the history of total float ownership in CPM-based construction? How have total float ownership and management become major issues in CPM-based construction?
- 3) How have scheduling specifications in the area of total float management been written in CPM-based construction contracts? What leads to the development of those scheduling specifications?
- 4) There are various techniques to intentionally or unintentionally appropriate float times. Some parties use float times for their own benefit, mainly for a monetary reason. Who attempts to appropriate float time for their own benefit? How? Why?
- 5) Total float times do not belong to an activity and should be shared with other activities on the same path. Using some total float time in a non-critical activity will reduce the amount of time available to remaining activities in the same path.

What are the significant results of consuming float time? How does total float relate to risks and uncertainties about scheduling?

- 6) In general, parties involved in the construction industry have recognized the importance of total float management. How have the parties coped with this float utilization issue? What techniques have been implemented to solve or mitigate the float issue? Which methods of total float allocation and management have been utilized in the construction industry or recently introduced by researchers to mitigate this float issue?
- 7) Concerning the total float issue, how have boards and courts made decisions on previous claim cases?
- 8) How can we advance specification language to improve the clarity of construction contracts with regard to float allocation and management?

1.2. RESEARCH OBJECTIVES AND TASKS

The purpose of this research is to introduce a new practice of float allocation in scheduling specifications of CPM-based construction contracts. The study aims also to develop contract documents that are well conceived and do not contribute to situations of ambiguity or poorly defined responsibility. The new concept introduced by this dissertation aims to advance specification language that will improve the clarity of construction contracts with regard to float allocation and management. To achieve its objective, the dissertation must accomplish eight related tasks. It must:

- (1) Explain a basic understanding of CPM scheduling techniques, as well as scheduling specifications in the area of CPM techniques, found in the contract documents of major organizations.
- (2) Study the development of and trends involving contract languages that address the issue of total float management, as discovered in the scheduling specifications of major organizations.
- (3) Explore total float ownership and management, and identify problems involving total float in CPM-based construction.
- (4) Study whether float consumption can significantly increase the risks of cost overrun and delays, and if so, by how much and in what ways.

- (5) Conduct research on and identify the pros and cons of any float allocation methods currently used in the construction industry or recently introduced by researchers.
- (6) Study previous delay claim cases involving the issue of total float by analyzing the courts' decisions in those cases and identifying the contract languages used in the relevant scheduling specifications.
- (7) Introduce a new practice of total float allocation and management for application in the scheduling specifications of CPM-based construction contracts.
- (8) Validate the new practice through the Delphi survey method for collecting and refining knowledge from pre-selected panels of experts.

1.3. SCOPE STATEMENT

As previously noted, the purpose of this research paper is to introduce a new theory of total float allocation and management for application in the scheduling specifications of CPM-based construction contracts. Based upon this goal, the dissertation is limited to developing scheduling language for a new total float management concept that can replace the current total float clauses of construction contracts. This simple step of inserting the new scheduling language into the construction contract assures that all participants will be more aware of the role float consumption can play in creating potential project delays. Although the courts may endorse the concept that float time is an expiring resource, thus permitting the individual who gets to it first to gain the benefits it provides, float ownership and allocation should always be set out deliberately and expressly in the contract documents. The ultimate goal of this research is to contribute to the current body of knowledge in the construction industry a new concept that will improve overall project performance and mitigate possible delay and disruption disputes.

1.4. RESEARCH METHODOLOGY

To address the research questions or meet the dissertation objectives, the following research steps were implemented.

STEP ONE Review textbooks regarding CPM scheduling, delay analysis, legal aspects with respect to CPM schedule, scheduling contracts, and total float management.

STEP TWO Identify and define a gap or problem area of total float ownership and management in the CPM-based construction contract. Decide to further study a solution to resolve the issue.

STEP THREE Further review literatures in the field of total float ownership and management issue as well as analyze the previous court cases concerning the issue. This step aims to address the eight research questions. The research method includes initially reviewing the existing body of literature concerning float allocation in an effort to understand the scope of previous studies, as well as to realize what additional work is required in an industry that currently operates under the CPM scheduling method.

A literature review performed for this purpose presents information gleaned from previous issues of key journals or publications, including the *Journal of Construction Engineering and Management*, *Construction Management and Economics*, *International Journal of Project Management*, and *Cost Engineering*. Other information sources include textbooks from the Virginia Tech library, the George Washington and Hill International (DC) libraries, and the Internet. References in the obtained documents also lead to other significant references.

Furthermore, the research aims to study previous and current practices in total float ownership and management, as well as new theories of total float management that have been introduced to resolve total float management issues. The current contractual provisions in major scheduling specifications will also be explored. The following information will be extracted from the scheduling specifications for this study:

- Scheduling techniques required for use in construction;

- Scheduling requirements, including total float clauses, time extension clause, nonsequestering of total float clause, no-damage to delay clause; and
- Delay management during the construction

In addition, previous and recent court decisions concerning float in delay and disruption disputes will be examined. Previous claim cases in relation to total float management issue are obtained through the Westlaw litigation database available at the Washington, DC office of Hill International, Inc. From such cases, this study will extract the following information:

- Factual background of the cases,
- Summary of the dispute indicating the contractors' and owners' positions,
- Boards' decisions and reasons for them, and

Total float clauses or other relevant clauses written in the contract documents will be applied to each case if available.

STEP FOUR Evaluate the potential solutions and identify the pros and cons of each. Discuss the total float issue with and acquire opinions on the solutions from professionals in the area of total float management.

STEP FIVE After reviewing the possible solutions previously introduced by experts, initiate and develop a new concept of total float ownership and management to solve the defined problem. Adopt the proposed concept of total float pre-allocation and management which involves pre-allocating an equal amount of total float to the two contractual parties, the owner and the contractor.

STEP SIX Develop four total float clauses to direct the application of the proposed concept and recommend them for insertion into contract documents. Develop formulas that can be applied to delay situations in order to determine responsibility.

STEP SEVEN Validate the concept by conducting a modified Delphi survey. The following steps were taken.

- Selection of panel members.
- Development of survey instruments, including a questionnaire and MS PowerPoint presentation.
- Distribution of the survey to the pre-selected panel of experts.
- Collection of data.
- Analysis of data.

To validate the proposed concept of total float management, select a Delphi survey to bring together opinions from pre-selected experts. The Delphi method—a structured process for collecting and refining knowledge from pre-selected groups of experts—has been chosen as the data collection approach. This method allows experts to deal systematically with a complex problem. It comprises a series of questionnaires to be sent either by mail or via computerized systems to a panel of pre-selected experts.

The new concept of total float management is presented as an animated graphic presentation using a Microsoft PowerPoint presentation disseminated to survey participants via email or mail. The detailed methodology and implementation of the survey is discussed in Chapter 7—Survey Validation of the Proposed Concept.

STEP EIGHT Refine the proposed concept by incorporating the experts' opinions and suggestions obtained through the validation survey. Two examples of the complex situations—*concurrent-delay* and *multiple non-critical-path* situations—are added to this dissertation to better present the application of the proposed concept.

1.5. DISSERTATION ORGANIZATION

The first part of this dissertation—chapters 2 and 3—provides for a basic understanding of key elements related to this topic. More specifically, Chapter 2 presents a basic concept of project planning and CPM scheduling in construction projects, while Chapter 3 examines construction contracts and scheduling specifications in the areas of delay, time extension and total float, as written in project contract documents. Additionally, Chapter 3 also includes reviews of legal perspectives on CPM scheduling in the construction industry. Figures 1.1 to 1.6 illustrate the structures of chapters 2, 3, 4, 5, 6, and 7, respectively.

Chapters 4 and 5 make up the second part of the dissertation, which presents a review of literature produced on the topic of total float concepts and related issues. In order to identify the problems and potential risks associated with total float consumption, Chapter 4 provides a more formal literature review of the topic, while Chapter 5 examines existing and recently introduced total float management methods in an effort to introduce potential solutions to these problems. To illustrate that the issues of total float management and ownership have long been problematical, previous and current court decisions regarding float-related delay claim cases are also explored.

Chapter 6 introduces the new and comprehensive concept of float allocation and management. Under the new concept of float, an explicit statement of float treatment should also be incorporated into the contract document pertaining to procurement and scheduling. To validate the new concept, a survey is conducted, as summarized in Chapter 7. Finally, research conclusions and recommendations for further study are presented in Chapter 8.

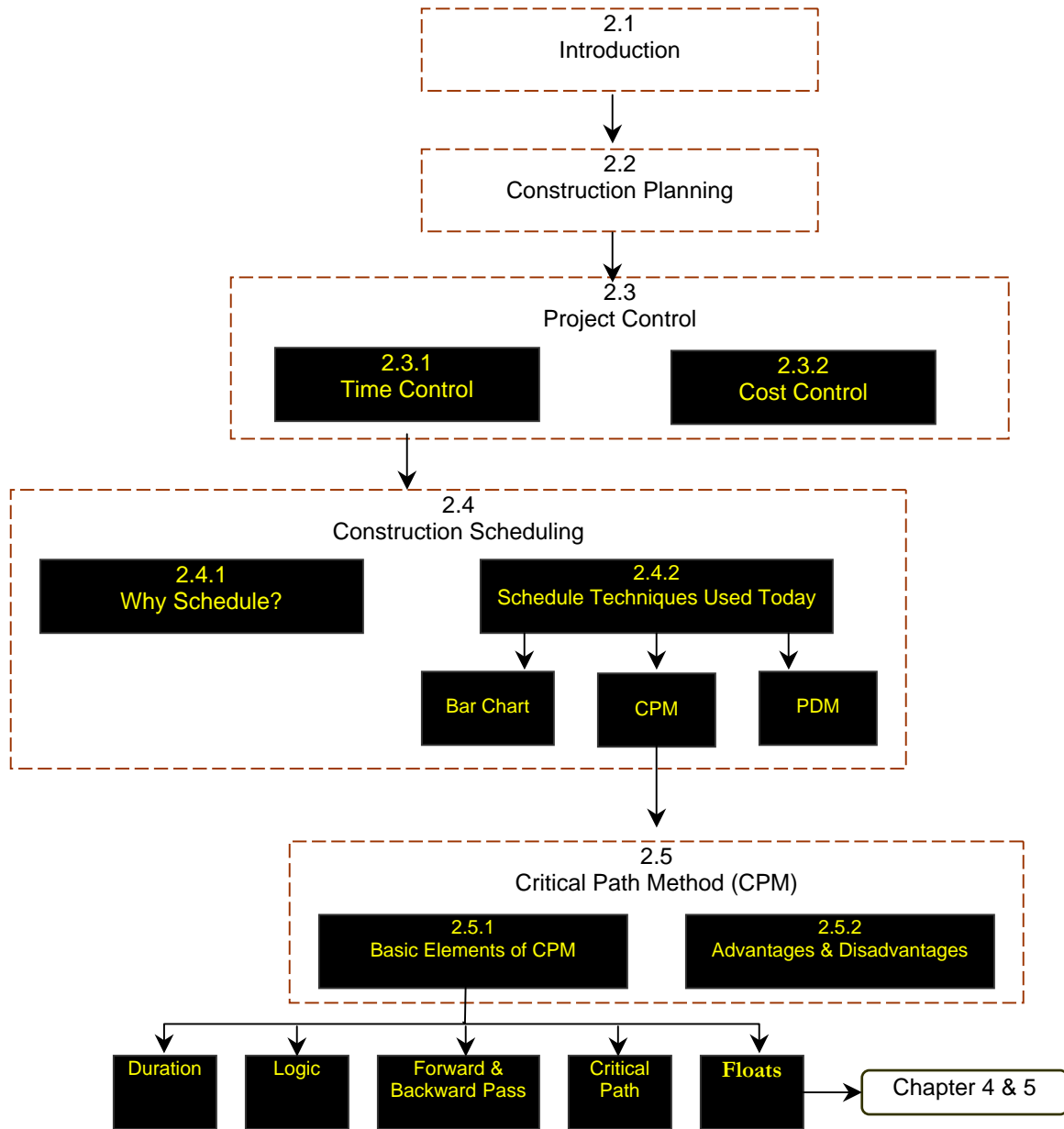


Figure 1.1: Chapter 2 – A Basic Knowledge of CPM Scheduling Technique

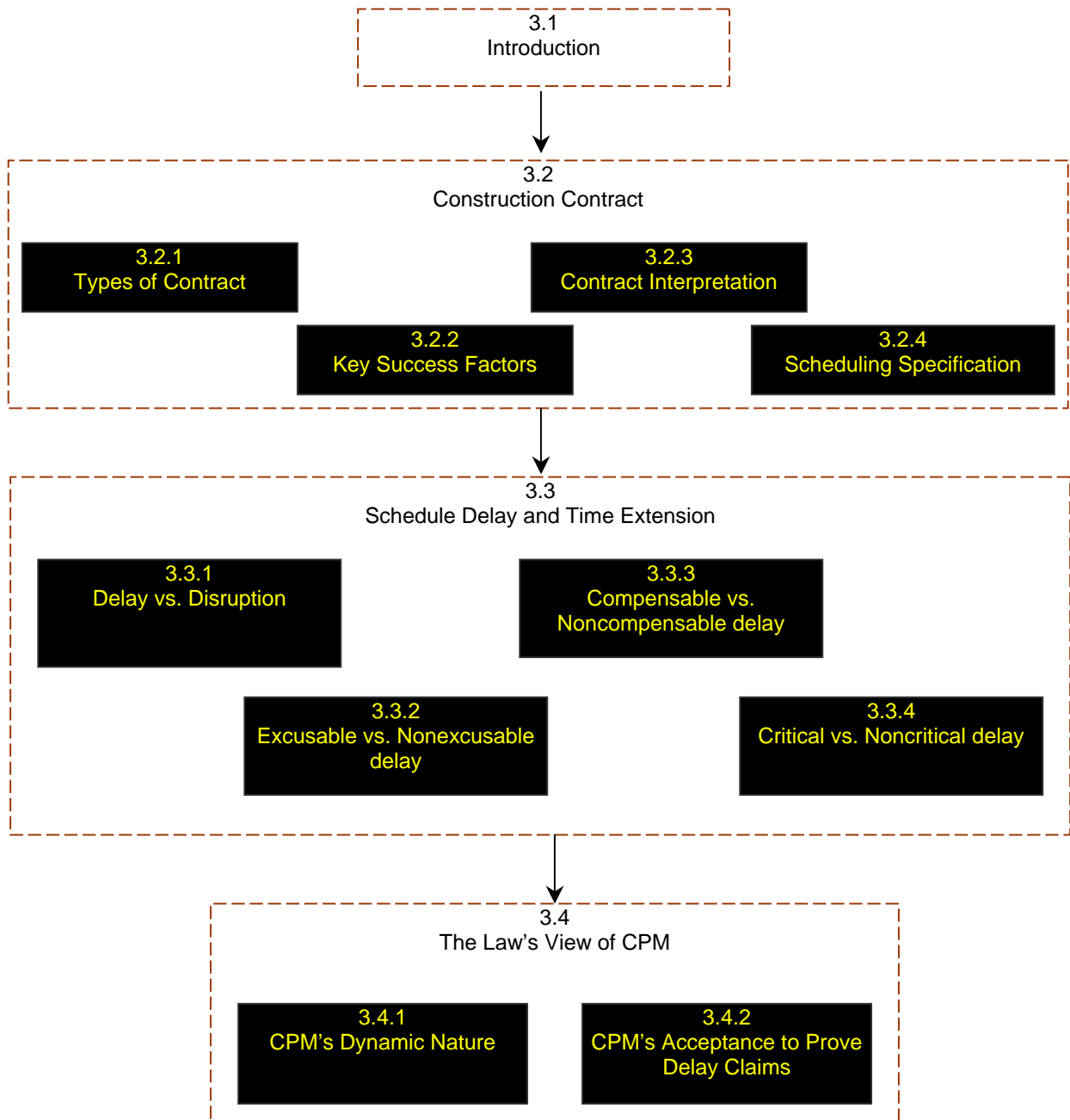


Figure 1.2: Chapter 3 – A Basic Knowledge of Schedule Contracting and Law

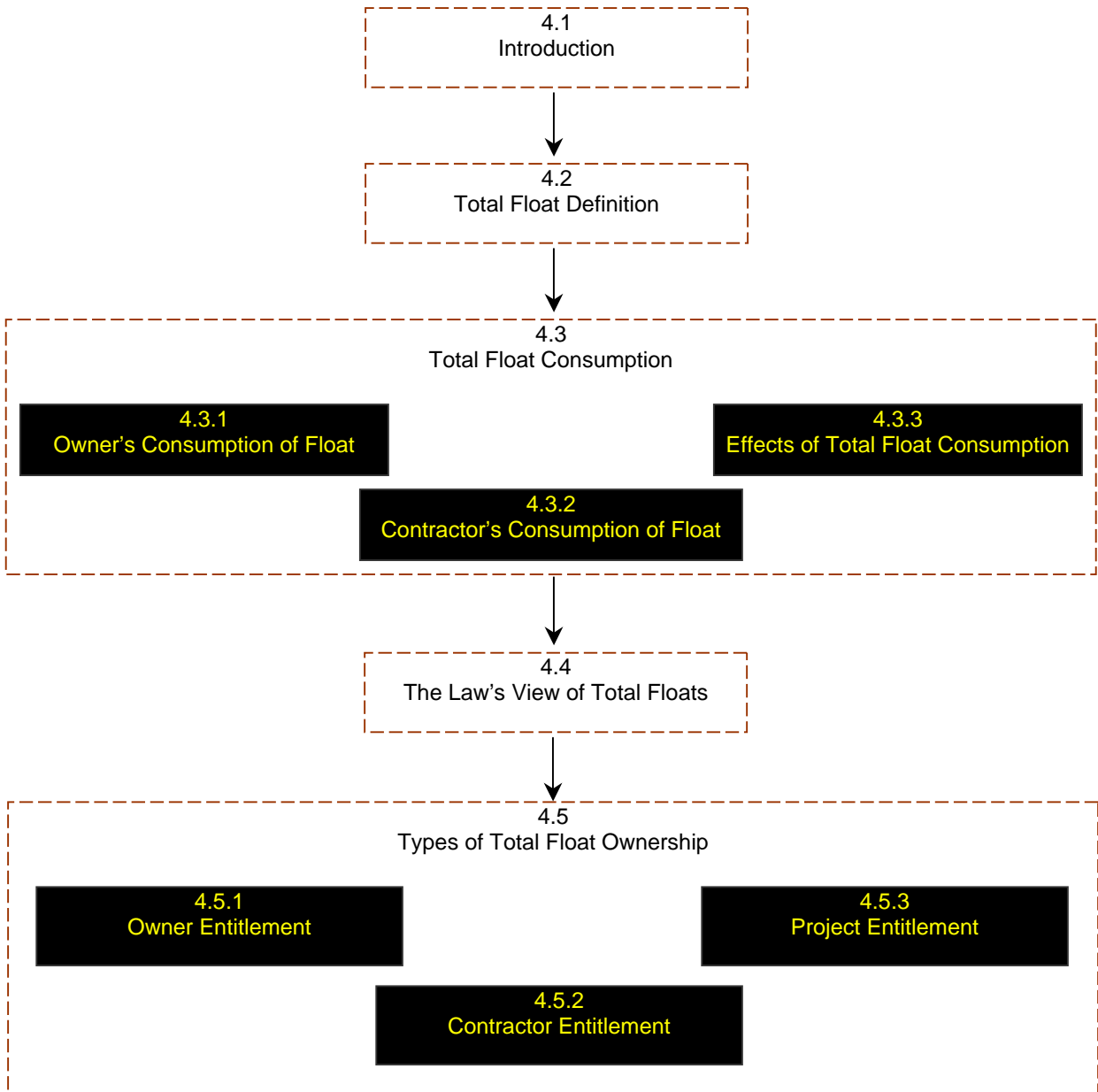


Figure 1.3: Chapter 4 – Evaluation of Total Float Management in CPM Scheduling

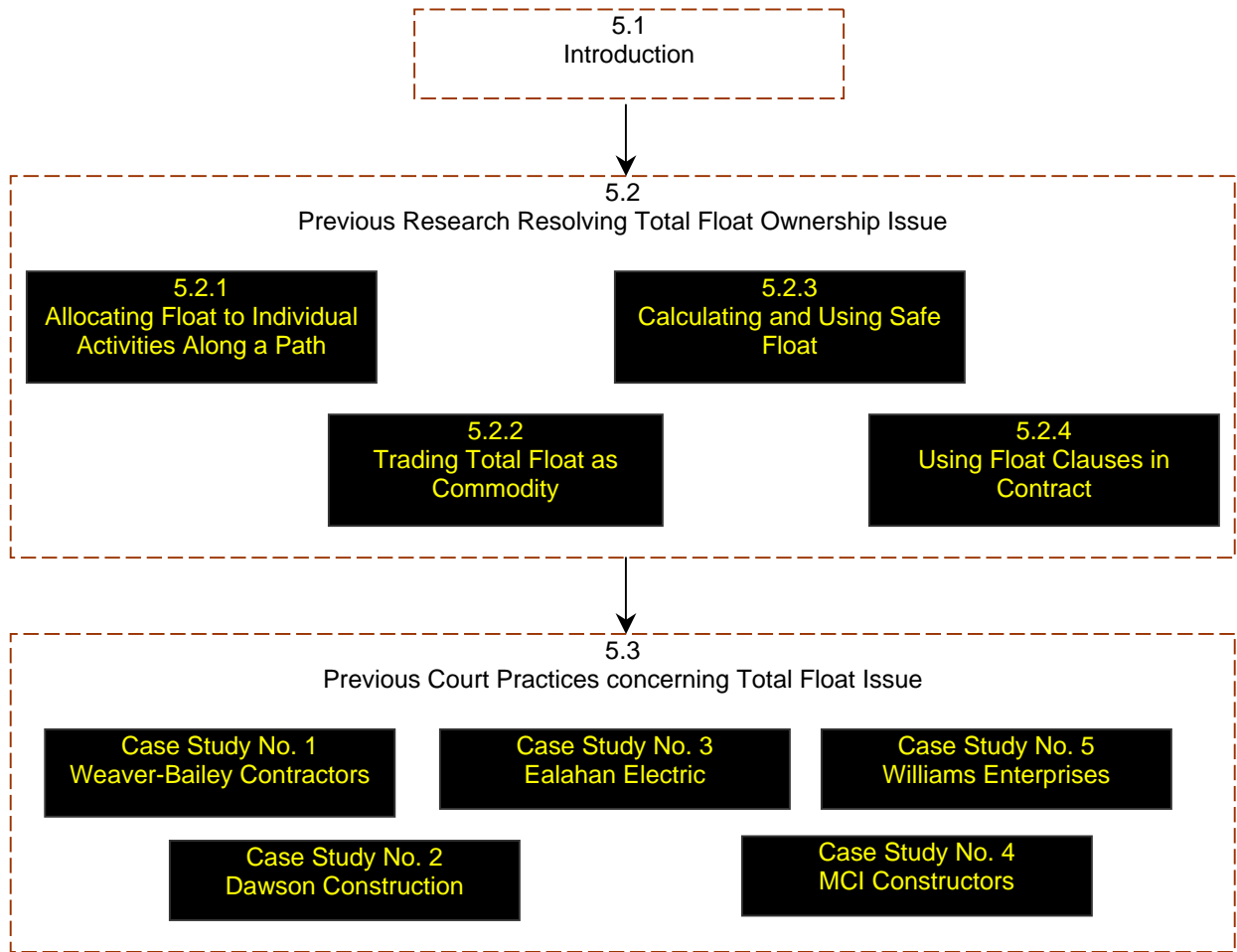


Figure 1.4: Chapter 5 – Research and Court Practices Concerning Total Float Management

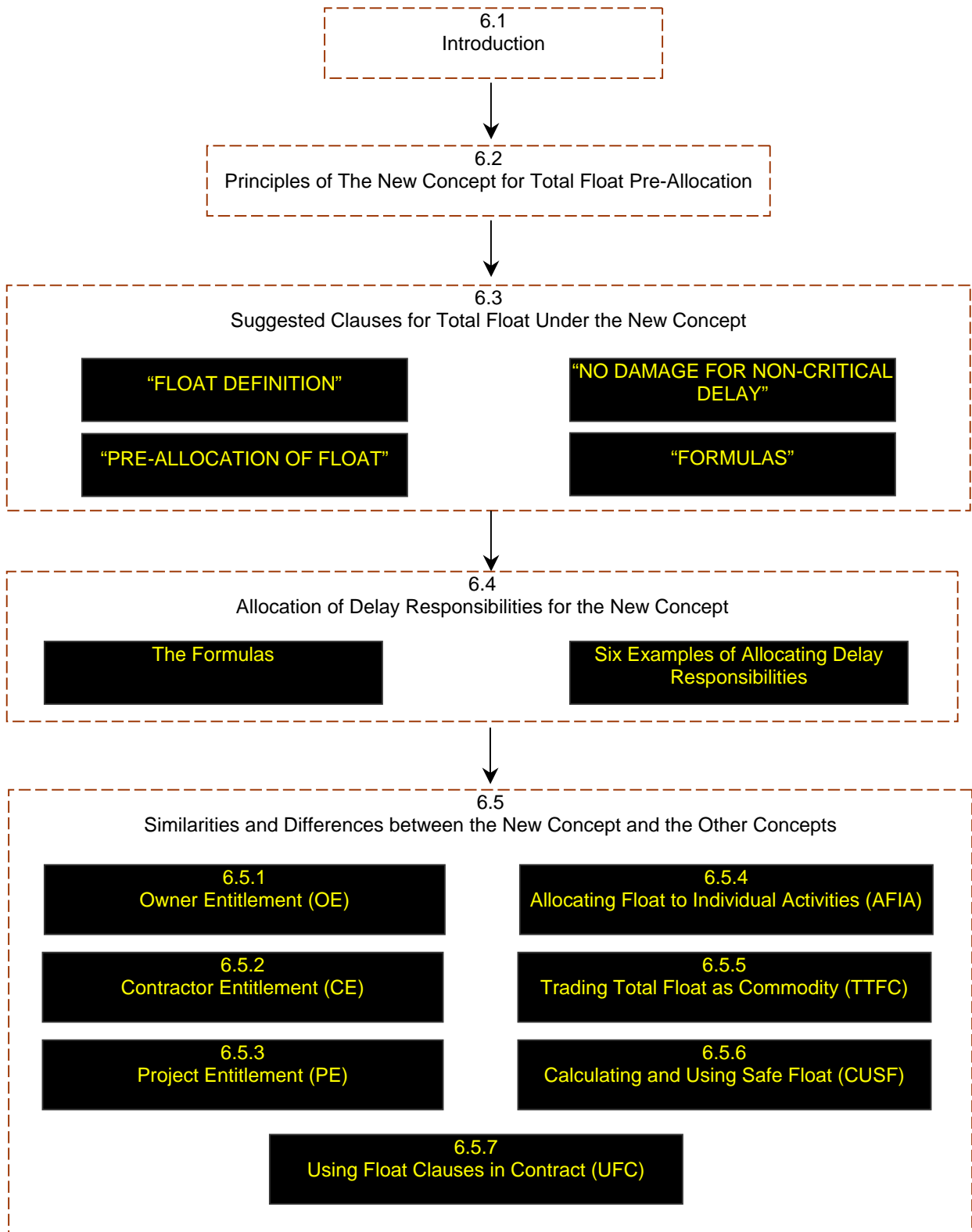


Figure 1.5: Chapter 6 – The New Concept of Total Float Allocation

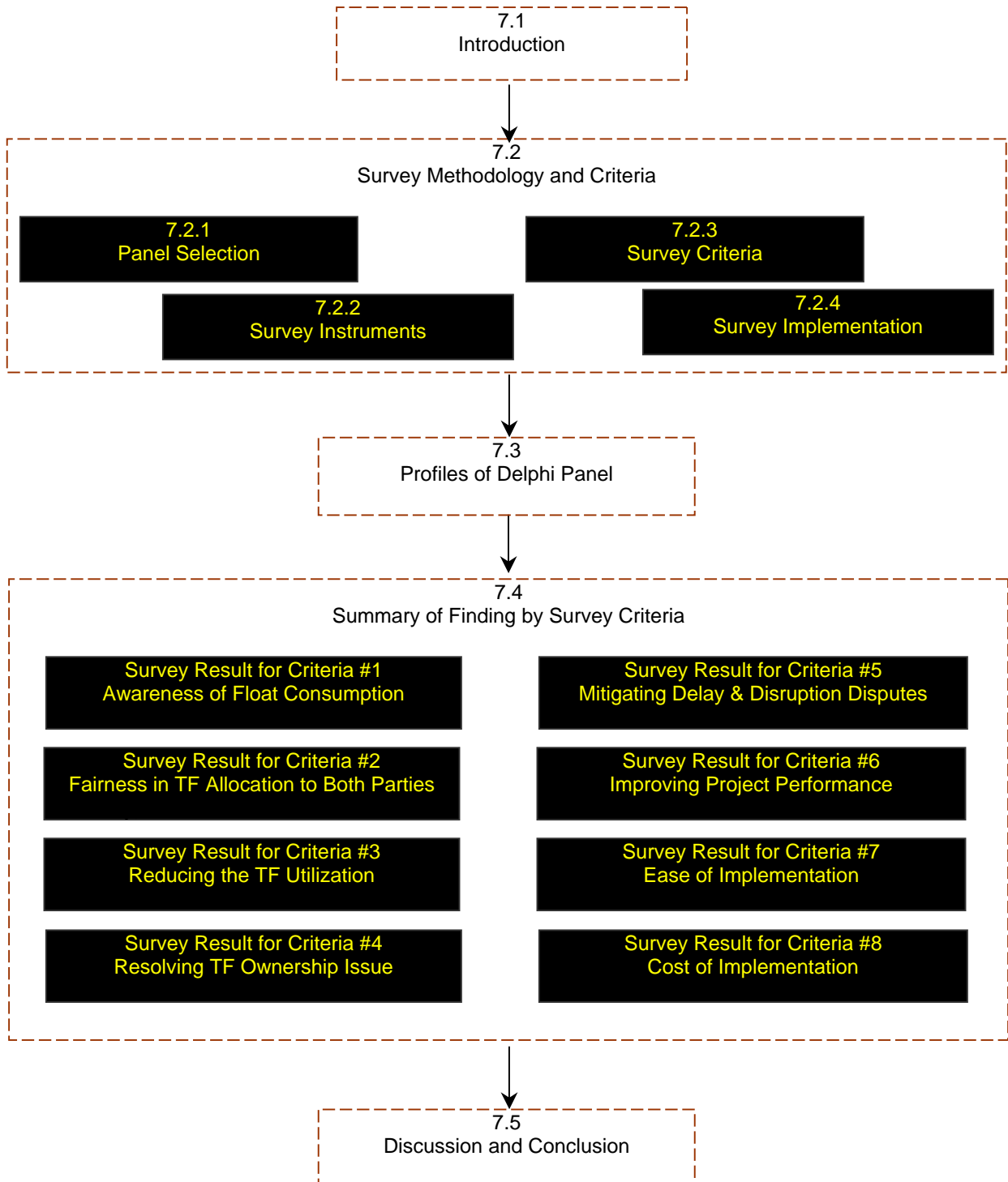


Figure 1.6: Chapter 7 – Survey Validation of the Proposed Concept

CHAPTER 2

A BASIC UNDERSTANDING OF CPM SCHEDULING

2.1. INTRODUCTION

Construction projects are growing increasingly complex and costly; therefore, greater attention must be paid to the control of both time and budget. Improved management and scheduling of construction projects are imperative to the success of any project, particularly large-scale ones. As a result, the construction industry has become proficient in developing many usable techniques to govern management, planning, and scheduling. One of the primary, if not the single most important, methods involves CPM scheduling techniques, which have been the most accepted in the industry because they serve not only as a tool for planning projects, but also as a means of supporting delay claims. However, the law's view of CPM has proven ambiguous, leaving open primary questions in the domain of CPM scheduling management and delay claim resolution (Ponce de Leon 1986).

The objective of this chapter is briefly to describe how scheduling fits into the overall construction planning, examine reasons for the use of scheduling in construction projects, and define basic concepts of CPM, as well as its advantages and disadvantages.

2.2. CONSTRUCTION PROJECT PLANNING

Project planning is a process of developing proper approaches to accomplish predefined objectives. Since it involves choosing among alternate courses of action, planning logically represents a form of decision making. In general, as noted by Jaafari (1984) and Glavinich (1994), project planning consists of seven objectives:

1. To balance uncertainty and modification.
2. To acquire a thorough understanding of project objectives and focus attention on predefined objectives.
3. To achieve economical operations and formulate strategies for achieving project objectives using available resources.

4. To facilitate control by developing a framework for monitoring and directing the project.
5. To allocate contractual responsibilities and provide clear lines of communication.
6. To coordinate contributions from various groups, during the engineering phase.
7. To mitigate and resolve delay and change order disputes on a predefined, quantifiable and equitable basis.

Planning establishes what needs to be done, who needs to do it, how long it will take to do it, when it must be done, and how to meet project objectives. Laufer and Tucker (1987), who have recognized the importance of planning in the implementation of construction projects, have also studied probable causes of planning failures. Their conclusions were that construction planning effectiveness could be improved by enhancing the qualifications, orientations, and motivation of the parties involved in the project.

However, the efforts of improving construction planning effectiveness also typically require time and resources. A study by Faniran, Love and Li (1999) shows how much efforts should be invested in construction planning activities in order to achieve the ultimate goals of the construction project: completing the project on time and within the budget. Their study suggests that investing in construction planning efforts beyond an optimum point would increase not just the probability of poor project performance but also overhead costs.

Total float allocation and management are two of the most important means of improving construction planning effectiveness. Therefore, since the wrong course could lead to high implementation costs and make impossible the achievement of overall project goals, the selection of a feasible and reliable total float allocation method should be of primary importance to any construction project.

2.3. CONSTRUCTION PROJECT CONTROL

During the life of any construction project, the primary objectives are completing work on time and within the budget while also meeting quality requirements and other contract specifications. Many researchers share the opinion that the success of construction

projects requires extensive planning and controlling systems (Pasiphol 1994; Rasdorf and Abudayyeh 1991; Wickwire, Driscoll and Hurlbut 1991).

During the construction phase, procedures for project control and monitoring become crucial tools to managers and other participants in the process. To support the construction management process effectively, an integration of cost and schedule controls is vital to collecting quality data in a timely fashion (Rasdort and Abudayyeh 1991).

In general, construction controls focus on cost and time. Some experts also include suggest that such controls should involve issues of resources, risk, quality, and safety (Ahuja, Dozzi and Abourizk 1994). Although these issues are indeed important, for the sake of refining its focus, this dissertation will deal specifically with project cost and time controls.

2.3.1. PROJECT COST CONTROL

The cost of capital places a high emphasis on establishing a schedule and on working to achieve its targets, as no one can afford to lose interest on the money invested in a project while it is unproductive. Therefore, it is important to control the use of the investment productively and as early in the process as possible.

For cost control on a project, the construction plan and associated cash flow estimates can provide a baseline reference for subsequent project monitoring and controlling. Similarly, contract and job specifications provide the criteria by which to assess and assure the required quality of construction. Lastly, the final or detailed cost estimates provide a baseline for assessing financial performance during the project's life.

For controlling and monitoring purposes, and as a means of generally representing the basic unit for cost control, the original, detailed cost estimate is typically converted to a project budget and to individual job cost accounts (Halpin and Woodhead 1998). Job cost accounts may be disaggregated or divided into work elements that are related both to particular scheduled activities and cost accounts.

In addition to costs, within each job account, information on material quantities and labor inputs is typically retained in the project budget. With this information, actual material usage and labor employed can be compared to the planned requirements. As a result, cost

overruns or savings on particular items can be identified as due to changes in unit prices, labor productivity, or the amount of materials consumed.

The early detection of actual or potential cost overruns in construction activities is critical to management because it both provides an opportunity to initiate remedial actions and increases the chance of eliminating such overruns or minimizing their impact (Halpin and Woodhead 1998).

2.3.2. PROJECT TIME CONTROL

In addition to controlling costs, project managers must also give considerable attention to managing time. Construction typically involves a deadline for work completion, so contractual agreements will force attention to schedules. Moreover, delays in construction represent additional costs due to late facility occupancy or other factors. Just as costs incurred are compared to budgeted costs, actual activity durations may be compared to expected durations. This process involves forecasting the time to complete particular activities, developing a baseline schedule, updating schedule, and evaluating schedule progress and updates.

As failure to properly manage time will result in both schedule slippage and cost overruns, control is vital to the completion of a construction project on time and within budget. Construction planning and scheduling provides the means to plan and manage a construction project effectively.

With regard to schedule monitoring and control, progress on individual activities and the achievement of milestone completions can be compared with the project schedule.

2.4. CONSTRUCTION PROJECT SCHEDULING

In the early 19th century, a project schedule started by developing a bar chart or a Gantt chart in industrial management. Later, the bar chart was adopted by the construction industry. Since then, advanced technology has been developed and widely applied to assist in the scheduling of construction projects. The forms of schedules vary from simple bar charts to critical path method schedules.

Simply put, a construction schedule is a “time-phased” plan for performing the work necessary to complete a construction project (Willis 1986). A construction schedule is a tool to determine the activities necessary to complete a project, the time it will take to complete the activities, and the sequence in which the work must be performed to complete the project in a timely and cost-effective manner.

Most people in the construction industry accept the need for the use of construction project schedules. For example, Callahan, Quackenbush and Rowings (1992) presented three surveys that proved both the significance of planning in construction and the importance of proper construction schedules to control and manage time. The first survey¹ involved 448 owners of construction projects worth over \$10 million. The second survey² involved 493 owners of construction projects. The two surveys reported similar results: over half of the owners who experienced cost overruns on their projects believed them to be caused by poor scheduling on the part of contractors.

The third survey³, of 800 construction industry participants—including contractors, designers, subcontractors, construction managers, and owners—focused on the contractual aspect of the construction industry. The survey reported that over half of the respondents considered the most threatening factor to contract relations to be poor contract administration. Eighty-three percent of the respondents expressed the opinion that contract administration could be enhanced by implementing computer-based cost and schedule control systems.

The results of the surveys support the importance of both planning and scheduling. Clearly, poor scheduling can be the result of poor planning or improper scheduling techniques. Callahan, Quackenbush and Rowings (1992) summarize:

1 Opinions of Building Owners on the Construction Industry, A Report to Wagner-Hohns-Inglis, Inc., Opinion Research Division, Fleishman Hillard, Inc., September 1983, St. Louis, MO.

2 Opinions of Building Owners on the Construction Industry, A Report to Wagner-Hohns-Inglis, Inc., Opinion Research Division, Fleishman Hillard, Inc., April 1985, St. Louis, MO.

3 A Report on Current Construction Contract Practices in the United States, Arthur Andersen & Co., Washington, D.C. 1984.

“Construction schedules can reduce delays, cost overruns, and disputes. Without a schedule, a project has a higher probability of delays and the cost overruns and disputes which seem to follow.”

2.4.1. WHY SCHEDULE?

Many major construction contracts require the contractors to use a specific CPM scheduling technique to manage and control project performance. In general, the contractors will receive payment based on the progress reported in the schedule; however, there are more important reasons to use the schedule than for the mere meeting of contractual requirements. Here summarized are seven other, and equally important, reasons for the use of schedules in the construction project:

To Predict Completion Time and Task Time

A construction schedule can be used to predict project completion time and task start and finish times (Willis 1986; Callahan, Quackenbush and Rowings 1992). The completion time is essential in construction projects. In most instances, failure to meet the contractual completion time required by contract results in the payment of financial penalties or liquidated damages. By knowing the completion time and task time, construction managers can arrange to have materials, craftsmen, and equipment on site when they will be needed. Examinations of the task times may mitigate conflicts that will occur among different trades or subcontractors because of limited workspace.

To Control Financing and Receive Payments

Contractors may also use schedules to control financing and receive payments from owners, as required in contract documents of construction projects (Willis 1986; Zack 1992). By using a construction schedule, the percentage of completion met by the project can be determined. Contractors will receive payments based on the percentage of completion at the time invoices are submitted. In addition, the difference between actual paid costs and payments received from owners is valuable information for controlling the project contractor's cash flow.

To Serve as a Record

A schedule may serve as a record of the project's progress. The schedule should be regularly updated to show both scheduled and actual task times, changes in work sequence and durations, changes in the project scope or design ordered by the owner, and unanticipated delays. By updating schedules regularly and accurately to reflect the actual events of the project, the period updates can be used to measure the percentage completion of remaining activities, as well as to determine the impacts of delays and time extensions.

To Satisfy a Contractual Requirement

Some contractors use construction schedules merely to satisfy a requirement specified in contract documents. Often, in contract construction, owners require the contractors to submit a copy of the contractor's schedules. Some contracts may specify the type of the schedules used to manage and control construction projects. Progress status reports of original and updated schedules may be required to provide detailed analysis of the schedules on a typically monthly basis. Most contracts require contractors to use updated schedules as a notice of claims or as a request for additional performance times or extra costs.

To Support Delay Claims

Construction schedules have been widely accepted for use in supporting delay claims (Kallo 1996; Knoke 1995; Ponce de Leon 1991; Zack 1992). When properly used and updated, the construction schedule can show the interdependencies between two activities and the effects of additional work and unanticipated delays on the projects. Review boards and courts have indicated a preference for using CPM scheduling to identify delays, disruptions, their causes, and responsible parties (Kallo 1996; Wickwire, Driscoll and Hurlbut 1991). However, when used to prove delays, the schedule must conform to the actual progress and sequences.

To Communicate the Construction Plan

A construction schedule can be used as a communication tool at the construction site to coordinate general contractors, subcontractors, suppliers, owners, and designers (Glavinich 1994). Without the schedule, these parties will not know when their tasks need to be

performed or how their work relates to that of others involved in the project. The schedule may reveal conflicts among trades because of required extra work. By identifying potential conflicts, remedial actions or special protection actions may be arranged to mitigate any possible potential damages in time and cost overruns to the projects.

To Manage Change and Uncertainty

It is commonly accepted that construction projects do not proceed as planned. During any project, unexpected events and conditions can occur to impact the contractor's ability to proceed with completion plans. Contractors and owners can use construction schedules to evaluate the effect of changes and unexpected events, then use this information to modify the schedules and thus avoid delays in project completion time (Glavinich 1994; Callahan, Quackenbush and Rowings 1992). The updated schedules can also be used to measure values and impacts of change orders originated by owners.

2.4.2. SCHEDULING TECHNIQUES USED TODAY

Many types of scheduling techniques can be used to manage a construction project, ranging from a simple bar chart to a sophisticated network schedule. Before discussing CPM scheduling techniques, however, it is essential to understand the basis and development of three major schedule methods, as presented in the following sections.

Bar Chart

Originally developed by Henry L. Gantt in the early 1900s, the bar chart is the most widely-used method of planning and scheduling construction projects because it is simple to read and interpret, easy to prepare, and easy to understand by all involved parties. This type of chart provides a graphic presentation of the project plan, including the tasks to be performed, the estimated time of each activity, and the planned sequence of activity performance.

However, the bar chart schedule is imperfect for scheduling and controlling large and complex construction projects that depend for progress and completion on multiple-activity interaction. Due to its simplicity, a bar chart simply cannot show the interrelationships between such activities.

Critical Path Method (CPM)

To overcome the drawback posed by bar chart schedules, network scheduling using the Critical Path Method (CPM) has been developed and widely used in the construction industry. As created by an engineering control group from the E.I. Du Pont de Nemours Company, the critical path method of network schedules was first used to improve the control methods of a large chemical plant construction. Wickwire, Driscoll and Hurlbut (1991) describe CPM as a graphic presentation of the planned sequence of activities showing the interrelationships and interdependencies of the activities in a project. CPM scheduling is discussed in greater detail later in this study.

Precedence Diagramming Method (PDM)

The concept of the Precedence Diagramming Method (PDM) was introduced by Professor John W. Fondahl of Stanford University in 1961 and was implemented for IBM in 1964 by the H.B. Zachery Company. Essentially, PDM is an advanced networking technique of activity-on-node diagramming with additional precedent relationships—basically a form of CPM. While CPM allows only one logical relationship (finish-to-start) between activities, during which the preceding activities must be completed before any succeeding activities can start, PDM uses four logical relationships between activities: finish-to-start, start-to-start, finish-to-finish, and start-to-finish.

Wickwire, Driscoll and Hurlbut (1991) state that use of the precedence diagramming method gained popularity because with it users could avoid the dummy activities required in CPM to maintain logic relationships. PDM allows for overlapping relationships between activities to be developed without splitting activities. The number of activities in PDM schedules are, therefore, smaller than those in CPM schedules. Thus, PDM is easier and faster than CPM to prepare. However, unlike CPM scheduling, the use of multiple logical relationships in PDM makes network or delay analysis more difficult (Callahan, Quackenbush and Rowings 1992).

