Unit 4 Estimation Process and Aligning Resources for a Project

Learning Outcomes

By the end of this unit the learner will be able to:

- ✓ Estimate task durations and determine project duration
- ✓ Construct a network diagram
- ✓ Calculate the critical path of a project

Unit 4

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Estimating Activity Durations

Estimating Tips and Techniques

There are various types of estimating techniques that you can use, depending on the stages of, and information you have, for a given project. For example, you might have just completed your work breakdown structure when your boss asks you for a project cost estimate. Depending on how quickly the turnaround requirement is for the number, this could be a good or fair estimate. Or, your boss may ask you how long it would take to complete a project similar to one you worked on last year. In either case, the type and quality of the estimate you provide is directly related to the information you have and are able to receive.

The main thing to remember when putting together an estimate, regardless of how preliminary, is to list all assumptions and factors that you considered. Listing your assumptions and factors lets the reviewer know what your calculations were based on, and also provides a base for estimate comparison.

Sample Spreadsheet

Below is a sample assumption and constraints spreadsheet.

Assumptions and Constraints			
Project		Project #	
Project manager		Sponsor	0
Project artifacts		Updated	

ID	Description	Comments	Type	Status	Date Entered
1					
2					
3					
4					
5					
6					

Gathering Resources

Estimating is not exact; it is a guess. If you or someone on your project team has completed a similar task before, then you should have a better idea of how long it will take to complete the task. It does not, however, guarantee that the estimate will be exact. However, if the project is new, you might have trouble finding someone who can advise you on how long a task will take to complete.

The more people who help you estimate, the better. This will allow you to generate an average expected completion time for tasks. Asking three different people for the time per activity is one way to get a good average.

As the project progresses, be sure to maintain a log of actual completion times for each task. This will enable results to be used as reference on future projects. Also, make special notes on where your estimations were well under and over.

Activity List

Once you know all of the activities involved with a task, you are able to estimate how long it will take to complete the activities, and thus roll up the estimation to the event level.

Since the WBS determines the unit
by which you will provide estimates (months, days, hours, or minutes), be consistent when assigning durations to activities. All activities should have the same time unit.

Resources

There are three types of resources that you can have on your project team: full-time, part-time and consultant.

- Full-time resources can be internal or external to your business and are dedicated toyour project and at your disposal 100% of thetime.
- Part-time resources are internal or external people who have full-time jobs, but are taking on project work in addition to their daily responsibilities. They are the resources who make up the majority of project teams.
- Consultants are specialists who are brought in for their expertise on specific projects and subject matter. Depending on the contract you have with them, they can be either full- or part-time resources.

Resource availability needs to factor into your estimates. For example, let's say that a software investigation is estimated to take five days to complete and your software expert is only available 50% of the time. Although the full-time employee could complete the task in one week (five consecutive days), the part-time resource needs two weeks (ten consecutive days) to complete the same task. The actual time it takes to complete the task hasn't changed, but the overall elapsed time is twice as long.

As a general rule, resources underestimate activity durations. They tend to overlook factors such as sick time, vacation, and personal fatigue and delay (PFD) when providing duration estimates. Although someone may be at work for eight hours a day, when considering PFD (washroom breaks, personal breaks, mealtimes, and fatigue), they are only truly available for about 6.8 hours a day (8 hours - (8 hours*15%) = 6.8 hours). Keep this in mind when estimating task durations.

Tips for Increasing Estimation Accuracy

Document all of the assumptions and factors that went into creating the estimate. This will allow anyone who views the estimate to be aware of how the number was reached and provides a baseline for the estimate.

If the project is large, complex, or completely new, ensure you allow ample time up front for requirements gathering and the estimating process. If there are no experts whom you can ask for help, you will be stuck figuring it out on your own, so allow enough time to work through these stages.

Set up contingency plans for critical path items, unanticipated events, and risk. The more you know about potential risks that can affect critical path items, the better. This will help you manage your timelines and estimates up front. (We'll talk about these kinds of events later on in the course.)

