CHAPTER I

INTRODUCTION

Project management has undergone considerable refinement with the development of network-based scheduling systems. As long as projects remained relatively small, and the interdependency of activities was minor, the well known Gantt charting techniques were sufficient. In fact, in many cases a project was controlled entirely on a manager's intuition. However, only a limited amount of information can be retained and processed by any one manager, and when the needs for better management techniques become so acute as to hinder the desired goals then managers and scholars began to pursue a body of knowledge commonly termed management science.

Now the science of materials and physical systems has progressed at a rapid rate bringing about this atmosphere which makes the undertaking of large projects both desirable and feasible. However, the area of project management has lagged far behind in development and is still being excelled by the pure and applied science areas. Here the old fact seems to emerge in that technological and engineering problems are confronted more readily than human oriented ones. But the emphasis is slowly changing and is bringing about a transition in management from that of an act to a science.

The transportability concept of applying a technique developed in one field to a problem in a new field has given the manager many new tools to better control and schedule large projects. The network-based scheduling system has a counterpart in signal flow graph theory which is used to analyze electrical networks. The concepts of randomness, estimation, and probabilistic planning are all based on theory well-known to the mathematical statistician. In this instance, the work done herein also relies heavily on the transportability concept by formulating a particular scheduling problem such that it can be solved by mathematical programming.

It is not proposed that the work to follow will solve all of the problems of a project manager. Indeed this work is limited to one particular problem frequently encountered in project scheduling. From the initial estimates for activity times, the total project duration can be determined. If this project duration is too long due to contractual or technological reasons, then time must be shortened or compressed in some optimum manner. The problem reduces to one of buying time along the critical path(s) at minimum cost.

The techniques presently available assure an optimum schedule only if the time-cost relationships are linear or piece-wise linear for each activity. However, it is recognized that indeed these trade-off curves are non-linear and are usually convex to the origin [1], [12], [21], [33]*. The problem confronted herein is that of developing a method which assures the project manager of an optimum schedule for any project duration where the activity trade-off functions are convex to the origin.

This work specifically contains a comprehensive review of the literature in Chapter II. This review covers the significant developments in network-based scheduling systems from their origin to their present day status. Chapter III is concerned with formulating a mathematical model for an activity time-cost trade-off function. It is shown that the trade-off functions are generally non-linear in nature, and one particular curve form is developed. Then the next two chapters are concerned with the development of the mathematical algorithm. Although the curve form as developed in Chapter III is frequently utilized, it should be noted that the algorithm is general in nature and the theory applies to any convex trade-off function. Indeed in Chapter V where the steps of the algorithm are documented there is no mention of a particular curve form.

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*Bracketed [ ] numbers are keyed to the publications contained in the section entitled REFERENCES.