2.5. CRITICAL PATH METHOD TECHNIQUES

The most widely used scheduling technique, the Critical Path Method breaks down an entire project into individual activities, estimates feasible durations in which to complete the activities, and—to control overall project completion and produce numerous activity paths—creates relationships among them. The longest path of the resulting schedule is called the “critical path”: it consists of activities that, if delayed, will extend the project beyond its predetermined completion date. In addition to the critical path, there are other various side paths called non-critical paths. If affected by improper scheduling or performance delays, these paths—not initially planned as critical—could become critical and thus alter the original critical path.

A CPM schedule is designed to advise involved parties about the relative importance of performing certain activities within the project completion parameters. For example, it indicates to participants whether their work is critical, non-critical, or has any float associated with its performance.

2.5.1. BASIC ELEMENTS IN CPM SCHEDULING

CPM scheduling consists of several basic elements, to be discussed in depth in the following sections.

Activity Duration

An activity’s duration is the amount of time estimated for its completion. The time unit for the project can be minutes, hours, work days, calendar days, weeks, or months. Most construction schedules commonly use durations of work days or calendar days. Fractional time units can be used for activity durations, but integer time units are more common. The only requirement is that the use of the time units expressed should be consistent throughout the schedule (Glavinich 1994).

The activity duration is a function of the estimated quantity of work that must be accomplished and the average production rate at which that work can be accomplished. Basically the activity duration can be estimated by the following formula:

$$\text{Activity duration} = \frac{\text{Work quantity}}{\text{Production rate}}$$

Willis (1986) and Callahan, Quackenbush and Rowings (1992) point out that activity durations are estimated, and that it is not essential for these estimates to be consistently exact. If all durations are reasonable, then variations in activity durations will compensate each other, resulting in a reasonably accurate project duration. Wickwire, Driscoll and Hurlbut (1991) suggest that the accuracy in estimating activity time should not be overemphasized because doing so could make more difficult the task of developing reliable duration estimates.

To obtain the best estimate of each activity's duration, the scheduler must consult with the project's estimator and superintendent. The accuracy of duration estimates depends on many factors including:

- Methods of construction
- Resource availability
- Work quantity
- Nature or complexity of work
- Labor and equipment productivity
- Quality of field management
- Weather and site conditions
- Concurrent activities

To gain the best duration estimate, it is also necessary to obtain duration estimates from each trade contractor or subcontractor involved in the project and then to incorporate these estimates into the schedule.

Logical Relationship

A major component of schedule preparation is determining the sequence or developing activity logic. After estimating durations, the next step in schedule preparation is arranging activities in the order in which they should be performed. Callahan, Quackenbush

and Rowings (1992) define “logic” as the order in which the activities will be performed and “logical relationship” as the relationship of any activity to another.

There are three possible logical relationships among activities: predecessor, successor, and concurrent or independent. A *predecessor* relationship between two activities means that one must be completed before the other can begin. For instance, steel fabrication must occur before steel installation. Conversely, a *successor* relationship between two activities means one must come after the other. Using the previous example, steel installation work must occur subsequent to steel fabrication. If two activities have neither a predecessor nor a successor relationship, then both activities are *independent* of or *concurrent* to each other. A concurrent or independent relationship between two activities does not always mean that the activities will be performed at the same time. It simply means that the completion of one activity is not contingent on the beginning or completion of another.

Activity logic must be logical, reasonable, and possible to carry out through construction. With an unreasonable, irrational, impossible sequence, the schedule is considered to be unworkable. Callahan, Quackenbush and Rowings (1992) and Willis (1986) highlight two important aspects for determining sequence on the logic diagram. The first aspect is that proper sequencing requires an understanding of the construction itself, not merely its scheduling. The second aspect is that there is always more than one correct way to sequence any construction project.

In their study of construction scheduling, Echeverry, Ibbs and Kim (1991) point out that the task of sequencing a schedule requires experience in and knowledge of construction issues so that activities can be arranged in the sequence most likely to result in cost-efficient and timely completion of the project.

Forward Pass and Backward Pass

The next step after estimating activity durations and drawing the logic is using it to calculate the critical or longest path, which will be discussed later. This calculation involves determining four event times for each activity: early start (ES), late start (LS), early finish (EF), and late finish (LF).

Early start and early finish times for each activity can be determined through the process known as the “**forward pass**.” In performing the forward pass calculation, all activities in the network are assumed to start as early as possible. Early time calculations begin at the first event—which has an early start time of zero—and work forward from there. The value of all subsequent early event times is the sum of the event time and the activity duration, obtained through the following formula:

$$EF = ES + D \quad \text{whereas } D = \text{estimated original durations}$$

When two or more activities merge into a node, the value of the early time is calculated for each path using the above formula, and the largest value is used:

$$ES = \text{Maximum EF of direct preceding activity(s).}$$

The “**backward pass**” process calculates the latest time that each event in the network can start and finish without delaying scheduled completion, as figured by the forward pass. In performing the backward pass calculation, all activities are assumed to start and finish as late as possible. The calculation is similar to the forward pass calculation but is calculated from the end to the beginning of the project: it starts with the last activity in the network and works backward.

The backward pass calculation begins with the late finish of the last activity in the network equal to either an arbitrary scheduled completion time or the early finish time calculated from the forward pass. The late time of succeeding events is determined by deducting the activity’s duration from the late event time. Therefore, the late start of an activity can be calculated as follows:

$$LS = LF - D$$

The smallest of all calculated values for a particular activity is the late event time when the activity involves merging two or more activities:

$$LF = \text{Minimum LS of immediate subsequent activities}$$

Critical Path

After performing the forward and backward pass calculations, some activities will be found to possess the same early and late times. These activities must begin and end on their early start and finish times, as failure to complete them within these limits can affect the completion time of the entire project. Thus, these activities are called “critical” activities.

These critical activities form a continuous chain through the network known as the “critical path,” the longest path from the beginning to the end of the project. Various noncritical activities not on this path have a certain amount of float time, and any delay in them within this predetermined time will not delay project completion. As a result, project managers logically focus more of their attention to critical activities.

Floats

In the event that the early times of activities are not equal to the late times computed from the forward and backward passes, such activities do not have to start or finish with the early start or early finish times for the project to come in under or on schedule. However, these activities must begin and end *with* the late start or finish times. The difference between the early and late start and finish times indicate the maximum time the activities can be delayed without hindering project completion.

Several types of float are recognized, including total float, free float, independent float, and interfering float. The first two types are generally recognized and will be discussed in this dissertation.

Total Float

Total float for an activity is the difference between the early start date and the respective late start date, or between an early finish date and the respective late finish date. Total float, therefore, designates the number of time units belonging to all activities on the same path, which can be delayed without extending the project completion time. To simplify, it is the amount of time by which an activity can be delayed without delaying the completion date of the entire project.

Total float is an attribute of a network path and does not belong to any one specific activity along that path. Using total float for any single activity on a path thus will reduce the total float times for following activities. The lower the value of total float, the less flexibility the activity will have for timely project completion. The total float application will be discussed in greater detail later in the dissertation.

Free Float

Free float is the difference between an activity's early finish time and the earliest start time for any succeeding activities. The free float of an activity is the amount of time by which that activity can be delayed without affecting the early start of any following activities or other activities in the network. Unlike total float, free float is the property of an activity and is not shared with any other activities in the network.

Free float is calculated by subtracting an activity's early finish time from the early start time of the next activity. It represents the flexibility a contractor has regarding start and finish dates before an effect is felt on other activities in the network.

2.5.2 ADVANTAGES AND DISADVANTAGES OF CPM

CPM possesses numerous advantages, as well as disadvantages. Those attributes are discussed in this section.

Advantages

Minimizing erroneous and misleading schedules. Willis (1986) mentions that because CPM scheduling preparation requires detailed analysis of the project, the scheduler or project manager in charge of it would have a better understanding of the project. This requirement minimizes the possibility of erroneous or misleading schedules.

Well-established and easy to understand. The CPM is well established and easy to understand, with techniques for drawing and calculating project durations developed from advanced high technologies. The CPM technique is like a "common language," widely used in and accepted by the construction industry.

Accepted in proving delays. The CPM can be used to determine the length of delays or additional times needed as a result of unexpected events occurring or changes demanded during the construction process (Jaafari, 1984 and Callahan, Quackenbush and Rowings 1992). As previously mentioned, review boards and courts of law have accepted the use of the CPM technique to prove delay and inefficient claims, identify the causes of such delays and inefficiencies, and assign responsibility for them (Wickwire, Driscoll and Hurlbut 1991; Sweet 1999). However, when used in delay analysis, the schedules should be realistic and reasonable.

Other benefits of the CPM techniques are those involving scheduling, explained in the previous section entitled “Why Schedule?”

Disadvantages

Simple nature of CPM logical relationship. The simplicity of the CPM logical relationship makes it difficult to specify in reality such relationships (Willis 1986). The single logical relationship used in the CPM technique simply is not adequate for expressing all of the various sophisticated relationships possible in the field. In the case that activity B can start when activity A is half finished, for instance, the single logical relationship in CPM cannot specify the real relationship in a simple way. In addition, two subdivided activities needed to replace activity A are required to present the correct relationship between the activities A and B. In summary, in order to replicate construction activities in the field, this method requires many subdivided activities linked as “stair steps,” where activities A and B can start or finish together or the start of activity A may overlap the completion of activity A (Callahan, Quackenbush and Rowings 1992). The overlapping need can be successfully addressed with PDM relationships.

Reliability of activity times. Willis (1986) and Hulett (1995) believe the reliability of activity times computed from forward and backward pass calculations to be questionable. The activity times are based on the network logic or sequence and on estimated activity durations developed by a scheduler. In most cases, the estimated task durations will not prove to be exactly correct, nor will the tasks be performed in the exact sequence. Hence, it is uncertain that the actual activity times will correspond exactly with the scheduled activity times. It is more likely that CPM durations are over-run rather than under-run although

contingencies are considered and incorporated during the scheduling preparation (Hulett 1995).

Cost of the CPM scheduling. Jaafari (1984) states that CPM scheduling is expensive to run, while Sweet (1999) notes that it can increase for owners the total contract price. The problem is a simple one: it requires time for managers and decision-makers to review status reports; by the time they review them, the information they provide tends to be outdated. In addition, Sweet mentions that the practical integration of CPM-based progress and cost control was extremely difficult, nonproductive, and expensive.

Attention of Project Managers to critical activities. Construction planning involves not just paying attention to a particular path related only to activity durations (Jaafari 1984). It involves giving equal attention to all activities in the network and perhaps alerting project managers to delete such artificial paths. Cost is also a significant element in construction planning; therefore, it should be considered in scheduling and in determining the criticality of activities.

2.6. CHAPTER CONCLUSIONS

The use of the Critical Path Method (CPM) scheduling technique as a management tool in construction projects is well known and widely accepted. Moreover, it has become not only a tool for planning projects, but also a tool for supporting delay claims. Many researchers have the same opinion that the success of construction projects demands such proper planning and controlling systems.

This dissertation presents two types of project controls: cost and time. Cost control is essential for managing the investment in a productive manner as early as possible in the process. Early detection of actual or potential cost overruns can provide parties with an opportunity to eliminate or minimize the impact of such problems or to initiate remedial actions.

Time control is important to the quick and cost-efficient completion of any construction project. Planning and scheduling provide the means for effectively planning and managing such projects.

Schedules are used in the management of construction projects for a variety of reasons: to predict completion and task times, control financing and receive payments, serve as a record, satisfy a contractual requirement, support delay claims, communicate the construction plan, and manage changes and uncertainty.

CHAPTER 3

A BASIC UNDERSTANDING OF SCHEDULE CONTRACTING AND LAW

3.1. INTRODUCTION

This chapter deals with the legal aspects of construction contracting, with an emphasis on scheduling or time terms. In this context, and in general terms, *law* includes federal or state enacted laws (also called *statutes*), the rules of federal and state regulatory bodies promulgated to give effect to enacted statutes, and the common law (Bartholomew 1998). *Common law*—often called “judge-made law”—is defined as the body of past court decisions that have an influence on future court decisions. Because all past court decisions have been and will continue to be influenced by the customs and practices of the construction industry, these practices are a part of the law as well and demand to be studied for their effects on the construction industry.

Before examining in detail the law’s view, this chapter aims to give a basic understanding of construction contracts, including the key elements in construction contracting, contract interpretation, samples of scheduling specifications, and schedule delay and time extensions. Finally, the law’s view on CPM scheduling will be presented as a way of better understanding how court decisions have been made.

3.2. CONSTRUCTION CONTRACT

A contract is an agreement between two or more parties containing specific project elements. Primarily, it defines the duties and responsibilities of the parties to the agreement. In general, there are five areas that must be identified and defined in the agreement, including (1) identity of the parties, (2) scope of the work, (3) time for performance, (4) price, and (5) payments (Richter and Mitchell 1982). This research dissertation focuses on the legal significance of the time allocated for performance within the framework of project schedules.

3.2.1. TYPES OF CONSTRUCTION CONTRACT

Due to the unique requirements of any construction project, as well as the individual owners' needs, owners can specify a particular contract type that should be used to govern or set forth the terms of their projects. Each type of contract allocates risk differently to the various parties involved. The selection of the contracting strategies will have a strong influence on project risk allocation, as well as on the responsibilities assumed by the individual parties regarding the schedule.

3.2.1.1. Fixed-Price Contracts

The *fixed-price* contract is also called a *Firm-Price Contract*, or sometimes a *lump sum* or *hard money* contract. Under this type of contract, the contractor commits to an agreed fixed price for providing all stipulated work and services required by the contract plans and specifications. Beside the agreed fixed price, the contractor is often obligated to submit to other specifications, such as a specific schedule, a management reporting system, or a quality control program. In the fixed-price contract, the contractor is required to absorb the cost if the actual price of the project is underestimated. On the other hand, the contractor will retain the savings as profit if the actual cost is less than estimated.

3.2.1.2. Unit-Price Contracts

In contrast to the fixed-price contract, in *Unit-Price Contracts*, the contractor agrees on the price by units. In effect, the contractor will receive payment for each unit of work that is actually performed. This type of contract is often used for projects—such as excavating, paving, etc.—in which the quantity of work can be broken down into work items that can be characterized by units, such as cubic yards, linear and square feet, and piece numbers. Under this unit-price contract, the contractor does not have to absorb the risk of inaccurately estimating uncertain quantities. If an underestimate or overestimate of quantities occurs, it will not affect the contractor's profit beyond the markup in the unit price. However, the contractor may incorrectly quote the unit cost and thus take in the risk of inaccurate estimation of unit price. Therefore, the unit price contract eliminates some—but not all—risk for the contractor.

3.2.1.3. Cost Plus Percentage Fee Contracts

When a *Cost Plus Percentage Fee Contract* is undertaken, the contractor is entitled to a reimbursement of the actual incurred costs, plus a percentage of those costs, to cover overhead costs and a profit. Under this type of contract, the owner is more vulnerable because the contractor has less motivation for controlling costs: the greater the actual incurred costs, the more the contractor earns.

3.2.1.4. Cost Plus Fixed-Fee Contracts

Similar to the cost plus percentage fee contract in application, under the *Cost Plus Fixed Fee Contract*, the owner agrees to pay the actual allowable costs, plus a fixed fee for the services performed. This type of contract overcomes for owners the drawback of the cost plus percentage fee contract, because the fixed fee component encourages the contractor's diligent efforts to finish the project early. If the costs or time overrun the original estimate, the contractor may risk the erosion of profits.

3.2.1.5. Other Types of Contracts

Other types of contracts include *Target Estimate (Cost Plus Incentive Fee)*, *Guaranteed Maximum Price*, *Convertible*, *Cost Plus Variable Percentage*, and other combinations of several types of contracts mentioned herein.

3.2.2. KEY SUCCESS FACTORS FOR CONTRACTS

The success of a construction contract is made, not given. To create a well-written contract suitable for the unique requirements of a particular project, many components must be considered, but four factors are crucial to success. They are selection of contract types, proper contract preparation, contractual risk management, and well-defined, well-written contract language.

3.2.2.1. Selection of Contract Types

As mentioned earlier, a number of contract types is available, each possessing its own particular advantages—and drawbacks. The contract type should be chosen with care so that it completely agrees not only with the uniqueness of the construction project but also with the

desires and needs of the project owner (Ashley and Mathews 1984). Regardless of which type of contract is chosen, however, in it the objectives of each project should be clearly defined and evaluated. The degree of risk or involvement that the owner is willing to assume must be predefined. The bottom line is that all determining factors must be considered before a particular type of contract is settled upon.

3.2.2.2. Proper Contract Preparation

The form a particular contract will take is specified by the project owner, who can choose to use standard forms developed by such organizations as the Associated General Contractors of America or the American Institute of Architects or even to prepare custom contracts in-house. In fact, many government agencies and large firms have developed their own standard contract forms.

The contracting plan should not be over-generalized. The rights and responsibilities of the parties involved in the agreement should be clearly stated in the contract documents (Ashley and Mathews 1984; Ibbs and Ashley 1986; Sweet 1999). Under the *time* heading in the contract, for instance, start and finish dates should be defined, and the planned construction period should be clearly stated. Delay and time extensions should also be covered.

Ashley and Mathews (1984) state, “Out of all the available contractual arrangements, none would be successful without proper preparation.” Ibbs and Ashley’s 1986 study has demonstrated the importance of thoughtful and meticulous preparation of contract documents with respect to the improvement of project performance. They also point out that well-prepared contracts would be relatively free of potential areas for dispute. In addition, Hartman, Snelgrove and Ashrafi (1997) have the opinion that well-defined wording in contract documents can clarify interpretation and significantly decrease the potential for dispute.

3.2.2.3. Contractual Risk Management

Contractual risk management is another key factor in contract preparation. Risk is the possibility of gain or loss caused by unexpected events that may occur during the life of the construction project. As mentioned previously, in order to select an appropriate contract

strategy, the owner must rationally determine the extent of risk which he is willing to assume. The contract document must also contain a legally defined relationship among project parties for assigning and allocating risk.

Ibbs and Ashley (1986) state that a key factor in successful contracting strategies is the transference of risk liability to enhance overall project objectives. When this strategy is undertaken, it becomes essential not only to select a proper contract strategy that suits the project objectives, but also to design the contract documents to incorporate the resource capabilities of the contractor. Unfair contract conditions obviously have an unfavorable impact on project performance and create adversarial relationships among involved parties. It is noted that the party with the greater involvement in the contract preparation is the one most likely to bear the risk even when the contract is silent on this issue (Richter and Mitchell 1982).

3.2.2.4. Well-Defined and Well-Written Contract Language

In terms of its language, the construction contract should be clear, complete, and precise. Certain terms in the contract must be clearly specified and defined in order to avoid any conflicts and inconsistencies within that particular document or between documents. Specifically, contracts should be written with such clarity and precision that they leave no question as to the clearly-defined duties and responsibilities of each party involved in the process.

Ambiguities of contract languages often are the source of disputes; they can create situations difficult to resolve (Vezina 1991; Ibbs and Ashley 1986). In the case of such ambiguities, courts generally will rule against the party who was responsible for developing the problematical language or terms in the contract (Willis 1986; Sweet 1999). Such a judgment is meant to penalize the party responsible for the ambiguity and to protect the party who had no voice either in preparing the contract or choosing the language (Sweet 1999).

3.2.3. CONTRACT INTERPRETATION

As previously mentioned, construction contract documents—including all plans and specifications—should be clear and complete. They should clearly define the owner's and contractor's individual duties. The contract language should be so clear and precise that it

effectively communicates, without question or debate, risk apportionment between the contracting parties.

However, Sweet (1999) points out, “even the best design professionals cannot do a perfect job of drafting the construction documents that encompass the complete construction obligation.” Because the contract documents must often be interpreted by various parties in a construction project—the designer, the contractor, the consultant and the owner—this multidimensional feature of contract documents can lay the groundwork for additional disputes, inconsistencies, and ambiguities (Sweet 1999).

In considering matters of contract interpretation, two factors must be taken into account: the *contra proferentem* rule and questions of good faith and fair dealing.

Contra Proferentem Rule

One well-known contract interpretation involves *contra proferentem*, which interprets ambiguous language against the party who prepared the contract and is thus responsible for its insertion (Sweet 1999; Hartmann and Snelgrove 1996). Based on this rule, the party who wrote the contract—often the owner—should consider the importance of using more precise language, and during the pre-bid process the other party—often the contractor—should demand better explanations of the intent of such language. Positive-sounding but actually quite ambiguous phrases such as “*reasonable* period of time,” “to the *satisfaction* of the designer,” and “act in *good faith*” often serve as the source of disputes (Vezina 1991; Sweet 1999).

Good Faith and Fair Dealing

On the subject of “good faith and fair dealing,” Sweet (1999) states,

The common law did not usually hold contracting parties to obligations of good faith and fair dealing. Refusal to do so reflected the common law’s belief that the written contract was sacred, contracting parties should take care of themselves, and good faith is imprecise.

*Beginning in the mid-twentieth century, however, and heavily influenced by the Uniform Commercial Code, American contract law began to hold contracting parties to the covenant of good faith and fair dealing. **One party cannot be expected to guarantee that the other party will receive the benefit it expects from a contract, nor must a contracting party make unreasonable sacrifices for the other party.** However, each party should not only avoid deliberate and willful frustration of the other party's expectations but should also extend a helping hand where to do so would not be unreasonably burdensome. Contracting parties, although not partners in a legal sense, must recognize the interdependence of contractual relationships. (p.375, emphasis added)*

Hartman, Snelgrove and Ashrafi (1997) point out:

The reliance that a contracting party or individual can place on their own interpretation of a written contract clause as being correct—and by implementation, the same as others—is questionable. What is thought to be a fair interpretation to one party may not necessarily be fair or meaningful to the other. (p. 384)

Because the principle of “good faith and fair dealing” is influential in the construction process, especially in the area of total float management, examples of “good faith and fair dealing” agreements will be illustrated later in this dissertation.

In order to avoid future conflicts in contract clause interpretation, several researchers have evaluated the effectiveness of written contract language in communicating risk apportionment between contracting parties. They believe that if contracting parties do not have the same understanding of risk allocation, they may mismanage a risk event by taking for granted that the consequences of the event will not be their responsibility. Hartman and Snelgrove's 1996 study recommends that to decrease the probability of a dispute between contracting parties, all parties must have the same understanding of risk allocation. A 1997 study by Hartman, Snelgrove, and Ashrafi shows that changing the wording of contract clauses can lead to a clearer interpretation of risk allocation among contracting parties.

3.2.4. SCHEDULING SPECIFICATION

Normally, the party preparing the network schedule for the project must follow a schedule specification that is part of the contract documents and that sets out the requirements for that schedule as it relates to the project under construction. A well-prepared scheduling specification is therefore essential to the ability of the parties to achieve their joint goals of timely and economical construction and to minimize the risk of disputes (Wickwire, Warner and Berry 1999).

Such specifications should address key elements of the scheduling process. These include such items as the party preparing the schedule, the scheduling method used, the party reviewing and approving the schedule, the time extension if delay occurs, and ownership of the float. The following exemplify schedule provisions and other total float-related provisions from several recent government contracts.

Sample Schedule Clauses

As cited by Barba and Lifschitz (1998), the Federal Acquisition Regulations (FAR) § 52.236-15, “Schedules for Construction Contracts” is as follows:

(a) The Contractor shall, within five days after the work commences on the contract or another period of time determined by the Contracting Officer, prepare and submit to the Contracting Officer for approval three copies of a practicable schedule showing the order in which the Contractor proposes to perform the work, and the dates on which the Contractor contemplates starting and completing the several salient features of the work (including acquiring materials, plant, and equipment). The schedule shall be in the form of a progress chart of suitable scale to indicate appropriately the percentage of work scheduled for completion by any given date during the period. If the Contractor fails to submit a schedule within the time prescribed, the Contracting Officer may withhold approval of progress payments until the Contractor submits the required schedule.

(b) The Contractor shall enter the actual progress on the chart as directed by the Contracting Officer, and upon doing so shall immediately deliver three copies of the annotated schedule to the Contracting Officer. If, in the opinion of the

Contracting Officer, the Contractor falls behind the approved schedule, the Contractor shall take steps necessary to improve its progress, including those that may be required by the Contracting Officer, without additional cost to the Government. In this circumstance, the Contracting Officer may require the contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules in chart form as the Contracting Officer deems necessary to demonstrate how the approved rate of progress will be regained.

(c) Failure of the Contractor to comply with the requirements of the Contracting Officer under this clause shall be grounds for a determination by the Contracting Officer that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the contract. Upon making this determination, the Contracting Officer may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of this contract. (p. 29)

For the purpose of this dissertation, several examples of clauses related to time extension and float ownership in scheduling specification written in government contracts are given below. They will be discussed in greater detail in the next chapter.

Sample Time Extension and Total Float Clauses

As earlier noted, float is widely accepted today as “an expiring resource available to the parties on a non-discriminatory basis,” as long as the parties act in good faith toward each other (Wickwire, Driscoll and Hurlbut 1991). Many scheduling specifications in public and government contracts have highly specific and defined language regarding *total float ownership and management* with respect to *time extension*. Examples of such clauses follow.

Federal Bureau of Prison Provisions (Barba and Lifschitz 1998)

- 1. When change modifications are indicated, delays are experienced, or the Contractor desires to revise the Project Schedule, the Contractor shall submit to the Contracting Officer a written Time Impact Analysis illustrating the influence of each modification, delay, or Contractor request on the contract time. The*

preparation of Time Impact Analyses is considered part of the construction process and will be performed at no additional cost to the Government. Each Time Impact Analysis shall include a Fragmentary Network (Network analysis) demonstrating how the Contractor proposed to incorporate the modification, delay or Contractor request into the Project Schedule. The Time Impact Analysis shall demonstrate the time impact based on the date the modification is given to the Contractor or the date the delay occurred; the status of construction at that point in time; and the event time computation of all affected activities. The event times used in the Time Impact Analysis shall be those included in the latest project Schedule Update or as adjusted by mutual agreement.

2. *Activity delays shall not automatically mean that an extension of the Contract time is warranted or due the Contractor. It is possible that a modification or delay will not affect existing critical activities or cause non-critical activities to become critical. **A modification or delay may result in only absorbing a part of the available total float that may exist within an activity chain of the Network, thereby not causing any effect on the Contracting time.** (p. 30, emphasis added)*
3. ***Float is not for the exclusive use or benefit of either the Government or the Contractor.** Extension of the Contract time will be granted only to the extent the equitable time adjustments to the activity or activities affected by the modification or delay, exceeds the total float of an activity; and forces the activity onto the critical path; and extends the contract time set forth in Contract Clause 52.212-3, “Commencement, Prosecution and Completion of the Work,” and Contract Clause 52.212-5 “Liquidated Damages.” (p. 31, emphasis added)*

U.S. Bureau of Reclamation (Barba and Lifschitz 1998)

(1) *Time impact evaluation*

1. *Time impact evaluation shall be used by the Contracting Officer in determining if a time extension or reduction to the contract milestone dates is justified. The Contractor shall provide a time impact evaluation to the Contracting Officer for any contract change, e.g., a change order,*

proposed modification, or value engineering proposal. The Contractor shall also provide a time impact evaluation to the Contracting Officer for any delay to support its request or claim for an equitable adjustment to the contract.

2. *A time impact evaluation is applicable whether the Contractor's current scheduled milestone dates are the same as, earlier, or later than those required under the contract. Changes, additions, or deletions to activities; activity durations; or activity time frames shall not automatically mean that an extension or reduction of contract time is warranted or due the Contractor. **Time extensions for performance shall be considered only to the extent that the Contractor's current scheduled milestone dates exceed the contract milestone dates. Float is not for the exclusive use by or benefit of either the Government or the Contractor.** (p. 32, emphasis added)*

Washington Metropolitan Area Transit Authority (Barba and Lifschitz 1998)

Appendix F

4. *Float time is not time for the exclusive use or benefit of either the Authority or the Contractor. Extensions of time for Contract performance as specified in the General Provisions will be granted only to the extent that equitable time adjustments to the affected activity or activities exceed the total float time along the affected paths of the approved computer printout report in effect at the instant of one of the following:*
 - a. *NTP with a change*
 - b. *Order of suspension or possession*
 - c. *Detection of a subsequently acknowledged differing site condition or excusable delay (p. 33)*

United States Postal Service (Wickwire, Driscoll and Hurlbut 1991)

The U.S. Postal Service has included the following scheduling provisions in its specification Section 01030.

I. “...A change may be considered of a major nature if the time estimated by being required or actually used for an activity or the logic of sequence of activities is varied from the original plan to a degree that there is a reasonable doubt as to the effect on the contract completion date or dates. Changes that affect activities with adequate slack time shall be considered as minor changes, except that an accumulation of minor changes may be considered a major change when their cumulative effect might affect the contract completion date.” (p. 465)

H. Float or slack is defined as the amount of time between the early finish date and the late finish date of any of the activities in the network analysis system schedule. Float or slack time is not time for the exclusive use of or benefit of either the Postal Service or the Contractor. Extension of time for performance required under the GENERAL PROVISION clause entitled “Changes,” “Differing Site Conditions,” “Termination for Default—Damages for Contractor Delay—Time Extensions,” or “Suspension of Work” will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total float or slack time along the channels involved at the time Notice to Proceed was issued for change. (p. 466)

Department of Defense (Person 1991)

The U.S. Army Corps of Engineers has developed a float ownership provision referred to as Regulation ER 1-1-11 (15 March 1990), found in the Department of Defense Federal Acquisition Regulation Supplement 252.23-7012:

Float available in the schedule at any time shall not be considered as for the exclusive use by either the contractor or the Government. Extensions of time for performance of work required under Contract Clauses entitled, ‘CHANGES,’ ‘DIFFERING SITE CONDITIONS,’ ‘DEFAULT (FIXED PRICE CONSTRUCTION),’ or ‘SUSPENSION OF WORK’ will be granted only to the extent

that equitable time adjustments for affected activities exceed the total float along their paths. (p. 5)

Veterans Administration (Person 1991)

The Veterans Administration has included the following clause (NAS-13, “Adjustment of Contract Completion Time”) in the construction contracts:

Actual delays in activities which, according to the computer-produced calendar-dates schedule, do not affect the extended and predicted contract completion dates shown by the critical path in the network will not be the basis for a change to the contract completion date. (p. 5)

Corps of Engineers Edwards Air Force Base (Wickwire, Driscoll and Hurlbut 1991)

The following scheduling provision is included in the 1985 Corps of Engineers specification Section 17—Contractor Project Management System:

(3) Float or slack is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, of any of the activities in the NAS schedule. Float or slack is not time for the exclusive use or benefit of either the Government or the Contractor. Extensions of time for performance may be granted to the extent that equitable time adjustment for the activities affected exceed the total float or where otherwise justified, effect on the contract completion can be shown. The contract completion date is fixed, and will be amended only by modifications which include time and are signed by the Contracting Officer. (p. 443)

Suggested Clauses from Previous Study

Zack (1996) believes that incorporating some detailed requirements into the scheduling specifications could improve schedule control and protect the owner from the contractor’s “scheduling games,” which will be discussed at length later. Such requirements include

- Joint ownership of float clause. As mentioned earlier, many contracts have adopted this clause in their scheduling specifications. According to this clause, float is viewed as a jointly-owned resource that can expire and is consumed on a first-come, first-served basis.
- Limited form of “no damage for delay” clause. With this clause, no time extension will be granted nor delay damages compensated if a delay did not cause a change in the current adjusted contract completion date.
- Delays to negative float clause. In the situation that all activity paths have negative float, a delay to any of these activities will increase the amount of negative float which may or may not affect the current project completion date. With this clause, no time extension will be granted if the delay did not change the current projected completion date.
- Nonsequestering of float clause. The contractor can sequester float in CPM schedules by using artificial activity durations, preferential logic, or sequencing. With this clause, the owner has an authority to reject any schedule submittal in which the contractor has sequestered float time.
- Project float shown as a schedule activity clause. In the event that the contractor’s schedule update shows early completion, the contractor can make the case that a delay affects the current projected completion date even if it does not exceed the contract completion date. To avoid such dispute, an activity of the time between the current project completion date and contract completion date should be inserted as *project float* in the schedule update.

3.3. SCHEDULE DELAY AND TIME EXTENSION

The primary objectives of a construction project involve completion of the work on time, within budget, and with all requirements met. To achieve these goals, the owner commonly requires the contractor to submit detailed job schedules and to meet fixed contractual completion dates. Therefore, any unpredictable or unforeseeable event—such as changes in scope of work or design, differing site conditions, acts of God, and the owner’s

and contractor's unanticipated actions—often disrupt the required schedules, resulting in substantial delay to the contractual completion dates.

A *delay* is defined as the time during which some part of the construction project is completed beyond the projected completion date(s) or not performed as planned due to an unanticipated circumstance (Callahan, Quackenbush and Rowings 1992). Delay may be caused not just by the owner or contractor but by any party participating in the project: designer, prime contractors, subcontractors, suppliers, labor unions, utility companies. A delay might also result due to an act of God, such as a tornado, flood, or fire.

Delays can be classified as *excusable* or *nonexcusable*, *compensable* or *noncompensable*, and *critical* or *noncritical*. Some delays are related to time extension, but some are not. In a broad view, much depends upon who causes the delays and when the delays occur. To understand the total float issue in the CPM schedule that will be discussed in the next chapter, it is essential to have a basic understanding of types of delays that can occur. Briefly, however, one must differentiate between a *delay* and a *disruption*.

3.3.1. DELAY VERSUS DISRUPTION

Closely associated with delays are disruptions, interruptions in the orderly flow of work that can result in anything from a minor loss of labor productivity to overruns of project costs. In his article “Schedule density as a tool for pricing compensable float consumption,” Finke (2000) states that *delay* and *disruption* are two different types of damages. Delay damages cannot be traced to specific activities, whereas disruption damages can. He points out that delay damages are valid only if delays to the overall project completion time are involved, while disruption damages can be caused by any change in the planned condition of work that can happen regardless of the change in the project completion time (Garvin, Miller, Toomey and Smith 1990). Disruption refers to a loss of productivity involving a specific activity and is caused by changes in working conditions, such as stacking of trades, work area congestion, resource diversion, skill dilution, and dilution of supervision (Finke 2000).

3.3.2. EXCUSABLE AND NONEXCUSABLE DELAY

Construction delays can be categorized as two major types: *excusable* and *nonexcusable*. An “excusable delay” is one for which the contractor is excused from meeting

a contractual completion date and for which he will therefore receive a time extension. Excusable delays can be caused by either the owner or a “third party” not participating directly in the contract. In general, excusable delays include unforeseen design problems, owner-initiated changes, a labor strike (unless caused by the contractor’s action), and acts of God (poor weather and the like).

A “nonexcusable delay” involves lost time caused directly by the contractor’s actions or inactions. In this case, the contractor is entitled neither to time extensions nor to additional compensation from the owner. Moreover, the contractor will be responsible for the possible impact its performance has on other involved parties. If the contract includes a liquidated damage clause, under it the owner could recover delay damages from the contractor. Generally, nonexcusable delays include failure to perform work within the agreed time period, subcontractor failures to perform the work, poor work performance causing rework and repair, and resource availability problems.

3.3.3. COMPENSABLE AND NONCOMPENSABLE DELAY

Excusable delays can be further categorized into two types: *compensable* and *noncompensable*. A “compensable delay” allows the contractor both a time extension and additional damage costs. In this case, the owner should compensate not only for damage costs caused by the compensable delay, but also for the cost of any follow-up work necessitated by the delay. This type of delay commonly is caused by the owners or their representatives. In the event of a “noncompensable delay,” the contractor is not entitled to compensation for additional costs caused by the delay, but may or may not be entitled to a time extension, depending on whether the delay is excusable or nonexcusable.

3.3.4. CRITICAL AND NONCRITICAL DELAY

Delays can also be classified as *critical* or *noncritical* (Callahan, Quackenbush and Rowings 1992). A “critical delay” results in an extended contract project completion date. Such an event involves the initial delaying of a critical-path activity that has zero day of total float, but it will also affect subsequent activities, thereby altering the completion date of the entire project. For instance, a delay involving the structural steel work, which is on the

critical path, will likely delay other jobs dependent on it and ultimately delay completion of the entire project.

Conversely, a “noncritical delay” is either one involving a non-critical path activity that has positive total float or one that does not extend the contract project completion date. A delay to fence work, for example, which can be done last and has a lot of total float, will normally not affect the project completion date. Commonly, the noncritical delay is a delay for which the contractor is not entitled to a time extension, but may actually recover financially due to the additional costs of delay. The concepts of critical and noncritical delays will play major roles in subsequent discussions.

3.4. THE LAW’S VIEW OF CPM SCHEDULE

When a project completion date is delayed, causing cost increases and other damages, one or more of the parties may seek compensation by submitting a “claim” for these occurrences. Use of Critical Path Management (CPM) concepts is valuable in analyzing delays in a claim context because the CPM can help to identify the period of the delay event and determine the cause and effect of the delay, as well as pinpoint the responsible parties. (Householder and Rutland 1990; Capuano Jr. 1995; Wickwire, Driscoll and Hurlbut 1991). Whether such delays are to non-critical activities, which do not change the project completion date, or to critical activities, which do impact completion, they are easily identified using CPM.

The value of CPM in claim analysis rests in its set up, application, and visual presentation of the project activities. Its components not only provide the most basic tools for visually separating and identifying which delay events are the direct responsibility of the owner or the contractor, but also display the effect of these delays on project completion (Wickwire, Hurlbut and Lerman 1989). Because of the importance of CPM, courts have long emphasized the importance of its use in scheduling. Courts have recognized the dynamic nature of CPM and accepted its use in proving delay claims, as discussed in the next section.

3.4.1. CPM's DYNAMIC NATURE

By its very nature, construction is dynamic. Changes to the scope of work and design, unexpected events, and parties' actions or inactions can occur at any time during the life of a construction project and thus can affect its original schedule. Because the critical path in the schedule is the longest path(s) of connected critical activities through the project, any change—whether it involves shortening or lengthening—in the durations of those activities can affect the critical path. The paths that were originally critical may later become non-critical and vice versa. Based upon such realities, there is little doubt that in a construction project the CPM is dynamic in nature (Richter and Mitchell 1982; Wickwire, Driscoll and Hurlbut 1997; Ponce de Leon 1991).

Wickwire, Driscoll and Hurlbut (1997) mention that “[t]he beauty of the CPM process is that is dynamic and allows the executor of the schedule, at any given point in time, to react to events as they change. Resources (work forces, equipment, time) thus can be applied in a different fashion and still achieve the planned project completion or minimize the effect of delays.” They provide three claim case examples to illustrate the boards' and courts' recognition of the dynamic nature of the CPM schedule. Those cases include *Fortec Constructors v. United States* (1985), *Continental Consolidated Corp.* (1967), and *J.A. Jones Constr. Co.* In all three cases, the courts rejected the Government's reliance on a CPM that was not properly updated and did not reflect the actual conditions of the construction.

Ponce de Leon (1991) provides an additional case example, that of *Preston-Brady*, in which the Board indicated that, in order to use the CPM to prove a delay claim, it must be updated to reflect the delays as they occur. *Preston-Brady*, however, had never updated the CPM.

3.4.2. CPM's ACCEPTANCE TO PROVE DELAY CLAIMS

As previously mentioned, the CPM schedule technique has been widely used as a reliable method in construction. It illustrates a logical sequence and durations for various activities to be performed by various trades. Because it can identify interface points among parties participating in the project, it can designate potential delay events showing the timing of delays, the delayed activities, and impacts of the delays on other activities in the schedule.

Richter and Mitchell (1982) mention that the CPM schedule can be used to set forth or defend a delay claim if it has been initially well prepared and periodically updated to note progress and changing conditions. Review boards and courts have also recognized the importance of CPM analysis techniques to prove delay and disruption claims (Wickwire and Ockman 1999; Kallo 1996; Richter and Mitchell 1982). The following examples show the boards' preference for using CPM in the proving of such claims.

As mentioned by Kallo (1996), the General Services Board of Contract Appeals in *Minmar Builders, Inc. v. United States* notes that:

Two of the (contractor's) construction schedules were....(nothing)...more than a bar chart showing the duration and projected calendar dates for the performance of the contractual tasks. Since no interrelationship was shown as between the tasks, the chart cannot show that project activities were dependent on prior performance...much less whether overall project completion was thereby affected (5). (p. 35)

As was stated in *Fortec Constructors v. United States*:

The reason that the determination of the critical path is crucial to the calculation of delay damages is that only construction work on the critical path had an impact upon the time in which the project was completed. If work on the critical path was delayed, then the eventual completion date of the project was delayed. Delay involving work not on the critical path generally had no impact on the eventual completion date of the project (2). (p. 35)

Wickwire and Ockman (1999) illustrate three additional case examples that use the CPM schedule to evaluate the delay claims, including *Haney v. United States*, *Utley-James, Inc.*, and *Weaver-Bailey Contractors, Inc. v. United States*.

3.5. CHAPTER CONCLUSION

In terms of legal aspects, it is essential to study not merely the construction contract as a whole but also and specifically any information that therein pertains to timing and dates. As previously mentioned in this chapter, owners and contractors have many different types of

contracts from which to choose, including fixed-price, unit-price, and cost plus fixed-fee, among others. Each type has its own advantages and disadvantages.

In addition to the type of contract chosen, there are other key components in the creation of a successful agreement: proper contract preparation, contractual risk management, and well-defined, well-written contract language.

This chapter also provides some samples of scheduling clauses, especially in the area of time extension and total float. Then three different classifications of schedule delays are presented, including excusable vs. nonexcusable, compensable vs. noncompensable, and critical vs. noncritical.

Finally the law's view of the CPM is presented as the basis for understanding how boards and courts currently perceive its use. As described in this chapter, the CPM is viewed as dynamic in nature and is widely accepted by courts as a method for proving delay claims.

CHAPTER 4

EVALUATION OF TOTAL FLOAT MANAGEMENT IN CPM SCHEDULING

4.1. INTRODUCTION

In construction projects utilizing the CPM scheduling methodology, “total float” is the amount of time units belonging to all activities on the same non-critical path. As mentioned in Chapter 2, total float is one of the most important elements in CPM scheduling. It has become so critical that often all parties involved in a project attempt to use the total float related to non-critical path activities for their own benefits. As a result, float ownership and utilization have become the subject of major disputes between CPM practitioners (owners and contractors) and construction lawyers.

This chapter will accomplish several related goals. First, it presents an understanding of total float and discusses its various applications to CPM scheduling. Then the chapter considers consumption of total float by owners and contractors. Ownership of float is another crucial issue under consideration. In the early days of delay claims, for example, some boards viewed the contractor as the owner of total float, while others did not. In order to understand current legal definitions of float and its application, this chapter will also review laws governing the issue. Finally, three types of total float ownership—owner entitlement, contractor entitlement, and project entitlement—are presented to illustrate the different views that decision-making boards have adopted with respect to the total float issue.

4.2. TOTAL FLOAT DEFINITION

Total float is the amount of float available to an entire chain or path of activities; it indicates the flexibility for all activities on the same path. While it is shared among these same-path activities, however, it does not necessarily represent the float available to a specific or singular activity. Where project completion is concerned, activities with float times can be delayed without extending the time. Figure 4.1 illustrates, for instance, that activity A is on the critical path with a zero-day float, and activity B is on a non-critical path with a total float of 20 days. Given the principles herein discussed, activity B can be delayed up to 20 days from its early start without postponing the project completion date. As

previously mentioned in Chapter 2, when timely project completion is a consideration, the lower the value of total float, the less flexible the activity can be with regard to time.

