Resource Allocation and Planning in Single and Multi-Project Environments

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ABSTRACT

IT projects often fail to be completed on time, on budget, within scope, with the required functionality and error free. The reasons for project failure are numerous and have been well studied and identified in the literature; however, most studies assume that project managers are completely devoted to the execution of the project and disregard any time wasting efforts that keep them from these duties. One such duty is the assignment and tracking of personnel to tasks within a project. As workers become over-allocated, the PM must redirect his or her efforts to balancing the overall schedule. This task is often performed manually causing PMs to spend much of their time attending to the details of the schedule instead of dealing with the issues critical to the project. The author describes here software that optimizes the schedule when resources are limited and describe its use in both single and multiple project environments.

KEYWORDS
Multiple Project Environments, Optimization, Project Management, Resource Allocation, Single Project Environments

INTRODUCTION

Software applications are developed by following a general project management paradigm specified by the Project Management Institute (PMI) and further refined by academics and practitioners within the MIS discipline (Lagerström, et al., 2012; Dennis, et al., 2012). This approach is used to improve the chances of success and to protect a firm’s investment in the development process (Marchewka, 2009). Despite this reliance on a highly structured methodology, it is often the case that IT projects fail, sometimes to the tune of hundreds of millions of dollars (cf. e.g., Nelson, 2007). While there are a number of reasons why IT projects fail, most failures are the result of people and process problems (Kappelman, et al., 2006; Nelson, 2007). At the top of the causal chain for these problems is project scheduling (Ropponen & Lyytinen, 2000). Scheduling involves assigning resources to sets of tasks that must be accomplished in a specific sequence. The number of resources that can be assigned is limited by the number available and this constraint complicates the scheduling process. This has come to be known as the Resource-Constrained Project Scheduling Problem (RCPSP) and has been the subject of a number of studies in the past 40 years (cf., e.g., Demeulemeester & Herroelen, 1997).

IT Projects are considered failures if they don’t work, don’t work correctly, are significantly over budget or are significantly late. In recent years despite extensive research and sophisticated project management software, projects continue to fail due to schedule and budget overruns (Herroelen & Leus, 2005). Data from the Standish Group’s Chaos report shows that the average percentage of projects that are considered as either a failure or challenged to be 71% from 2011 through 2015 (Standish Group,
Such abysmal performance has prompted additional research into the reasons for both failure (cf. e.g., Kappleman, et al., 2006) and success (cf. Herroelen & Leus, 2005). Successful projects have good user involvement, support from managers, clear requirements and proper planning, and there is general agreement in the literature that technical problems are almost never the cause of IT project failure (Kappleman, et al., 2006). The clear majority of unsuccessful projects occurs because of either process or people mistakes (Nelson, 2007). In fact, Nelson (2007) identified poor estimation and/or scheduling as the primary reason for failure in 54% of the 99 projects in his study.

That poor scheduling ranks so highly among the causes of failure seems to be an odd result for two reasons. First, information technology development is all about creating leading edge software. One would therefore think that IT workers could apply this technology to their own discipline and use it to correct such problems with scheduling, yet there doesn’t seem to be such an ongoing effort. In defense of the IT discipline, however, project management is more than applying algorithms in a computer program, and so the fact that IT has not come up with effective solutions is not so surprising. Second, the amount of research that has been devoted to devising optimal scheduling methods has been vast and great strides have been made; however much of that work has not yet made its way into practice (Herroelen, 2005). The intractability of the problem seems to be what draws researchers, but on the other hand it is what continues to elude practitioners.

Assigning resources efficiently and effectively can be accomplished in one of two ways, depending on the project type. The first type refers to projects whose duration is fixed and that utilize non-renewable or consumable resources, resource leveling is done (Son & Skibniewski, 1999) to minimize the variation of resources throughout the life of the project (Ranjibar, 2013; He & Zhang, 2013). The goal is to consume the resources evenly during the project. The second type refers to projects whose goal is to minimize the project duration (makespan) subject to the constraints imposed by the sequence of activities (the technical sequence) and the number of renewable resources (Herroelen, 2005). In this type of project, resources are allocated to tasks through a scheduling process, and any resource allocation decisions are made to support the goal of minimizing the makespan. Because IT development projects fall into the second category, this study focuses solely on the resource allocation problem. Resource allocation can be especially troublesome in multi-project environments.

Researchers have approached this problem in several different ways, but the problem is classified as a resource constrained project scheduling problem (RCPSP) whose objective is to find that sequence of tasks for which a project will be completed in the shortest possible time, or minimizing the makespan. Approaches that have been developed to improve and/or optimize scheduling include bounded enumeration (e.g., Davis & Heidorn, 1971), dynamic programming (e.g., Jeng & Lin, 2004) and linear programming (e.g., Stinson, et al., 1978). More recent research has uncovered some more creative methods, such as genetic algorithms (Besikci, et al., 2015, Afşhar-Nadjafi, et al., 2013, Debels & Vanhoucke, 2007, Alcarz, et al., 2003), evolutionary programming (Sebt, et al., 2013) and artificial learning agents, such as ant colony optimization (Mokhtari, et al., 2011, Wauters, et al., 2011).

While there is no clear explanation for continued high rates of failure due to scheduling, many researchers have identified several problem areas. Hashim and Chileshe (2012) found a total of 22 areas in the literature that were considered major challenges in a multi-project environment. Although their study was aimed at the construction industry, much of what they found overlaps with almost any kind of project. They classified the areas broadly into three major groups, inputs, processes and outputs. Some common problems within these groups include human resource allocation and availability, competition among projects, the lack of information sharing and the distraction of side projects that may not contribute to organizational success (Hashim & Chileshe, 2012).

Other causes of project failure may include a gap between research and practice such that the techniques devised by researchers are not widely adopted (Herroelen, 2005). This may result from
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