

resources are delayed until ongoing tasks are completed and the required resources are freed-up for use. If this increases the project duration, the change will be visible on the project's Gantt chart or network as it was when the videotape project client was not available while on vacation. (See Figures 6-3, 6-4, and 6-9.) No matter what priority rule is used, the project's technology always takes precedence.

Some Comments about Constrained Resources

Every time a project falls behind schedule, the PM is apt to plead for more resources. In spite of the PM's complaints about the scarcity of resources, serious cases of resource scarcity rarely apply to resources in general, but rather to one or two very specific resources. We call such resources "Walts." The term was derived from the name of an individual, Walter A., who is employed by a large insurance company. Walt is a specialist in the rules and laws affecting insurance policies for certain types of casualty losses in the firm's commercial lines of business. He has an excellent analytical mind and many years of experience. His knowledge is required when designing new policies in this area of risk. The firm has only one Walt, and while the firm is training others, such training takes years. Walt is a true scarce resource. Projects requiring Walt's input are scheduled around his availability.

There are many other examples. Military combat missions may be scheduled around the availability of attack aircraft. Construction projects may be scheduled around the availability of a large crane. A Broadway opening may be scheduled around the availability of a star actress. The key problem to be solved is deciding which activities get the scarce resource and in what order.

Some Priority Rules

There are many possible rules for assigning preference to some activities over others when allocating scarce resources. Most popular project management software packages have a limited number of rules that can be automatically applied to level overallocated resources so many of the priority rules for assigning scarce resources to activities may have to be applied manually. Fortunately, as we will see, this is not as difficult as it might seem. Several of the most commonly used rules are as follows:

As soon as possible—This is the standard rule in scheduling. Activities are scheduled to start on their ESTs, and resources are made available with that in mind.

As late as possible—With this rule, resources are made available so that activities start on their LSTs whenever possible without increasing the project's duration. This may seem irrational, but it preserves the firm's resources and delays cash outflows as long as possible. This rule is also compatible with Eliyahu Goldratt's contention that the "student syndrome" leads workers to delay starting an activity until the last possible moment (Goldratt, 1997, Ch. 13).

Shortest task duration first—Always consistent with technological precedences, shorter tasks are given priority over longer tasks. This rule maximizes the number of tasks that can be completed by a system in a given time period.

Minimum slack first—Tasks are supplied with resources in inverse order of their slacks. This rule usually minimizes the number of late activities.

Most critical followers—The number of successors on the critical path(s) for each activity is counted. Activities with a higher number of critical successors take precedence. The rationale here is that such activities would cause the greatest damage to the desired project schedule if they are late.

Most successors—The same as the previous rule except that all successors are counted. This rule has the same rationale as the preceding rule.

Most resources first—With this rule, the greater the use of a specific resource on a task, the higher the task's priority for the resource. This rule is based on the assumption that more important activities have a greater demand for scarce resources.

In addition to these rules, there are many others. For example, it may be company policy to put favored customers' projects at the head of the resource line—or to reserve special resources for such clients by withholding them from the available supply. The same type of favoritism is sometimes shown to specific projects of high value to the parent firm. (Some firms show favoritism to specific high-value *activities*, but this rule makes little sense because *all* activities of an individual project must be completed to finish the project.) Application of a value measure for allocating scarce resources across several projects is both rational and common.

There are many other priority rules that might be used, but most project management software packages recognize only a few; however, assigning scarce resources manually is not difficult. From our earlier example, recall Figure 6-5, in which all tasks requiring the scriptwriter were listed alone on a Gantt chart showing the task duration, scheduled start, scheduled finish, activity slack, and other needed information. The scheduled start dates would allow us to apply either the early or late start rules. Information on activity slack allows us to use the minimum slack rule. Task duration is the necessary input to apply the Shortest Task Duration rule. The project network, Gantt chart, and the task list all allow a simple count of followers, critical or not. MSP and most other project management software allow verbal or numeric priorities to be assigned easily. This allows the use of any priority system required.

Considerable research has been done on these rules* and the minimum slack rule is usually best or second best. It rarely performs poorly. If a high-slack task is not given resources in one period, its slack is automatically decreased and in the next period it has a better chance of receiving resources. The resource allocation is repeated periodically (hourly, daily, weekly, or monthly, etc.), depending on the time frame of the project's activities. If a task becomes critical, that is, all the slack is used up before the activity receives resources, the project will be delayed. We will consider borrowing resources from ongoing tasks when we discuss the allocation of scarce resources among several projects.

When a resource is overallocated, MSP can level resource usage by adopting a variety of priority rules, including available activity slack. If there is insufficient slack, other priority rules may be used to allocate the scarce resource. Most of the priority rules originated as job shop scheduling rules. The minimum slack rule usually works best. Only a few critical resources are actually scarce in the sense that project schedules must be adjusted to resource availability.

6.5 ALLOCATING SCARCE RESOURCES TO SEVERAL PROJECTS

When the problem of allocating scarce resources is extended to the case when several projects are being carried out concurrently, the size and complexity of the problem increase but the nature of the underlying problem remains the same. The projects might be independent or members of one large superproject. In any case, there is a decided advantage if several projects are joined as a set.

*Kurtulus and Davis (1982) and Kurtulus and Narula (1985) in two excellent research papers extended the earlier work of Fendley. They tested many more priority rules than can be covered here.