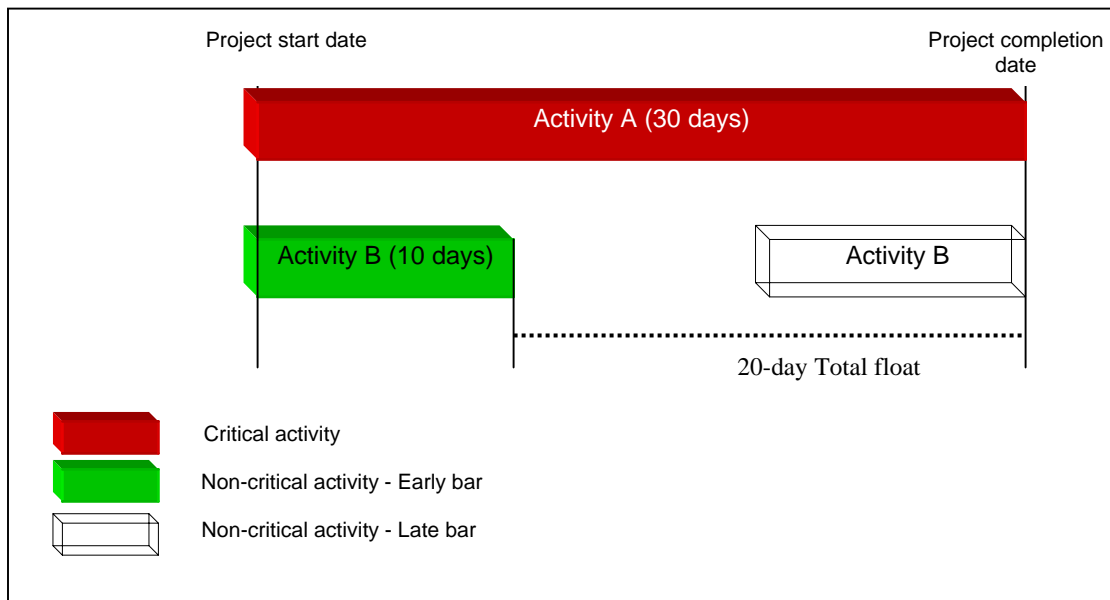


Figure 4.1: Fenced bar chart indicating total float

As previously stated, activities share total float with other activities on the same path (Callahan, Quackenbush, and Rowings, 1992). This means that total float cannot be “owned” by individual activities on the path. Therefore, using float time in the performance of one activity will reduce it in all remaining activities in the chain.

Many researchers have defined and discussed total float and its application in CPM-scheduling construction projects. For example, de la Garza, Vorster, and Parvin (1991) define total float as a by-product of CPM calculations representing the length of time that an activity’s finish date may be delayed without changing the entire project completion date. The activities with zero total float, which have no flexibility, are called “time-critical.”

Glavinich (1994) defines total float as “a measure of leeway in starting and completing an activity” and states that “total float assumes that all activities preceding the activity being studied are finished as early as possible and all successor activities are started as late as possible” (p. 75).

Raz and Marshall (1996) view total float as an important degree of the scheduling flexibility associated with activities in a project network, as well as an indicator of the amount to which the schedule can absorb delays without affecting the project completion dates. However, they believe that when resource allocation is taken into consideration, the current calculation of total float might be misleading. They propose a new float definition called “scheduled total float” that retains the original meaning and reflects the resource availability on the schedule. Gong (1997) also views total float with respect to resource availability and believes that float is often used for resource allocation and for reducing project costs without extending project duration.

Sweet (1999) considers float as “the number of days a non-critical path activity that can be delayed before it becomes part of the critical path” (p. 498). This means that delay of a non-critical path activity within its float time will not affect the timely progress of the entire project; however, the delay of a critical path activity will most certainly result in an altered schedule.

It is notable that the above definitions of total float do not apply to a CPM schedule with a restraint of a fixed project completion date (shown in the Figure 4.2), where some activities might have negative float when the schedule is updated. As indicated in the figure 4.3, total floats for the activities on the critical or longest path in this schedule will be negative and not equal to zero if the entire project experiences a delay or the project completion date is extended. The activities with the largest negative total floats will be on the critical path of the schedule. Thus, the number of days that a non-critical path activity can be delayed without extending the project completion date is not equal to the total float indicated in the schedule, but equal to its total float plus the number of the largest negative total floats. Therefore, the total float discussed throughout this dissertation is limited to a CPM schedule without a constraint of a fixed project completion date or without negative total float activities.

Both owners and contractors have recognized the flexibility awarded to activities with positive total float. Contractors use float to deal with unanticipated conditions or uncertainties, whereas owners use it to accommodate changes in contract scope. The consumption of total floats by various parties involved in the project will be discussed next.

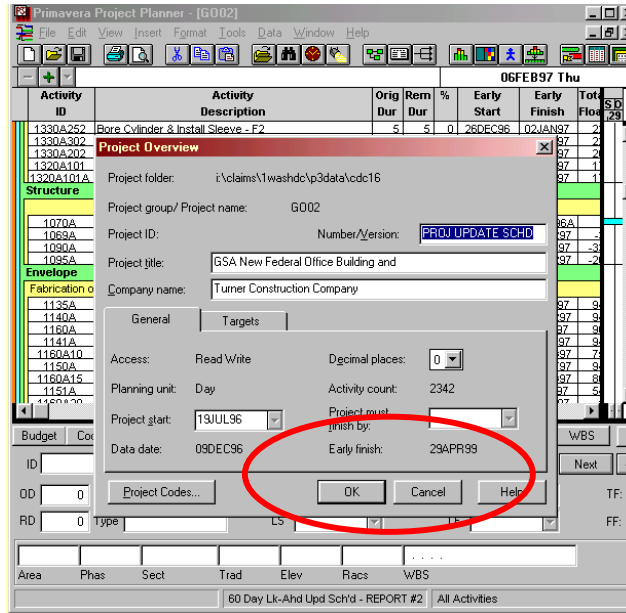
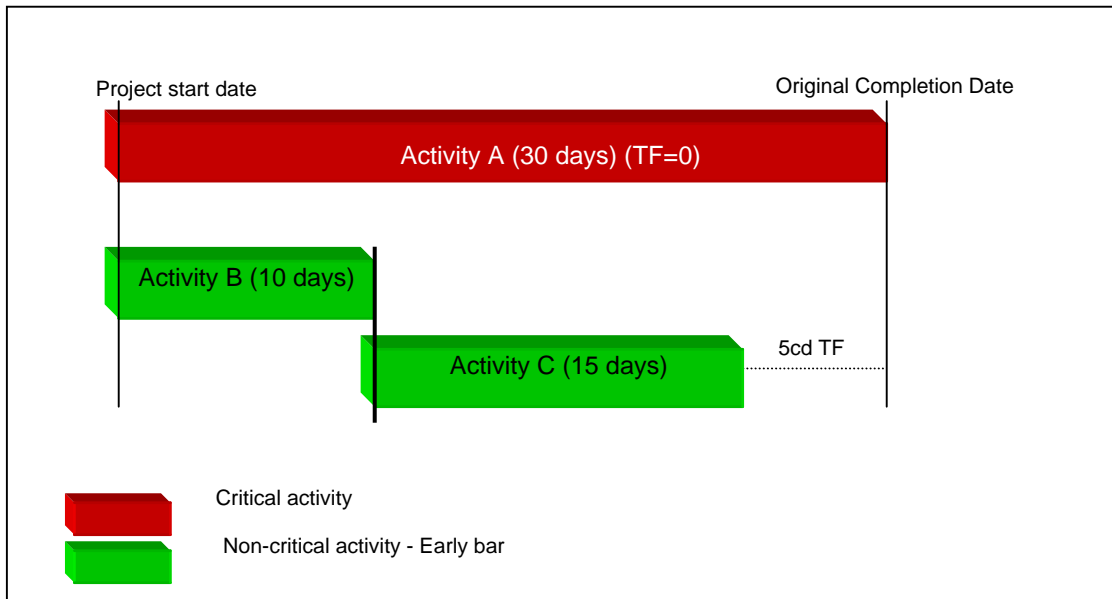
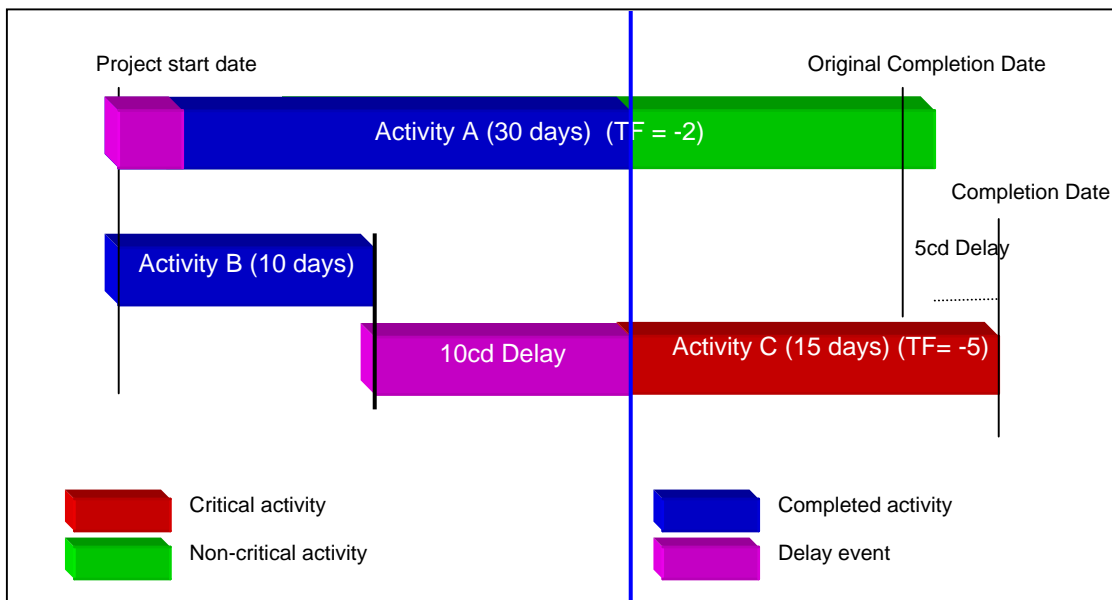


Figure 4.2. Image of P3 printscreen showing the constraint of the fixed project completion date



As shown in the above baseline schedule, Activity A was on the critical path with 0 day of total float and Activity B and C were on a non-critical path with 5 days of total float.



The above schedule update shows a 10-day delay to the Activity C, which originally had 5 days of total float and a 2-day delay to the Activity A. As a result of the delays in the fixed completion date schedule, the Activity C has negative 5 days of total float and the Activity A has negative 2 days of total float. The project delay is equal to 5 days or the largest negative total float.

Figure 4.3: Fenced bar chart indicating negative total float

4.3. TOTAL FLOAT CONSUMPTION

Periodically, all participants involved in construction are likely to appropriate float times to advance their own benefits, and there are many valid reasons for doing so. Yet, the practice remains problematical. The more participants are located on the same path, the more the difficulty in fairly controlling the use of shared float times. This section will cover two major categories of total float consumptions—owner’s consumptions and contractor’s consumptions—and the effects of total float consumption.

From a legal point of view, when the A/E and consultant enter into agreements with the owner to provide services, the owner is held responsible for any actions they take—or don’t take—that will result in time or cost effects on the contractors. The first category of the owner’s consumption will include the use of total float by the owner and representatives. By the same token, the contractor is held responsible for the performances of its subcontractors, suppliers, and agencies, and the total float consumptions of the contractor and its representatives are included in the second category.

4.3.1. OWNER’S CONSUMPTION OF FLOAT

Owners often attempt to appropriate the float times of non-critical path activities either to consume it for their own benefit or to help them cope with unpredictable problems that might arise. The owner’s consumption of float may have a negative impact on the contractor’s working conditions, stacking of trades, work area congestion, resource diversion, skill dilution, and dilution of supervision (Finke 2000). In general, according to Vezina (1991) and Householder and Rutland (1990), owners consume floats in the following ways:

1. ***Failure to perform required duties in a timely manner***, including:
 - a. Failure to release site accesses, obtain permits, easement, right-of-way in a timely manner.
 - b. Failure to arrange for site preparation or demolition of existing facilities prior to the arrival of the general contractor in a timely manner.
 - c. Failure to approve shop drawings or submittals in a timely manner.

- d. Failure to deliver owner-furnished materials in a timely manner.
 - e. Failure to coordinate the work of other prime contractors in a timely manner.
2. ***Changes in scope of work.*** Generally, any changes the owner makes in the construction process are considered necessary. Change orders can lengthen the activities, however, resulting in a time impact to the project completion date. Large-scale changes are likely to have an impact on the schedule or to consume the float times of non-critical path activities. However, if the owner fails to issue or approve it in a timely manner, even a small-size change might have significant impact on the schedule. The process of making changes, such as issuing and approving a change, often is the leading cause of the owner’s consumption of total float for non-critical path activities. Generally, the owners prefer that the schedule makes total float available for the incorporation of changes. It must be noted, however, that not all changes will adversely impact the project schedule.
 3. ***Owner’s interference.*** The owner’s duty is to coordinate among prime contractors and other agencies, but not to interfere with the performance of other parties, including general contractors and their subcontractors. Potentially disruptive interferences from owners can include issuing excessive modifications, providing oral directives, over-inspecting, removing or interrupting subcontractors as they perform their work, and utilizing the job site prior to the project completion date.
 4. ***Including a schedule contract provision.*** Another method that the owner uses to consume total float is to include scheduling provisions in contracts using such clauses as “the owner owns the float” or “no damages for delay.” The owner may also attempt to control float by assigning target/conditional dates to individual activities or phases of works in a contract.
 5. ***Failure of owner representatives to perform their duties in a timely manner.*** The owner’s representative or agencies include, but are not limited to, Architect/Engineer, Construction Management Consultant, Schedule Consultant, and other prime contractors. On behalf of the owner, these agents might fail to perform their duties in a timely manner, which results in the consumption of float.

4.3.2. CONTRACTOR'S CONSUMPTION OF FLOAT

In general, contractors are obligated to schedule, plan, and execute the work of various trades on the project in a reasonable and workable sequence of activities. It is not unusual for a contractor to appropriate total float in order to cope with problems or to reduce overall project costs. According to Householder and Rutland (1990), Vezina (1991), and Hulett (1995), they generally consume the total float of non-critical path activities in a number of ways:

1. ***Failure to perform work properly***, in such ways as:
 - 1.1. Failure to perform duties in a timely manner.
 - 1.2. Failure to coordinate among subcontractors, suppliers, owners, and owners' representatives.
 - 1.3. Inexperience in the type of construction, resulting in poor-quality work performance and then enormous amounts of repairs.
 - 1.4. Poor resource and time management.
 - 1.5. Failure to obtain or incorporate subcontractors' schedules into its baseline schedule resulting in an unworkable schedule.
2. ***Through Subcontractors' and suppliers' actions and inactions***. These include late or incomplete shop drawings, fabrication defects and delays, and shipping delays. The general contractor is responsible for coordinating the work crews of its subcontractors and suppliers.
3. ***Lack of a realistic schedule***. Contractors often create schedules indicating the project will be completed on time, but these schedules often reflect inaccuracies with respect to the availability of total float. For example, a 30-day float work might show only 10 days of float in a schedule; and thereby the owner's 20-day delay to the work will result in delaying the entire project for 10 days.

4. ***Playing “schedule games.”*** As it is written in most construction contracts that contractors own construction means, methods, techniques, and sequences of construction, they may use any of the following techniques to develop project schedules that have little or no float. The reason for these games is to show in the project schedule a negative impact to the project completion date resulting in a time extension to the contractor, regardless of what and when the owner does to consume the floats.

4.1. *Using target or conditional dates.* The conditions are utilized to force activities to start or finish on such dates. Conditions include: “not-earlier-than-start”, “must-start”, “not-later-than-finish”. Over-use of the conditional dates may make the schedule unrealistic (Hulett 1995). Contractors sometimes use the constraint dates to alter the float shown in a schedule (Glavinich 1994).

However, Wickwire, Driscoll, and Hurlbut (1991) note that this technique can be used to minimize the claimed delay of one contractor’s performance as compared to another; if properly implemented and controlled, target and conditional dates can be used to allocate project floats to individual activities or phases of work for a single contract or for multiple prime contracts.

4.2. *Using lead/lag restraints.* This method uses lead-time and lag-time activities as logical restrictions inserted to manipulate certain activities and force specific dates to be computed and reflected in the output. Float can be reduced by the use of the lead-lag restraints (Ponce de Leon 1986). This method is not considerably preferable to the owner’s points of view in that the restraining activities affect the critical and non-critical paths. Allowing manpower and equipment restraints solely within the control of the contractor may be the result of float abuses, which attempt to hide float that normally exists (Wickwire, Driscoll, and Hurlbut 1991). Such restraints are commonly used for phasing work, for equipment and manpower planning, and for fixing milestones (key events) and contractual dates.

4.3. *Using preferential sequencing.* This technique sequences activities not in the most logical manner, but in a manner preferred by the contractor. Contractors can use this technique to appropriate or abuse float in a schedule (Zack 1992; Ponce de Leon 1986).

4.4. *Using artificial activity durations.* Some contractors attempt to appropriate float by artificially extending or over-estimating activity durations in a schedule network (Zack 1992).

By using the two techniques of artificial activity durations and preferential sequencing, the contractor's schedule will show little or no float within the schedule and possess multiple critical paths or a single critical path with multiple near-critical paths through the schedule. With this schedule, whenever owners interrupt the contractors' work or request a different sequence of activities, contractors may have the chance to lay claim against the owner for delays caused by such interference.

4.5. *Inaccurate schedule updates.* During the construction process, contractors must update a schedule network on a regular basis to reflect the actual progress of construction. Contractors can simply and slowly abuse or consume floats in the schedule by inaccurately updating the start and finish dates of activities.

4.6. *Changing project history.* The last technique that the contractors may use to appropriate float is to change project history (Zack 1992). This technique is unusual, but not impossible. Some contractors go back and adjust start and finish dates on activities that have been completed previously. This technique can be harmful to the owner and is not a common practice in construction.

4.3.3. EFFECTS OF TOTAL FLOAT CONSUMPTION

If all activities were started using projected early start dates, the risk of delaying the whole project may be minimized. However, in the real construction world, an activity may finish either later than or ahead of the projected completion date. Hulett (1995) and Gong and Hugsted (1993) point out that, given such uncertainties of time, through the increase of float consumption along a particular path, a *non-critical* activity can become a *near-critical* activity and then even a *critical* activity. As total floats are consumed, project schedules become more difficult to manage and control (Finke 2000 and de la Garza *et al.* 1991). As a result, the consumption of floats can increase both the risk of project schedule overruns and of project costs (Gong 1997). As delays occur to a non-critical activity, that activity

consumes its total float, and the possible necessity for extending the completion date increases greatly (Hulett 1995; Gong and Rowings 1995).

As shown in the previous section, there are many ways in which owners can consume time units and reduce the total floats of non-critical activities. Such total float consumption can lead to increased financial risk for the owner, particularly if the delays occur on the critical path (Householder and Rutland 1990). If this occurs, once the project is completed, the owner may end up having to pay delay damages to the contractor.

Other harmful effects of an owner's consumption of total float is the contractor's reduced ability to allocate manpower and equipment, or even to control the construction means and methods as defined in the contract agreement. If the contractor manages multiple projects concurrently, this occurrence might also create a "domino effect," impacting progress on or successful completion of these other jobs.

Similar risks are assumed by the contractor who consumes the total float of non-critical path activities. Should the delay be on the critical path at project completion, the contractor might have to pay liquidated damages for a late finish or lose any early completion bonus applied to the project. Furthermore, contractor float consumption denies the owner the ability to change the scope of work or cope with unforeseeable problems without affecting the project completion date. If the contractor has used all of the total float, for instance, even minor changes made by the owner to original non-critical path activities can then adversely impact the completion date of the project.

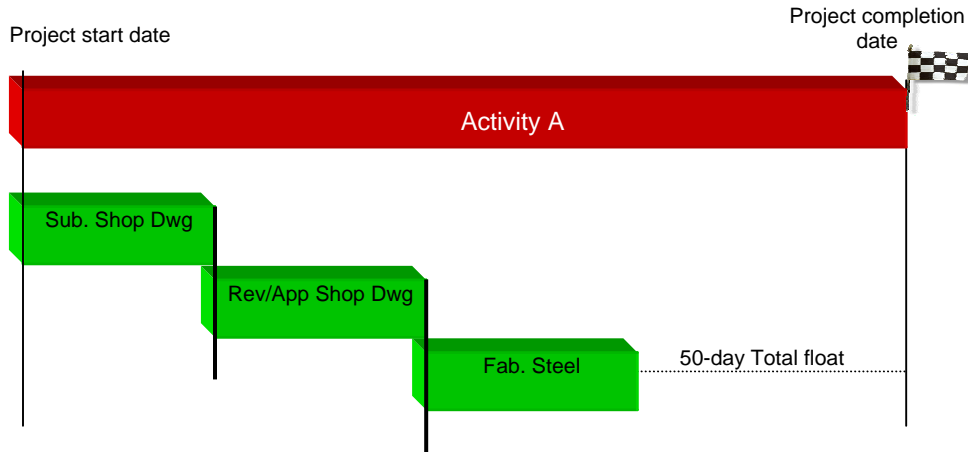
4.4. THE LAW'S VIEW OF TOTAL FLOATS

The total float is a by-product of a contractor's CPM calculations and estimates. It may or may not exist if the activities were not started on the estimated dates set forth in the CPM schedule. Total float is considered an expiring time unit; i.e. if it is not used by anyone on the project, it "disappears" as construction progresses. If the project does not progress as planned, any available total float must be used; otherwise, the overall project will be delayed. Regardless of who causes the delays or who consumes the total float, construction case law supports the principle that total float shall be available to all parties and should not belong to any one party on a project.

During the 1970s and 1980s, as noted by Wickwire, Driscoll, and Hurlbut (1991), the courts recognized total float time clearly as “an expiring resource available to all parties involving in the project” (p. 242). As mentioned in Chapter 3, almost all significant public procurements include contract clauses designating that float not be used for the exclusive benefit of any one party involved in the project. The clauses do permit, however, the individual who gets to the float first to gain the benefits it provides. Under this concept, the parties with some float time may take advantage of it for their own benefit and interest without considering the impact their decision might have on other involved parties or on project completion time.

For instance, if an owner so delays approval of structural steel shop drawings that only ten days of total float remain out of an original limit of 50 days, and then the contractor further delays the succeeding steel erection activity for an additional 50 days, the contractor can be held responsible for 40 days of delay to the project (See Figure 4.4). On the other hand, if the contractor “gets to the float first” and delays submittal of shop drawings (the predecessor activity to the owner’s approval), and thereafter, the owner delays review and approval to the point that the entire project is postponed, the owner can be held responsible (See Figure 4.5).

BASELINE SCHEDULE



AS-BUILT SCHEDULE

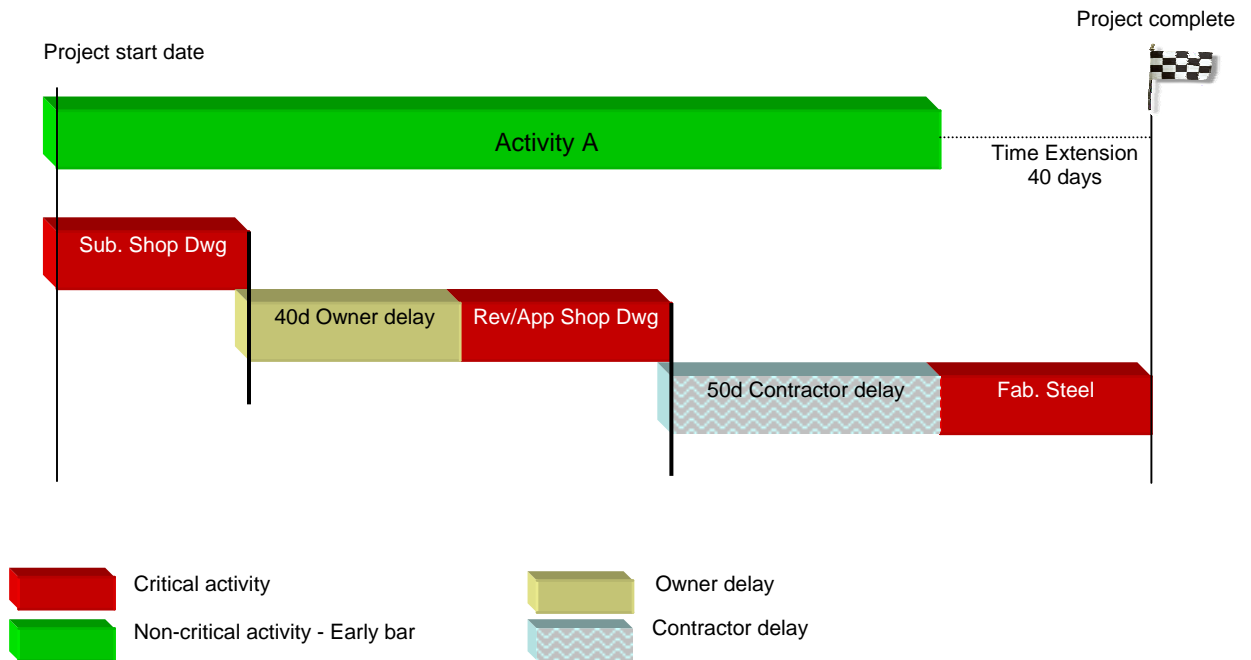
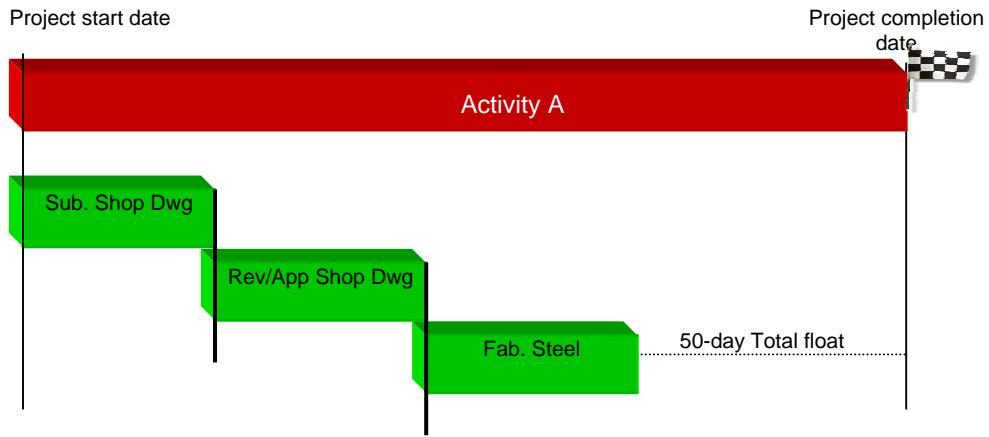


Figure 4.4: Effect of contractor delay occurring last

BASELINE SCHEDULE



AS-BUILT SCHEDULE

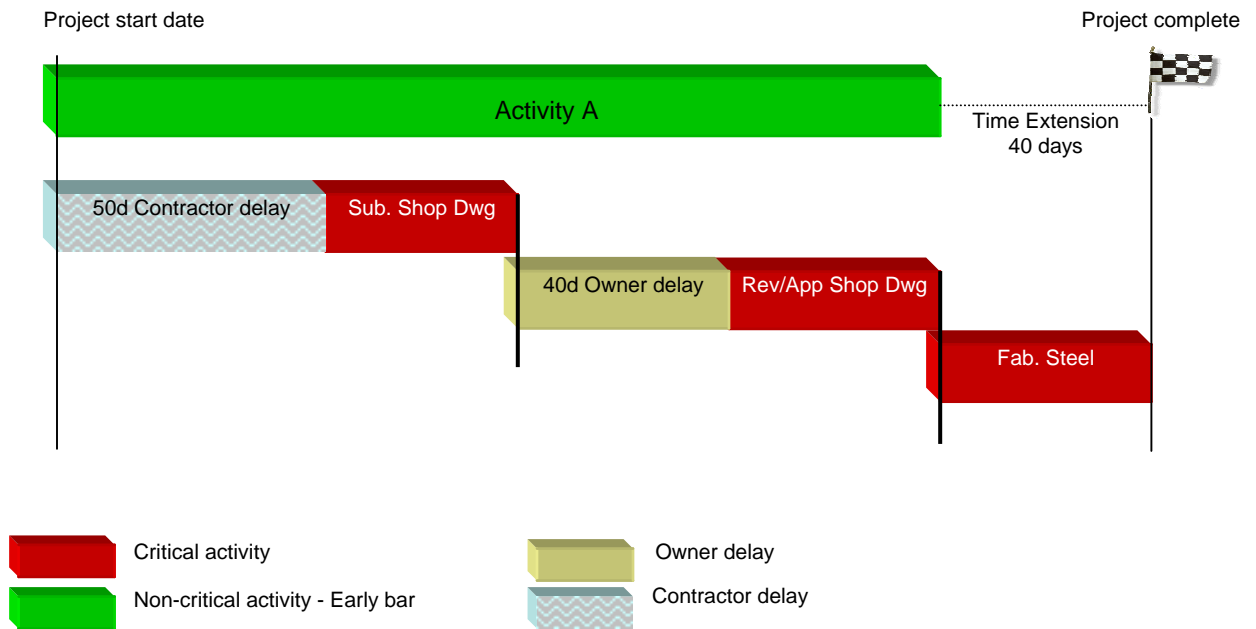


Figure 4.5: Effect of owner delay occurring last

To end this section, it is interesting to consider—as have Wickwire, Driscoll, and Hurlbut (1991)—the following legal perspectives on the topic of total float:

“1. Time cannot be stopped. It cannot be saved or stored. Activities are planned and scheduled to meet established goals within given time constraints. If the scheduled rate of progress is not achieved, any available float must be utilized or certain activities, milestones, or the overall project may fall behind schedule.

2. Activity duration changes and/or logic changes made as part of the updating process can increase or decrease available float.

3. Updating and incorporating actual finish dates to reflect history and as-built conditions can increase or decrease available float.

4. The incorporation of fragments (additional or changed activities) into the CPM schedule during updates to reflect change orders, delays, and so on, can change float positions.

5. Extending contract milestones and completion dates based on approved time extensions can increase the remaining float.” (p. 183)

4.5. TYPES OF TOTAL FLOAT OWNERSHIP

The ownership of total float shifts between owner and contractor. Courts have sometimes granted ownership of the total float to the contractor, at other times to the owners, and lately to the project under the first-come-first-served basis. In general, there are three main concepts of total float ownership that have been implemented in the construction industry. These include the owner’s entitlement, the contractor’s entitlement, and the project’s entitlement.

4.5.1. OWNER ENTITLEMENT

Under this concept, the owners should have a right to appropriate the total float of non-critical path activities. Pasiphol (1994) argues that owners should control total float because they pay for the project and should be able to use the total float to reduce costs and control progress, thus ensuring timely project completion. The total float is important to the

owner because it grants flexibility for incorporating project changes without delaying the project completion date. When the contract does not contain the total float ownership clause, legal decisions have given the float to the owner (Callahan, Quackenbush, and Rowings 1992).

It is noted here that, under the cost-plus contracts wherein the owner faces the greatest financial risk, total float should be given to the owner in order to minimize the total project expenditures. However, some owners, especially the government, can insert the clause that the total float belongs to the owner even in fixed-cost construction contracts. By inserting such a clause, owners ultimately may pay extra costs as contractors realize that these projects contain for them a greater degree of risk (Householder and Rutland 1991).

In the *Appeal of Santa Fe, Inc.*, the Veterans Board denied a contractor's claim for a time extension when the government issued a change order to the scope of work (Ponce de Leon 1991). Under the terms of the contract, the float time belonged to the government, and the CPM schedule indicated that the government's changes to the non-critical work did not affect the project completion date.

4.5.2. CONTRACTOR ENTITLEMENT

This concept implies that contractors should own the total float because they plan for construction means, methods, and equipment, and for scheduling the entire project, in order to meet the contractual completion date. Based upon this level of responsibility, therefore, they should be able to control the sequences and durations of the project activities and maximize the utilization of resources. If contractors cannot appropriate the total float, they will lose the flexibility to perform their duties properly and effectively to meet the completion date. Total float principally benefits contractors by helping them optimize the use of their resources and ultimately save project costs (Person 1991). In addition, the total float is a consequence of CPM scheduling prepared by the contractors; it is an option to be used in the future, which may not ever exist (Royer 1986). In most states, floats belong to the contractor unless specified otherwise in the contract documents (Zack 1992; 1996).

Finke (2000) and Wickwire, Hurlbut and Lerman (1974) support the concept that total float ownership should belong to the contractor and should not be freely appropriated by

owners. They believe that total float is an important resource that allows the contractor to maximize resources and maintain the flexibility required to manage the construction means and methods in such a way as to complete the project within budget and on schedule.

Person (1991) and Barba-Arkxon International, Inc. (1996) present two early cases in which the board recognized contractors' ownership of the total float. In *Heat Exchangers*, ASBCA 8705, 1963 BCA ¶3881, without speaking in terms of "float ownership," the board decided that the contractor was entitled to retain what it called a "cushion" of time. The board in *Continental Consolidated Corp.* (ENG BCA 2743 et al., 67-2 BCA ¶6624, Affd. In part, 200 Ct. Cl. 737, 1972) recognized the contractor's entitlement to modify its construction schedule, thus granting benefit of the total float.

In the case of Joseph E. Bennett Co., GSBCA No.2362, 72-1 BCA ¶ 9364 at 43,467, the General Services Board of Contract Appeals asserted that the contractor was entitled to appropriate the float because it scheduled and planned its own work and should also be able to use the float time as a resource in scheduling the work (Wickwire, Hurlbut and Lerman 1974; Ponce de Leon 1991).

4.5.3. PROJECT ENTITLEMENT

This concept implies that the total float belongs not to any individual party, but to the project itself. Under this construct, total float is considered an expiring resource available to all parties involving in the project. Whoever gets to it first can reap its benefits. This means that if the total float of non-critical path work is used up in the early construction stages, then a party at the later stage may have to perform work on the critical path. Thus, the late-stage party might be liable for damages if any work delays occur that result in an extension of the project completion date.

In *Preventing and Solving Construction Disputes* (1979), Murray Hohns supports the concept that float should belong to the project by allocating it among activities on the same path on a shared basis (Callahan, Quackenbush, and Rowings 1992). This concept departs from the total float ownership issue and focuses on whether existing delay(s) affect the current critical path of the project, resulting in extension of the project completion date (Person 1991 and Finke 2000).

Typically, under this concept the parties performing late-stage work run a higher risk of finding themselves—and their projects—on the critical path. As the total float of non-critical activities is reduced, they have to allocate their resources and to schedule their work according to the revised schedule.

As a result of this concept, the contractor may develop unrealistic schedules and inaccurate updates on the construction progress to report faulty amounts of total float or to show owner-caused delays on the project critical path. Often when the CPM schedules are used to prove a claim under litigation, boards deny using them as evidence because they are unreliable and not updated accurately to reflect the real progress of work.

In *Blackhawk Heating & Plumping Co.*, GSBCA 2432, 75-1 BCA ¶11261 and *Dawson Construction Co.*, GSBCA 3998, 75-2 BCA ¶11563, the boards found that the contractors were not entitled to a time extension because the government's delays did not affect project completion dates (Ponce de Leon 1991).

4.6. CHAPTER CONCLUSION

Total float is the amount of float available to a chain or path of activities and indicates the flexibility for all activities on the same path. It is shared by all activities along a given path, and does not necessarily represent the float available to a specific activity. It is also defined as an important component in scheduling flexibility associated with the activities in a project network and as an indicator of how much a schedule can absorb delays in activity completion without extending the project duration (Raz and Marchall 1996).

All participants involved in construction are likely, at one time or another, to consume float to advance their own benefits. This chapter presents two major categories of total float consumption: owner's and contractor's. Owners generally consume float in several basic ways: they fail to perform their duties in a timely manner, they make changes in the scope of work, they interfere with the process, and they insert schedule contract provisions. In addition, their representatives often fail to perform their duties in a timely manner.

Contractors commonly consume total float of non-critical path activities in the following ways: they perform actions (or don't perform them) resulting in float

consumption, they fail to set forth a realistic schedule, and they play a number of “games,” including using target or conditional dates, lead/lag restraints, preferential sequencing, artificial activity duration, inaccurate schedule updates, and altered project histories. In addition, subcontractors and suppliers can also affect float if they fail to perform an action on time or properly—or fail to perform it altogether.

The chapter also discusses how, through increased float consumption along a path, a non-critical activity can become a near-critical activity and even a critical activity. As a non-critical activity is delayed, it thus consumes its total float, and the possibility that the completion date will be delayed increases significantly (Hulett 1995, Gong and Rowing 1995).

Under the current law, courts view total float time clearly as “an expiring resource available to all parties involving in the project.” Almost all significant public procurements include contract clauses asserting that float cannot be used for the exclusive benefit of any one party. However, these clauses do permit the individual who gets to the float first to gain any benefits from it. Under this policy, parties with some float time are free to use it for their own benefit and interest without regard to the impact such activity might have on other parties or to the project completion time.

Finally, this chapter discusses the idea that while ownership of total float generally shifts between owner and contractor, there is a third alternative: it belongs to the project. Under the concept of owner’s entitlement, owners would have the right to appropriate the total float because they pay for the project and should be able to use it to save project costs, control progress, and ensure timely completion.

Under the contractor’s entitlement concept, contractors should own total float because they responsible for construction means, methods, equipment, and scheduling. Therefore, they should be able to control the sequences and durations of the project activities and maximize the utilization of resources. Under the project’s entitlement, the total float should belong to the project and is considered an expiring resource available to all parties involved. Whoever gets to it first can gain any benefits it provides. This means that if the total float of non-critical path work is used up in the early construction stages, then a party at the later stage may have to perform work on the critical path. Thus, the late-stage party

might be liable for damages if any work delays occur that result in an extension of the project completion date.

CHAPTER 5

RESEARCH AND COURT PRACTICES CONCERNING TOTAL FLOAT MANAGEMENT

5.1. INTRODUCTION

As CPM scheduling has been increasingly utilized both as a management tool in construction projects and as evidence in proving delay claims, the issue of total float management has become a major concern. This chapter will present, summarize and consider applications for previous studies that have been developed, as well as new theories that have been introduced to resolve problems associated with the topic of total float management.

As mentioned in the Chapter 3, past court decisions have and will continue to influence the construction industry; these past court practices are also a part of the law. In order to understand how various boards and courts of law have under different situations approached the issue of total float management, this chapter will then introduce and discuss five previous case studies.

5.2. PREVIOUS RESEARCH RESOLVING TOTAL FLOAT OWNERSHIP ISSUE

The main purpose of this research is to introduce a new concept of total float management that will resolve any the conflicts inherent in current conceptions and applications. Before doing so, however, it is essential to perceive how other people have introduced potential solutions to the problem. There are four methods that have been used or recently introduced to allocate and control float, including 1) allocating float to individual activities along a path of activities, 2) trading total float as commodity, 3) calculating and using safe float, and 4) using float clauses in contracts.

5.2.1. ALLOCATING FLOAT TO INDIVIDUAL ACTIVITIES ALONG A PATH

The first method of float allocation involves simply distributing it to individual activities along a path of activities (Wickwire, Driscoll, and Hurlbut, 1991). The allotted float of an activity is equal to:

$$\frac{\text{Duration of activity}}{\text{Total duration of activity path}} \times \text{Total float on path}$$

Another concept for allocating total float distribution to each project participant was introduced by Pasiphol and Popescu (1995) and Pasiphol (1994). Under this method, the involved parties know from the beginning of the project the exact portion of the total float they are entitled to use. The concept advances the above total float distribution method of using the activity duration. It allocates total float to activities on the same path by proposing two criteria classifications: quantitative and qualitative.

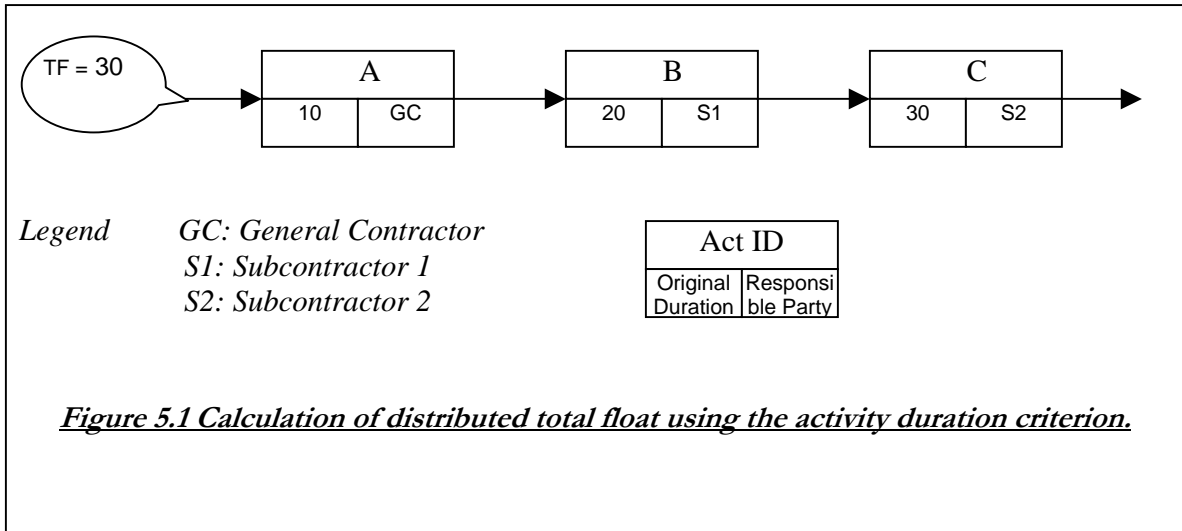
The first classification is quantitative, using numbers from the associated activity information as the criteria for total float distribution. There are three quantitative criteria involved in this classification method:

1. *Uniform Distribution Criterion* — Equal allocation of the total float to all activities on a path. This criterion considers every activity on a path as equally important.
2. *Activity Duration Criterion* — Allocating more total float to the activity requiring the most time to perform.
3. *Activity Direct Cost Criterion* — Allocating more total float to the activity requiring more direct cost for work completion.

The second classification involves qualitative criteria, non-numeric factors that can cause an activity delay. This classification requires the use of information that is not available from the baseline schedule and that needs to be subjectively evaluated by the project management team. Possible qualitative criteria are:

1. *Activity Resource Demand Criterion* – Allocating more total float to the activity that requires more resources such as special materials or equipment.
2. *Labor Strike Prone Criterion* – Allocating more total float to the activity that is more prone to the effects of a strike.
3. *Late Material Delivery Criterion* – Allocating more total float to the activity that has a higher risk of a late material delivery.
4. *Type of Work Criterion* – Allocating more total float to the activity requiring highly skilled labor for completion or to the activity requiring stringent quality control.
5. *Insufficient Drawings & Specifications Criterion* – Allocating more total float to the activity possessing the most complex drawings, which might require changes as construction progresses.
6. *Environmental Permission Criterion* – Allocating more total float to the activity with environmental considerations, such as an environmental permit requirement or the material disposal of hazardous material/waste.

The following exemplifies manual calculation of distributed total float (DTF) using the activity duration criterion proposed by Pasiphol (1994). The figure 5.1 shows an activity path with 30 days of total float, which consists of three activities, A, B, and C.



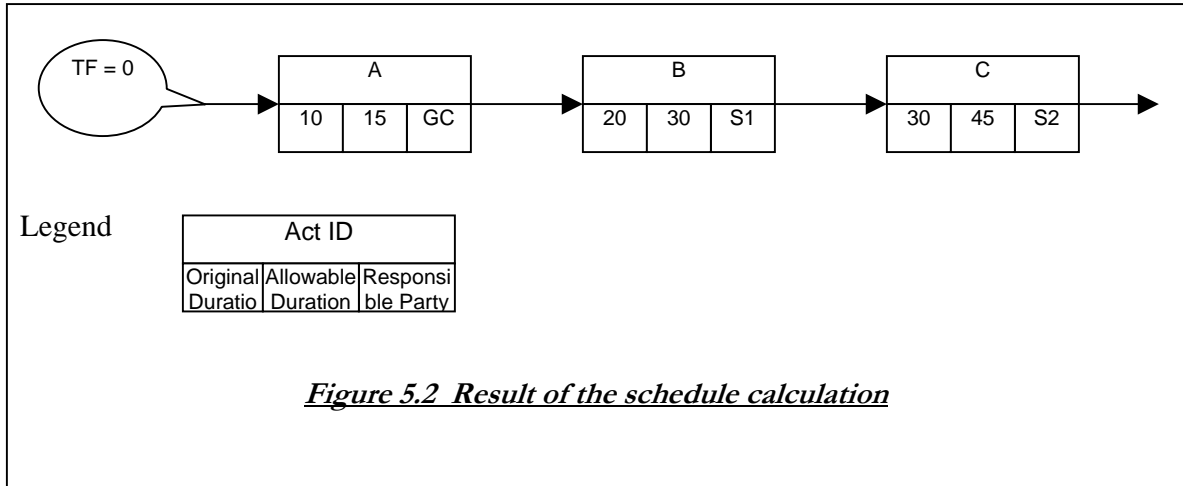
$$\text{DTF for an activity} = \frac{\text{TF of the path} \times \text{the activity's original duration}}{\sum \text{activity's original duration of the path}}$$

$$\text{DTF for activity A} = \frac{30 \times 10}{10+20+30} = 5$$

$$\text{DTF for activity B} = \frac{30 \times 20}{10+20+30} = 10$$

$$\text{DTF for activity C} = \frac{30 \times 30}{10+20+30} = 15$$

Then the allowable duration (AD) is equal to the activity original duration plus the DTF. The figure 5.2 indicates the results of the schedule calculation:



After total float is completely allocated to the activities on the paths, all activity paths in the schedule are critical, with zero total float available to the project. All activities will be performed within the allowable duration (the original duration plus the distributed total float).

