Reduced Project Duration & Improved Critical Resource Determination via Intelligent Scheduling: Navy and Other Applications

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Abstract

In complex production and maintenance environments, such as ship production, the method of allocating resources and managing other constraints significantly affects the efficiency of progress as well as the overall project duration. Resources include human resources, equipment resources and physical-space resources. Human resources alone can be quite complex; for example, tasks may require multiple individuals, each may need to have certain occupations (such as a mechanic), and there may be additional requirements for some or all the individuals to have additional specific skills/certifications. Add to this the limitation of equipment (e.g., cranes) and the complexity only grows. In ship production and maintenance, physical space is often a limiting resource; for example, when conducting submarine maintenance, physical-space limitations are common, as well as the physical-space limitation of submarine ingress and egress. As if these considerations were not complex enough, other constraints are usually present, such as constraints on certain types of work (e.g., hot work), when other conditions are in effect.

Due to the inherent complexity of resource allocation and constraint management for such complex production and maintenance environments, the project durations can be two-times, or more, longer than needed. Mathematically, the resource-constrained scheduling problem can be shown to be very complex, and for projects of any realistic size the globally-optimum solution cannot be guaranteed in less than geological time even on the fastest computers. Therefore, many branches of science and engineering from operations research to artificial intelligence have developed techniques to find relatively optimum solutions in realistic timeframes. Unfortunately, most commercial project management software does not benefit from such intelligent scheduling technology.

Software that does not leverage intelligent scheduling may also determine incorrect *critical resources*. A resource is critical if the project duration would be shorter if more of that resource were available. That is, one project management software might indicate that more of resource x is needed if the project duration is to be shortened, while a more intelligent scheduler might not only reveal a shorter schedule but may determine that resource x is not critical (although some other resource(s) is/are). So not using intelligent scheduling will result in longer than necessary schedules and might direct users in the wrong direction per critical resources, thus leading to wasteful acquisition of more resources to shorten the schedule when this is an option.

This paper shows that the scheduling method used affects the project duration even for relatively small projects consisting of a few dozen tasks, and the effect becomes more pronounced as the number of tasks grows and number of types and quantity of resources expand. Some of the literature on this topic reviewing different techniques and results, which reveals the major difference in schedule

duration due to the scheduling method, is also reviewed. Many lessons will be drawn from Stottler Henke's own work in this area. Since the early 1990s, Stottler Henke has been working with NASA, Boeing, the US Navy and other companies to develop intelligent scheduling technologies and software using artificial intelligence and other techniques. Lessons learned from experience at the Naval Submarine Support Facility (NSSF) and at Boeing per the manufacture of the B787 Dreamliner are provided. Without adding one extra resource, an entire project can be shortened significantly; therefore the application of more-efficient resource allocation and constraint management methods can improve the planning & production process, enhancing the productivity of ship production.