Involve as many people as you can in estimating activity durations. Between you, experts, and your resource team, everyone should be happy with and agree upon the time it takes to complete the activities. The more people involved in the estimating process, the more accurate your estimates will be.

Create an activity list from the WBS and follow it. Once the WBS is complete, and the project is disaggregated into manageable chunks, you can create an activity list that describes each of the tasks that need to be completed during the project. The activity list should include all of the required activities, assumptions, restrictions for each activity, along with the assigned resource. The WBS activity list encompasses the scope of your project and will ensure all tasks are included on the project schedule.

Be aware that people often underestimate activity durations. Underestimation isn't done intentionally; people just tend to think it will take less time to complete their tasks than it actually does.

Track actual completion times for all projects and tasks. This will allow you to see how accurate your estimates are, and will prove to be an invaluable resource if a similar project arises again.

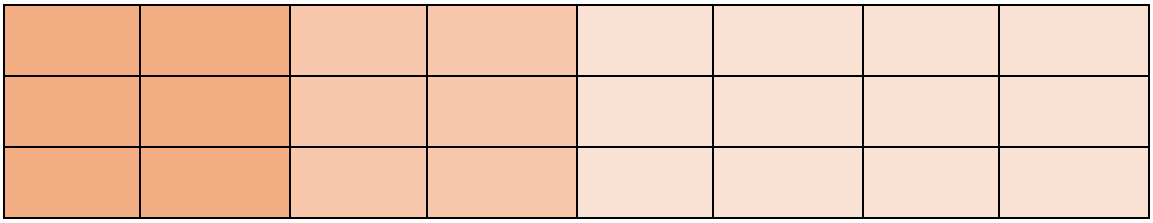
Be aware of the time of year during which your project will be carried out. From illnesses during back-to-school and Christmas vacation, to summer vacations, there are certain times every year that will almost guarantee resources will be out of the office and unavailable to you. Make sure you pay attention to this and that your estimates reflect the seasonal highs and lows of your resource pool.

If **training** is a prerequisite for learning appropriate project skills, be sure to include the time for training in your task estimate.

Camping Case Study

Fill out the chart in below with the work breakdown structure a camping trip. Then, go through each task and assign durations (in hours) to each activity. Finally, roll up the activity durations to the event level and then to the project level.

Level 1		Level 2		Level 3		Level 4	
Task	**Duration**	**Task**	**Duration**	**Task**	**Duration**	**Task**	**Duration**



Identifying Task Dependencies

About Task Dependencies
At this point in the creation of the project schedule, we know what activities need to be completed to carry out the project, and we've established how long it will take to complete each activity or task. The next piece we need to understand is the order (or sequence) in which activities are to be completed. Tasks cannot be completed independently of one another; they often need to be completed with, before, or after other tasks. This linking of tasks creates what are called **task dependencies**.

Think about the project of washing a car. Four tasks that are usually associated with washing a car are:

1. Close window and doors on car
2. Turn on hose
3. Wash with soap
4. Rinse off soap

Task 1 needs to be complete before Task 2 can start, and Task 4 can't start until Task 3 is finished. This example illustrates that all projects have task dependencies, even if the dependencies are intuitive. Similar to the example just described, workplace projects have tasks that are dependent on one another.

In order to establish the interrelationships between tasks, here are a few helpful questions you can ask yourself:

- What precedes this task? (What other tasks must be completed before this one can get started?)
- What tasks follow this task? (What tasks can't be started until this task is done?)
- What tasks can take place concurrently with or in parallel to this one? (What tasks can be worked on while this is being completed?)

Dependency Definitions
A **predecessor** is a task/activity that precedes another task/activity. (A must be complete before B can begin, thus A is a predecessor to B.)

A **successor** is a task/activity that must follow another task/activity. (In the example above, B is a successor to A.)

Series tasks are tasks that happen one after the other. (For example, you get engaged before you get married.)