However, because of the dynamics of a schedule, the administration of this method can become impractical. As the activity logics and durations of the schedule are updated and changed during the construction, the original project critical path may no longer be critical. Instead, some activities that were not originally on the critical path and had total float available may now be on the current project critical path. In addition, the criteria used to distribute total float to the activities might be changed during the construction period. For instance, the activities that originally had a low risk of late material delivery may face a delivery problem resulting from unforeseeable events. Because of the difficulties in implementing the concept, it is considered the least practical method of float allocation (Wickwire, Driscoll, and Hurlbut, 1991).

5.2.2. TRADING TOTAL FLOAT AS COMMODITY

In 1991, de la Garza, Vorster, and Parvin introduced a concept that treats the total float as commodity. This method recognizes that total float is beneficial to both owners and contractors. It asserts that because both owners and contractors can gain or lose if unforeseen conditions affect the project scope or schedule, contractors not only have the right to administer and use total float but also the obligation to trade it on demand. Thus, total float time taken away from the schedule needs to be replaced with either incentive or monetary

contingencies. The total float is treated as any other resource. It becomes an especially useful commodity during change order negotiations.

This concept proposes a method for calculating an explicit commercial trade-in-opportunity value and introduces a contract clause governing the trading of total float as a commodity.

The calculation of the daily trade-in value of total float for a given activity is:

$$\frac{\text{Late finish cost (LFC)} - \text{Early finish cost (EFC)}}{\text{Total float}}$$

This method involves determining an early finish cost (EFC) and a late finish cost (LFC), a process similar to that of the time-cost trade-off analysis. The EFC is based on the most efficient method and resource with respect to a perfect world and the perfect availability of all resources. The LFC is the estimated increased performance cost that accompanies an activity's loss of flexibility as total float is consumed and the contractor moves closer to the late finish dates.

This method treats float in a manner opposite to the current float practice, which considers float as “free” and an expiring resource available to all. Under the current method, the total float amount is an estimate or a by-product of CPM calculation, and if it not used by any part, it will expire—and thus be of benefit to no one. The greatest benefit of having total float available in the schedule is to give the owner and contractor flexibility to deal with unforeseeable events or potential change orders.

In terms of the owner's change orders, the contractor, in general, is paid for both indirect and direct costs that might result from them. In most cases, contractors are allowed to include impact costs into their estimated change order costs. Therefore, there is usually no argument about paying extra for the use of total float.

Another barrier for implementing the commodity concept can be attributed to the dynamic nature of the schedule, as mentioned previously with the first method. The activity durations and logics of the CPM schedule can be adjusted during the period of construction

and the total float will, of course, be changed as well. Implementation of this concept, therefore, can be both difficult and impractical.

5.2.3. CALCULATING AND USING SAFE FLOAT

The third method, calculating and using safe float, was introduced by Gong and Rowings (1995) and updated by Gong (1997). These studies recognize the increased risk of schedule overruns caused by the use of total float and introduce a new concept of “safe float use,” indicating the amount of float that can be used safely to reduce the risk of project delay caused by delay(s) to non-critical activities. Such studies suggest that as long as all parties consume float in the suggested safe float range, the risk of project delay caused by total float consumption is minimized and total float ownership does not become an issue.

This method measures the joint influence of float use and the uncertainty of non-critical activities on the project duration, called the *combined influence*, and suggests a calculation of safe float use in risk-analysis-oriented network scheduling. The study involves two basic concepts: a back-forward uncertainty estimation (BFUE) procedure and a safe float range.

The BFUE procedure estimates the influence of non-critical activities at each merge event in a project schedule (Gong and Rugsted 1993). The following mathematical model is applied to calculate the expected time and time variance for a merge event when two merging activities *a* and *b* are connected:

$$E(t) = \int_0^{\infty} t [f_a(T_a)F_b(T_b) + f_b(T_b)F_a(T_a)]d_t$$

$$\sigma^2(t) = \int_0^{\infty} (t - E[t])^2 [f_a(T_a)F_b(T_b) + f_b(T_b)F_a(T_a)]d_t$$

$$T_a = \frac{t - E_a[t]}{\sigma_a(t)}$$

$$T_b = \frac{t - E_b [t]}{\sigma_b (t)}$$

$$E_a [t] = EE_a [t] + FU_a$$

$$E_b [t] = EE_b [t] + FU_b$$

where t is the time variable of a merge event, $E(t)$ and $\sigma^2(t)$ are the expected time and time variance of a merge event connected with two merging activities a and b . $f(T)$ and $F(T)$ are the probability density function and the cumulative probability function for the finish time of the merging activity, respectively. $EE [t]$ is the earliest expected finish time of the merging activity and FU is the float use of the merging activity.

Given an example presented in the 1995 study, the figure 5.3 illustrates the *combined influence* using the above formulas. FU on the x-axis represents the float use. $E(t)$ on the y-axis represents the expected change in network time. When the float use FU is zero, the expected time is 45. When FU is equal to the amount of the total float or 20, the expected time reaches its largest value, 48.

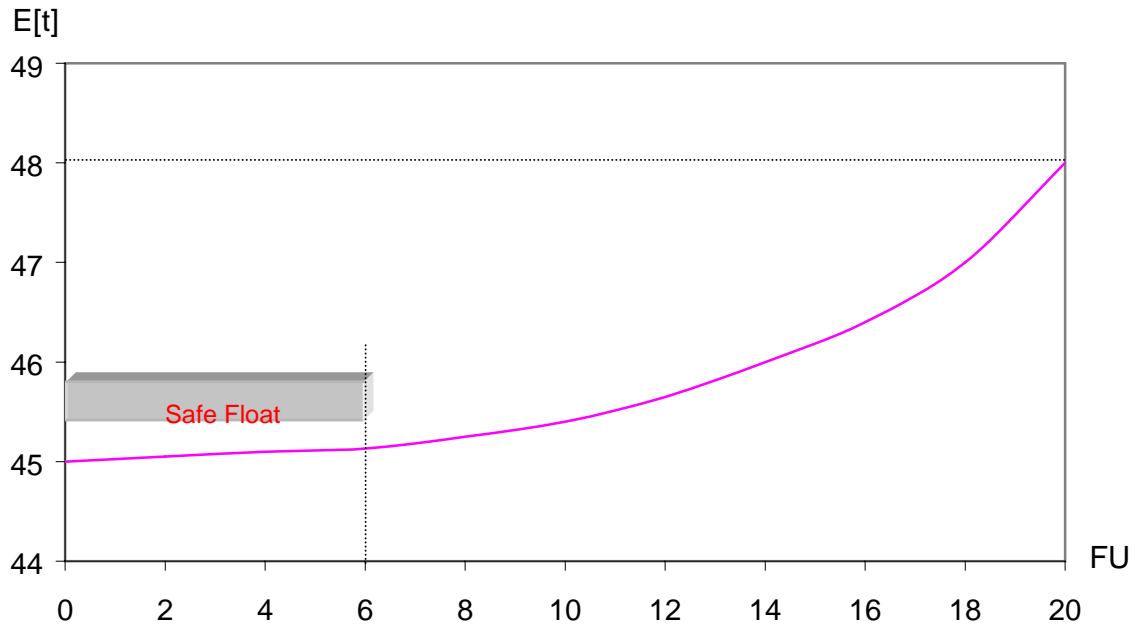


Figure 5.3 Calculation of the combined influence of non-critical activities.

As shown in the figure 5.3, when FU is less than or equal to 6, there is virtually no change in the expected time. When FU is larger than 6, the expected time starts to increase. To avoid possible delays to the project caused by total float use, float use should be limited within the flat-curve range, which is called the safe range of float use. Gong and Rowings (1995) gives the definition of the safe range of float use as “*the amount of float use in non-critical activities that does not lead to a disturbance in the total project time*” (p. 189).

In conclusion, this method shows that the risk of schedule overruns—and, accordingly, project costs—can increase if total floats are consumed up to a certain point. If parties use float time above the suggested safe floats, they face the choice of paying the price of project delays. However, there could be several reasons that this method is not used in practice. One reason is that defining the safe range of float use is related to the project manager’s attitude to the magnitudes of the changes in the expected time of a merge event. Another reason is that implementation of the method can be difficult and complex. In addition, the risk of schedule overruns caused by using total floats beyond the safe float may

or may not become true. Therefore, the parties face the choice of either paying the price of a higher cost now or paying the price later if a project delay occurs.

5.2.4. USING FLOAT CLAUSES IN CONTRACT

The last method of float management is inserting float clauses and other scheduling clauses in contract documents during the design phase. This method has been widely accepted and used in the construction industry. Zack (1996), Ashley and Mathews (1984), Ibbs and Ashley (1986), Hartman, Snelgrove and Ashrafi (1997) and Sweet (1999) believe that good and fair project scheduling can be accomplished if during the design phase scheduling specifications are well-prepared and well-written.

In most cases that occur in the United States, unless the contract document states otherwise, float belongs exclusively to the contractor (Zack 1996). To avoid the rule that the contractor owns the float, recent studies have recommended that owners include such clauses in contract documents during contract preparation (Zack 1992; 1996; Person 1991; Wickwire, Driscoll, and Hurlbut 1991). Clauses that are currently in construction contracts to deal with the float ownership issue take the forms of:

- “Joint Ownership of Float” or “Float-Sharing” Clauses
- “No-Damages-For-Delay” Clauses
- “Nonsequestering of Float” Clauses

5.2.4.1. “Joint Ownership of Float” Clause

As mentioned earlier, if the contract is silent about the issue, float times are exclusively owned by the contractor. With this rule in mind, contractors may be entitled to a time extension and costs on almost any delay that consumes float time, even when the delay does not affect the project completion date.

To avoid this type of contractor’s delay claim, Zack (1992; 1996) suggests that the owner inserts a “joint ownership of float” clause in the scheduling specification. Such a clause could read as simply as “float is a jointly owned resource that expires as the project progresses and is consumed on a first-come, first-served basis.” Insertion of this or a similar

clause prevents the contractor from making claims against the owner for delay(s) to non-critical activities that have some float times.

The float-sharing clause has been most commonly used by the Government to reverse the perspective that the contractor owns float (Person 1991). For instance, the U.S. Army Corps of Engineers (Dept. of Defense Federal Acquisition Regulation Supplement 252.236-7012) provides the following Regulation ER1-1-11 regarding float ownership (March 15, 1990):

“Float available in the schedule at any time shall not be considered as for the exclusive use by either the contractor or the Government. Extensions of time for performance of work required under Contract Clauses entitled, ‘CHANGES,’ ‘DIFFERING SITE CONDITIONS,’ ‘DEFAULT (FIXED PRICE CONSTRUCTION),’ or ‘SUSPENSION OF WORK’ will be granted only to the extent that equitable time adjustments for affected activities exceed the total float along their paths.” (Person 1991, p. 5)

Other examples of this float-sharing clause are presented in Chapter 3 of this research. In conclusion, under this clause, contractors are entitled to a time extension only to the extent that the owner’s delaying of zero-day float activities results in extending the project completion date.

5.2.4.2. Limited Form of “No Damage for Delay” Clause

In order to enhance the “joint ownership of float” clause, a “no damage for delay” clause should also be included in the scheduling specification, stating that “no time extensions will be granted nor delay damages paid until a delay arises that is caused by the owner and causes the work to exceed the current adjusted contract completion date” (Zack 1996, p. 46). This clause protects the owner from contractor claims for delays that neither affect the project’s critical path nor change the project completion date.

In 1991, Wickwire, Driscoll, and Hurlbut introduced a model scheduling specification. A part of the suggested “Change Orders, Delays, and Time Extension” clauses includes the following time extension clause, which related to total float.

“Time extensions will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total or remaining float along the path of activities at the time of actual delay or at the time notice to proceed was issued for a change.” (p. 475)

As noted by Bartholomew (1998) and Richter and Mitchell (1982), typical examples of this clause that have been used in construction contracts include:

1. *“The Contractor (Subcontractor) expressly agrees not to make, and hereby waives, any claim for damages on account of any delay, obstruction or hindrance for any cause whatsoever, including but not limited to the aforesaid causes, and agrees that its sole right and remedy in the case of any delay...shall be an extension of the time fixed for completion of the Work.”*
2. *“No payment or compensation of any kind shall be made to the contractor for damages because of hindrance or delay from any cause in the progress of the work, whether such delays be avoidable or unavoidable.”*
3. *“Apart from extension of time, no payment or claim for damages shall be made to the contractor as compensation for damages for any delays or hindrances from any cause whatsoever in the progress of the work notwithstanding whether such delay be avoidable or unavoidable.”*

Owners often include this provision to shift the entire risk of delays to contractors or to preclude contractors from recovering damages for any delay, including those caused by the owner (Sweet 1999). By stating in the contract that time extensions will be granted only for delays on the critical path, it implies that the Owner owns the float (Richter and Mitchell, 1989). Under this provision, for owner-caused delays, contractors may receive only a time extension, but not delay damages. However, Richter and Mitchell (1982), Person (1991) and Sweet (1999) state that courts have excluded the “No-Damage” clause under five certain circumstances:

- i. delays not within the contemplation of the contracting parties,
- ii. delays amounting to an abandonment of the project,

- iii. delays caused by fraud, misrepresentation, or bad faith of the owner,
- iv. delays caused by active interference of the owner, and
- v. delays caused by gross negligence.

5.2.4.3. “Nonsequestering of Float” Clause

As mentioned earlier, the contractor can sequester or take control of float in a project schedule by using preferential logics, artificial activity durations, or constraints. To avoid the contractor’s control of floats in the schedule, the owner should insert a “nonsequestering of float” clause in the scheduling specification prohibiting the sequestering of float and giving the owner authority to review and reject any schedule submittal if float is sequestered.

5.3. PREVIOUS COURT PRACTICES CONCERNING TOTAL FLOAT ISSUE

In the following cases, the court addressed in some manner delay claims involving the float allocation issue. The courts essentially found that float was an expiring resource available to all parties who act in good faith on a non-discriminatory basis and that it could be used on a first-come-first-served basis. As indicated by the cases, the boards shifted their focus from the total float ownership issue to the impact of delays on the critical path or project completion date. However, this shift in focus does not resolve the issue; instead, it simply hides the root cause of the problem. The following five case studies are summarized to illustrate the boards’ decisions on different cases involving delay claims associated with total float.

*CASE STUDY NO. 1 - WEAVER-BAILEY CONTRACTORS, INC. v. THE UNITED STATES, 19
CL.CT.474, 475, 81-2 (1990).*

Factual Background

Weaver-Bailey Contractors, Inc. entered into a contract agreement with the United States Army Corps of Engineers on July 5, 1984, for a firm fixed price of \$1,434,023.94. The project called for Weaver-Bailey to build beaches, breakwaters, parking areas, boat ramps, and other items for the improvement of recreation areas surrounding Arcadia Lake in Edmond, Oklahoma.

Weaver-Bailey began work on August 8, 1984, and the project progressed smoothly through the late summer and early fall. The contract specifications, which were prepared by the Corps, estimated the amount of unclassified excavation at 132,000 cubic yards (cy). However, in early October 1984, the contractor suddenly learned that the total amount of unclassified excavation it was required to perform was not 132,000 cy, but rather 186,695 cy. In early October, a modification was issued to cover the additional amount of excavation. The original project contract had called for completion by February 13, 1985, but the Corps had extended the time for performance by 68 days due to inclement weather conditions. The project was finally completed on April 23, 1985.

This case is a direct-access appeal from the contracting officer's denial of the contractor's request for an equitable adjustment, and it comes before the court for disposition following a four-day trial. The central issue presented is whether the delay in completing the contract was caused in whole or in part by the contractor, thus precluding recovery, or whether the government was the sole cause of the delay, in which case the contractor is entitled to compensation.

Dispute or Contractor's Claim

The contractor has shown that it is entitled to an equitable adjustment under the Differing Site Conditions clause. The Corps argues that the contractor has already been compensated for its claim. However, the \$180,000 modification for moving the extra 54,695 cy of unclassified excavation merely compensated the contractor for moving the dirt itself, at a unit-price comparable to the unit-price for the rest of the unclassified excavation. The \$180,000 modification in no way took into account the cost effect of the delay resulting from the extra earthwork; indeed, the modification was entered into long before any assessment could be made of costs related to the delay.

Owner's Response/Position

The Corps argues that this is not a delay case. The argument is as follows: (i) Weaver-Bailey projected that it would use the entire time allowed under the contract, i.e., until February 13, 1985, to complete performance; (ii) the time for performance was extended due to inclement weather; and (iii) Weaver-Bailey completed the required work

within the extended time period. Therefore, from the Corps' standpoint, the contract was completed on time.

Board's Decision

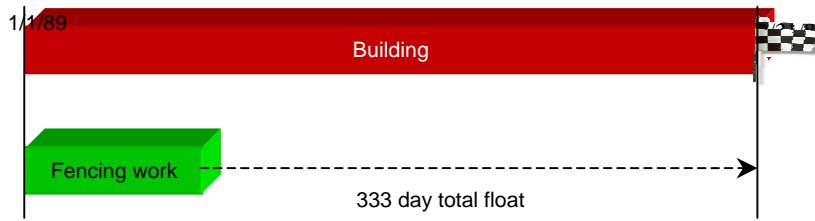
The board gave an explanation regarding a critical path activity that, if allowed to grow in duration at all, will cause an increase in the overall time required to complete the project. By contrast, an activity with float time may grow in duration up to a certain point, without an adverse impact on the time required to complete the project.

The board also provided an example of a contractor who committed himself to building a house beginning on January 1, 1989. The contractor has determined that he will need one year to complete the job. Suppose that as part of the job, the contractor promised to build a fence along two edges of the property, and that building the fence will take 20 days. No other work depends on the completion of the fence, so delaying work on the fence until December 11, 1989 will not put the contractor in danger of late completion. In other words, building the fence is an activity with a lot of float time. However, float time is never unlimited. From the foregoing, one can make the following generalization: regardless of whether an activity is on the critical path of a project, if the time required to complete the activity is greater than the time remaining to complete the project, then project completion will be delayed.

Consider now the effect on our hypothetical contractor if on December 1, before fencing work had begun, the buyer of the house told the contractor that he would like all four sides of the property to be fenced, thereby doubling the fencing work. Clearly the contractor could not complete the entire project by the end of the year, but through no fault of his own. The time required for the fencing portion of the job is now 40 days, and the contractor has only 31 days left.

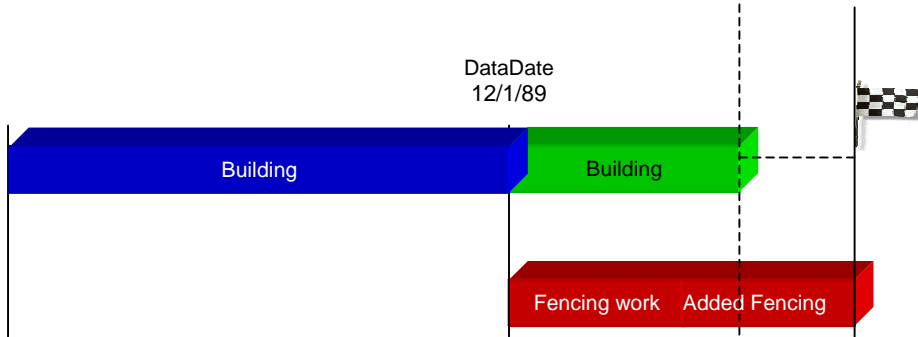
BROAD’S EXAMPLE PROVIDED IN THE CASE

Baseline Schedule

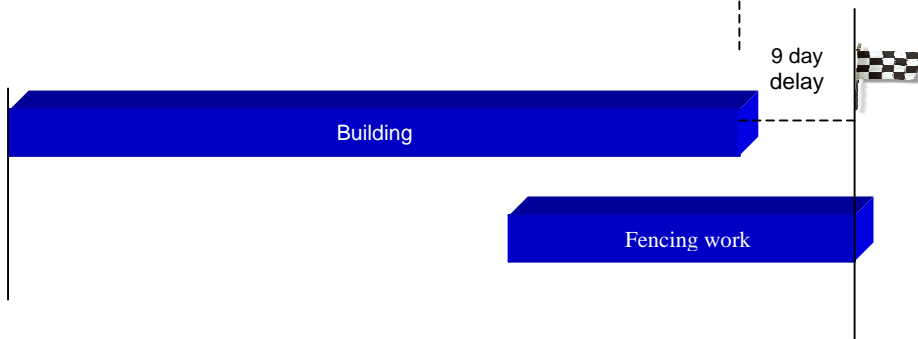


December 1, 1989 Schedule Update

On 12/1/89, the Owner doubled the fencing work, while the contractor had only 31 days left to complete the project.



As-built Schedule



Weaver-Bailey was in much the same position as the hypothetical contractor when it discovered in October that the unclassified excavation portion of the project had increased. It was progressing toward a late November or early December completion, until the work was increased by 41%. Based upon the testimonial and documentary evidence presented at trial, it is clear that Weaver-Bailey would have completed the project by December 3, 1984. Thus, the government's underestimate actually delayed Weaver-Bailey's completion by 138 days.

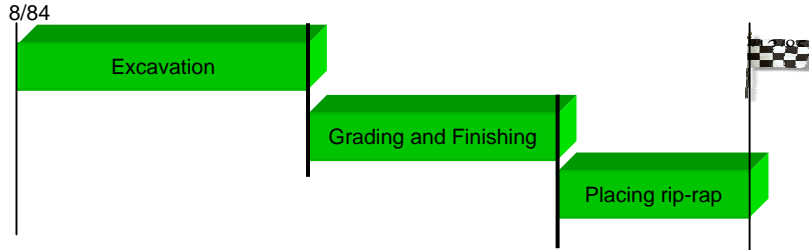
The court does not see how Weaver-Bailey can be faulted for the way it handled the unclassified excavation. The government does not even allege that, in the absence of the 41% increase in unclassified excavation, the contractor *would not have* completed the project by early December. The court concludes that neither Weaver-Bailey nor its subcontractor can be faulted for delaying completion of the project. The contractor has met its burden of proving entitlement to an equitable adjustment in the amount of \$469,041.00, with interest.

Current Application

In this case, the board awarded ownership of total float to the contractor. The contractor proved that its plan was to complete the project early, by the end of December 1984, in order to avoid potentially severe winter weather. With the contractor's early completion plan, the project total float was no longer available to accommodate the government's change order, which was found in October. As a result of activities directed by the change order, the project completion date was extended. The court rejected the government's dispute, providing a detailed discussion on float and confirming its availability to all parties as long as they act in a reasonable manner. In this case, the contractor provided enough evidence to indicate that it would be unrealistic to place rip-rap during the Oklahoma winter. So the contractor's early completion plan was reasonable and reliable.

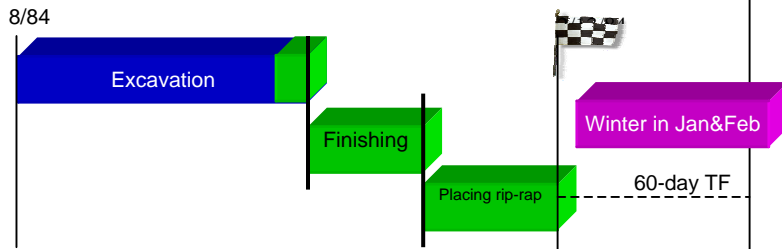
AS-PLANNED VS. AS-BUILT SCHEDULES - WEAVER-BAILEY CONTRACTORS V. THE UNITED STATES

Baseline Schedule

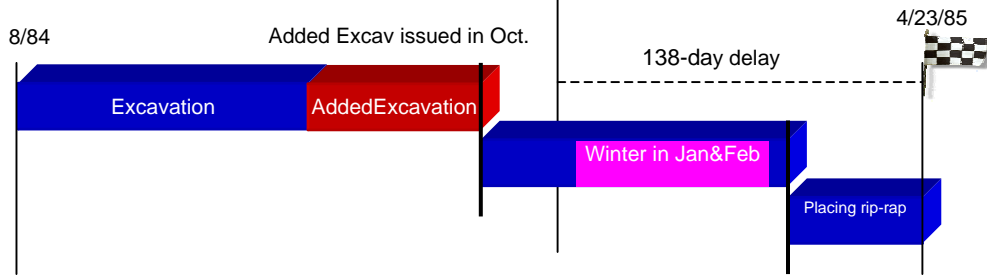


October 1984 Schedule Update

As of October 1984, the contractor intended to complete the project in December 1984 to avoid the severe winter.



As-built Schedule



***CASE STUDY NO. 2 – DAWSON CONSTRUCTION CO., GSBCA NO. 3998, 75-2 BCA 11,563
(1975).***

Factual Background

This appeal is from a contracting officer's final decision denying the contractor's claim for a time extension of 555 calendar days, together with extended operating costs for the same period. The contracting officer awarded a time extension of 46 days from the scheduled contract completion date of August 10, 1973 to the date of actual substantial completion, September 25, 1973, but denied the contractor's request for additional compensation.

The contractor seeks an equitable adjustment of \$444,000, alleged operating expenses at the rate of \$800 per day for each of the 555 days comprising its time extension request. The time request is based on two claims of differing site conditions, a delay claim for unusually severe weather, and a number of claims for delays caused either by change orders issued by the Government or by constructive changes. An evaluation of these claims was made using the Critical Path Method (CPM) construction plan technique.

Dispute or Contractor's Claim

The contractor combined 10 delay items to come up with the 555-day claim. For the purpose of this dissertation, only Item #4—relating to total float—will be examined. The contractor based its April 2, 1973 claim of a 25-day time extension on “delay caused by waiting until winter weather to install these pits when the water table was almost at ground level.” On May 1, 1973, the claim was raised to 45 days “caused by a lack of answers on the lift pits.” The Contractor responded to the owner’s position on November 14, 1973:

“This dispute has been going on since November of 1972, and is still not settled, but after 209 days (November 18, 1972--June 15, 1973), we went ahead and installed the lift pits. This total delay of 209 days less the 160 days slack leaves a net delay to the job of 49 days. We hereby revise our request for time extension on Item No. 4 to be 49 days.”

Owner's Response/Position

In analyzing the claim, Warner—the government consultant—pointed out that the installation of lift pits affected only the completion of the Vehicle Maintenance Facility (VMF) in which the pits were located and that such completion had 160 days of slack on the CPM construction plan. Warner therefore determined that the 45-day delay claim was not justified.

Warner took a dual approach in its time extension analysis. Following accepted procedures it prepared an as-built CPM and from it analyzed the various non-contractor caused delays. The actual project completion was found to have been delayed only one day as a result of unusually severe weather and differing site conditions. The result appeared unfair in view of the contractor's obviously having made up for the delays by working around them.

Board's Decision

The Board found no basis for any claim based on a government delay in settling the problem. The only issue was who was financially responsible. The contractor did not hold up pit construction until the contracting officer rendered his decision. The potential delay would be that caused by construction of the lift pits themselves. The contractor's estimated duration for that work was 25 days. During the hearing, however, the contractor introduced no evidence showing that overall contract completion was in any way affected by such extra work.

The Board already determined that the contract could reasonably be interpreted as not requiring construction of hydraulic lift pits. The Boards remanded to the parties the determination of equitable adjustment by reason of installing such pits. The Board still needed to determine whether the project was delayed by reason of pit construction. Because the hydraulic lifts, whose operation depend upon installation of lift pits, were a part of the VMF, we have seen that Warner recommended no time extension since there were 160 days slack in completion of the VMF and The Contractor's claim was only 45 days. Although the Contractor responded by claiming that the matter was in dispute for 209 days (Nov. 18, 1972 to June 15, 1973) and that there should still be 49 days extension due after subtracting the

160 days slack, there was no evidence introduced to show that this resulted in any project delays. The pits were in fact installed long before a final decision had been rendered that such installation was a contract requirement. The boards can find no relationship in the length of time the matter was in dispute to any specific actual time delay in the work itself, much less any delay in overall project completion. The contractor has simply failed to prove this claim.

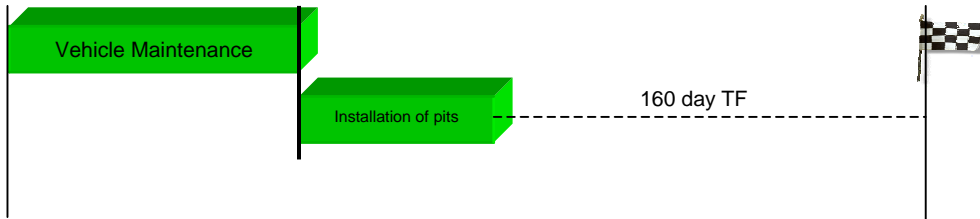
Current Application

The court denied the contractor's claim for a time extension even though the government had delayed resolving the issue of payment for construction of a hydraulic lift pit. The court indicated that there was no evidence that the critical path for the project was affected by the government's delay.

Under the board's decision in this matter, the total float belongs to the owner, who can consume total float of non-critical path activities as long as the project completion date is not affected by such action.

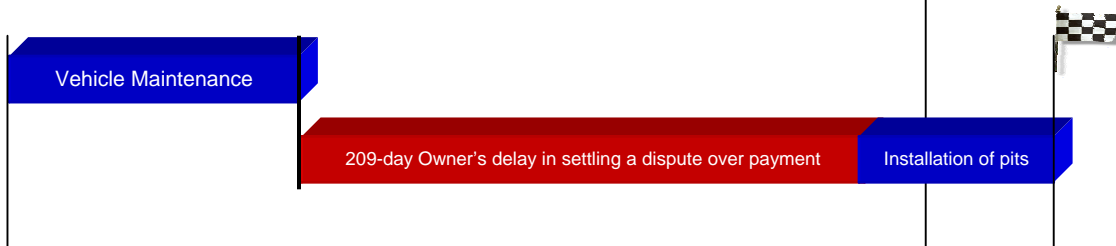
AS-PLANNED VS. AS-BUILT SCHEDULES - DAWSON CONSTRUCTION CO.

Baseline Schedule



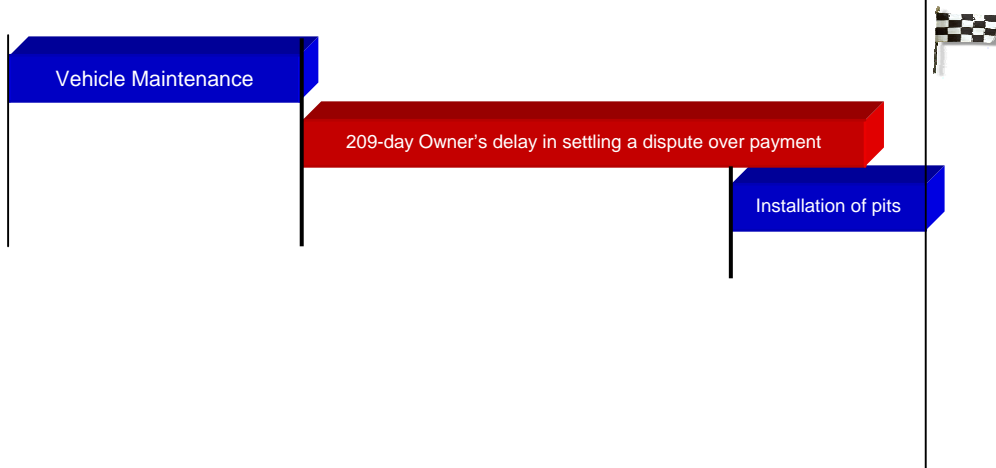
The Contractor's Alleged As-built Schedule

The contractor alleged that the owner's 209-day delay in settling a dispute over payment caused a delay to the installation of pits.



Board's As-built Schedule

There is no evidence indicating that the owner's 209-day delay in settling a dispute over payment caused a delay to the project completion date and the pits were installed long before the settlement.



***CASE STUDY NO. 3 – EALAHAN ELECTRIC CO., DOTBCA NO. 1959, 90-3 BCA 23,177
(1990).***

Factual Background

On June 19, 1984, the Coast Guard awarded the Ealahan electric company a contract in the amount of \$276,600 to furnish all labor, material, and equipment necessary to renovate an existing shop building and to construct a two story addition, including sitework and exterior utilities, at the Coast Guard Station located in Montauk, New York. The contract contained the Standard Form 23-A (Rev. 4-75) "Changes," "Disputes," and "Suspension of Work" clauses. The project started on August 1, 1984, to be completed by December 28, 1984.

Dispute or Contractor's Claim

Throughout construction Ealahan experienced difficulties which were its responsibility and which took time to correct. Also, during performance, the Coast Guard issued ten changes to the contract, which caused further delays in Ealahan's work. Ealahan claims that it does not have to consider its own delays in computing the adjustment to which it is entitled.

Owner's Response/Position

The Coast Guard claims that Ealahan's delays were concurrent with the change orders and that Ealahan is, therefore, not entitled to a contract time extension.

Board's Decision

The threshold issue is whether a contractor is entitled to a time extension for government-issued change orders that would otherwise extend performance time if, during the time period for performing the change orders, the contractor is delayed by matters which are its own responsibility.

The evidence is sufficient that the critical path was affected by these changes. Although the government introduced evidence as to the actual amount of days spent on each change, since there is an overlap in the periods of time during which the changes were

performed, the board cannot simply add up the time taken for each change in determining the amount of delay attributable to these changes.

Certain of the delays caused by Ealahan occurred in an earlier time frame than the change orders issued by the Coast Guard. Such delays are not concurrent. Though Ealahan may have delayed completion by its actions early in the project, the boards found that these delays are independent of delays caused by the Coast Guard at a later time. A contractor is entitled to a time extension for government-caused delays although it also has delayed performance, if such delays have occurred in a different time period than the government-caused delays and assuming the actions delayed the job completion.

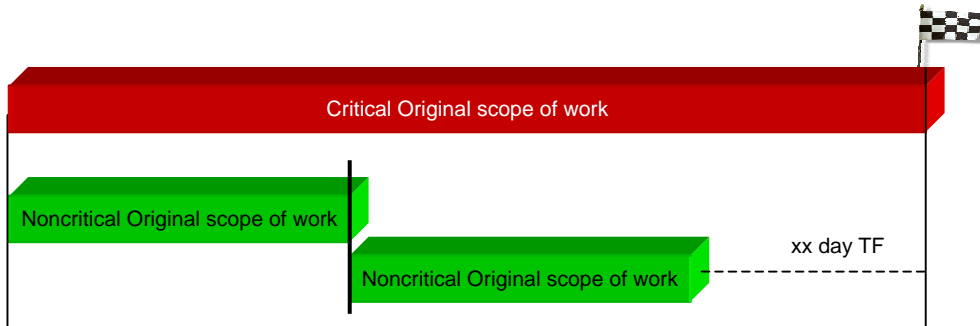
Current Application

The Department of Transportation Board of Contract Appeals considered an argument that certain delays occurring in an earlier time frame in the project were the basis for offsetting, as concurrency, delays which were encountered at a later time in the project. The board found the owner's attempt to move delays from one time frame to another to be invalid. The contractor was entitled to a time extension for government-caused delays, although it also delayed performance, where such delays occurred in a different time period than the government-caused delays.

The case implies that total float belongs to the contractor, whose delays occurred in the early time period. The owner's delay to the non-critical activities, where total floats were consumed up by the contractor, caused an extension to completion date of the project.

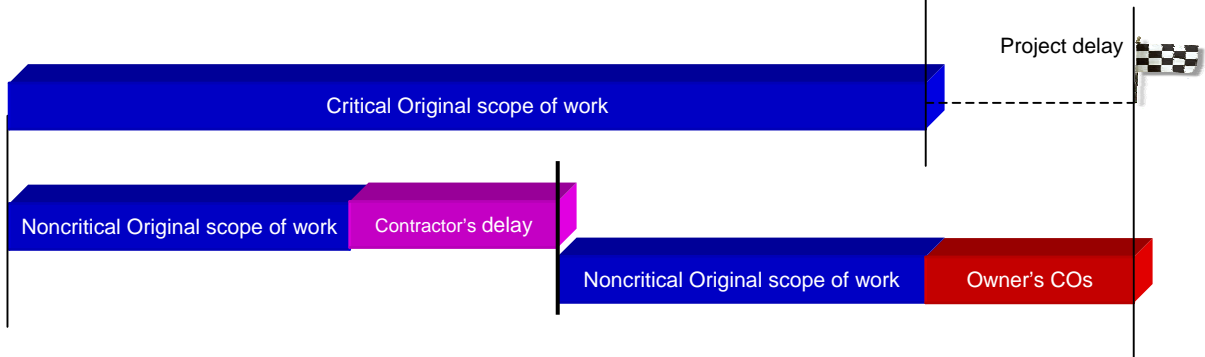
AS-PLANNED VS. AS-BUILT SCHEDULES - *DAWSON CONSTRUCTION CO.*

Baseline Schedule



As-built Schedule

The owner's change orders, which were occurred in a later time period, have delayed the project completion date.



***CASE STUDY NO. 4 – MCI CONSTRUCTORS, INC., DCCAB No. D-924, 1996 WL 331212
(JUNE 4, 1996).***

Factual Background

In this appeal, the Appellant, MCI Constructors, Inc. ("MCI"), seeks convenience termination costs pursuant to the board's previous entitlement decision, which converted the District of Columbia's default termination of MCI's contract into a termination for the convenience of the District. The boards conclude that MCI is entitled to recover \$764,842, plus interest.

The contract was for the construction of the Chlorination/Dechlorination Facility at the Blue Plains Wastewater Treatment Plant. It was a fixed-price contract in the amount of \$2,882,850.00. The project was designed to provide the final treatment of wastewater from the Blue Plains Wastewater Treatment Plant before its discharge into the Potomac River. Notice to Proceed was issued to MCI on July 21, 1986. Construction of the project was to be completed 550 consecutive calendar days after Notice to Proceed, i.e., on or before January 21, 1988.

Dispute or Contractor's Claim

MCI claims that it is entitled to compensation for 252 days of delay measured from the original completion date, January 21, 1988, through the date its contract was improperly default-terminated, September 30, 1988. MCI takes the position that because the Board in its entitlement decision found that the 252-day delay period was caused by District acts or omissions, and did not make any findings that MCI had caused concurrent delay, it has made out a prima facie case that the 252-day delay period was not only excusable but also fully compensable. MCI witnesses testified at the quantum hearing that MCI did not concurrently delay critical path activities.

Owner's Response/Position

The District claims that because MCI was responsible for concurrent delays through July 29, 1988, it is therefore entitled to compensation only for the 62 days of delay from July 30, 1988 through September 30, 1988. The District contends that the board in its entitlement

decision did not find that the 252-day delay period was compensable but rather was merely excusable. The District has stated that it is not challenging the findings of fact made by the board in its entitlement decision. Rather, it says that the issue of whether there were any concurrent delays caused by MCI was not before the board in the entitlement phase and was not resolved in the entitlement decision. An expert witness for the District testified at the quantum hearing that MCI was responsible for approximately 190 days of concurrent critical path delay to project completion.

The District argues that it established concurrent critical path delays caused by MCI in (1) delivering the built-up roofing system between May 1987 and September 1987, (2) fabricating and delivering the monitor and control console, and (3) fabricating, delivering, and installing the chlorinators, sulfonators, evaporators, and associated valves, piping, and fittings, from October 13, 1987 to July 29, 1988. According to the District, MCI-caused delays and District-caused delays were concurrent through July 29, 1988, and the only period of non-concurrent District-caused delay was the period beginning with July 30, 1988 and ending on the termination date of September 30, 1988, a total of 62 calendar days.

Board's Decision

In its decision, the board found that the District had significantly delayed the completion of the project and was responsible for: (1) a 149-day critical path delay from October 1987 to March 1988 because of forebay problems; (2) an approximate six and one half month critical delay between October 1987 and May 2, 1988, based on the District's failure to provide a timely approval of MCI's proposal for rehabilitating the pumps; and (3) a critical delay to completion—measured up to September 30, 1988, the termination date—caused by the District's failure to resolve its defective design for the chlorine injection water pumps. It is in this quantum phase of the case that the parties focus on the issue of whether MCI caused concurrent critical path delays. To determine the issue of concurrency the boards must examine whether MCI is responsible for delays in the prosecution of its work and whether any such delays caused a concurrent critical path delay to project completion.

The board agrees with MCI that the delays attributed to MCI by the District were not critical path delays and generally come within the category of "why hurry up and wait." For explanation, see J. Wickwire, et al., *Critical Path Method Techniques in Contract Claims*:

Issues and Developments, 1974 to 1988, 18 PUB. CONTRACT L.J. 338, 381 (1989), which states "[w]here the government causes delays to the critical path, it is permissible for the contractor to relax its performance of its work to the extent that it does not impact project completion." See also *Utley-James, Inc.*, GSBCA No. 5370, 85-1 BCA p 17,816 at 89,109, *aff'd*, *Utley-James, Inc. v. United States*, 14 Cl. Ct. 804 (1988). Although it is clear that MCI completed roofing later than the date called for in the as-planned schedule, and it is true that MCI was having difficulty prodding Fischer & Porter in early 1988 to complete its delivery of instrumentation, the boards conclude that those delays simply did not affect project completion in view of the overriding District-caused critical path delays.

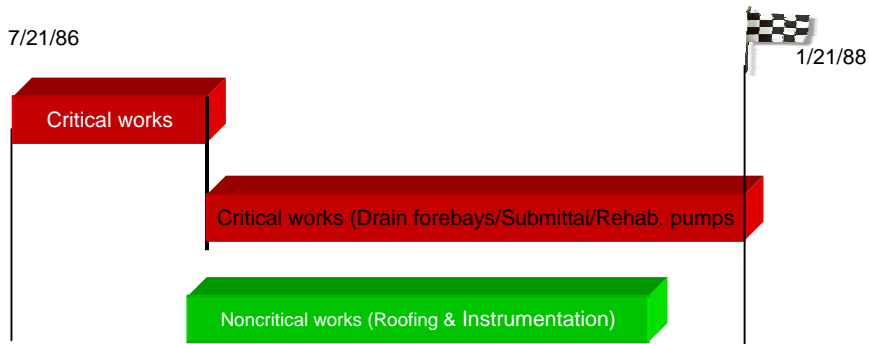
Current Application

MCI Constructors, Inc. represents a reaffirmation of the principle that parties are entitled to use additional float created during performance in the schedule as a result of another party's delays—the "why hurry up and wait concept." In this decision, the District of Columbia sought to diminish recovery by a contractor also responsible for concurrent critical path delays. However, the board found that—given the earlier owner-generated delays to the critical path, which clearly had extended the completion date for the work—the delays of the contractor did not affect the critical path for the project.

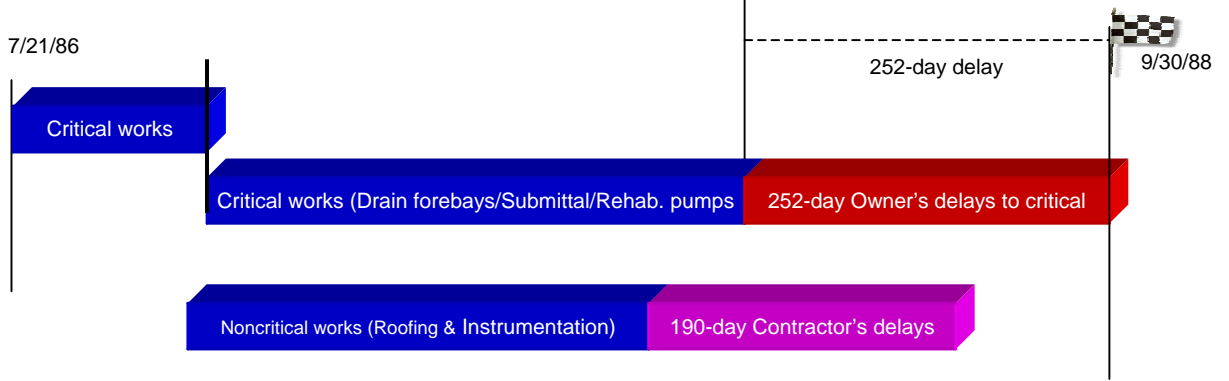
In this case, the total float of the non-critical path activities was considered to be free for all parties. The contractor's delays to the non-critical path activities did not affect the critical path of the project and therefore did not extend the project completion date. As a result, the contractor was not held responsible for the project delay even though its actions consuming the total float of the activities had occurred concurrently with the owner's delays to the critical path activities.

AS-PLANNED VS. AS-BUILT SCHEDULE

As-Planned Schedule



As-built Schedule



CASE STUDY NO. 5 – WILLIAMS ENTERPRISES V. STRAIT MANUFACTURING & WELDING, INC., 728 F. SUPP.12 (D.D.C. 1990).

