ABSTRACT

In a **Resource Constrained Project Scheduling Problem** (RCPSP), we are given a set of *activities* partially ordered by precedence constraints. An activity has a pre-specified non-negative duration and makes use of different types of renewable resources. The resource requirements of individual activities and the total resource availabilities are specified in advance. A unit of resource cannot be shared by two activities. An activity can be scheduled only when all its predecessor activities are completed and the necessary resources are free and can be allocated to it. Once started an activity is not interrupted and runs to completion. The objective is to assign start times to activities to minimize the makespan.

This problem can be generalized to accommodate other situations encountered in real life. Constraints can be imposed on the maximum number of activities that can be scheduled in parallel. Non-zero ready times and duedates can be assigned to activities, and the resource availabilities can be made to vary with time. Other objectives can be imposed, such as minimization of mean flow time, maximization of Net Present Value (NPV), and minimization of earliness-tardiness penalties. Some of these performance measures are regular, while others are non-regular. In the NPV maximization problem, cash inflows and outflows occur during the execution of activities. These are discounted to the start of the project and summed; the total sum of the discounted values must be maximized. In the minimization of earliness-tardiness penalties, an activity has a pre-specified delivery time, and a penalty is imposed on an activity if it is early or tardy; it is the sum total of these penalties that must be minimized.

This thesis aims to present exact and approximate solution methods that solve problems of the above types. The exact solution methods employ best-first and breadth-first tree search schemes. The details of the method vary depending on which performance measure is being optimized. Theoretical proofs of optimality are provided for many of the schemes. The algorithms have been extensively tested on standard benchmark problems and on problem instances derived from standard benchmark problems (in those cases where standard benchmark problems were unavailable). Experiments have been performed on a Pentium II PC, an RS 6000 workstation and a DEC-Alpha workstation. The solution methods described here generally performed as well as or better than the best existing methods. Our algorithm for the minimization of earliness-tardiness penalties in the presence of precedence and resource constraints makes use of a totally new approach and appears to be the first algorithm to address the problem satisfactorily.