Parallel tasks are tasks that can happen simultaneously. (For example, you can research vendors for a software solution at the same time as you are working to determine your budget.)

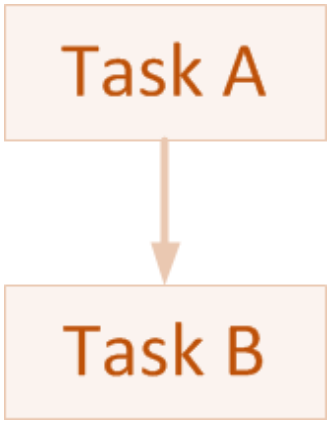
Sequencing is the order in which activities are to be carried out. It considers predecessors, successors, series, and parallel tasks.

Lead time is when one task gets a head start. (For example, a new server is required for a software project that is about to start. The project manager knows it will take three weeks for the server to arrive, so a lead time of three weeks will be worked into the duration of the task.)

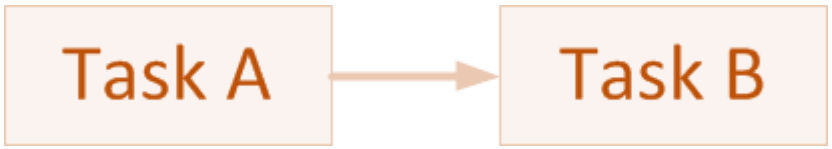
Lag time represents a delay between tasks. (If you have the tasks "pour concrete" and "frame house," you need to add a lag time of a few days to the "pour concrete" task to ensure the concrete is dry prior to framing the house.)

Task Dependency Types
The four types of task dependencies are: start-to-start (SS), finish-to-start (FS), start-to-finish (SF), and finish-to-finish (FF).

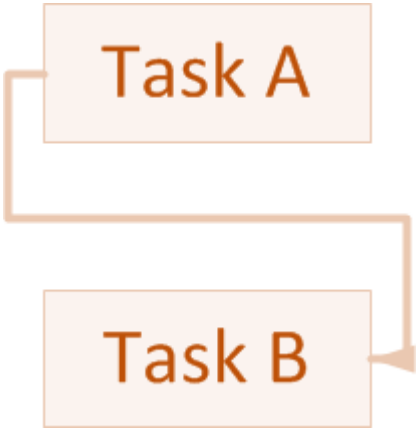
SS: Start-to-Start
Tasks can run in parallel, but Task B can't start until Task A has started. For example, if Task A is "Watch television" and Task B is "Change channels," it's obvious that you can't "Change channels" until you're watching television.



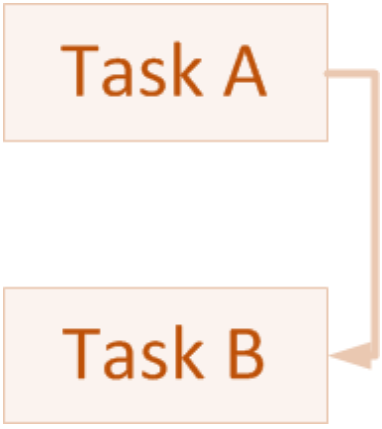
FS: Finish-to-Start
Task B can't start until Task A has finished. For example, let's say that Task A is "Hang drywall," and task B is "Paint drywall." "Paint drywall" can't start until "hang drywall" is complete.



SF: Start-to-Finish
Task B can't finish until Task A has started. Consider a 24/7 production environment; in order to maintain constant flow within the facility, Shift B can't finish until Shift A arrives and receives the hand-off.



FF: Finish to Finish
Task B can't finish until Task A has finished. For example, Task B, "Software test report," cannot finish before Task A, "Software testing," finishes.



Case Study: Trip to New York

You and a friend are planning a weekend trip to New York. It is up to you to ensure each task gets completed in the correct order.

First, put these activities into the proper sequence by numbering them.