Factual Background

This negligence and breach of contract action arises from the construction of a new gymnasium and certain modernizations at the Coolidge High School ("project") in Washington, D.C. ("District"). The prime contract for the project was between the District and Smoot, an Ohio Corporation.

Smoot entered into a subcontract with Strait on December 15, 1983, which then undertook fabrication and erection of the steel frame for the project. That subcontract provided that Strait would take reasonable safety precautions. Thereafter, Strait engaged Williams as a second tier sub-contractor to undertake steel erection on the project.

On September 25, 1984, a steel tower assembled in the area of the project, which was almost completed by Williams, collapsed, causing 25 tons of steel to fall nearly 50 feet to the ground below. Work on the steel erection was fully interrupted. This accident was highly visible and dramatic; it was featured prominently in reports by the print and electronic media. The damaged steel was removed from the job and replaced. The new refabricated steel was delivered to the project on December 17, 1984.

Dispute or Contractor's Claim

It is obvious that the critical path delay occurred from the date of the collapse until the steel was reerected. Williams did not deny that this occurred, but rather asserted that other events created a "concurrent delay." Williams pointed to delays in the approval of shop drawings for structural steel and shop drawings for precast fabrication, which occurred in the first month of the project. Both Williams and Strait argued strenuously that a delay in approval of structural steel shop drawings occurred concurrent to the delay caused by the collapse.

Owner's Response/Position

A more likely argument was made by defendants that the delay in approval of precast drawings could have caused a delay in fabrication of the exterior precast panels which were used to enclose the building—in fact the next activity scheduled on the critical path, after steel erection. The panels were to be hung from the completed steel superstructure, a process that could be achieved only after the structure had been erected. Williams, through a separate, affiliated company, Marietta Concrete ("Marietta") was responsible for precast erection, which began in fact on January 30, 1985, the same day that the final steel erection work was completed.

Delays were clearly experienced in obtaining approval of precast shop drawings by the District and its Architect, H.L. Walker. Nevertheless, defendants' witness Arthur Durrah testified for Williams that some 17 drawings had been approved as early as July and full approval was provided by October 12. The precast panels had been fabricated by Marietta and were awaiting erection as of November 7. A large number of panels were fabricated as of November 27. It is important to note that at this point the collapse had already occurred and that there was no possibility of precast erection until the replacement steel was fabricated and erected. These facts create a strong inference that Marietta could have begun, not later than November 8, to fabricate precast panels at a rate sufficient to maintain project momentum.

Board's Decision

Delays in approval of drawings had no impact on beginning or performance of structural steel erection in the period prior to collapse of the erected steel. Additionally, the collapse was the result of negligence on the part of the sub-contractor. Structural steel erection could not begin until shop drawings had been completed and the structural steel had been fabricated. But structural erection began in fact on August 13, 1984. Williams continued work unimpeded until September 25, the day of the collapse. Similarly, it is clear that any delays in approval of precast shop drawings had no impact on the beginning or performance of structural steel erection in the period prior to the collapse. Any delays of other parties prior to August 13 could not be charged to defendants. The court thus finds that there was no "concurrent" delay in this period.

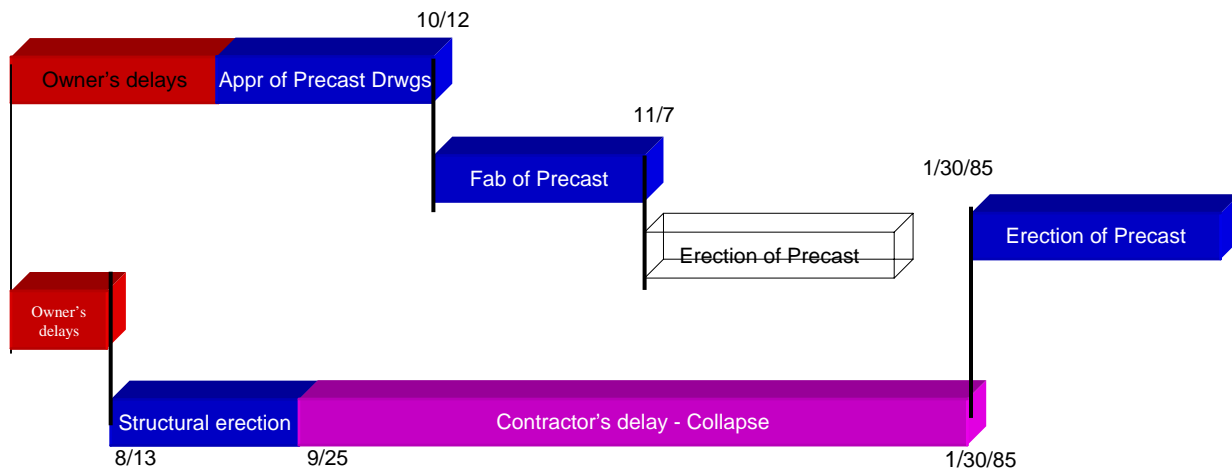
Current Application

The court found that the owner’s delays in approving structural steel shop drawings had no impact on the critical structural steel activities. The structural steel subcontractor argued that owner delays in approving structural steel shop drawings, which occurred in the very first month of the project, presented a delay concurrent with that caused by the collapse, which occurred much later.

The boards decided that the owner’s delays in approval of shop drawings, which occurred in the early time frame, had not impacted the critical path of the project. In fact, the board asserted that the contractor’s delay, which occurred in a later time period, had alone caused an extension to the project completion date. The boards disregarded the owner’s delays that occurred in the very first month of the project. This case implies that the boards give possession of total float to the owner.

AS-BUILT SCHEDULES

The erection of Precast Panels could have started on November 8, 1984, but for the contractor’s collapse. The owner’s delays to the approval of structural steel drawings and precast panel drawings in the earlier time frame had no impact on the critical structural steel activities.



5.4. CHAPTER CONCLUSION

As noted by previous studies, new theories have been introduced to resolve the issue of total float ownership. This chapter discusses four methods that have been used or recently introduced to allocate and control float. The first method is allocation of float to individual activities along a path of activities using two main criteria, quantitative and qualitative classifications. After total float is allocated to the activities on the paths, all paths in the schedule become critical, with zero total float available. All activities must, therefore, be performed within the allowable duration (the original duration plus the distributed total float).

The second method involves trading total float as a commodity. Total float taken away from the schedule needs to be replaced with either incentive or monetary contingencies. The concept proposes a method for calculating an explicit commercial trade-in-opportunity value and introduces into contract specifications a clause for trading total float as a commodity.

The third method utilizes safe float, which indicates the amount of float that can be used safely to reduce the risk of project delay caused by delay(s) to non-critical activities. As long as all parties consume float in the suggested safe range, the risk of project delay caused by total float consumption is minimized and total float ownership does not become an issue.

The last method for allocation of control of float involves inserting float and other scheduling clauses in contract documents during the design phase. This method has been widely accepted and used in construction projects. Recent studies have also recommended that owners include the following clauses in contract documents during contract preparation: “Joint Ownership of Float,” “No-Damages-For-Delay” and “Nonsequestering of Float.”

This chapter also presents five major claim cases related to the total float allocation issue. The courts in these cases essentially found that float was an expiring resource available to all parties who act in good faith on a non-discriminatory basis. Float was used on a first-come-first-served basis. As indicated in the five cases, the boards recently have shifted their focus from the total float issue to the impact of delays to the critical path or project completion date.

CHAPTER 6

THE NEW CONCEPT OF TOTAL FLOAT PRE-ALLOCATION

6.1. INTRODUCTION

The concept of total float allocation and ownership that has been employed in construction scheduling for many years has become a major cause for dispute, which can result in the potential for delay claims and litigation. As summarized in Chapter 5, many different theories have been developed to address the problems associated with various approaches to the allocation and use of “total float” as it relates to project delays. However, because none of these theories has adequately resolved the problems, none has been unconditionally adopted. This study sets out to develop a new methodology for the pre-allocation and management of “total float,” one that will resolve the conflicts inherent in current theories.

The principles of this new concept for pre-allocating and managing “total float,” herein presented, include recommending contract clauses to direct its use and to explain the manner in which responsibility for any resulting delay may be assigned. The basis for determining responsibility for delay are provided in the form of six factual situations, with illustrations. This chapter concludes by comparing the features of this pre-allocation concept with those of other theories presently being used. Comparing the similarities and differences of past and current theories with those of this proposed concept should provide some insight as to what has not worked in the past—as well as to what may now be more workable.

6.2. PRINCIPLES OF THE NEW CONCEPT FOR TOTAL FLOAT PRE-ALLOCATION

The amount of total float owned by each party in a construction project is known as the *Allowable Total Float*. Traditionally, if either party does not use its allocated amount of float, the other party has the opportunity to use any “leftovers” above and beyond its own allocation. However, given such provisions, if either party should consume total float beyond its allowable amount to the degree that such use impacts activities on the critical path and thus extends the project completion date, said party can be held responsible for resulting delays and/or damages.

The proposed concept for managing “total float” seeks to alleviate such potential problems by pre-allocating a set amount of total float on the same non-critical path of activities to the two contractual parties, the owner and the contractor. This research further proposes that such *pre-allocation* of total float must be clearly and expressly stated by specific clauses in the prime contract.

The pre-allocation of total float can range from 0-100 or 100-0. However, in order to achieve equity, this research *recommends 50-50 allocation*. This policy functions to give the owner and the contractor equal rights to the total float, as shown in the project network schedule—stated another way, the owner and the contractor each owns one-half of the total float available on any non-critical path activity of the project.

This new concept of total float management respects the dynamic nature of construction projects, recognizes that “total float” is an essential asset for both the owner and the contractor, and places equal responsibility on each party to mitigate unforeseeable and unanticipated problems that arise during construction. “Total float” is made available on an equal basis to enable both parties to benefit from their shared best interests—that is, completion of the project on time and within budget, with full adherence to all specifications and quality requirements of the prime contract.

As an asset, “total float” is unique in that it can cost the parties any amount from nothing to millions of dollars. Under this new concept, however, “total float” retains a feature shared by other theories: it remains an expiring resource. If it is not used within a certain period of time, it simply disappears. Consequently, the owner and the contractor must each use Allowable Total Float with care. Each should be cognizant not just of how much of the total float is being consumed but also whether such an amount will impact activities on the critical path, extend the project completion date, or result in additional costs.

6.3. SUGGESTED CLAUSES OF TOTAL FLOAT UNDER THE NEW CONCEPT

This new concept begins during contract preparation. The owner and/or the contractor must prepare contract clauses that will for their purposes define the concept and describe its application. In private projects, the owners and contractors may agree upfront to adopt the new concept of total float pre-allocation; however, under public or hard-bid

projects, the owner with or without the contractor’s agreement will adopt this new concept and insert contract clauses during bid preparation. In this case the public owner will need to make an arbitrary determination of the pre-allocation percentages.

In the following sections, four contract clauses are recommended to be inserted into contract documents: (1) “float definition”, (2) “pre-allocation of float”, (3) “no damage for non-critical delay” and (4) “formulas”.

The first clause of “Float Definition” is to define the meaning of total float. The second clause of “Pre-Allocation of Float” is the key clause defining the concept of total float pre-allocation and its application. The pre-determined amount of total float to be shared between the owner and the contractor must be clearly stated in this clause. In this dissertation, the two parties agree to share total float equally (50-50); that is, each will own and be entitled to use one-half (or 50 percent) of the total float. The third clause of “No Damage for Non-Critical Delay” is aimed to address delays to non-critical activities which the accumulation of it does not have a negative impact to the project completion date. The last clause of “Formulas” is suggested to properly quantify the two parties’ responsibility for delays.

“FLOAT DEFINITION” CLAUSE

Total Float is the amount of time between the early finish date and the late finish date of any activities in the network schedule—in other words, the amount of time any given activity or path of activities can be delayed before it will affect the contract completion date or the critical path.

“PRE-ALLOCATION OF FLOAT” CLAUSE

Under this project, the two parties agree to share total float equally (50-50); that is, of the total float attributed to any non-critical activity, the owner will own and be entitled to use one-half (or 50 percent), while the contractor will own or be entitled to use one-half (or 50 percent) of the total float. The amount of total float owned or shared by each is called the “Allowable Total Float.” The owner and the contractor acknowledge and agree that each will use its Allowable Total Float in the best interests of the project, to complete the

project on time and within budget, while meeting all specifications and quality requirements of the contract.

The owner and the contractor agree that if either party uses float in excess of its Allowable Total Float, that party shall be held responsible for delays in the project's completion, but only if the accumulation of delays has impacted negatively the critical path. The party's responsibility for delays will be quantified by the equations provided in the FORMULAS clause.

“NO DAMAGE FOR NON-CRITICAL DELAY” CLAUSE

From the perspective of total float, a delay to activities with adequate float time is considered a “non-critical” delay. Pursuant to the contract's pre-allocation of total float to the owner and to the contractor, neither is entitled to a time extension or to delay damages unless a critical delay or the accumulation of non-critical delays caused by the other party impacts the project's critical path, consumes all available float or contingency time, or extends the work beyond the contract completion date.

“FORMULAS” CLAUSE

In order to properly allocate the party's responsibility for delays, the following formulas are recommended for 50-50 allocation:

TF = Total Float

ATF = Allowable Total Float = $TF / 2$

TDD = # of total delayed days for the entire project

PDD = # of days that a party delays on the affected activity path.

RDD = # of delayed days that a party is held responsible for.

If the total number of the days of delay for the entire project (*TDD*) is greater than zero (0), then that each party will be responsible for the minimum value of the total delayed days for the entire project (*TDD*) or the difference between its actual days of delay (*PDD*) and its Allowable Total Float (*ATF*), i.e., $PDD - ATF$:

If $TDD > 0$,

$$RDD = \text{MIN}(TDD, PDD - ATF)$$

If the total number of days of delay for the entire project is equal to zero ($TDD = 0$) or a party uses total float within its ATF ($PDD - ATF < 0$), then that party is not responsible for any delay damages to the entire project:

If $TDD = 0$ or $PDD - ATF < 0$,

$$RDD = 0$$

6.4. ALLOCATION OF DELAY RESPONSIBILITIES FOR THE NEW CONCEPT

In keeping with the principles of current methods, this new concept of total float pre-allocation and management provides that no delay damage will be paid nor time extension granted for an accumulation of non-critical delays or total float consumption for any activity path not impacting the project completion date and/or the project critical path.

If a party consumes total float beyond its Allowable Total Float for any given activity and the total float consumption or accumulation of all total float consumption on the affected activity path adversely impacts the project critical path or extends the project completion date, then that party shall be held responsible for any delays and damages.

THE FORMULAS

Under this new concept of total float pre-allocation, in order to properly allocate the responsibility for delays, the following formulas are recommended:

TF	=	Total Float	
ATF	=	Allowable Total Float	= TF / 2
TDD	=	# of total delayed days for the entire project	
PDD	=	# of days that a party delays on the affected activity path.	
RDD	=	# of delayed days that a party is held responsible for.	

If the total number of the days of delay for the entire project (TDD) is greater than zero (0), then that each party will be responsible for the minimum value of the total delayed days for the entire project (TDD) or the difference between its actual days of delay (PDD) and its Allowable Total Float (ATF), i.e., $PDD - ATF$:

If $TDD > 0$,

$$RDD = \text{MIN} (TDD, PDD - ATF)^4$$

If the total number of days of delay for the entire project is equal to zero ($TDD = 0$) or a party uses total float within its ATF ($PDD - ATF < 0$), then that party is not responsible for any delay damages to the entire project:

If $TDD = 0$ or $PDD - ATF < 0$,

$$RDD = 0$$

SIX EXAMPLES OF ALLOCATING DELAY RESPONSIBILITY

Pursuant to this new concept of total float pre-allocation, the allocation of delay responsibilities between the parties can be performed in a number of ways, as illustrated by the following six examples of factual delay situations involving the consumption of total float for non-critical path activities.

The first two cases involve the owner's and contractor's delays to a non-critical path activity, which did not result in any change to the project completion date. The third and fourth cases, while also involve delays to a non-critical path activity, show that an accumulation of the delays results in changing the project completion date and critical path. The fifth case shows the *concurrent-delay* situation which involves two concurrent delays to

⁴ Originally, the following two formulas were recommended in this dissertation and were used in the Delphi survey as detailed in the Chapter 7 of this dissertation.

$$\text{If } TDD > (PDD - ATF), RDD = PDD - ATF$$

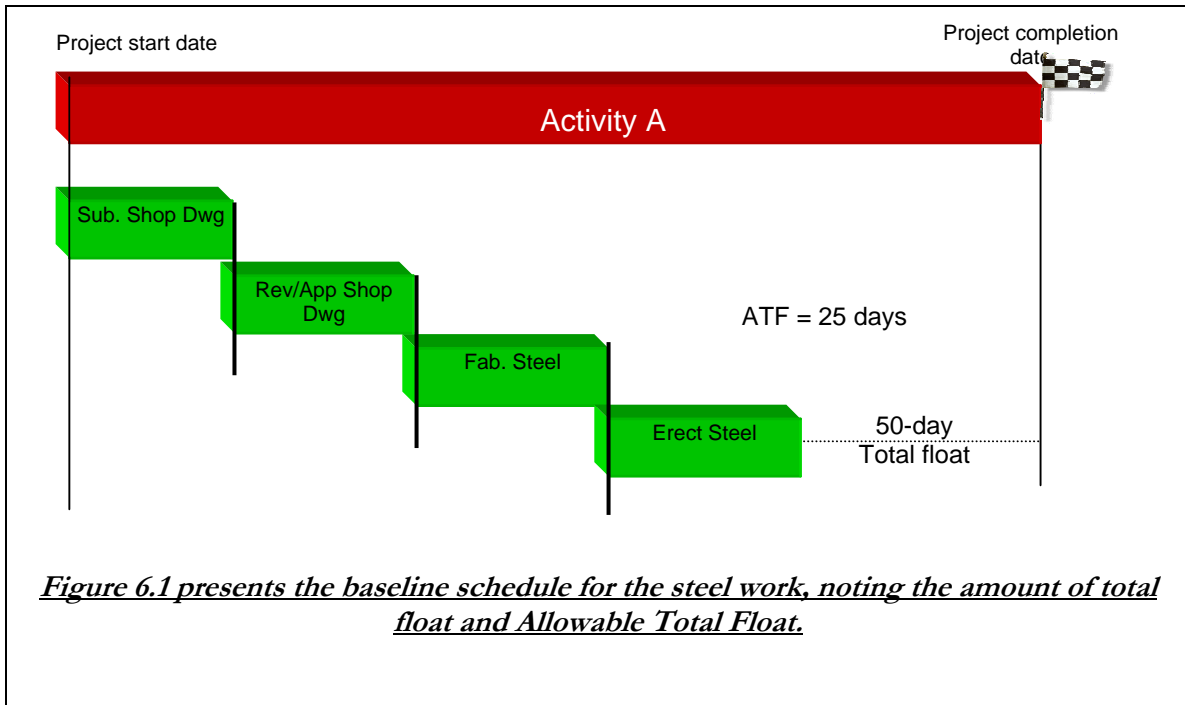
$$\text{If } TDD < (PDD - ATF), RDD = TDD$$







two different paths of activities affecting the project completion date. The sixth case presents the situation of *multiple non-critical paths*, in which only one delayed path affects the project completion date.

Additionally, the delay impact analysis of the proposed concept is compared with those of the other four methods of schedule impact analysis; the comparison is summarized and presented in a table at the end of each case example. The four methods of delay impact analysis in this study consist of

- 1) Time-Impact-Analysis or Current Contemporaneously,
- 2) As-Built or Current Retrospectively Analysis,
- 3) But-For Owner's Delays, and
- 4) But-For Contractor's Delays.

The original schedule shown in Figure 6.1 is a baseline for the first four delay cases presented. As shown in Figure 6.1, Activity A involves steel work, a non-critical path activity with 50 days of total float. The steel work consists of four related, interdependent activities: Shop Drawing Submission, Shop Drawing Review and Approval, Steel Fabrication, and Steel Erection. Under the new concept, the total float of 50 days is allocated equally to the owner and to the contractor. In other words, the owner's Allowable Total Float (ATF) is 25 days and the contractor's ATF is 25 days.



- | | | | |
|---|--|--|------------------|
|  | Critical as-planned activity |  | Owner delay |
|  | Non-critical as-planned activity - Early bar |  | Contractor delay |
|  | As-built activity |  | Project delay |

Case 1

The first case involves two delay events: the owner's 20-day delay to the review and approval of steel shop drawings and the contractor's 20-day delay to the steel fabrication. Figure 6.2 demonstrates the as-built schedule and the delay events. The Allowable Total Float for each party is 25 days, and under this scenario each consumes total float for the affected activities within its allowable total float. The accumulation of the two parties' consumption of total float does not impact the project completion date.

By applying the formulas shown above, the total number of days of delay for the entire project equals zero ($TDD = 0$); therefore, the delaying parties are not held responsible for any delay damage ($RDD = 0$).

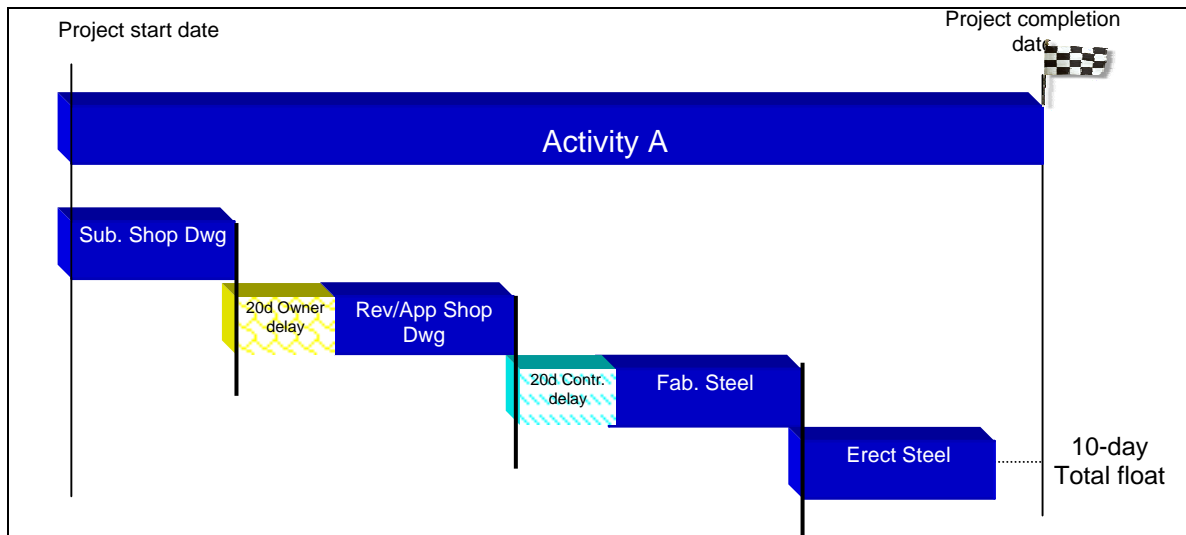


Figure 6.2. As-Built Schedule Showing Owner's 20-day Delay and Contractor's 20-day Delay

The owner delays in reviewing steel shop drawings for 20 days and the contractor later delays the steel fabrication for 20 days. The project completion date remains unchanged. Under this situation, the owner and the contractor do not have to respond for any delay because the amount of their accumulated delays does not affect the project completion date.

Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	0	0
Current “As-Built” Retrospectively	0	0
But-for Owner’s Delays	0	0
But-for Contractor’s Delays	0	0
New Method “Pre-Allocation of Total Float”	0	0

Table 6.1: Case 1 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

Case 2

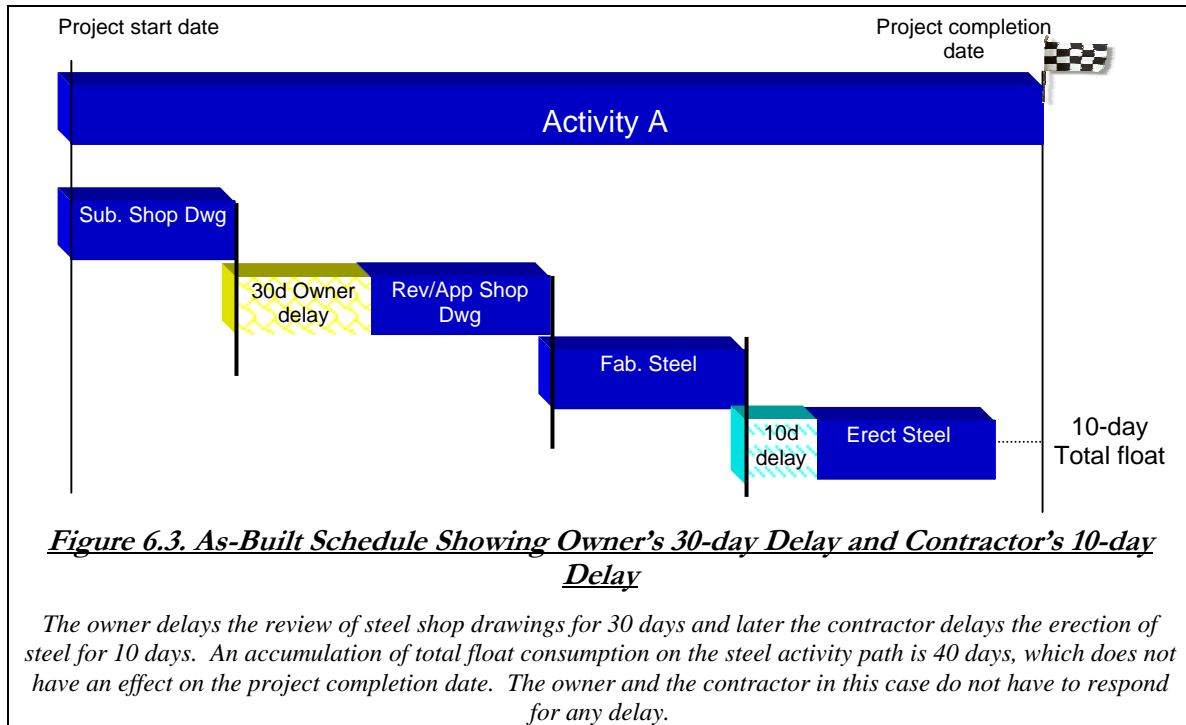
The second case also involves two delay events, but in this scenario the owner’s consumption of total float exceeds the Allowable Total Float allocated to each. First, the owner delays the review and approval of steel shop drawings for 30 days, five days beyond its Allowable Total Float. Subsequent to the owner’s delay, the contractor delays the steel erection for 10 days, an amount within its allowable total float time. Figure 6.3 shows the as-built schedule and the two delay events.

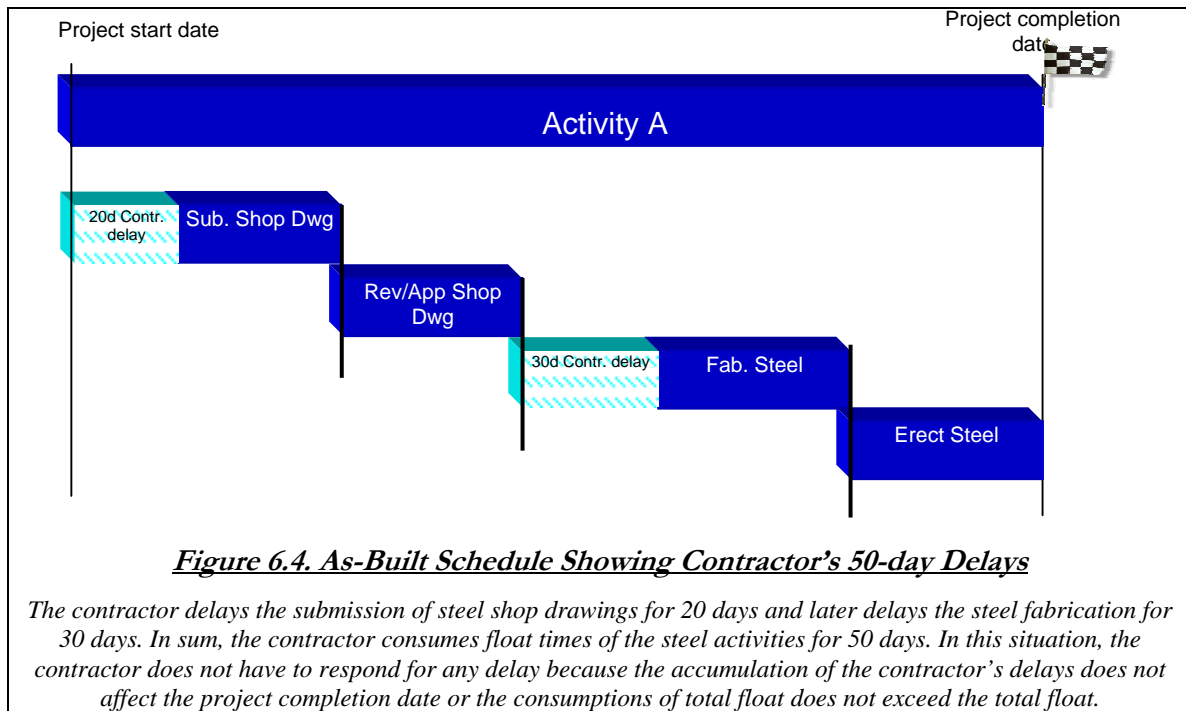
The accumulation of the two parties’ consumption of total float does not impact the project critical path or extend the project completion date. Similar to the first case, by using the above formulas, the total number of days of delay for the entire project (TDD) is determined to equal zero; therefore, the delaying party is not held responsible for any delay damage (RDD = 0).

Under the new concept, total float is still considered to be free as long as an accumulation of consumption on the affected activity path does not adversely impact the project completion date.

Figure 6.4 shows the contractor’s two delay events. First, he delays the submission of shop drawings for 20 days; later, he delays the steel fabrication for 30 days. Therefore, the contractor consumes total float for 50 days, well beyond the Allowable Total Float of 25

days. The contractor's consumption of total float, however, does not impact the project completion date; therefore, the contractor is not held responsible for any associated delay and/or damages to the project.





Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	0	0
Current “As-Built” Retrospectively	0	0
But-for Owner’s Delays	0	0
But-for Contractor’s Delays	0	0
New Method “Pre-Allocation of Total Float”	0	0

Table 6.2: Case 2 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

Case 3

The third case describes three delay events, the accumulation of which does impact the project completion date. As shown in Figure 6.5, the contractor delays the submission of shop drawings for 20 days in the early time frame and later delays the steel fabrication for 30 days. The total number of days of delay attributed to the contractor's steel activity equals 50, a full 25 days beyond its Allowable Total Float.

Subsequent to these events, the owner's actions delay the steel erection for 10 days, well within the Allowable Total Float of 25 days. When all three delays are accumulated, the result is an adverse impact to the project critical path, which extends the project completion date by 10 days.

By using the above noted formulas, the contractor's delay responsibility can be allocated as follows:

$$\text{TDD} = 10 \text{ days, PDD} = 50 \text{ days, ATF} = 25 \text{ days.}$$

$$\text{Since } \text{TDD} > 0, \text{ RDD} = \text{MIN} ((\text{TDD} = 10), (\text{PDD} - \text{ATF} = 25)) = 10 \text{ days}$$

Thus, the contractor is held responsible for 10 days of delay to the project's completion.

By using the same formulas, the owner's delay responsibility may be allocated as follows:

$$\text{TDD} = 10 \text{ days, PDD} = 10, \text{ ATF} = 25 \text{ days.}$$

$$\text{Since } (\text{PDD} - \text{ATF} = -15) < 0, \text{ RDD} = 0$$

Thus, the owner—who has not consumed float beyond the allowable total—cannot be held responsible for delaying the project's completion time.

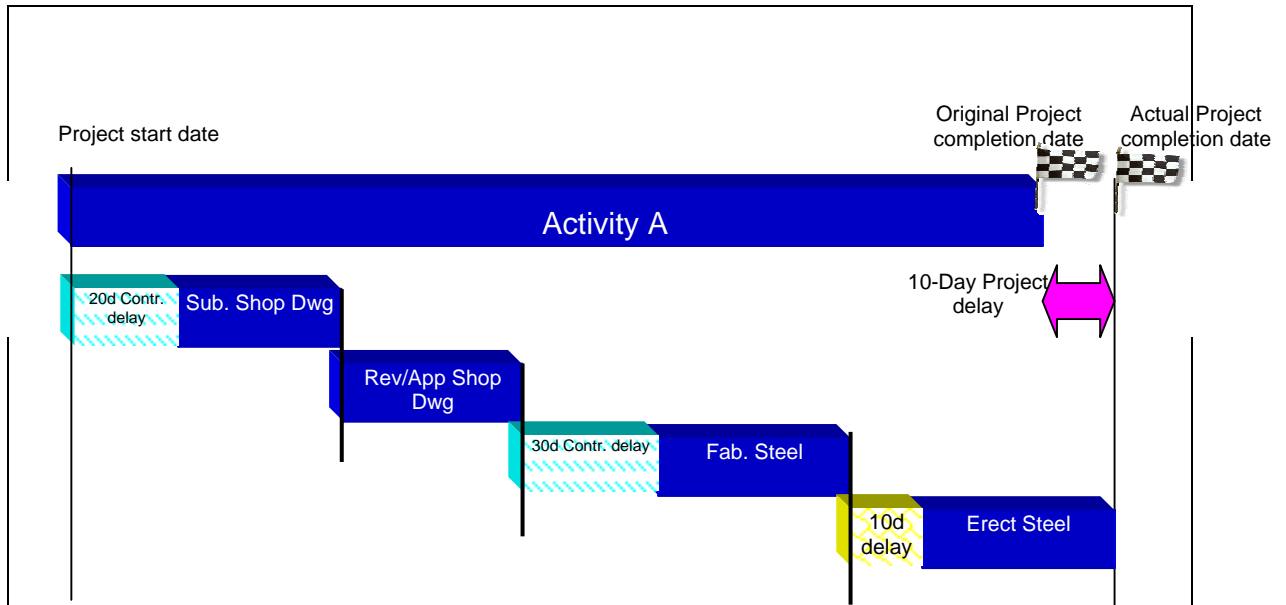


Figure 6.5. As-Built Schedule Showing Contractor’s 50-day Delays and Owner’s 10-day Delay

The contractor delays the submission of steel shop drawings for 20 days and delays the steel fabrication for 30 days; subsequently, the owner later delays the steel erection for 10 days. In sum, the contractor consumes steel activity float times for 50 days (25 days beyond the allowable amount) and the owner consumes float times for 10 days (within the allowable amount of 25 days). In this situation, the accumulation of all delays has affected the project completion date for 10 days. The owner who used float time within the allowable times does not have to respond for the project delay while the contractor is held responsible for the project delay of 10 days.

Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	10	0
Current “As-Built” Retrospectively	10	0
But-for Owner’s Delays	10	0
But-for Contractor’s Delays	0	10
New Method “Pre-Allocation of Total Float”	0	10

Table 6.3: Case 3 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

Case 4

This case also describes three delay events, the accumulation of which does impact the project completion date. As indicated in Figure 6.6, the contractor delays the submission of shop drawings for 20 days and later delays the steel fabrication for 30 days. The total number of days the contractor delays the steel activity equals 50 days, 25 days beyond its Allowable Total Float.

Subsequent to these events, the owner’s actions delay the steel erection for 30 days, which exceeds its Allowable Total Float by five days. The accumulation of all three delays adversely impacts the project critical path and extends the project completion date by 30 days.

By using the above formulas, we can determine the allocation of the contractor’s delay responsibility, as presented below:

$$\text{TDD} = 30 \text{ days, PDD} = 50 \text{ days, ATF} = 25 \text{ days.}$$

$$\text{Since } \text{TDD} > 0, \text{ RDD} = \text{MIN} ((\text{TDD} = 30), (\text{PDD} - \text{ATF} = 25)) = 25 \text{ days}$$

Thus, the contractor is held responsible for the 25-day delay to the project completion date.

The above formulas also indicate the number of delay days for which the owner is responsible:

TDD = 30 days, PDD = 30, ATF = 25 days.

Since $TDD > 0$, $RDD = \text{MIN} ((TDD = 30), (PDD - ATF = 5)) = 5$ days

Thus, the owner is held responsible for a five-day delay to the project completion time.

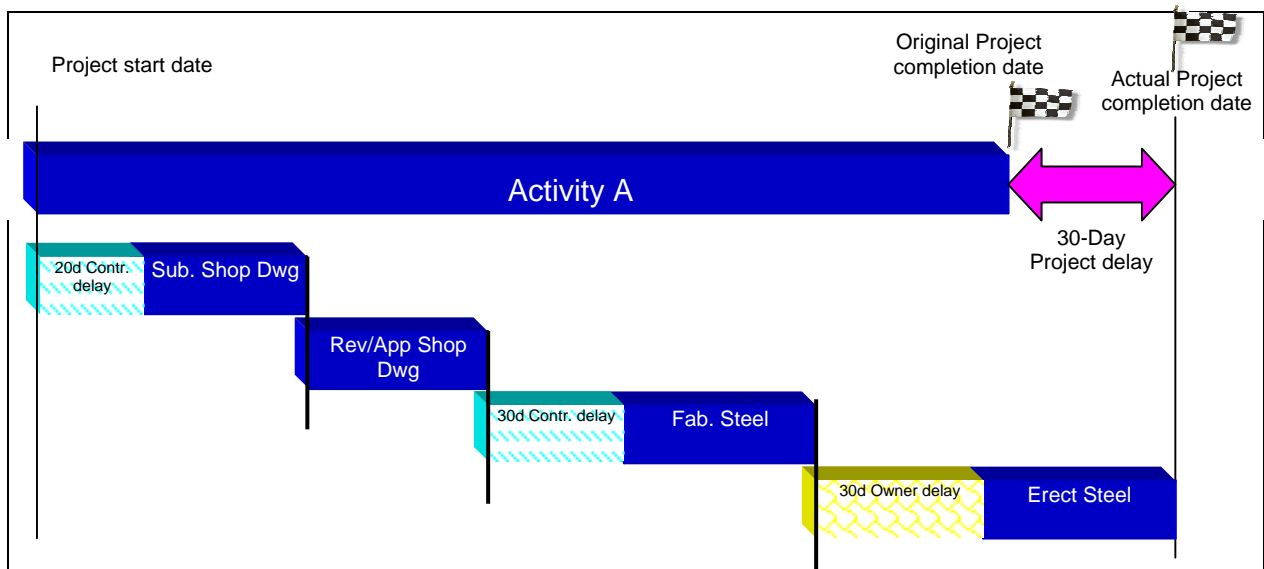


Figure 6.6. As-Built Schedule Showing Contractor’s 50-day Delays and Owner’s 30-day Delay

The contractor delays the submission of steel shop drawings for 20 days and delays the steel fabrication for 30 days; subsequently, the owner later delays the steel erection for 30 days. In sum, the contractor consumes float times of the steel activities for 50 days (25 days beyond the allowable amount) and the owner consumes float times for 30 days (5 days beyond the allowable amount). Under this situation, the accumulation of all delays has affected the project completion date for 30 days. The owner is held responsible for the project delay of 5 days while the contractor is held responsible for 25 days.

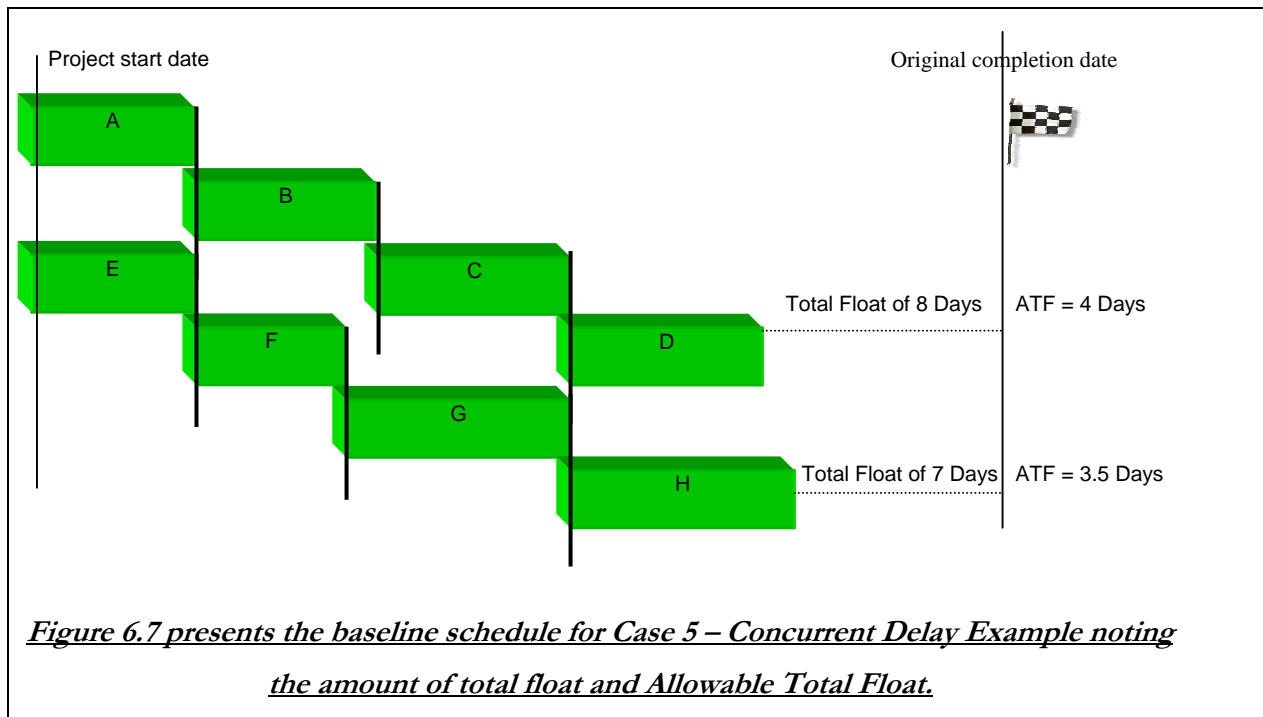
Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	30	0
Current “As-Built” Retrospectively	30	0
But-for Owner’s Delays	30	0
But-for Contractor’s Delays	0	30
New Method “Pre-Allocation of Total Float”	5	25

Table 6.4: Case 4 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

Case 5

In this case of concurrent delays⁵, the contractor and the owner concurrently delay activities on two non-critical paths, but the accumulation of delays ultimately alters the project completion date. The original baseline schedule for this case is presented in Figure 6.7. The activity path of A-D originally has eight days of total float, with each party possessing four days of ATF. The activity path of E-H has seven days of total float, with each party having 3.5 days of ATF.

⁵ Concurrent delays in this dissertation is defined as the situation in which an owner and a contractor each delay simultaneously delay activities on two separate critical paths and impact the overall project.



As indicated in Figure 6.8, the contractor delays Activities B, C and H for 4, 6 and 3 days respectively; and the owner delays Activity G for 9 days and D for 3 days. At the completion of the project, the two original non-critical paths (A-D and E-H) then become the longest or critical paths. The delays on the two paths are considered to be concurrent delays. In order to allocate the delay responsibility under the proposed concept, each then-critical path would be considered separately but use the same methodology presented in the previous cases.

The Activity Path of A-B-C-D

Under the new concept, the total number of days that the contractor delayed the activity path of A-D equals 10 days, six days beyond its ATF of four days, while the owner delays this path for three days, within its ATF. Therefore, on the activity path of A-D, the contractor—with a delay of six days beyond its ATF—is held responsible for the five-day project delay.

By using the above formulas, we can determine the allocation of the contractor's delay responsibility, as presented below:

TDD = 5 days, PDD = 10 days, ATF = 4 days.

Since $TDD > 0$, $RDD = \text{MIN} ((TDD = 5), (PDD - ATF = 6)) = 5$ days

Thus, the contractor is held responsible for the 5-day delay to the project completion date.

The above formulas also indicate the number of delay days for which the owner is responsible:

TDD = 5 days, PDD = 3, ATF = 4 days.

Since $PDD < ATF$, $RDD = 0$ days

Thus, the owner is held responsible for a 0-day delay to the project completion time.

The Activity Path of E-F-G-H

Concurrently on this path of activities, the owner delays Activity G for nine days, which is 5.5 days beyond its ATF, while the contractor delays the activity H for three days, well within its ATF. Therefore, the owner is held responsible for five days and the contractor is responsible for zero days.

By using the above formulas, we can determine the allocation of the owner's delay responsibility, as presented below:

TDD = 5 days, PDD = 9 days, ATF = 3.5 days.

Since $TDD > 0$, $RDD = \text{MIN} ((TDD = 5), (PDD - ATF = 5.5)) = 5$ days

Thus, the owner is held responsible for the five-day delay to the project completion date.

The above formulas also indicate the number of delay days for which the contractor is responsible:

TDD = 5 days, PDD = 3, ATF = 3.5 days.

Since $PDD < ATF$, $RDD = 0$ days

Thus, the contractor is held responsible for a zero-day delay to the project completion time.

In conclusion, both the contractor and the owner are held responsible for the five-day project delay. In this case, the owner should give a five-day time extension to the contractor, but in reality the five-day delay is not compensable because the contractor is also held responsible for the project delay. It should be noted that the new concept considers a situation to involve concurrent delays only when the project involves two or more concurrent longest (critical) paths.

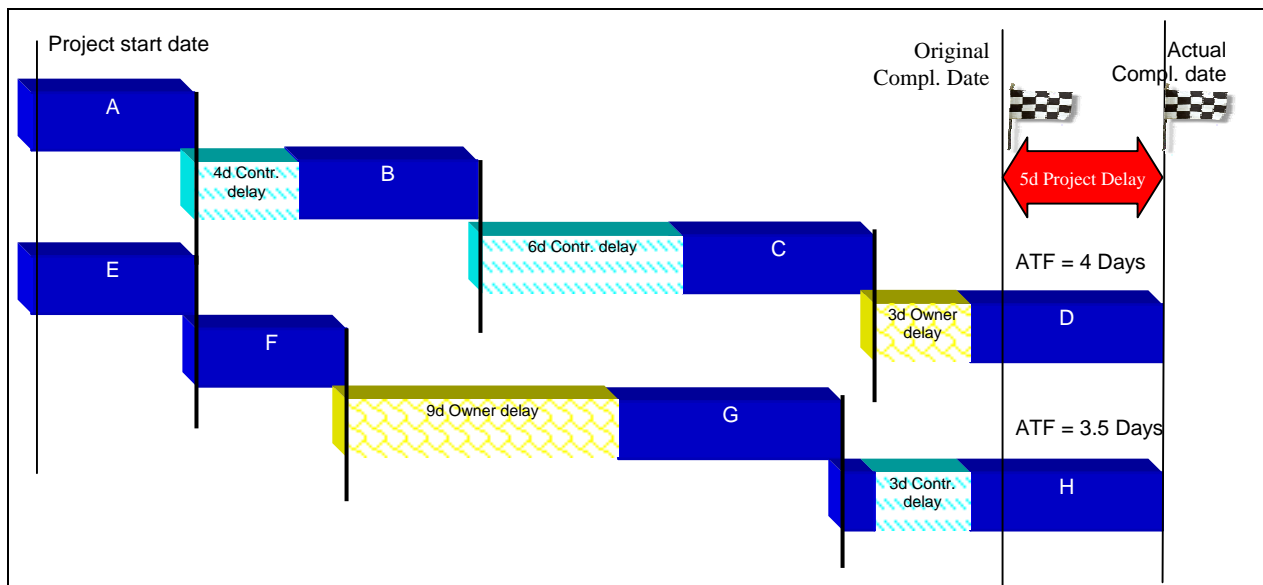


Figure 6.8 As-Built Schedule Showing Concurrent Delays of Contractor's 13-day Delays and Owner's 11-day Delays.

This case involves concurrent delays occurring on the two then-critical paths, an accumulation of which does change the project completion date for 5 days. Considering the first path of A – D, the contractor delays this path for 10 days in total which 6 days beyond its ATF while the owner delays this path for 3 days within its ATF.

Therefore, the contractor is held responsible for 5 days of project delays on the activity path of A - D. On the same token, the owner delays Activity G on the path of E – H for 9 days which 5.5 days beyond its ATF; and the contractor delays Activity H for 3 days within its ATF. On this path of E – H, the owner is held responsible for the 5-day project delay. In conclusion, since both parties are held responsible for the 5d project delay, the owner must give a 5d time extension to the contractor, but the 5 days of delay are not compensable.

Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	5 (3 are non-compensable)	0
Current “As-Built” Retrospectively	3 (non-compensable)	2
But-for Owner’s Delays	3	2
But-for Contractor’s Delays	2	3
New Method “Pre-Allocation of Total Float”	5 (non-compensable)	0

Table 6.5: Case 5 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

Case 6

This case involves multiple non-critical paths, one of which then becomes the project’s critical path. Figure 6.9 shows the original baseline schedule of this case, which consists of three non-critical paths. Path 1 consists of Activity G-H-I, each of which has a total float of six days and an ATF of three days. Path 2 consists of Activity J-K-L-M, each of which has total float of three days and an ATF of 1.5 days. Path 3 has Activity N and O, both of which possess nine days of total float and 4.5 days of ATF. The number of ATF for each party and each activity is indicated in the activity bar in Figure 6.9.

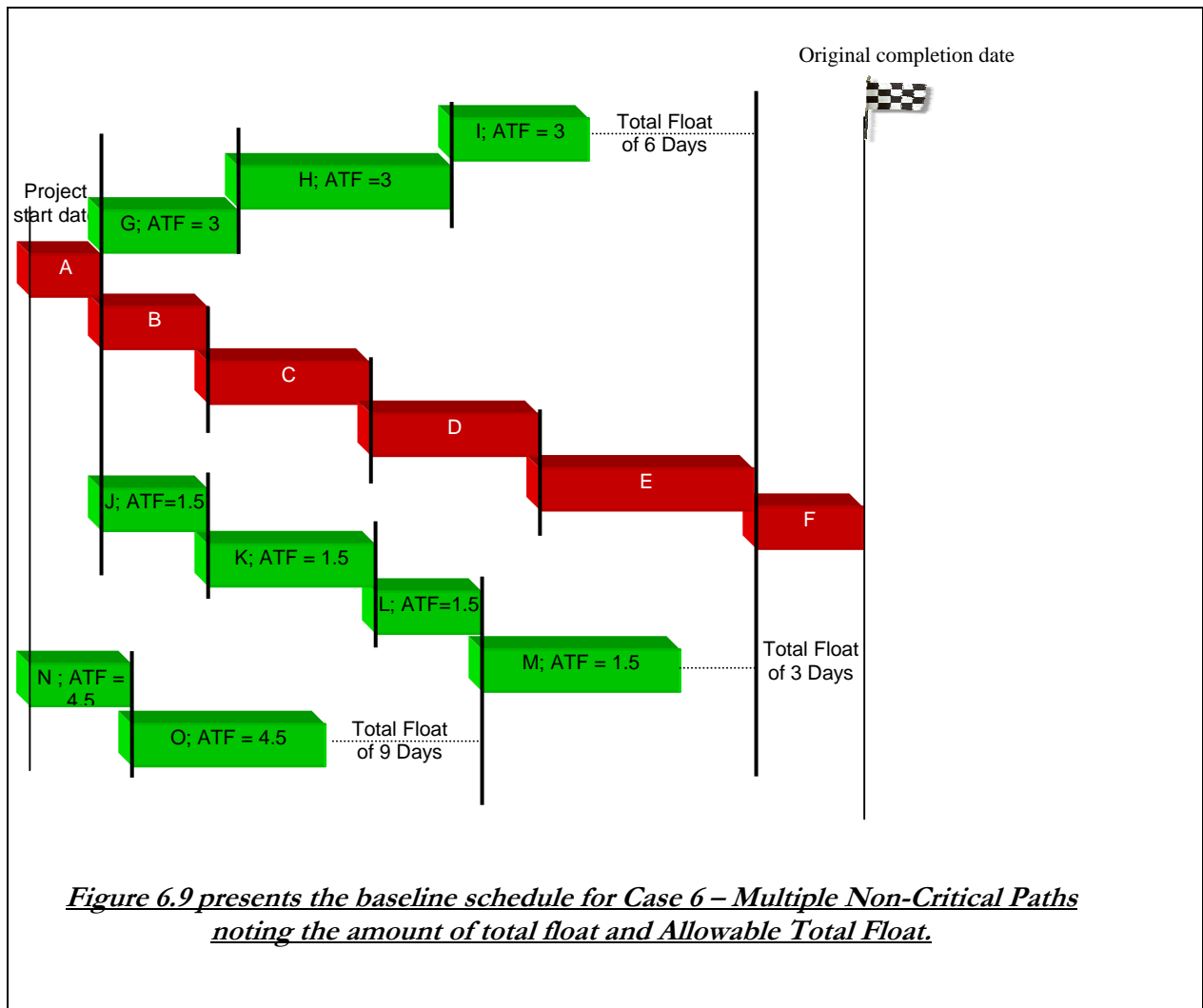


Figure 6.10 illustrates the as-built schedule showing multiple-non-critical paths. This case involves delays to the three non-critical paths, one of which then becomes critical. The contractor delays Activity J and N for eight and seven days, respectively; and the owner delays Activity O for five days. Although all delays to the non-critical activities are beyond its ATFs, under the proposed concept allocation of delay responsibility considers only delays on the longest or then-critical path which impacts the overall project completion date.

In this case, the owner's delay of five days to Activity O and the contractor's delay of seven days to Activity N are not considered critical. Only the contractor's delay of eight days to Activity J, which is on the project then-critical path of A-J-K-L-M, is considered to impact the project completion date. The contractor delays Activity J for eight days, or 6.5

days beyond its ATF of 1.5 days. Because the project completion date is delayed for five days, the contractor is held responsible for the project delay.

By using the above formulas, we can determine the allocation of the contractor's delay responsibility, as presented below:

$$\text{TDD} = 5 \text{ days, PDD} = 8 \text{ days, ATF} = 1.5 \text{ days.}$$

$$\text{Since TDD} > 0, \text{RDD} = \text{MIN} ((\text{TDD} = 5), (\text{PDD} - \text{ATF} = 6.5)) = 5 \text{ days}$$

Thus, the contractor is held responsible for the 5-day delay to the project completion date.

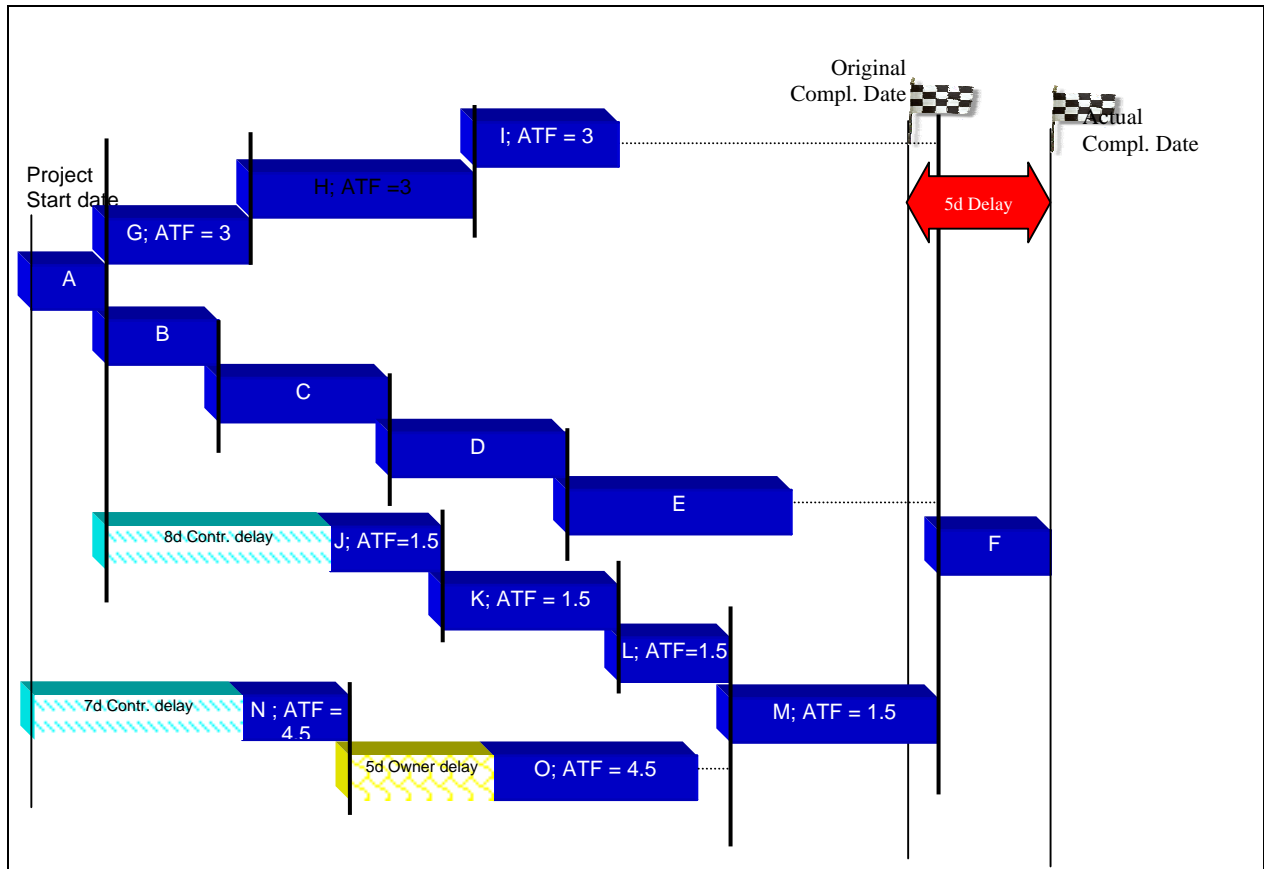


Figure 6.10 As-Built Schedule Showing Multiple Non-Critical Paths of Contractor's 13-day Delays and Owner's 11-day Delays.

This case involves three non-critical paths, which one of these then becomes critical. The contractor delays Activity J for 8 days which 6.5 days beyond its ATF of 1.5 days. As a result of the contractor's delay, the project completion date is moved for 5 days. Under this proposed concept, the contractor is held responsible for the project delay of 5 days.

Considering the contractor's delay on Activity N and the owner's delay on Activity O, the accumulation of which, although both consume total float beyond their ATF, does not impact the project completion date. In conclusion, under this proposed concept, any delays on non-critical paths are considered to be non-critical delays or not impact the project completion date.

Five Delay Analysis Methodologies	Owner	Contractor
Current Contemporaneously	0	5
Current “As-Built” Retrospectively	5	0
But-for Owner’s Delays	0	5
But-for Contractor’s Delays	0	5
New Method “Pre-Allocation of Total Float”	0	5

Table 6.6: Case 6 - Comparison of the Allocation of Delay Responsibilities under 5 Delay Analysis Methodologies

6.5. SIMILARITIES AND DIFFERENCES BETWEEN THE NEW CONCEPT AND OTHERS

As previously indicated, chapters 4 and 5 describe the seven concepts currently or potentially used by the industry with regard to the allocation of total float. Chapter 4 presented three concepts of total float allocation that have been used for quite a long time: *Owner Entitlement* (OE), *Contractor Entitlement* (CE), and *Project Entitlement* (PE). The other four concepts of total float allocation have been introduced only recently to the industry. These include *Allocating Total Float to Individual Activity* (AFIA), *Trading Total Float as Commodity* (TTFC), *Calculating and Using Safe Float* (CUSF), and *Using Float Clauses in Contract* (UFC). This section compares the features of these current concepts with the new concept of *equal allocation* of total float.

6.5.1. OWNER ENTITLEMENT (OE)

The concept of OE gives the owner the right to appropriate total float for non-critical path activities. This approach is similar to equal allocation in the following ways:

Similarities

- The OE concept is similar to the new concept in that both give ownership of total float to the owner. Both concepts allow the owner to consume total float available in the project schedule network as long as the consumption of total float does not adversely impact the project critical path or the project completion date. Under these

two concepts, the owner is not responsible for project delays caused by extending/delaying activities that have adequate total float.

Differences

- Under the OE concept, the contractor does not have ownership rights to the available float time and cannot use the total float to its benefit. However, under the new concept, the owner and the contractor each have an amount of Allowable Total Float equal to the other's, and each may appropriate the available total float as long as each acts in a good faith.
- Under the new concept, the owner may be held responsible for a project delay only if the owner consumes total float beyond its Allowable Total Float, and that consumption adversely impacts the project completion. Consequently, the owner must use the total float with care.

6.5.2. CONTRACTOR ENTITLEMENT (CE)

This concept gives the contractor the right to appropriate the total float of non-critical path activities. The CE approach shares some features of the new equal allocation concept:

Similarities

- The similarity between the CE concept and the new concept is that the ownership of total float belongs to the contractor. Both concepts permit the contractor to consume all total floats available in the project schedule network on condition that the consumption of total float does not adversely impact the project critical path or the project completion date. The contractor in these two concepts is not responsible for its delays to activities that have adequate total float.

Differences

- Under the new concept, the owner also owns float times and can gain benefits from using total float. However, the new concept gives the owner and the contractor an Allowable Total Float equal to the other, and each has an equal right to appropriate total float as long as each acts in a good faith.

- Under the new concept, the contractor must use total float with care. The contractor may be held responsible for project delays if allowable total float is exceeded, and that consumption of total float has an adverse impact to the project completion date.

6.5.3. PROJECT ENTITLEMENT (PE)

This concept implies that the total float belongs not to any individual party but to the project itself. It also considers total float as an expiring resource available to all parties involved in the project.

Similarities

- Total float treatment under the PE concept is similar to that of the new concept in that total float belongs to both parties—the owner and the contractor. The two parties can appropriate total float as long as each acts in a good faith. If either party accumulates delays or consumes total float on any non-critical path activity that results in an adverse impact to the project completion date and critical path, that party may be held responsible for the delay damages of the entire project.
- In addition, total float under the PE concept and the new concept is considered to be free and is treated as an expiring resource. If said total float is not used within a certain time, it will expire. Therefore, either party may use it before its expiration.

Differences

- Under the concept of PE, total float available to both the owner and the contractor may be used on a first-come, first-served basis, as long as each acts in good faith. This, however, presents a potential conflict: one party's earlier consumption of total float could leave following parties with less total float than required and therefore less flexibility for dealing with unforeseen and unanticipated problems. Under the new concept, the party who has used up all Allowable Total Float in the early time frame, may still be held responsible for a project delay since its use of the total float may itself be the main cause of delays in project completion.
- In contrast, under the new concept, use of total float is based initially on an equal allocation of Allowable Total Float, and the ability to use available total float is not designated on a first-come, first-served basis. The owner and the contractor have an equal right to appropriate total float.

- Under the PE concept, delaying parties do not have to be responsible for a project delay when it involves a non-critical activity with adequate total float, whereas under the new concept the delaying parties might be held responsible for a project delay although the affected non-critical activities have adequate total float. As stated previously, under the new concept, if an accumulation of non-critical delays to activities with adequate total float has an adverse impact on the project completion date, the delaying parties might be held responsible for the project delay.

6.5.4. ALLOCATING FLOAT TO INDIVIDUAL ACTIVITIES (AFIA)

This method uses pre-determined criteria to allocate total float to individual activities along an activity path. The parties involved in the project know from the beginning the exact portion of the total float they are entitled to use.

Similarities

- Like the AFIA concept, the new concept gives both the owner and the contractor the right to use total float. Total float in both is shared among parties involved in the project.
- Furthermore, these two concepts recommend to insert a total float clause of sharing the ownership of total float into the contract to resolve the total float allocation issue. The owner and the contractor under these two concepts acknowledge at the beginning of the project the amount of total float attributed to certain activities and both agreeing to share in the use.

Differences

- A significant difference between the AFIA allocation methodology and the new project is that the latter allocates total float to both the owner and the contractor and is not dependent upon the need for pre-determined criteria to determine the specific activities to which total float will be attributed.
- The AFIA concept requires preliminary effort and agreement in order to assign total float to the individual activities shown in the project schedule, and it also requires further adjustments each time the schedule is changed or updated. The concept of AFIA also requires designating at the beginning of the project the party responsible for each activity.

- To implement the concept of AFIA, all activity paths for which total float is attributed will be represented in the project schedule as “critical path,” which is unrealistic.
- In addition, in predetermining which activities in the AFIA concept will be subject to the shared allocation of total float and in determining which party is “responsible” for each activity, the result will be that most of the total float belongs to the contractor. This is because the distributed total float belongs to the party performing the activity and most of the work is performed by the contractor and its subcontractors. Under the new concept, total float belongs equally to the owner and the contractor.

6.5.5. TRADING TOTAL FLOAT AS COMMODITY (TTFC)

This concept recognizes that total float taken away from the schedule needs to be replaced with either incentives or monetary contingencies. The concept calculates explicit commercial trade-in-opportunity values and introduces a contract clause governing the trading of total float as a commodity.

Similarities

- Similar to the TTFC concept, the new concept acknowledges that total float should benefit the owner and the contractor. They also recognize that, in the event of unforeseen conditions affecting the project, both the owner and the contractor are affected; therefore, to mitigate losses, both should have the opportunity to use total float.
- In addition, both concepts designate that specific contractual language should be used and inserted into contract documents to resolve the total float issue. They introduce new total float clauses to be inserted into the contract document to mitigate the total float ownership issue.

Differences

- The TTFC concept gives the contractor the absolute right to administer and use total float, whereas the new concept gives both parties an equal right to appropriate total float.

- Total float under the TTFC concept is not free and has costs which are associated with each individual activity. As such, the owner must pay for the use of total float on any activity or the owner's use of total float time must be replaced with monetary contingencies. The new concept maintains the current industry view that total float is free. Under it, the owner does not have to pay for the use of total float unless he uses total float beyond the allowable total float and such consumption affects the project completion date.
- Whereas the TTFC concept requires high levels of effort and assessment, which might be based upon a number of different factors vaguely defined, the new concept is speculation. For example, the daily trade-in-value of total float under the TTFC concept would be assessed by such different factors vaguely defined, which then requires a tremendous reliance on the good faith of each of the parties. The new concept simplifies this process considerably.

6.5.6. CALCULATING AND USING SAFE FLOAT (CUSF)

The CUSF concept recognizes the increased risk of schedule overruns caused by the use of total float and introduces a new concept of “safe float use,” indicating the amount of float that can be used safely to reduce the risk of overall project delay caused by extensions of non-critical activities.

Similarities

- Under both concepts, the owner and the contractor know at the beginning of the project the amount of total float that each can use without increasing the risk of incurring responsibility to delay damages. Both concepts recognize that total float can be used by either party, up to a certain amount, without increasing the risk of project schedule overruns.

Differences

- The concept of CUSF, like the AFIA concept, allocates total float or calculates safe float for individual activities throughout the network schedule. But the new concept calculates the allowable total float equally for both parties involved in the contract.
- The CUSF concept is complicated and requires input from the project managers throughout the duration of the project in order to define the safe range of float use.

6.5.7. USING FLOAT CLAUSES IN CONTRACT (UFC)

The concept of *Using Float Clauses in Contract (UFC)* maintains the current concept of Project Entitlement. Total float is used on a *first-come, first-served* basis. Any party delaying an activity with adequate float time is not held responsible for a project delay.

Similarities

- Both concepts recommend the *no damage for delay* and *nonsequestering of float* clauses be inserted into the contract to avoid the sort of scheduling games that can result in total float abuse. Additionally, the two concepts propose inserting the *shared ownership of total float* clause into pertinent documents during the contract preparation phase.
- Total float in the UFC concepts is similar to that of the new concept and PE concept in that it is considered to be “free” and is treated as an expiring resource. This similarity is discussed under the PE concept.

Differences

- The UFC concept provides some of the same problematic differences as those discussed in the Project Entitlement section. The new concept allows the owner and the contractor to share on an equal basis the available total float for any non-critical path activity.

6.6. CHAPTER CONCLUSION

In order to address the total float allocation issue as stated throughout this dissertation, this chapter presents a new concept for the pre-allocation and management of total float. This study involves allocating an equal amount to the two contractual parties, the owner and the contractor, on the same non-critical path activities (called *equal allocation*). This pre-allocation of total float must be clearly and expressly stated in specific clauses in the prime contract.

To direct its use, four contract clauses are recommended: *Float Definition*, *Pre-Allocation of Float*, *No Damage for Non-Critical Delay*, and *Formulas*. Similar to various concepts currently used, this new concept of total float management provides that no delay

damage will be paid nor time extension granted for an accumulation of non-critical delays or total float consumption involving any activity that does not impact the project completion date and/or the project critical path.

If total float is consumed beyond its Allowable Total Float for any given activity, and the total float consumption or accumulation of all total float consumption on the affected activity path adversely impacts the project critical path or extends the project completion date, then the responsible party shall be held responsible for any delays and damages.

The chapter ends by comparing features of this new allocation concept with those of the other seven current theories in an effort to provide insight into what has not worked in the past and what may now be more workable. These seven theories include *Owner Entitlement (OE)*, *Contractor Entitlement (CE)*, and *Project Entitlement (PE)*, *Allocating Total Float to Individual Activity (AFIA)*, *Trading Total Float as Commodity (TTFC)*, *Calculating and Using Safe Float (CUSF)*, and *Using Float Clauses in Contract (UFC)*.

CHAPTER 7

SURVEY VALIDATION OF THE PROPOSED CONCEPT

7.1 INTRODUCTION

To validate the merits of the proposed concept of total float pre-allocation and management, a Delphi survey was used to compile opinions from pre-selected experts. This study also forecasts opinions on the proposed dramatic change in the current practice of Total Float Management, which has been widely accepted and implemented for a decade. Such a survey also explores the range of potential positions on the issue, as well as examines the pros and cons of each perspective.

Beginning with the proposition that a Delphi survey will assist in the validation of the proposed practice, this chapter will present and discuss the survey methodology and results. It opens with a discussion of the methodology and criteria, including such factors as panel selection, survey instruments, survey criteria, and survey implementation. It continues with a description of the Delphi panel profiles, followed by a summary presentation of the survey criteria and results. Finally, the survey results, as well as potential limitations and recommendations offered by the panel members, will be discussed.

7.2 SURVEY METHODOLOGY AND CRITERIA

The Delphi Method—a structured process for collecting and refining knowledge from pre-selected groups of experts—was chosen for data collection. This method, which allows experts to deal systematically with a complex problem, is composed of a series of questionnaires sent either by mail or via computerized systems to a panel of pre-selected, established authorities on the topic. To fully illustrate the proposed concept to panel members, an animated graphic presentation was developed using Microsoft PowerPoint for dissemination along with the questionnaire. Panel selection and survey instrument development processes are described in the following sections.

7.2.1 PANEL SELECTION

From contact lists established by the author and by committee members, experts were chosen for inclusion on the panel based primarily on their degree of subject knowledge. Among their number, one can find construction lawyers, construction claim consultants, and scheduling experts. All panel members possess extensive knowledge of the total float issue or CPM scheduling and have accumulated over ten years of construction claim experience in the areas of delay or CPM scheduling analysis. Additionally, each member must be willing to contribute to academia their own ideas regarding total float issues.

7.2.2 SURVEY INSTRUMENTS

The survey instruments include an animated graphic presentation and a questionnaire. The purposes of the presentation are (1) to illustrate both the current and proposed concepts of total float management and (2) to compare the allocation of delay responsibilities under the two concepts. An understanding of the two concepts is essential in the survey process; therefore, it must be assured that panel members either possess an awareness of or are given a thorough introduction to them prior to starting the questionnaire. The panel members are encouraged to ask questions, particularly regarding the proposed concept.

The animated presentation, which is distributed to pre-selected professionals, consists of 26 slides (see Appendix 1) and covers the following areas:

- ◆ Survey Objectives
- ◆ The Current Practice of Total Float Ownership
- ◆ The New Concept: “*Equal Ownership of Total Float to the Owner and the Contractor*”
 - *Major Principles*
 - *Suggested Contract Clauses*
 - *Allocation of Delay Responsibility*
 - *Six Delay Examples*
 - *Comparison of Both Concepts*
- ◆ Questionnaire Introduction

As indicated by Table 7.1, the questionnaire contains four parts, each with its own set of component questions, designed to gauge personal experience, knowledge, and opinion. A combined total of forty-four open-ended and multiple-choice questions is used to explore the full range of experts' responses to the complex problem. The original questionnaire is shown in Appendix 2.

Part No.	Objective	Survey Questions
Part 1	Participants' personal experiences, including involvement in delay claims.	1 – 12
Part 2	Participants' knowledge of total float issue and possible solutions.	13 – 24
Part 3	Significance of clauses written in contract documents.	25 – 29
Part 4	Significances of implementing the proposed concept to resolve the total float issue.	30 – 44

Table 7.1: Questionnaire Components

7.2.3 SURVEY CRITERIA

The primary objective of this survey is to validate the merits of the new concept of total float allocation. To meet the objective, the survey asks participants to rate the proposed concept of total float management on the following eight criteria, which were covered in Part 4 of the questionnaire:

Criteria 1 *Significance in Increasing Awareness of Float Consumption.*

Question 33 aims to address Criteria 1 by asking participants to respond to the statement “The proposed concept can significantly increase awareness that

float consumption can play a role in creating potential project delays.”

Criteria 2 *Significance in fairly allocating total float to an owner and contractor.*

Question 38 and 39 address this criteria. Participants are asked to respond to the statements “The proposed concept fairly allocates total float to an owner” and “The proposed concept fairly allocates total float to a contractor.”

Criteria 3 *Significance in Reducing the Utilization of Total Float.*

Question 30 and 31 focus on this topic by asking participants opinions on the statements “The proposed concept can significantly reduce the utilization of total float by owners and their representatives” and “The proposed concept can significantly reduce the utilization of total float by contractors and their representatives.”

Criteria 4 *Significance in Resolving Total Float Ownership Issue.*

Question 32 gauges participants’ reaction to the statement that “[t]he proposed concept can significantly resolve the total float ownership issue.”

Criteria 5 *Significance in Mitigating Delay and Disruption Disputes.*

Question 34 asks participants to consider whether “[t]he proposed concept can significantly mitigate delay and disruption disputes caused by the owner or the contractor.”

Criteria 6 *Significance in Improving Project Performance.*

Question 35 measures respondents’ opinions regarding whether “[u]ltimately, the proposed concept can significantly improve project performance.”

Criteria 7 *Ease of Implementation.*

Question 36 asks participants to respond to the query “Does the proposed concept appear easy to implement?”

Criteria 8 *Cost of Implementation.*

Question 37 asks “Does the proposed concept appear costly to implement?”

The ratings for the eight criteria are based on the pre-determined Likert scale responses, which offers rankings from one to five or six—one being the best and five or six the worst. At the conclusion of the questionnaire, survey participants are asked to provide opinions regarding potential barrier(s) to implementing this concept, potential limitation(s) of the concepts and suggestions for further improving this new concept.

7.2.4 SURVEY IMPLEMENTATION

Originally, 31 potential panel members were contacted via email asking for their willingness to contribute their knowledge in the survey. Twenty-three experts agreed to participate in the survey; however, only 20 of them actually participated and returned the questionnaire. All survey responses are handled in a confidential manner: data will be kept confidential unless its originator officially allows the research team to handle the material without concerns for confidentiality.

At first, the author presented the proposed concept using the animated presentation to a group of 10 potential panel members, among them construction lawyers, construction claim consultants, and schedulers. Eight panel members returned completed questionnaires. The author found that the group presentation had one shortcoming: an opinion or question raised during the presentation could have influenced others to respond in a similar fashion. In this case, an opinion raised by a senior scheduling expert clearly influenced the opinions of participants with non-scheduling-backgrounds.

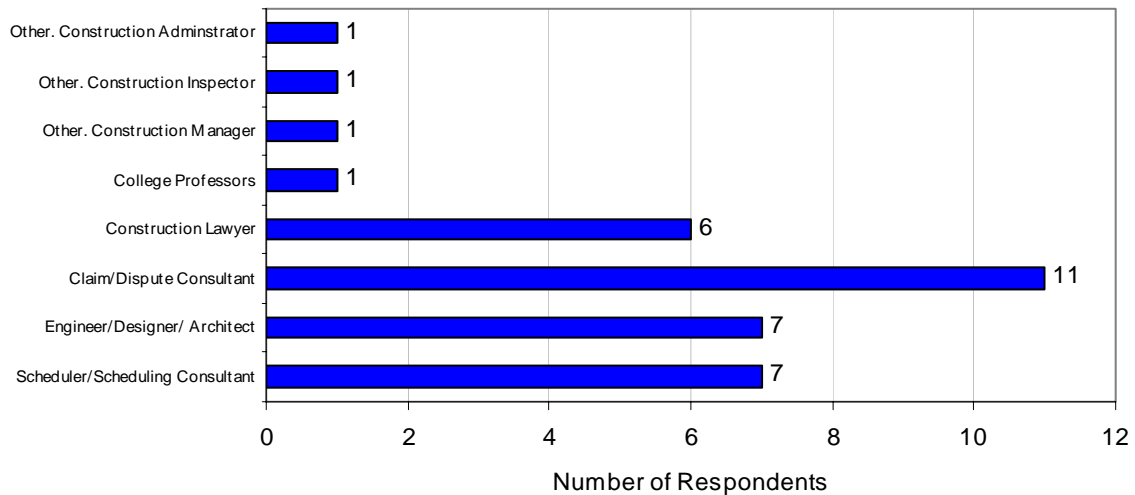
To overcome the limitation of the group presentation, the author added self-explanatory slide notes to the MS PowerPoint presentation (see Appendix 1). The self-explanatory presentation and questionnaires were then distributed to 17 experts via either email or traditional mail. Twelve panel members participated and returned the questionnaires. Before beginning the questionnaire, they were asked to review the presentation, along with the slide notes, and encouraged to consult the author for clarification

regarding facets of the proposed concept. After reviewing the presentation, none of the participants had questions.

7.3 PROFILES OF THE DELPHI PANEL

Characteristics of the panel members were obtained through Part I of the survey and are shown in Table 7.2. Of the 20 panel members, 19 (or 95 percent) have over ten years of experience in the construction industry, while 12 of those (60 percent) have worked in the industry for more than 20 years. Seventeen (85 percent) have over 10 years of experience in CPM-based construction project, and 14 (70 percent) have over 10 years of experience in construction delay analysis.

As shown in Figure 7.1, the primary occupation of the panel members is construction claim/dispute consultant, followed (in order) by scheduler/scheduling consultants, engineer/designer/architect, and construction lawyer. Thirteen of the panel members have represented or worked for owner(s) for more than 10 years, while seven—fewer than half—of the panel members have worked for contractor(s) for more than 10 years.



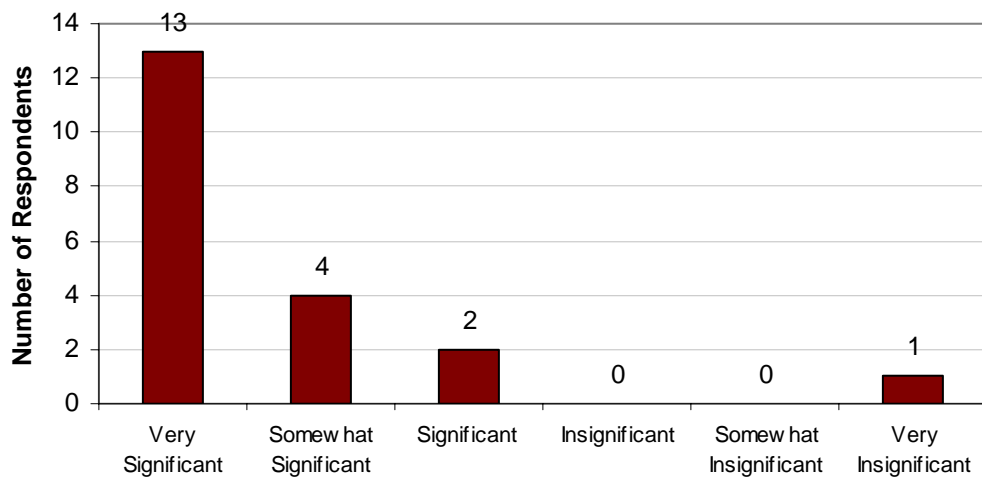
■ Q10: What category best describes your expertise in the construction industry?

Figure 7.1 Category by expertise in the construction industry.

Respondent #	Q7 Experience in Construction				Q8 Experience in CPM-Based Construction				Q9 Experience in Delay Analysis				Q10 Expertise in Construction						Q11 # of Years W/ Owner					Q12 # of Years W/ Contractor(s)										
	0-5 years	6-10 years	11-20 years	Over 20 years	0-5 years	6-10 years	11-20 years	Over 20 years	0-5 years	6-10 years	11-20 years	Over 20 years	Scheduler/Scheduling Consultant	Engineer/Designer/Architect	Claim/Dispute Consultant	Construction Lawyer	College Professors	Other. Construction Manager	Other. Construction Inspector	Other. Construction Administrator	None	1-5 years	6-10 years	11-20 years	Over 20 years	None	1-5 years	6-10 years	11-20 years	Over 20 years				
1	1				1				1				1	1											1									
2			1				1				1		1																			1		
3			1				1				1			1		1																1		
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18			1				1				1		1																			1		
19			1				1			1			1																			1		
20	1				1					1				1			1															1		
Total	0	1	7	12	1	2	10	7	2	4	7	7	7	7	11	6	1	1	1	1	1	1	1	1	1	2	4	7	6	4	6	3	3	4

Table 7.2 Characteristics of the Panel

Part II of the survey—consisting of questions 13-24—covers panel members’ knowledge of the total float issue and of potential solution(s). Figures 7.2 and 7.3 show the results from questions 13 and 14, respectively. Nineteen (95 percent) of the 20 panel members believe that total float is *significant* in a CPM schedule, while thirteen (65 percent) indicate that to them it is *very significant*. One only member considers it to be *very insignificant*. Eighteen members (90 percent) agree strongly that total float utilization and ownership can be sources of dispute when a delay occurs. Two members disagreed with this opinion.



Q13: In your opinion, is total float significant in a CPM schedule?

Figure 7.2 Opinion in the significance of total float in a CPM schedule.

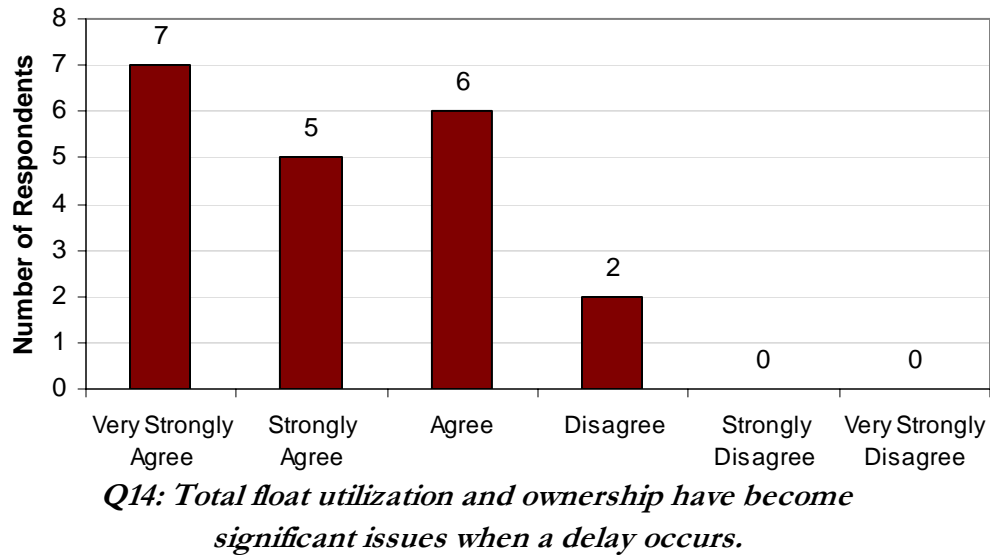
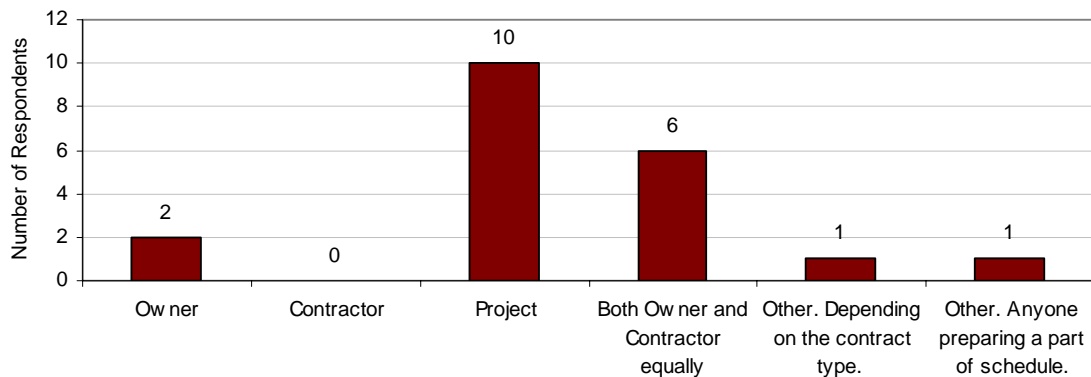


Figure 7.3 Opinion in total float utilization and ownership issues

Questions 15 and 16 focus on panel members’ involvement in the issue of total float-related delay analysis. About 75 percent of the panel members or 15 panel members have been involved in resolving an issue of total float utilization or ownership in a CPM-based construction project or were involved in analyzing a total float-related delay. These panel members were then asked in question 18 to indicate the party they represented or worked for at the time of the involvement. Of the 15 panel members, 9 members or 60 percent have represented both parties, two have represented contractors and four have represented owners. By having more than 50 percent of the panel members representing the two parties, credibility of the survey is maximized.

Questions 19 to 22 focus on the experts' opinions regarding total float ownership. The results show that 63 percent agree with the assessment of the current concept of total float: that it should be free or have no cost to any involved party. Thirty-seven percent disagree with this assessment. Seventy-six percent of the panel members believe that total float should belong to the project rather than to any individual party in the construction project. Although most of the members agree that total float should be free and should belong to the project, 44 percent agree with the current concept of total float that it should belong to the individual who gets to it first. About 43 percent disagree that it should belong to the individual who gets to it first, while 13 percent indicate that ownership should depend upon on the situation.

Question 22 asks experts to suggest who should own total float. As Figure 7.4 shows, of the 20 panel members, 10 (50 percent) consider that the project itself should own total float while six participants believe that both owner and contractor should share it equally. To the last question of this part, 50 percent (10 panel members) respond that they have never thought or heard of a possible solution for resolving the conflict.



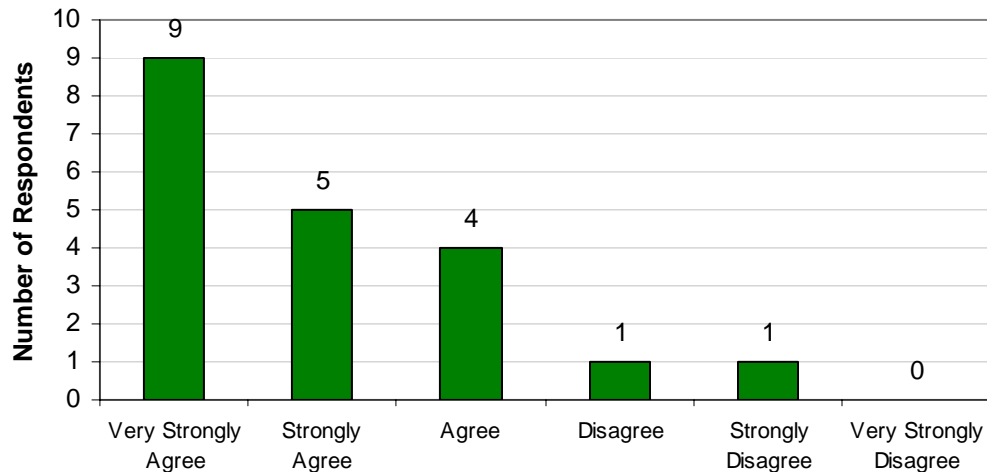
Q22: In your opinion, who should own total float?

Figure 7.4 Opinion on Ownership of Total Float

Part III of the survey—questions 25 to 29—focuses on gleaning panel members' opinions regarding the significance of clauses written into contract documents. Eighty-five

percent of the panel members have been involved in writing scheduling specification in construction contracts. All panel members think that schedule clauses are *important*, while ninety percent consider schedule clauses *very important*. However, only 55 percent of the panel members have been involved in a construction contract that includes a clause regarding total float ownership or utilization, which means that a full 35 percent do not have experience with such clauses.

As shown in Figure 7.5, which depicts results from Question 29, 18 of the panel members on average *agree strongly* that a clause involving total float ownership and utilization is of sufficient importance to be written into a construction contract. Only two members disagree.



Q29: A clause involving total float ownership and utilization is of sufficient importance to be written in a construction contract.