- Book flight
- Research hotels
- Trip to New York (project)
- Research restaurants
- Go to airport
- Plan activities
- Book hotel
- Book car
- Pack suitcases
- Determine budget
- Select dates
- Renew passports
- Talk to travel agent

Then, copy the tasks into the table below and identify each dependency relationship.

Activity	Depends On	Dependency (SS, FS, SF, FF)
Trip to New York (Project)		
Determine budget		
Select dates		
Renew passports		
Book flight		
Research hotels		
Book hotel		
Book car		
Plan activities		
Pack suitcases		

Go to airport		

Task Relationships Exercise
Now, fill in the dependency table for your camping trip.

Activity	Depends On	Dependency (SS, FS, SF, FF)

Aligning Resources with Activities

Definitions

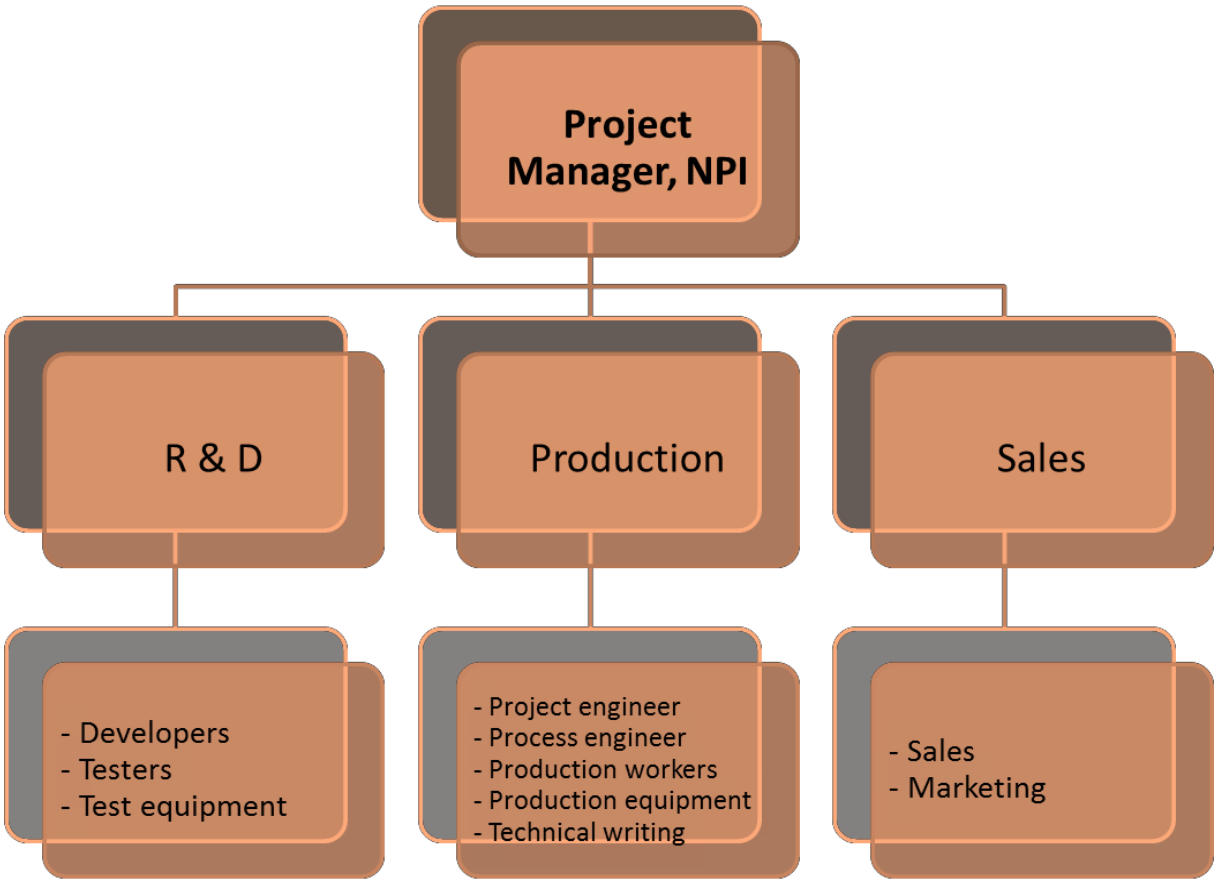
What is a Resource?
According to the Project Management Body of Knowledge guide, resources are any people, machines, cost, facilities, and material required to complete a project. Resources are typically thought of as human bodies, but they involve much more than that.