Figure 7.5 Opinion on the importance of a clause involving total float ownership and utilization

7.4 SUMMARY OF FINDINGS BY SURVEY CRITERIA

- Part IV of the survey asks panel members to evaluate the proposed concept against
- six criteria using a six point Likert scale, in which 1 = *Very Strongly Agree*, 2 = *Strongly Agree*, 3 = *Agree*, 4 = *Disagree*, 5 = *Strongly Disagree*, and 6 = *Very Strongly Disagree*, and against.
 - two additional criteria using a five point Likert scale, in which 1 = *best* and 5 = *worst*.

The average scores and standard deviations were calculated for each criterion and are presented in Table 7.3. The results for each panel member are shown in Appendix 3. The number of panel members (N) varies because some panelists did not respond to certain criteria.

Besides seeing the overall result of the survey by the criteria, it is interesting to see the comparison of the panel members who represented owners, contractors or the two parties. In question, 18, the panel members who answer “yes” to either question 15 or 16 were asked to indicate the party they represented or worked for at the time of the involvement. Table 7.4 presents the average scores of those representing the two parties, owners and contractors.

Criteria	Number of respondents	Average Score	SD
1 Significance in increasing awareness that float consumption can play a role in creating potential project delays.	20	2.7	1.27
2 Fairly allocating total float to an owner.	19	3.3	1.20
2 Fairly allocating total float to a contractor.	19	3.3	1.20
3 Significance in reducing the utilization of total float by owners and their representatives.	20	3.5	1.10
3 Significance in reducing the utilization of total float by contractors and their representatives.	19	3.5	1.22
4 Significance in resolving the total float ownership issue.	20	3.5	1.05
5 Significance in mitigating delay and disruption disputes caused by the owner or the contractor.	20	3.8	1.02
6 Significance in improving project performance.	20	3.7	0.88
7 Ease to implement**	18	3.3	1.28
8 Cost to implement**	19	2.8	1.23

Note: The Delphi panel members responded to the first six criteria using a six point Likert scale in which 1 = Very Strongly Agree, 2 = Strongly Agree, 3 = Agree, 4 = Disagree, 5 = Strongly Disagree, and 6 = Very Strongly Disagree.

**The Delphi panel members responded to the criteria 7 and 8 using a five point Likert scale in which, 1 = Very Easy and 5 = Very Difficult, or 1 = No Cost and 5 = Very Costly.

Table 7.3 Average Scores and Standard Deviations for Eight Criteria

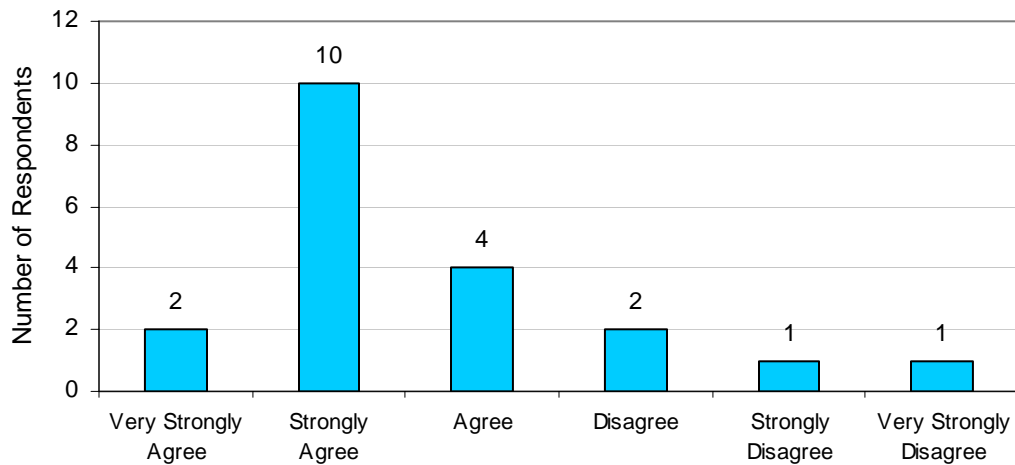
Criteria		Overall Average Score	Panel Members Representing*		
			Both Parties	Owner	Contractor
<i>Number of Respondents</i>		20	9	4	2
1	Significance in increasing awareness that float consumption can play a role in creating potential project delays.	2.7	3.4	2.0	2.0
2	Fairly allocating total float to an owner.	3.3	3.9	3.0	3.5
2	Fairly allocating total float to a contractor.	3.3	3.9	3.0	3.5
3	Significance in reducing the utilization of total float by owners and their representatives.	3.5	3.8	3.3	4.0
3	Significance in reducing the utilization of total float by contractors and their representatives.	3.5	4.0	3.3	4.0
4	Significance in resolving the total float ownership issue.	3.5	4.0	3.0	3.0
5	Significance in mitigating delay and disruption disputes caused by the owner or the contractor.	3.8	4.1	3.8	4.0
6	Significance in improving project performance.	3.7	3.9	3.5	4.0
7	Ease to implement	3.3	4.0	2.5	2.5
8	Cost to implement	2.8	2.8	3.8	4.5

Note: * Panel members who responded to question 18; “If your answer to either Q15 or Q16 was yes, please indicate the party you represented or worked for at the time of the involvement.”

Table 7.4 Comparison of Average Scores for Panel Members Representing Both Parties, Contractors and Owners

The results for the eight criteria can be interpreted as follows:

1. Significance in Increasing Awareness of Float Consumption. As Figure 7.6 notes, 16 of the panel members (80 percent) agree that the proposed theory can significantly increase awareness of consuming total float, while only four disagree. By a wide margin, then, panel members agree that the proposed theory of total float management can significantly increase awareness of total float consumption. As shown in Table 7.4, the panel members who represented or worked for owners or contractors strongly agree with the proposed concept, while those who represented the two parties disagree.



■ **Q33: The proposed concept can significantly increase awareness that float consumption can play a role in creating potential project delays.**

Figure 7.6 Survey Results for Criteria #1

2. Significance in fairly allocating total float to an owner and contractor. The average score registers the opinion that the proposed concept would fairly allocate the total float amount to the two parties, owner and contractor (see Figure 7.7). Interestingly, those who represented owners agree with the proposed concept that can fairly allocate total float to an owner and contractor whereas those who represented the two parties disagree.

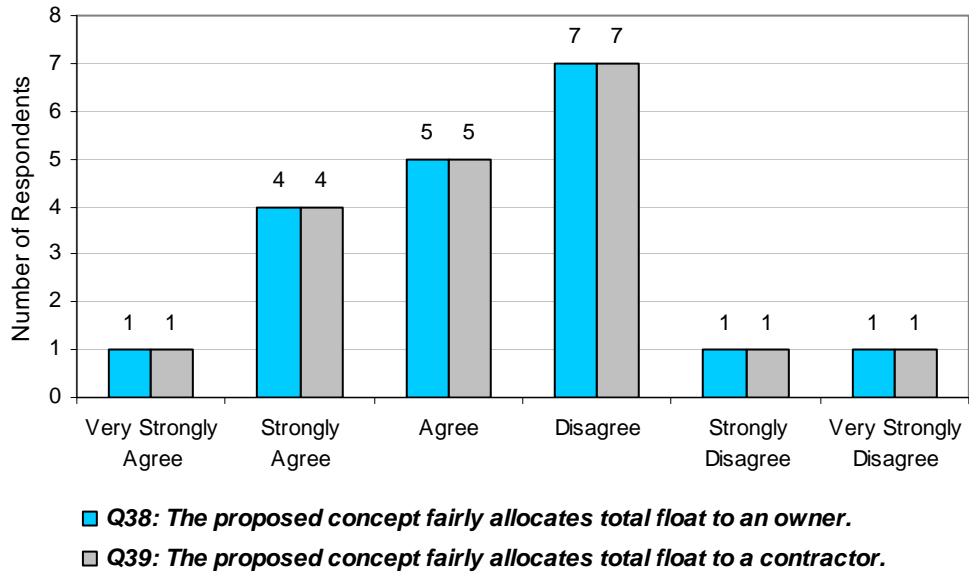
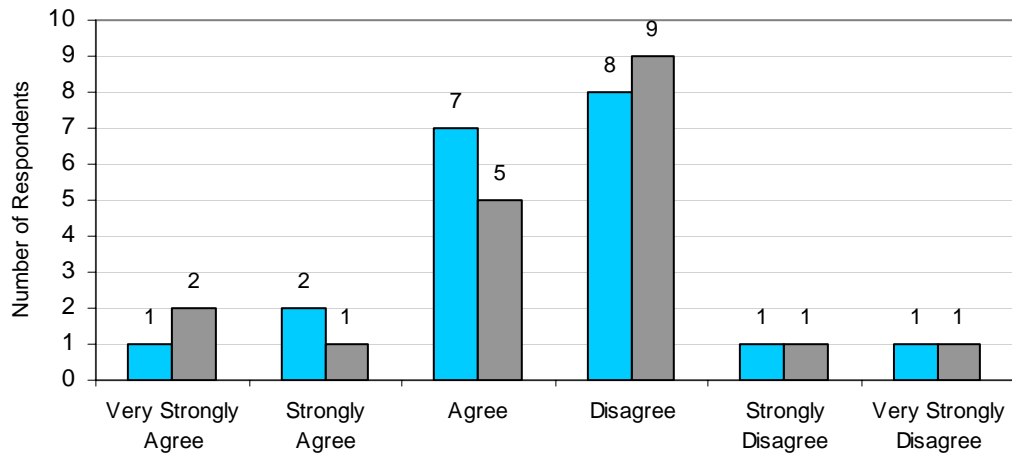


Figure 7.7. Survey Results for Criteria #2

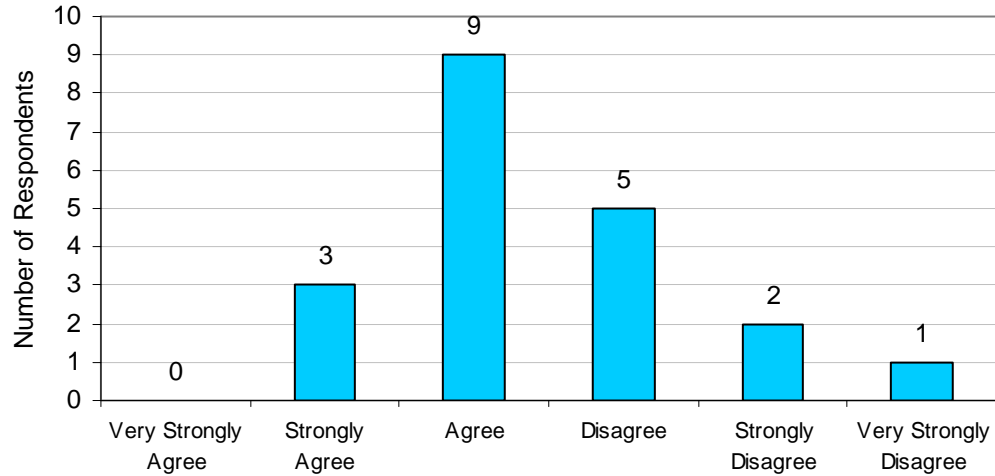
3. Significance in Reducing the Utilization of Total Float by the two contractual parties—the owner and the contractor—including their representatives. On average, as indicated by Figure 7.8, panel members do not agree or disagree that the proposed concept can significantly reduce the utilization of total float by owners or contractors and their representatives. However, the panel members who worked for owners agree that the concept can significantly reduce the utilization of total float while those working for contractors or the two parties disagree.



- Q30: The proposed concept can significantly reduce the utilization of total float by owners and their representatives.
- Q31: The proposed concept can significantly reduce the utilization of total float by contractors and their representatives.

Figure 7.8 Survey Results for Criteria #3

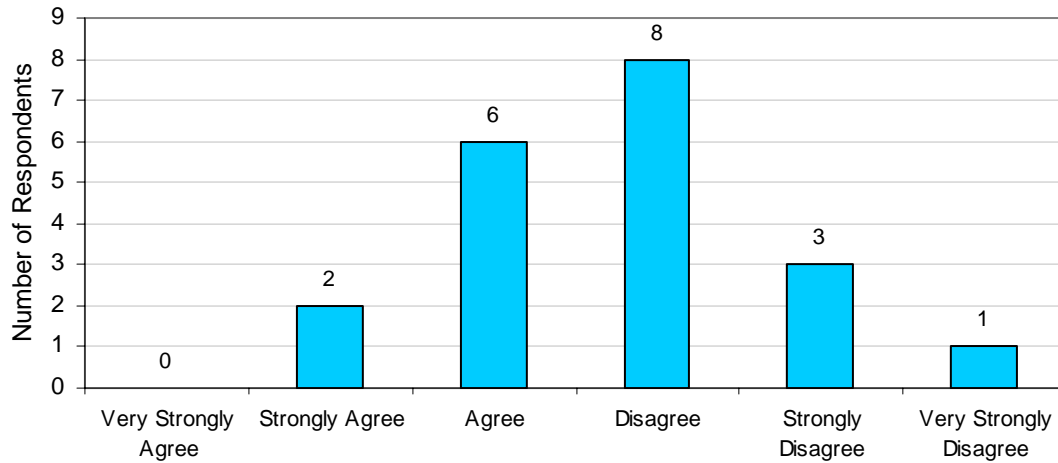
4. Significance in Resolving Total Float Ownership Issue. The result, shown in Figure 7.9, indicates that 12 (60 percent) of panel members agree that the concept can significantly resolve the total float ownership issue, whereas eight members (40 percent) disagree. As shown in Table 7.4, the panel members who worked for owners or contractors agree that the proposed concept can significantly resolve the total float ownership issue, while those who worked for the two parties disagree.



Q32: The proposed concept can significantly resolve the total float ownership issue.

Figure 7.9 Survey Results for Criteria #4

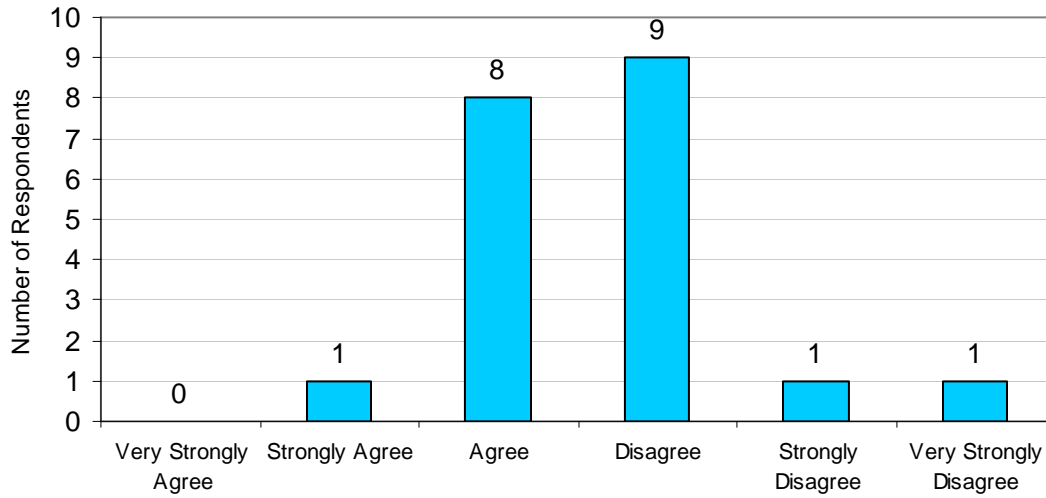
5. Significance in Mitigating Delay and Disruption Disputes caused by the owner or the contractor. The panel members generally disagree that implementing the concept can significantly mitigate delay and disruption disputes caused by the owner and the contractor. Eight members agree that the concept can significantly mitigate delay and disruption disputes caused by the owner and the contractor, whereas 12 disagree with this idea, as shown in Figure 7.10.



- **Q34: The proposed concept can significantly mitigate delay and disruption disputes caused by the owner or the contractor.**

Figure 7.10 Survey Results for Criteria #5

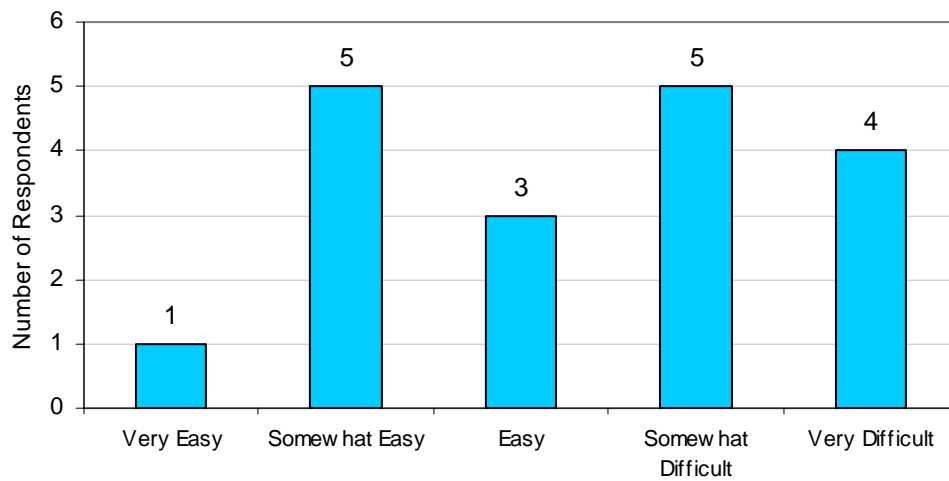
6. Significance in Improving Project Performance. As noted in Figure 7.11, nine of the panel members agree that the concept can help improve project performance, while 11 disagree with this belief. Overall, the panel members disagree about whether implementing the concept can ultimately improve project performance.



■ Q35: *Ultimately, the proposed concept can significantly improve project performance.*

Figure 7.11 Survey Results for Criteria #6

7. Ease of Implementation. Results show that the panelists consider the concept might be somewhat difficult to implement (see Figure 7.12). However, as stated previously, the results might be skewed by the settings from which they derived. For example, it is interesting to compare the responses of the 12 panel members who did not attend the group presentation but participated by reviewing the self-explanatory presentation with those of the eight panel members who attended the group presentation. The results indicate that, on average, members of the former group believe that the concept is easy to implement, while six members of the latter think that it is somewhat difficult to implement. In addition, Table 7.4 shows that those who represented owners or contractors believe that the concept is easy to implement, whereas those who worked for the two parties think it is somewhat difficult to implement.



■ Q36: Does the proposed concept appear easy to implement?

Figure 7.12 Survey Results for Criteria #7

8. Cost of Implementation. Ten panel members express the opinion that the proposed method would not be costly to implement, while one believes it would cost nothing at all. Three panelists see it as *costly*, while two indicate their beliefs that it would be *somewhat costly*, and three perceive it to be *very costly*. See Figure 7.13. In term of cost of implementation, the panel members who worked for owners or contractors have the same opinions that the concept is costly to implement, while those who worked for the two parties think it is not costly to implement.

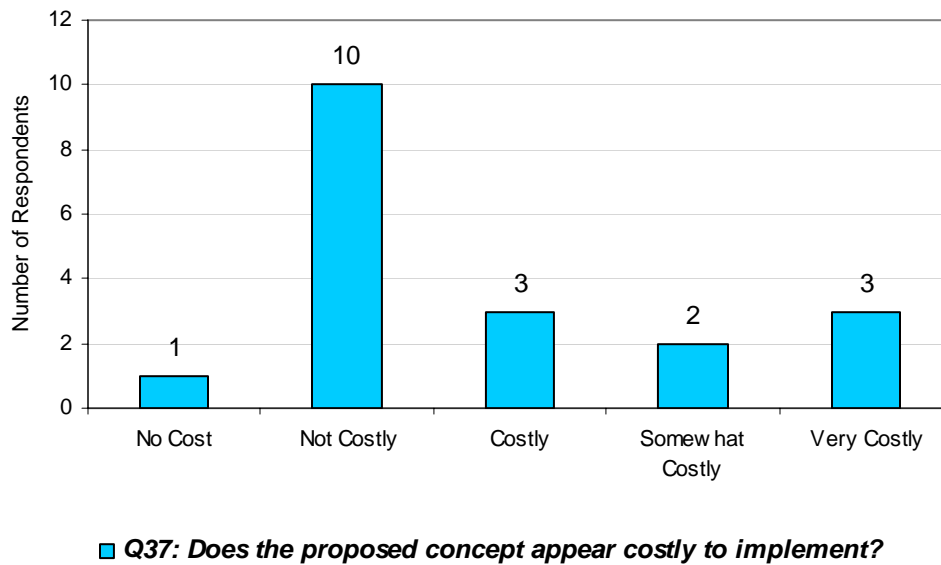


Figure 7.13 Survey Results for Criteria #8

At the end of the survey, panel members were asked to respond to two more five-point Likert scale questions and three open-ended questions. Overall, results are mixed: the respondents *might* or *might not* implement the proposed concept or suggest the concept to another individual.

7.5 DISCUSSION AND CONCLUSION

Given the fact that the statistical analysis derived from the Delphi Survey presents a mixed bag of results, the question that must be asked at this point is “What has been discovered by the study?”

The study found that most of the panel members agree with the author that, when owners and contractors are faced with a dispute, the current practice of total float ownership and management has become a major source of conflict. Although the current practice has been widely accepted and implemented in the construction industry for a decade, only 50 percent of the panel members agree with its feasibility and efficiency. Only 50 percent think that total float should belong to anyone who gets to it first, while the other half believe it should be owned not by an individual party but by the project itself.

According to the results of this study, the proposed concept could significantly increase awareness of float consumption by the two parties. In fact, more than 50 percent of the panel members agree that the proposed concept can significantly resolve the total float ownership issue. Unlike results involving opinions of the current concept or any resolutions for resolving such conflicts, which are generally unanimous, those concerning experts' responses to the proposed concept—as indicated by the Delphi study—indicate both agreement and disagreement with it.

One of the panel members who agrees with the proposed concept states “Like all endeavors, relationships are built on trust. If the parties to a contract are responsive and earnest, then it really doesn't matter as much how you address float.” Another member suggests that “this concept is much fairer to the parties of a contract.”

Clearly, some panel members agree that the proposed concept is valid and workable, while some disagree. The major rationale of those who disagree with the proposal can be attributed to the dynamic nature and complexity of the schedule, the incompleteness and lateness of the original baseline schedule, and additional floats resulting from owner's change orders or contractor's actions.

The author was aware of and considered the complexity of the CPM schedule when developing the proposed concept of total float management. The other scheduling issues and contractors' “schedule games” mentioned by the panel members and in the most recent ENR feature story (ENR 2003) are issues separate from that of total float management. They must be addressed concurrently, but separately, with the proposed practice. In addition, the “added mathematical and bookkeeping” complexity implied by the proposed concept of total float pre-allocation is actually needed and that the benefits of such complexity far outweigh the

pitfalls associated with the current use of total float, which basically penalize those who use it last. This pre-allocation of float will essentially remove the "first come, first served basis" concept.

One of the panel members who supports the proposed concept provided a suggestion to address the additional total float issue resulting from owners' change orders and contractors' actions. The suggestion is to add an incentive provision that encourages responsive and earnest behavior. He notes that "[t]he tendency would be for the party creating it to want to keep it all, and this is a strong incentive to create it."

Other barriers to implementing the proposed concept include higher bids for covering contingencies, the difficulty in computing total float on a monthly basis, and acquiring decision-makers from involved parties to forego established practice and accept the new concept.

The biggest challenge facing the proposed concept is whether the construction industry as a whole would be willing to reject a decades-old, "comfortable" practice in order to solve what has become a well-recognized and persistent problem. In order to implement the proposed theory, one of the panel members mentioned that "[i]t requires a complete rethinking of an already accepted principal of float ownership, and overcoming habit and industry tradition is a largest challenge."

Those experts who agree with the concept have provided useful recommendations for enhancing it, as summarized below:

- **Recommendation:** Consider limiting the amount of total float that can be used by either party after the entire total float is gone. The contractor should be disallowed from using its portion of the total float if the activity is in negative float.

If one party uses up all float at the onset of activities and there is no project delay, other party who has no incentive to not use its portion of the allowable float may use its float, therefore causing a delay to the project. Depending on the circumstances, the threat of using the unused portion of the float by the second

party could be used as a means of securing concessions from the party that has already used all the float.

- **Recommendation:** Consider applying the proposed concept to a real-life project with a high level of complexity.
- **Recommendation:** Consider incorporating a schedule into the contract. This way, a contractor will know the size of total float before bidding. Once the project is awarded, the contractor may be allowed to submit an alternate schedule incorporating similar logic relationships. Should the contractor's alternate schedule produce additional total float, the additional float should be shared on a 2:1 (contractor:owner) ratio. Allocating the higher number of float to the contractor will ensure that contractor ingenuity is encouraged for the benefit of all.
- **Recommendation:** Consider how the proposed concept would work in other, non-traditional methods of contract deliveries, such as design-build, turn-key, or a situation that involves more than two parties.
- **Recommendation:** To preserve float on some activity chains that are at a higher risk of being delayed, consider placing several key milestones in the schedule, with incentive/ disincentive provisions attached to them.

In conclusion, the result shows that most of the panel members agree with the author's assertion that when owners and contractors are faced with a dispute, the current practice of total float ownership and management can aggravate the possibility for conflict. The survey shows also that the total float pre-allocation concept could significantly increase awareness of total float consumption by the two parties and resolve the total float ownership issue.

After evaluating the opinions and recommendations from the twenty experts, the researcher has revised and incorporated their opinions into the proposed concept. To demonstrate the application of the concept, two examples of *concurrent-delay* and *multiple non-critical-path* situations are added to the dissertation. The principle of the concept is refined by clarifying that its main goal is pre-allocating the amount of total float to the two parties, in this case on an *equal (50-50) allocation* basis. Although the concept is successfully developed to increase the awareness of total float utilization, one cannot know

whether the concept is practical. Therefore, the researcher suggests that this concept is implemented to explore any possible problems that may arise in a real construction project. Recommendations for future research are discussed and presented in the next chapter.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 SUMMARY

This dissertation consists of two separate literature reviews. The first review considers project planning and CPM scheduling in construction projects, as well as construction contracts and scheduling specifications in the areas of delay, time extension, and total float, as written in project contract documents. This review also includes legal perspectives on CPM scheduling in the construction industry. The second review focuses on the concept of total float ownership and related issues, which become the focus of this study. In an effort to introduce potential solutions to the problems surrounding total float issues, this review also examines existing and recently-introduced total float management methods.

In order to resolve the issue of total float ownership, a new concept of total float pre-allocation and management is developed. As proposed, this concept pre-allocates a set amount of total float on the same non-critical path of activities to two contractual parties—the owner and the contractor. Under this plan, *equal allocation* of total float ensures that the owner and the contractor each owns one-half of the total float available on any non-critical path activity of the project. However, in order for this method to work effectively, the pre-allocation of total float must be clearly and expressly stated by specific clauses in the prime contract prior to the project's starting date.

For the proposed concept of total float pre-allocation, this dissertation recommends four specific contract clauses. Formulas are given to facilitate the allocation of delay responsibilities, and to indicate how the concept might be implemented, six factual examples of delay situations involving the consumption of total float for non-critical path activities are presented, along with appropriate illustrations. In an effort to validate the concept, the Delphi survey method was used to compile opinions from 20 pre-selected experts. This survey also explores the range of potential positions on the issue, as well as examines the pros and cons of each perspective.

8.2 CONCLUSIONS

The main purpose of this dissertation is to develop a new methodology for the management of total float that will resolve the conflicts inherent in current theories. The principles of this new concept for managing total float can be summarized as follows.

Implementation of the concept begins during contract preparation, prior to the project's starting date. The owner and/or the contractor must prepare contract clauses that will for their purposes define the concept and describe its application. In private projects, the owners and contractors may agree upfront to adopt the new concept of total float pre-allocation; however, under public or hard-bid projects, the owner with or without the contractor's agreement will adopt this new concept and insert contract clauses during bid preparation. In this case the public owner will need to make an arbitrary determination of the pre-allocation percentages.

Four contract clauses have been developed and are recommended for directing the use of total float and explaining the manner in which responsibility for delays should be assigned. The recommended clauses are

- “FLOAT DEFINITION” CLAUSE
- “PRE-ALLOCATION OF FLOAT” CLAUSE
- “NO DAMAGE FOR NON-CRITICAL DELAY” CLAUSE
- “FORMULAS” CLAUSE

Six factual situations, with illustrations, serve to identify the basis for determining responsibility for delays. Cases #1 and #2 involve multiple delays to a non-critical path, none of which impact the project completion date. Cases #3 and #4 deal with multiple delays to a non-critical path, the accumulation of which impacts the project completion date. Case #5 presents a concurrent-delay situation, while Case #6 illustrates multiple delays to multiple-non-critical paths.

The merits of the proposed concept of total float pre-allocation and management is validated via the Delphi survey. Survey results indicate that most of the panel members agree with the author's assertion that when owners and contractors face a dispute, the current practice of total float ownership and management can lead to greater conflict. The survey

shows also that the total float pre-allocation concept could significantly increase awareness of total float consumption by the two parties and thus help resolve any questions surrounding the issue of total float ownership.

8.3 CONTRIBUTION TO THE BODY OF KNOWLEDGE

This research makes the following contributions:

- This research has contributed a systematic and fair methodology to replace the “first-come-first-served” approach to total float management. Parties needing to use total float last no longer have to be unfairly penalized.
- The principle of total float pre-allocation is reasonably and carefully developed and analyzed. The four clauses developed for insertion into the contract will direct how the concept is used and explain the manner in which responsibility for delays will be assigned.
- Formulas are recommended for use in determining delay responsibilities. Based on these formulas, six examples of factual delay situations are developed to illustrate implementing the proposed concept and determining delay responsibilities. The examples show how the concept can be applied to “real life” delay situations.
- Comparisons are made between the features of this new concept and those of other theories presently being used. Comparing the features in this manner should provide some insight regarding what has not worked in the past—and what might work more effectively.
- The validation of the concept via the Delphi survey proves that if the concept of total float pre-allocation is implemented in construction projects, it could significantly increase involved parties’ awareness of total float consumption and thus mitigate any potential disputes.

8.4 RECOMMENDATIONS FOR FUTURE RESEARCH

As a result of this study’s findings, the following recommendations can be made regarding future research:

- To test the practicality of this proposed concept, it should be implemented in a real construction project. Although the concept of total float pre-allocation is successfully developed in this research, it might not solve all other scheduling problems that occur during construction.
- Criteria must be developed to determine and allocate an amount of total float to the two parties. One possible criterion is the degree of schedule risk; in other words, the party who faces the higher risk should receive a larger amount of total float.
- Solutions must be developed to resolve other total float-related questions, such as who owns additional total float given a particular situation, e.g., the contractor's actions alone cause delays.
- Contract clauses must be developed to deal with scheduling changes that occur naturally during the life of the construction project. The changes could be caused by the owner's alterations in activities or the contract's playing of the "schedule game," either of which can consume total float.
- A computer program must be created or existing scheduling programs must be enhanced the better to show each party's allocated amounts of total float. This would allow both parties to track their amounts of remaining total float as the project progresses.

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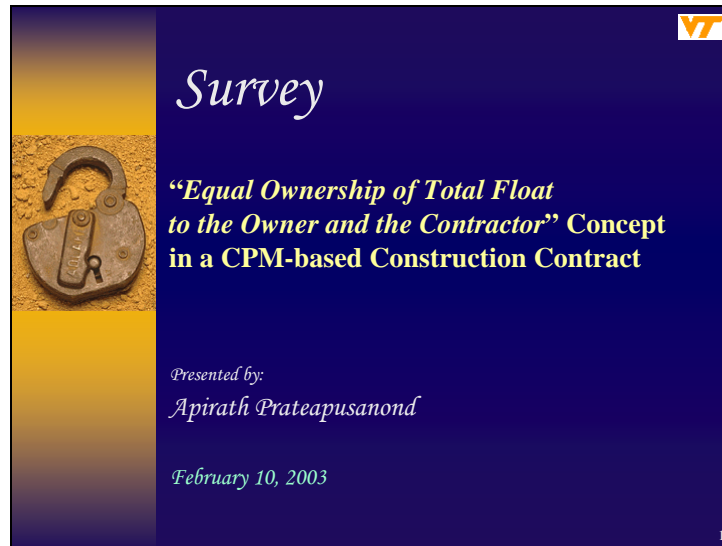
APPENDIX

- Appendix 1 – A Sample of PP Presentation of the TF Allocation Concept with Slide Notes.
- Appendix 2 – A Sample of Questionnaire
- Appendix 3 – A Detailed Result of the Delphi Survey

APPENDIX 1

A SAMPLE OF POWERPOINT PRESENTATION OF THE TOTAL FLOAT ALLOCATION CONCEPT

Slide 1

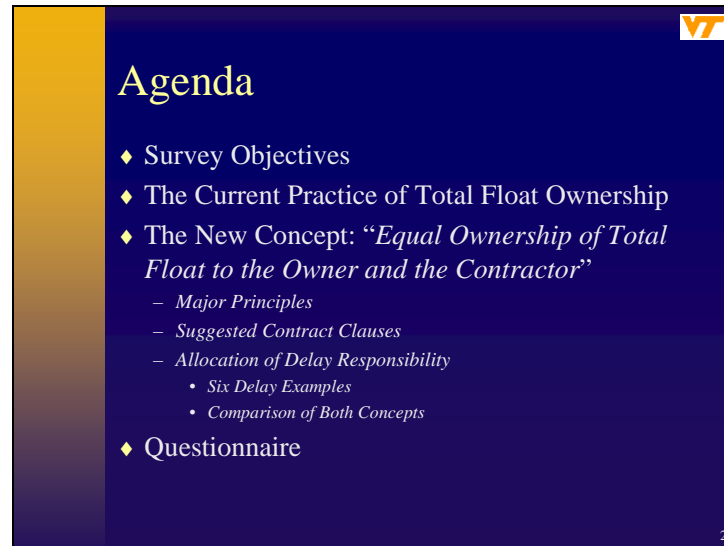


Dear Participant,

I am conducting a research study on the topic "Total Float Ownership and Management in a CPM-Based Construction Contract" to complete my doctorate in Construction Management at Virginia Tech. In order to validate the proposed concept of TF management, I am seeking feedback through a survey of pre-selected professionals in the construction claim or scheduling fields.

This survey consists of two (2) sections. The first section involves a PowerPoint presentation of the new concept, which should take about 20-30 minutes, while the second involves completion of a questionnaire. The questionnaire can be returned to me either via email or by mail. My contact info is given in the questionnaire.

Slide 2

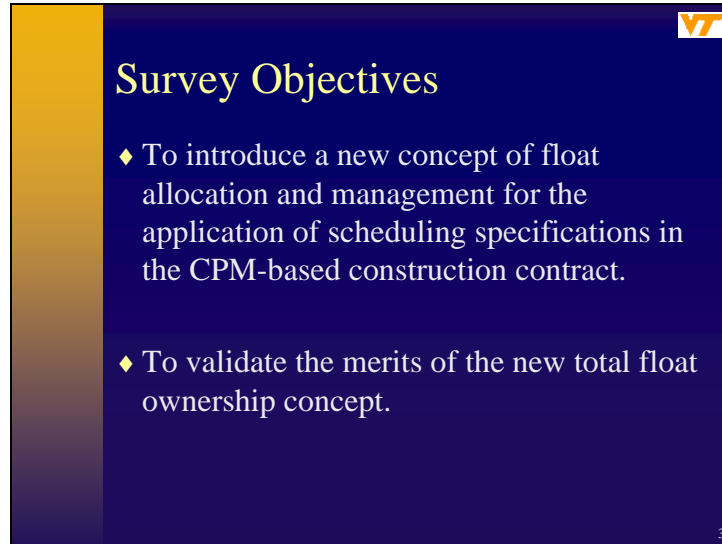


Agenda

- ◆ Survey Objectives
- ◆ The Current Practice of Total Float Ownership
- ◆ The New Concept: “*Equal Ownership of Total Float to the Owner and the Contractor*”
 - Major Principles
 - Suggested Contract Clauses
 - Allocation of Delay Responsibility
 - Six Delay Examples
 - Comparison of Both Concepts
- ◆ Questionnaire

2

Slide 3



The slide features a dark blue background with a vertical orange bar on the left side. The title 'Survey Objectives' is written in a light yellow font. Below the title, there are two bullet points, each preceded by a yellow diamond symbol. In the top right corner of the slide, there is a small orange logo with a white 'V' shape. In the bottom right corner, the number '3' is displayed in a small white font.

Survey Objectives

- ◆ To introduce a new concept of float allocation and management for the application of scheduling specifications in the CPM-based construction contract.
- ◆ To validate the merits of the new total float ownership concept.

Many construction contracts require that contractors use the Critical Path Method (CPM) schedule technique as a management tool in construction projects. In such projects, it is common that many participating parties attempt to appropriate float time shown in the CPM schedules to advance their own interests and benefits. Under current scheduling practices, float time is considered “free” and does not belong to any party in the construction process. Float ownership and its utilization has become a major dispute when project delay occurs.

In order to mitigate the TF issue, the research study aims to introduce a new concept of float allocation and management for the application of scheduling specifications in the CPM-based construction contract.

This survey is to validate the merits of the new total float ownership concept by collecting feedback from pre-selected experts with over 10 years of experiences in delay claim and scheduling.

Slide 4



The Current Practice
of Total Float Ownership

Total Float is considered by the courts to be:

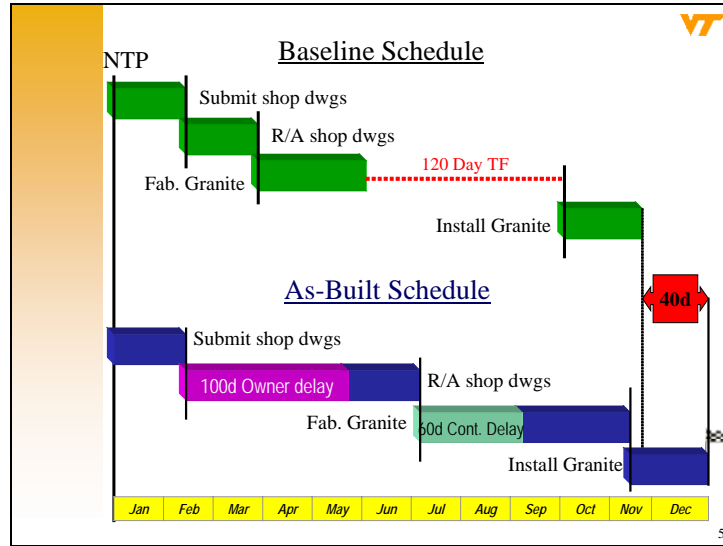
- ◆ “An expiring resource available to all parties involved in the construction process”
- ◆ “FREE ...not belong[ing] to any party in the construction process”

4

Currently, the courts have recognized total float time clearly as “an expiring resource available to all parties involved in the project” and “free and does not belong to any party in the construction process”. This current practice has been implemented and widely accepted in the construction industry.

However, with the float concept, the parties with some float times may take advantages by using floats for their own benefit and interest **without wondering about the impact to the following parties or to the project completion time**. Due to the dynamics of schedule, an activity that originally has float may later have zero or negative floats and thereby become critical as a result of delays to its predecessor activities. In this scheme, a party who delays this then-critical activity can be held responsible for the delay regardless of its earlier performance.

Slide 5

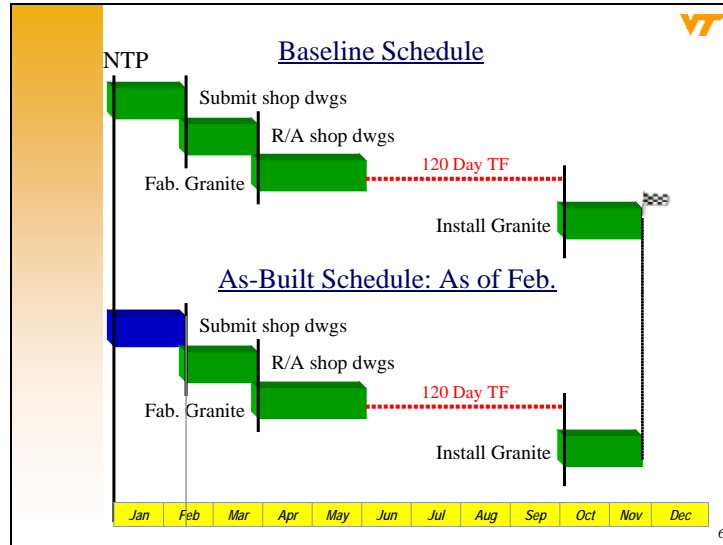


To illustrate the implication of the current concept, the example of granite work schedule is used.

In this example, there are 2 significant delays occurring on the granite activity path. Originally, the granite path has 120 days of total float. The owner delayed its activity of reviewing and approval of shop drawings for 100 day delay and the contractor then delayed in its fabrication activity. As a result of the two delays, the project completion date was extended for 40 days.

The question is "**who responds for the 40-day project delay?**". Should the contractor be charged for a liquidated damage or should the owner give a 40 day time extension and additional overhead costs to the contractor? Or should they both partially respond for this delay?

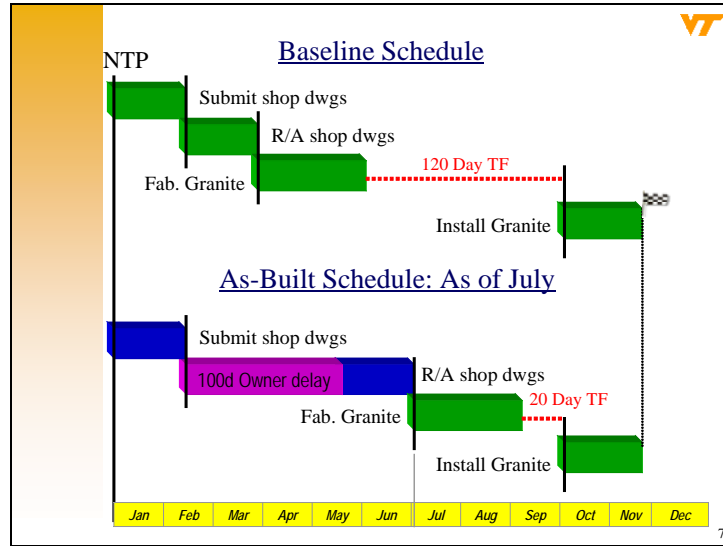
Slide 6



To allocate the delay responsibility under the current concept, the time impact analysis is used to identify the delay to the non-critical activity as well as delay to the critical activity that changed the project completion time.

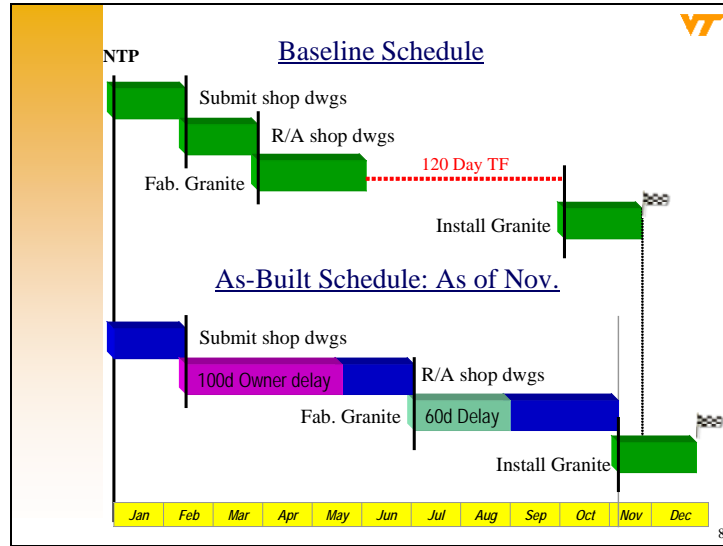
The as-built schedule shown in the slide is showing the progress of the granite work as of February. As shown in the update, the contractor finished the submit activity on time and the granite path still had 120 days of TF.

Slide 7



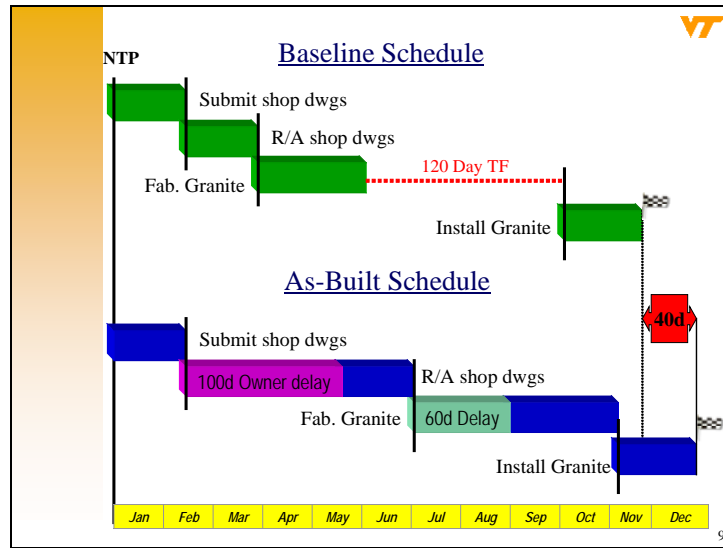
In July, the schedule update showed the owner's delay to the review and approval of shop drawing activity for 100 days. However, because the path had 120 days of TF by the time the owner's delay occurred, the owner delay did not change the project completion time. There is still no indication of the delay to the entire project in July. The court will decide that the owner's delay, occurred while the impacted activity still had total float of 120 days, did not have a significant impact to the project completion date.

Slide 8



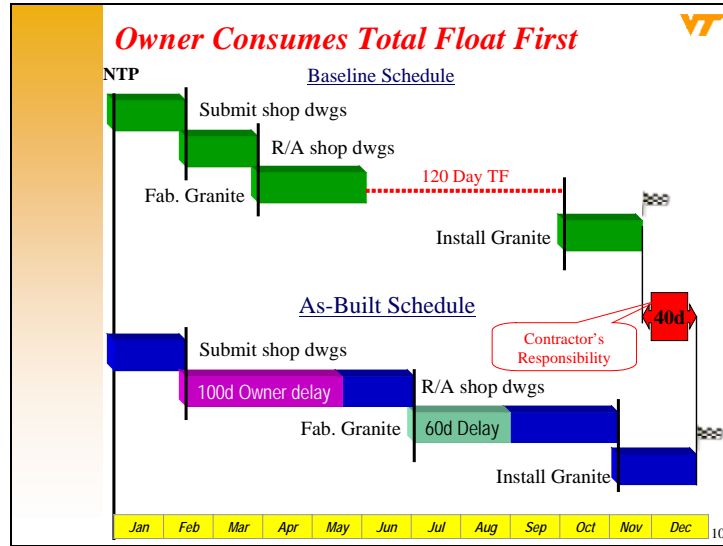
In November, the contractor did delay its granite fabrication activity, which at that time had only 20 days of TF left to be used. Therefore, the contractor delay, which occurred last, did have a significant impact to the project completion date and push the completion date off for 40 days as of the November update.

Slide 9



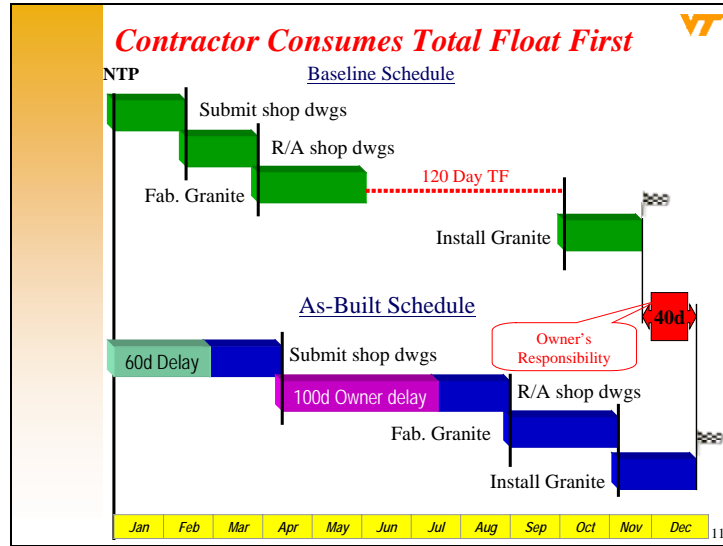
At the end of the project, the actual completion date was extended from its original date for 40 days.

Slide 10



The answer to the question is that the court will decide that the owner delayed to the approval activity while the 120 days float was available did not have an impact to the completion time. The contractor, which its delay impacted the project completion time, will be held responsible for the 40 day delay to the entire project.

Slide 11



On the other hand, if the contractor gets to the float first and delays its submittal of the shop drawings, and thereafter, the owner delays its review and approval to the point that it delays the entire project, the owner would be held responsible for the delays to the project.

Under the current practice, total float is clearly based on the “first-come-first-serve” basis and belongs to individual who gets to it first.

Slide 12



**The Current Practice
of Total Float Ownership**

Almost all significant public procurements include contract clauses indicating that *“total float is not for exclusive benefit of any one party to the project.”*


The parties permit the individual who gets to float first to gain its benefits without regard to downstream parties.

12

Almost all significant public procurements include contract clauses providing that the float is not for exclusive benefit of any one party to the project. The parties permit the individual who gets to the float first to gain the benefit of the float.

To mitigate the total float utilization issue and improve the ambiguous interpretation of the total float clauses, the new concept is developed and will be introduced in the next section.

Slide 13



The New Concept: “Equal Ownership of Total Float to the Owner and the Contractor”
- Major Principles

- ◆ *Equal Allocation* of total float to the two contractual parties: owner and contractor.
- ◆ Amount of total float owned by each party known as “*Allowable Total Float*” hereafter called “ATF”
- ◆ Basic Features:
 - Respects the dynamic nature of construction projects.
 - Recognizes that total float is an essential asset for both owner and contractor.
 - Places equal responsibility on each party to mitigate unforeseeable and unanticipated problems that arise during construction.
 - Considers total float an expiring resource.

13

The proposed concept involves allocating an equal amount of total float on the same non-critical path of activities to the two contractual parties, the owner and the contractor. This concept is identified as “*equal allocation*”. This equal allocation of total float must be clearly and expressly stated in specific clauses in the prime contract. Under the new concept, the owner and the contractor each owns one-half of the total float available on any non-critical path activity of the project. The amount of total float owned by each party is called the *Allowable Total Float*.

If either party does not use its Allowable Total Float, the other party has the opportunity, beyond its own Allowable Total Float, to use what float is available. However, under ordinary circumstances, should either party consume total float beyond its allowable amount and such use impacts activities on the critical path and/or extends the project completion date, the delaying party may be held responsible to the other for any resulting delays and/or damages. The allocation of delay responsibilities will be shown in the next section.

This new concept still

respects the dynamic nature of construction projects,

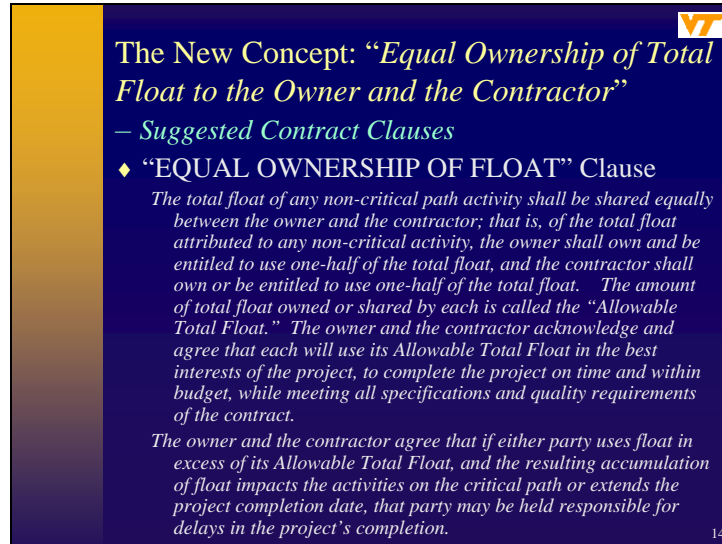
recognizes that “total float” is an essential asset for both the owner and the contractor, and

places equal responsibility on each party to mitigate unforeseeable and unanticipated problems that arise during construction.

4) “total float” retains a feature shared by other theories: it remains an expiring resource. If it is not used within a certain period of time, it simply disappears.

Therefore, the owner and the contractor under this concept must each use Allowable Total Float with care. Each should be aware not just of how much of the total float is being consumed but also whether such an amount will impact activities on the critical path, extend the project completion date, or result in additional costs.

Slide 14



The New Concept: “Equal Ownership of Total Float to the Owner and the Contractor”

– Suggested Contract Clauses

◆ **“EQUAL OWNERSHIP OF FLOAT” Clause**

The total float of any non-critical path activity shall be shared equally between the owner and the contractor; that is, of the total float attributed to any non-critical activity, the owner shall own and be entitled to use one-half of the total float, and the contractor shall own or be entitled to use one-half of the total float. The amount of total float owned or shared by each is called the “Allowable Total Float.” The owner and the contractor acknowledge and agree that each will use its Allowable Total Float in the best interests of the project, to complete the project on time and within budget, while meeting all specifications and quality requirements of the contract.

The owner and the contractor agree that if either party uses float in excess of its Allowable Total Float, and the resulting accumulation of float impacts the activities on the critical path or extends the project completion date, that party may be held responsible for delays in the project’s completion.

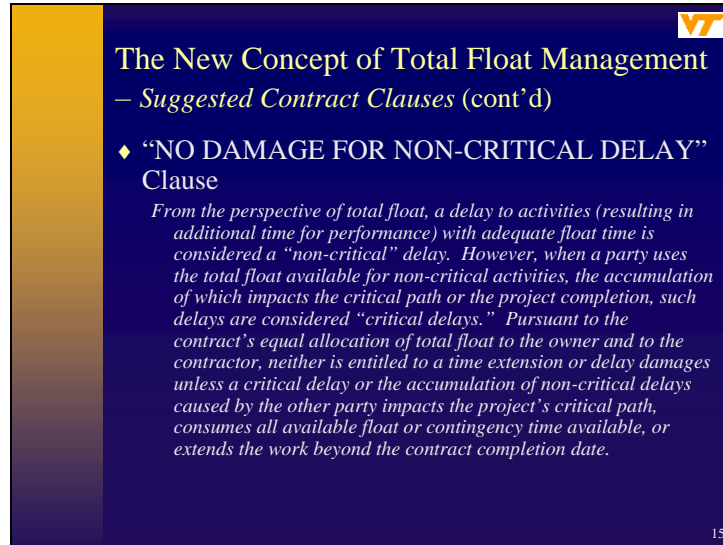
The following two clauses are suggested to be inserted into a contract document if implementing this proposed concept.

“EQUAL OWNERSHIP OF FLOAT” Clause

The total float of any non-critical path activity shall be shared equally between the owner and the contractor; that is, of the total float attributed to any non-critical activity, the owner shall own and be entitled to use one-half of the total float; and the contractor shall own or be entitled to use one-half of the total float. The amount of total float owned or shared by each is called the “Allowable Total Float.” The owner and the contractor acknowledge and agree that each will use its Allowable Total Float in the best interests of the project, to complete the project on time and within budget, while meeting all specifications and quality requirements of the contract.

The owner and the contractor agree that if either party uses float in excess of its Allowable Total Float, and the resulting accumulation of float impacts the activities on the critical path or extends the project completion date, that party may be held responsible for delays in the project’s completion.

Slide 15



The New Concept of Total Float Management
– *Suggested Contract Clauses (cont'd)*

◆ **“NO DAMAGE FOR NON-CRITICAL DELAY” Clause**

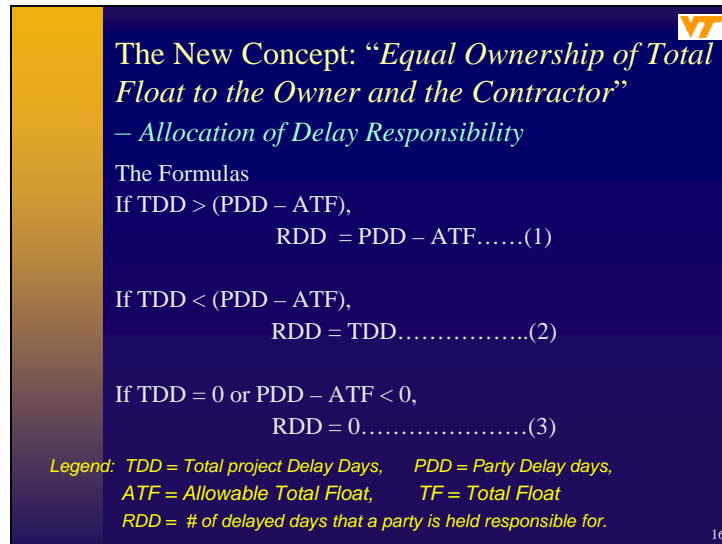
From the perspective of total float, a delay to activities (resulting in additional time for performance) with adequate float time is considered a “non-critical” delay. However, when a party uses the total float available for non-critical activities, the accumulation of which impacts the critical path or the project completion, such delays are considered “critical delays.” Pursuant to the contract’s equal allocation of total float to the owner and to the contractor, neither is entitled to a time extension or delay damages unless a critical delay or the accumulation of non-critical delays caused by the other party impacts the project’s critical path, consumes all available float or contingency time available, or extends the work beyond the contract completion date.

15

“NO DAMAGE FOR NON-CRITICAL DELAY” Clause

From the perspective of total float, a delay to activities (resulting in additional time for performance) with adequate float time is considered a “non-critical” delay. However, when a party uses the total float available for non-critical activities, the accumulation of which impacts the critical path or the project completion, such delays are considered “critical delays.” Pursuant to the contract’s equal allocation of total float to the owner and to the contractor, neither is entitled to a time extension or delay damages unless a critical delay or the accumulation of non-critical delays caused by the other party impacts the project’s critical path, consumes all available float or contingency time available, or extends the work beyond the contract completion date.

Slide 16



The New Concept: “*Equal Ownership of Total Float to the Owner and the Contractor*”
– Allocation of Delay Responsibility

The Formulas

If $TDD > (PDD - ATF)$,
 $RDD = PDD - ATF.....(1)$

If $TDD < (PDD - ATF)$,
 $RDD = TDD.....(2)$

If $TDD = 0$ or $PDD - ATF < 0$,
 $RDD = 0.....(3)$

Legend: *TDD = Total project Delay Days, PDD = Party Delay days,
ATF = Allowable Total Float, TF = Total Float
RDD = # of delayed days that a party is held responsible for.*

Under this new concept, in order to properly allocate the responsibility for delays, the following formulas are developed and recommended:

Formula #1: If $TDD > (PDD - ATF)$, $RDD = PDD - ATF$

If the total number of the days of delay for the entire project is greater than the number of days that a party delays beyond its Allowable Total Float, then that party will be responsible for the difference between its actual days of delay and its Allowable Total Float.

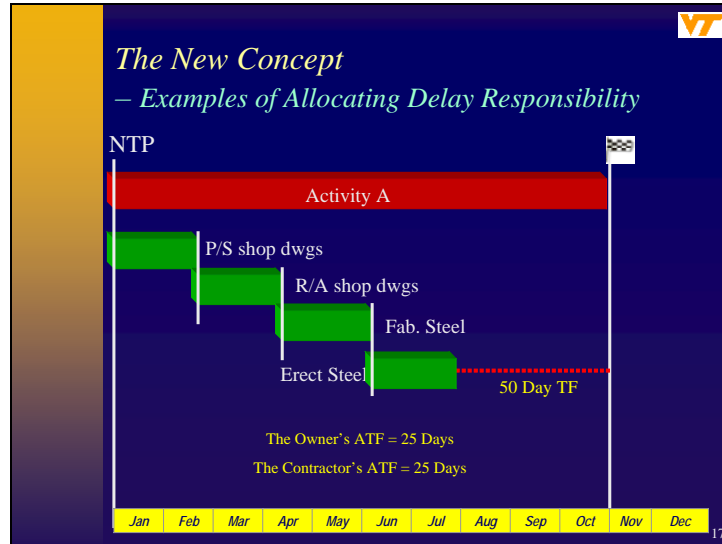
Formula #2: If $TDD < (PDD - ATF)$, $RDD = TDD$

If the total number of days of delay for the entire project is less than the number of days that a party delays beyond its Allowable Total Float, then that party will be responsible for the total number of days of delay to the entire project.

Formula #3: If $TDD = 0$ or $PDD - ATF < 0$, $RDD = 0$

If the total number of days of delay for the entire project is equal to zero or the delaying party uses total float within its own ATF, that party is not responsible for any delay damages to the entire project.

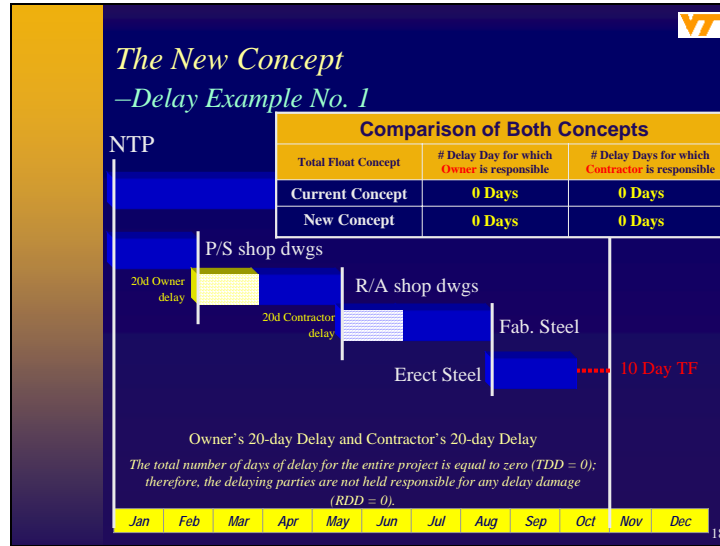
Slide 17



To illustrate the formulas and the allocation of the delay responsibility, the following six factual cases are presented.

The slide shows the baseline schedule of the case example. Activity A is the project critical path. The steel work is a non-critical path activity with 50 days of total float. The steel work consists of four related, interdependent activities: Shop Drawing Submission, Shop Drawing Review and Approval, Steel Fabrication, and Steel Erection. Under the new concept, the total float of 50 days is allocated equally to the owner and to the contractor. In other words, the owner's Allowable Total Float (ATF) is 25 days and the contractor's ATF is 25 days.

Slide 18

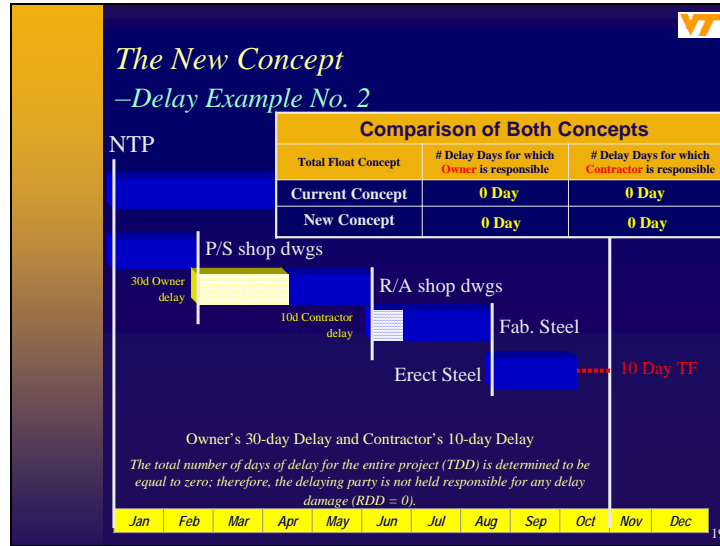


The first case involves two delay events: the owner’s 20-day delay to the review and approval of steel shop drawings and the contractor’s 20-day delay to the steel fabrication. Under this scenario, each consumes total float for the affected activities within its allowable total float. The accumulation of the two parties’ consumptions of total float does not impact the project completion date. The project completion date remains unchanged.

By applying the formula (3) shown previously, the total number of days of delay for the entire project is equal to zero (TDD = 0); therefore, the delaying parties are not held responsible for any delay damage (RDD = 0).

Both the current concept and new concept show the same result that the owner and the contractor are not held responsible for any project delay.

Slide 19



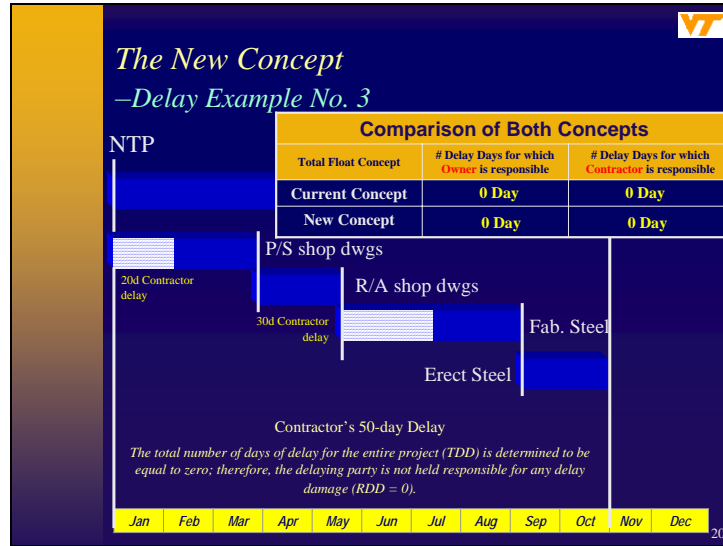
The second case also involves two delay events, but in this case the parties' consumption of total float exceeds the Allowable Total Float allocated to each. First, the owner delays the review and approval of steel shop drawings for 30 days, five days beyond its Allowable Total Float. Subsequent to the owner's delay, the contractor delays the steel fabrication for 10 days, an amount within its allowable total float time.

The accumulation of the two parties' consumptions of total float does not impact the project critical path or extend the project completion date. Similar to the first case, by using the formula (3), the total number of days of delay for the entire project (TDD) is determined to be equal to zero; therefore, the delaying party both the owner and the contractor is not held responsible for any delay damage (RDD = 0).

Under the new concept, the total float is still considered to be free as long as an accumulation of consumption on the affected activity path does not adversely impact the project completion date.

Similar to the current concept, both the owner and contractor are not responsible for any delay.

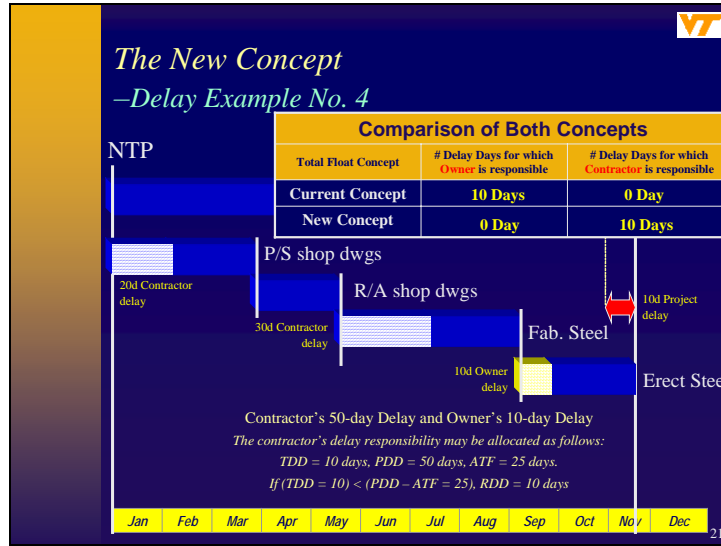
Slide 20



The example No. 3 shows the contractor's two delay events. First, he delays the submission of shop drawings for 20 days; later, he delays the steel fabrication for 30 days. In total, the contractor consumes the total float for 50 days, well beyond the Allowable Total Float of 25 days. The contractor's consumption of total float, however, does not impact the project completion date; therefore, the contractor is not held responsible for any associated delay and/or damages to the project.

Again both parties are not held responsible for any project delay under the two concepts.

Slide 21



The case describes three delay events the accumulation of which does impact the project completion date. The contractor delays the submission of shop drawings for 20 days in the early time frame and later delays the steel fabrication for 30 days. The total number of delay days attributed to the contractor's steel activity equals 50, a full 25 days beyond its ATF.

Subsequent to these events, the owner's actions delay the steel erection for 10 days, which is within its ATF of 25 days. When all three delays are accumulated, the result is a negative impact to the project critical path, which extends the project completion date by 10 days.

By using the previous formulas, the contractor's delay responsibility may be allocated as follows:

TDD = 10 days, PDD = 50 days, ATF = 25 days.

If (TDD = 10) < (PDD - ATF = 25), RDD = 10 days

Thus, the contractor is held responsible for 10 days of delay to the project's completion.

By using the same formulas, the owner's delay responsibility may be allocated as follows:

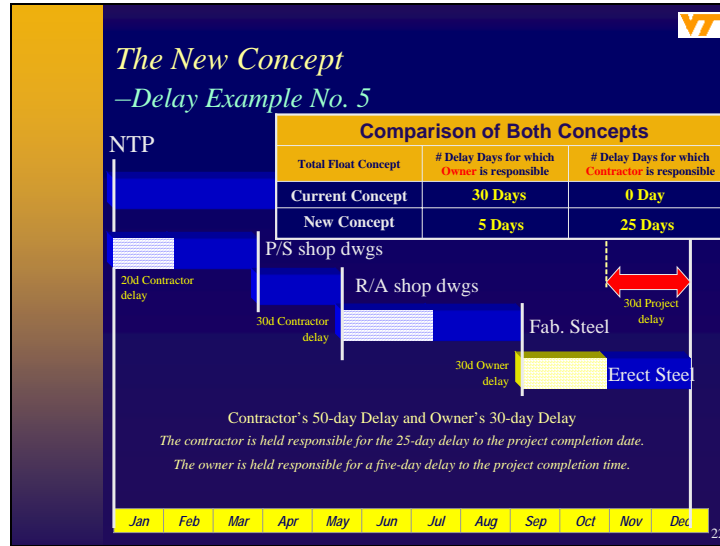
TDD = 10 days, PDD = 10, ATF = 25 days.

If (PDD - ATF = -15) < 0, RDD = 0

Thus, the owner—who has not consumed float beyond the ATF—is not held responsible for the delay to the project's completion time.

But under the current concept, the owner will be held responsible for a 10-day project delay because the owner's delay occurred last or when the steel erection activity had no total float.

Slide 22



This case also describes three delay events, the accumulation of which does impact the project completion date. The contractor delays the submission of shop drawings for 20 days and later delays the steel fabrication for 30 days. The total number of days that the contractor delayed the steel activity equals 50 days, 25 days beyond its Allowable Total Float.

Subsequent to these events, the owner's actions delay the steel erection for 30 days, which exceeds its Allowable Total Float by five days. The accumulation of all three delays results in an adverse impact to the project critical path and extends the project completion date by 30 days.

By using the above formulas, we can determine the allocation of the contractor's delay responsibility, as presented below:

TDD = 30 days, PDD = 50 days, ATF = 25 days.

If (TDD = 30) > (PDD – ATF = 25), RDD = (PDD – ATF) = 25 days

Thus, the contractor is held responsible for the 25-day delay to the project completion date.

The above formulas also indicate the number of delay days for which the owner is responsible:

TDD = 30 days, PDD = 30, ATF = 25 days.

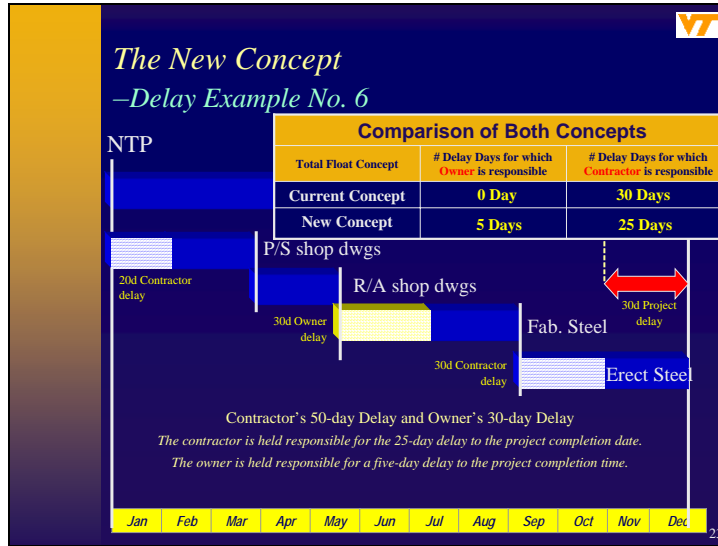
If $TDD > (PDD - ATF)$, $RDD = (PDD - ATF) = 5$ days

Thus, the owner is held responsible for a five-day delay to the project completion time.

In conclusion, under the new concept, the owner is responsible for 5 days of project delay and the contractor is responsible for 25 days of project delay.

However, the owner under the current concept will be held responsible for the 30-day project delay and the contractor is not held responsible for any project delay.

Slide 23



This case involves three delay events, the accumulation of which does impact the project completion date. The contractor delays the submission of shop drawings for 20 days and later delays the steel erection for 30 days. The total number of days that the contractor delayed the steel activity equals 50 days, 25 days beyond its Allowable Total Float.

Subsequent to these events, the owner’s actions delay the steel fabrication for 30 days, which exceeds its Allowable Total Float by five days. The accumulation of all three delays results in an adverse impact to the project critical path and extends the project completion date by 30 days.

By using the above formulas, we can determine the allocation of the contractor’s delay responsibility, as presented below:

TDD = 30 days, PDD = 50 days, ATF = 25 days.

If (TDD = 30) > (PDD – ATF = 25), RDD = (PDD – ATF) = 25 days

Thus, the contractor is held responsible for the 25-day delay to the project completion date.

The above formulas also indicate the number of delay days for which the owner is responsible:

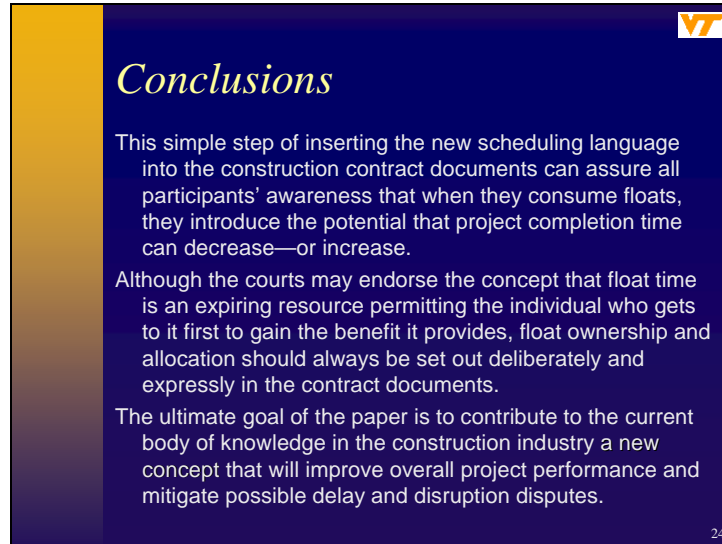
TDD = 30 days, PDD = 30, ATF = 25 days.

If $TDD > (PDD - ATF)$, $RDD = (PDD - ATF) = 5$ days

Thus, the owner is held responsible for a five-day delay to the project completion time.

Under the current concept, because the contractor's delay occurred last while the steel erection activity had 0 day of total float, the contractor will be held responsible for the project delay of 30 days. But the owner in this case is not held responsible for any project delay because the owner's delay occurred while the steel fabrication still had total float.

Slide 24



The slide features a dark blue background with a vertical yellow bar on the left side. In the top right corner, there is a small logo consisting of a white 'V' shape inside a yellow square. The title 'Conclusions' is written in a white, italicized serif font. Below the title, there are three paragraphs of white text. The first paragraph discusses the impact of inserting new scheduling language into construction contracts. The second paragraph discusses the concept of float time as an expiring resource and the importance of explicit contract terms. The third paragraph states the ultimate goal of the paper to contribute to the construction industry's knowledge.

Conclusions

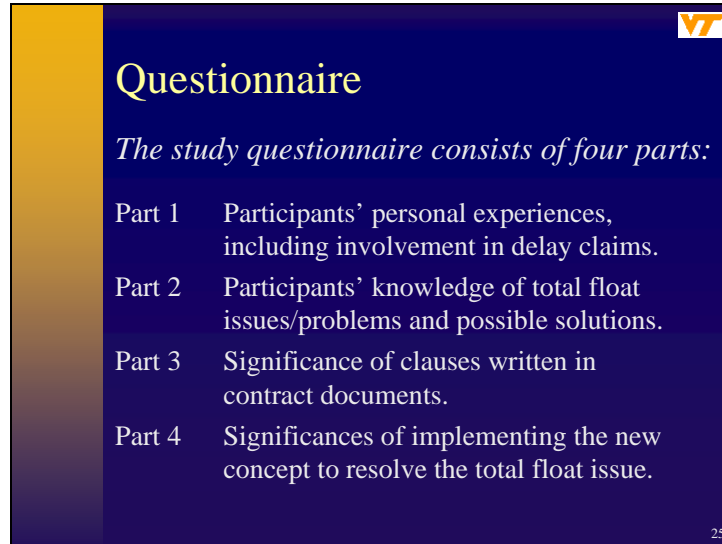
This simple step of inserting the new scheduling language into the construction contract documents can assure all participants' awareness that when they consume floats, they introduce the potential that project completion time can decrease—or increase.

Although the courts may endorse the concept that float time is an expiring resource permitting the individual who gets to it first to gain the benefit it provides, float ownership and allocation should always be set out deliberately and expressly in the contract documents.

The ultimate goal of the paper is to contribute to the current body of knowledge in the construction industry a new concept that will improve overall project performance and mitigate possible delay and disruption disputes.

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Slide 25



Questionnaire

The study questionnaire consists of four parts:

- Part 1 Participants' personal experiences, including involvement in delay claims.
- Part 2 Participants' knowledge of total float issues/problems and possible solutions.
- Part 3 Significance of clauses written in contract documents.
- Part 4 Significances of implementing the new concept to resolve the total float issue.

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Slide 26



Thank you very much for your participation!

This survey is a part of the research study conducted by Apirath Prateapusanond. Reproduction or distribution of this material only allows after receiving written approval from the research team.

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APPENDIX 2

A SAMPLE OF QUESTIONNAIRE



*The Charles E. Via Jr. Department of Civil and Environmental Engineering
Construction Engineering and Management*

Study Questionnaire

“Equal Ownership of Total Float to the Owner and the Contractor” Concept
in a CPM-based Construction Contract

The study is conducted by Apirath Prateapusanond.

Principal Advisor: Prof. Jesus de la Garza

Committee members: Prof. Mike Vorster,

Prof. Jim Lefter,

Prof. Jim Lowe, and

Prof. Julio Martinez

Confidentiality

All responses will be handled in a confidential manner. Completed questionnaires and any accompanying materials will be reviewed and analyzed by the research team at Virginia Tech. The data will be kept confidential unless the originator of the data officially allows the research team to handle the material without concerns for confidentiality. Reproducing the data only allows after receiving written approval from the originator.

General Instruction

Before starting this survey, please review and ensure that you understand completely the proposed concept of “Equal Allocation of Total Float to the Owner and the Contractor,” as introduced in the PowerPoint presentation. The questionnaire consists of four parts; the first part involves personal experiences of participant, the second part involves participant’s knowledge of the total float issue and potential solutions, the third part deals with significance of clauses written in contract documents, and the last part involves significant of implementing the proposed concept to resolve the total float issue.

If you have any questions, or need further clarification on any issue, please contact me via apirath@vt.edu. Please either email the response to apirath@vt.edu or mail it to the following address: Apirath Prateapusanond, Hill International, Inc. 1225 Eye Street, N.W., Suite 601, Washington, DC 20005.

PART 1 – PERSONAL EXPERIENCES OF PARTICIPANT

1. Your name _____
2. Company name _____
3. Your position _____
4. Company address _____

5. Your phone number _____
6. Your email address _____
7. How long have you been in the construction industry?
 0-5 years
 6-10 years
 11-20 years
 Over 20 years
8. Please check the number of years you have been involved in CPM-based construction projects.
 0-5 years
 6-10 years
 11-20 years
 Over 20 years
9. Please check the number of years you have been involved in construction delay analysis.
 0-5 years
 6-10 years
 11-20 years
 Over 20 years
10. What category best describes your expertise in the construction industry? (Check all applicable)
 Scheduler/Scheduling Consultant
 Engineer/Designer/Architect
 Claim/Dispute Consultant
 Construction Lawyer
 College Professors
 Other. Please specify _____
11. Please indicate the number of years you have represented or worked for any owner.
 None
 1-5 years
 6-10 years

- 11-20 years
- Over 20 years

12. Please indicate the number of years you have represented or worked for any contractor.

- None
- 1-5 years
- 6-10 years
- 11-20 years
- Over 20 years

PART 2 – PARTICIPANT’S KNOWLEDGE OF THE TOTAL FLOAT ISSUE AND POTENTIAL SOLUTIONS

13. In your opinion, is total float significant in a CPM schedule?

- Very Significant
- Somewhat Significant
- Significant
- Insignificant
- Somewhat Insignificant
- Very Insignificant

14. Total float utilization and ownership have become significant issues when a delay occurs.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

15. Have you involved in resolving an issue of total float utilization or ownership in any CPM-based construction project?

- Yes
- No

16. Have you ever been involved in analyzing a total float-related delay?

- Yes
- No

17. If your answer to either Q15 or Q16 was *yes*, please describe your involvement and cite court cases as appropriate _____

18. If your answer to either Q15 or Q16 was *yes*, please indicate the party you represented or worked for at the time of the involvement.

- Owner
- Contractor
- Other. Please specify _____

Under current scheduling practices, float time is considered “free” and does not belong to any party in the construction process.

19. Should total float be “free” or “no cost” to any involved party?

- Yes
- No

Please explain _____

20. Should total float belong to the project rather than to any party in the construction process?

- Yes
- No

Please explain _____

21. Should total float belong to the individual who gets to it first?

- Yes
- No

Please explain _____

22. In your opinion, who should own total float?

- Owner
- Contractor
- Project
- Both Owner and Contractor equally
- Other parties. Please indicate _____

Please explain _____

23. Please describe your opinion of the current practice of total float ownership and utilization.

24. Have you in any way thought or heard of a possible solution to resolve the total float ownership issue?

- Yes
- No

If yes, please describe _____

PART 3 — SIGNIFICANCE OF CLAUSES WRITTEN IN CONTRACT DOCUMENTS

25. Have you ever been involved in writing scheduling specifications in construction contracts?

- Yes
- No

If yes, please describe involvement _____

26. In your opinion, how important are schedule clauses written in construction contracts?

- Very Important
- Important
- Not Important
- Don't know

27. When would you refer or review any schedule clauses written in a construction contract?

- Never.
- Only when a problem occurs.
- Only before performing any work.
- At all times during performance of the work.
- At other times. Please explain _____

28. Have you ever been involved in a construction contract that includes a clause regarding total float ownership or utilization?

- Yes
- No
- Don't know

If yes, please specify _____

29. A clause involving total float ownership and utilization is of sufficient importance to be written in a construction contract.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

PART 4 – SIGNIFICANCE OF IMPLEMENTING THE PROPOSED CONCEPT TO RESOLVE THE TOTAL FLOAT ISSUE

The following questions are meant to validate or evaluate the proposed concept of “*equal ownership of total float to the owner and the contractor.*” Before beginning this section, it is essential that you understand clearly the proposed concept.

30. The proposed concept can significantly reduce the utilization of total float by owners and their representatives.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

31. The proposed concept can significantly reduce the utilization of total float by contractors and their representatives.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

32. The proposed concept can significantly resolve the total float ownership issue.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

33. The proposed concept can significantly increase awareness that float consumption can play a role in creating potential project delays.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

34. The proposed concept can significantly mitigate delay and disruption disputes caused by the owner or the contractor.

- Very Strongly Agree
- Strongly Agree
- Agree
- Disagree
- Strongly Disagree
- Very Strongly Disagree

35. Ultimately, the proposed concept can significantly improve project performance.
- Very Strongly Agree
 - Strongly Agree
 - Agree
 - Disagree
 - Strongly Disagree
 - Very Strongly Disagree
36. Does the proposed concept appear easy to implement?
- Very Easy
 - Somewhat Easy
 - Easy
 - Somewhat Difficult
 - Very Difficult
37. Does the proposed concept appear costly to implement?
- Very Costly
 - Somewhat Costly
 - Costly
 - Not Costly
 - No Cost
38. The proposed concept fairly allocates total float to an owner.
- Very Strongly Agree
 - Strongly Agree
 - Agree
 - Disagree
 - Strongly Disagree
 - Very Strongly Disagree
39. The proposed concept fairly allocates total float to a contractor.
- Very Strongly Agree
 - Strongly Agree
 - Agree
 - Disagree
 - Strongly Disagree
 - Very Strongly Disagree
40. Overall, would you implement the proposed concept of “*equal ownership of total float to the owner and the contractor*”?
- Definitely yes
 - Probably yes
 - Might or might not
 - Probably not
 - Definitely not
41. Would you recommend the proposed concept of “*equal ownership of total float to the owner and the contractor*” to others?

- Definitely yes
- Probably yes
- Might or might not
- Probably not
- Definitely not

42. Please briefly describe any barrier(s) you believe could affect implementation of this concept.

43. Please briefly describe any potential limitations of the proposed concept.

44. Please provide any suggestions or comments to enhance the proposed concept.

APPENDIX 3

A DETAILED RESULT OF THE DELPHI SURVEY

Respondent #	Criteria #1						Criteria #2						Criteria #3																
	Q33 Significance in Increasing Awareness of Float Consumption						Q38 Significance in fairly allocating total float to an owner						Q39 Significance in fairly allocating total float to a contractor						Q30 Significance in Reducing the Utilization of Total Float by Owners						Q31 Significance in Reducing the Utilization of Total Float by Contractors				
	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree					
1	1								1						1						1								
2			1						1							1							1						
3			1					1						1							1								
4		1							1						1						1								
5		1						1							1						1								
6						1						1												1					
7				1																									
8			1						1						1									1					
9		1						1						1										1					
10		1							1						1									1					
11		1							1						1									1					
12		1					1						1								1								
13		1						1						1							1								
14		1						1						1								1							
15		1							1						1									1					
16			1						1						1									1					
17		1							1						1									1					
18					1					1							1							1					
19	1								1				1						1										
20				1					1					1										1					
Total	2	10	4	2	1	1	1	4	5	7	1	1	1	4	5	7	1	1	1	1	2	7	8	1					

Table A: Survey Results of Each Panel Member for Criteria 1 - 3

Respondent #	Criteria #4						Criteria #5						Criteria #6						Criteria #7					Criteria #8					
	Q32 Significance in Resolving Total Float Ownership Issue						Q34 Significance in Mitigating Delay and Disruption Disputes						Q35 Significance in Improving Project Performance						Q36 Ease of Implementation					Q37 Cost of Implementation					
	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Strongly Agree	Strongly Agree	Agree	Disagree	Strongly Disagree	Very Strongly Disagree	Very Easy	Somewhat Easy	Easy	Somewhat Difficult	Very Difficult	No Cost	Not Costly	Costly	Somewhat Costly	Very Costly	
1			1						1						1					1					1				
2				1						1						1							1			1			
3			1						1						1					1					1				
4			1								1				1							1			1				
5			1						1						1								1			1			
6						1						1						1					1						1
7			1								1				1														
8					1						1					1						1			1				
9				1							1					1					1				1				
10		1									1					1				1				1					
11				1					1							1						1			1				
12		1										1				1			1					1					
13			1								1					1				1				1					
14		1						1							1					1				1					
15				1							1					1					1					1			
16			1						1						1							1			1				
17			1						1						1							1					1		
18					1						1						1				1							1	
19			1						1					1													1		
20				1							1					1							1						1
Total	0	3	9	5	2	1	0	2	6	8	3	1	0	1	8	9	1	1	1	1	5	3	5	4	1	10	3	2	3

Table B: Survey Results of Each Panel Member for Criteria 4 – 8

VITA

APIRATH PRATEAPUSANOND

Apirath Prateapusanond was born in Thailand on October 6, 1969, a daughter of Chanvit and Sompis Phanasantiphap. Apirath got married with Dr. Akraej Prateapusanond in August 1997 and had one daughter born in Washington, D.C. in February 2002.

She attended the Aubsornsawan School, Bangkok in 1987. She got a Bachelor of Business Administration majoring in Industrial Management from the faculty of Accountancy and Commerce from Thammasat University in February 1992. After the graduation, she worked as an assistant managing director for S.P. Electric Industry, a power transformer and ballast company for one year.

In May 1995, Apirath received her Master of Science degree in Operations Research from George Washington University, Washington, D.C. In December 1997, she also got her Master of General Administration degree in marketing management from University of Maryland University College, College Park, Maryland. After the graduation, she worked as a technician of a construction claim group for Hill International, Inc. which is a construction management consulting firm specializing in construction dispute analysis and resolution.

Apirath is now a construction claim consultant for Hill International, Inc. She has performed delay and cost overrun analysis, construction and/or design issue analysis, and graphic presentation developments in order to support dispute resolutions and litigations. Her highlighted construction claim experiences include such projects as Bank One Ballpark, Enron Power Plant, GSA Courthouse and Office Buildings, and the Big Dig Underground Expressway Project in Boston. During her employment at Hill International in August 1999, she continued to pursue the doctoral degree in Civil Engineering with a major in Construction Engineering and Management at Virginia Tech.

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