Resources can be a piece of production equipment, a budget, a sheet of chipboard, or a colleague from accounting. It's important to understand the different types of resources, as they all need to be managed by the project manager.

Resource Breakdown Structure
Now that we know the basic schedule, the question becomes, how can we best allocate resources based on availability and experience? The first step is to look at the WBS and activity list to identify the types of resources required to complete the outlined tasks. The project manager needs to know the skills required for each of the activities. The better the project manager understands the tasks involved with each phase of the project, the better equipped they will be when it comes time to assign resources to the tasks.

Resource Breakdown Structures (RBS) graphically display, in organization chart format, the resource requirements for the entire project. They are a helpful tool because they force the project manager to look at each phase and consider the resources that need to be involved to get the task complete. Once the project team is finalized, resource breakdown structures provide a high-level breakdown of the resources involved with the project.

Sample Resource Breakdown Structure
Below is a sample RBS as created for a new product introduction (NPI) project.



Creating the Resource Breakdown Structure

If the resources are known at the beginning of the project, list names and information in the RBS. Otherwise, it is okay to initially list teams and departments. Reduce the teams and departments to the lowest level you can. Once resources are determined, update the RBS chart by adding the names of required personnel and equipment.

Availability and Skills

Resources volunteer, are assigned, or are nominated for projects. A sponsor might select the project team, people with an interest in the work might volunteer for the team, or people who care about the project outcome might nominate a colleague in whom they have confidence to get the job done.

Regardless of how project teams are formed, there are two things every project manager needs to know about each resource: their availability and their skill set. Without this knowledge, you will not be able to accurately plan the project or assign appropriate resources to activities.

The time a resource is able to dedicate to your project is of the utmost importance. If a resource is only available 50% of the time and you have them assigned to work that requires 100% of their time, you're going to have a problem meeting your schedule.

When determining resource availability, you must also consider the personal fatigue and delay (PFD) factor we discussed during "Estimating Activity Durations." The PFD factor accounts for personal breaks, fatigue as we get tired, and delays due to waiting for information, computers, etc. PFD accounts for 15 to 20 percent of everyone's work day. If a task is scheduled to take eight actual working hours to complete, do not assign it to a resource and expect that it will be completed in one working day. With PFD factored into an eight-hour workday, there are only 6.8 actual working hours in one day. This means that the most one resource would be able to accomplish is 6.8 hours of estimated work.

If your project team is not predetermined, use your resource breakdown structure to help you select departments and fill personnel requirements. Solicit each department for resources that have the experience you're looking for. The manager of the department will need to know your weekly time commitment for each resource, so be sure to have an idea of what tasks the person will be assigned.

When project teams have already been formed, knowing the skill set for each of your resources is critical. Each resource should be assigned to tasks within their department, their role, and most importantly, their competence level. Once you know the skill required to complete the task, assign an appropriate resource. Be aware of task relationships and critical path items as you assign resources to tasks.

If you have a resource requirement that you cannot fill with resources already assigned to your project, you must address it immediately. You could ask for additional resources, recommend training, or you could make a case for bringing in an experienced consultant for the duration of the project. Whatever route you deem necessary, it is crucial that you address all resource shortcomings up front and that you build a pool of resources that can complete the project.

Resources should be assigned to a project in an economical way; they shouldn't be sitting idle 50% of the time and they shouldn't be expected to work 150% of the time. There is a fine balance between keeping resources busy and overwhelming them with tasks.

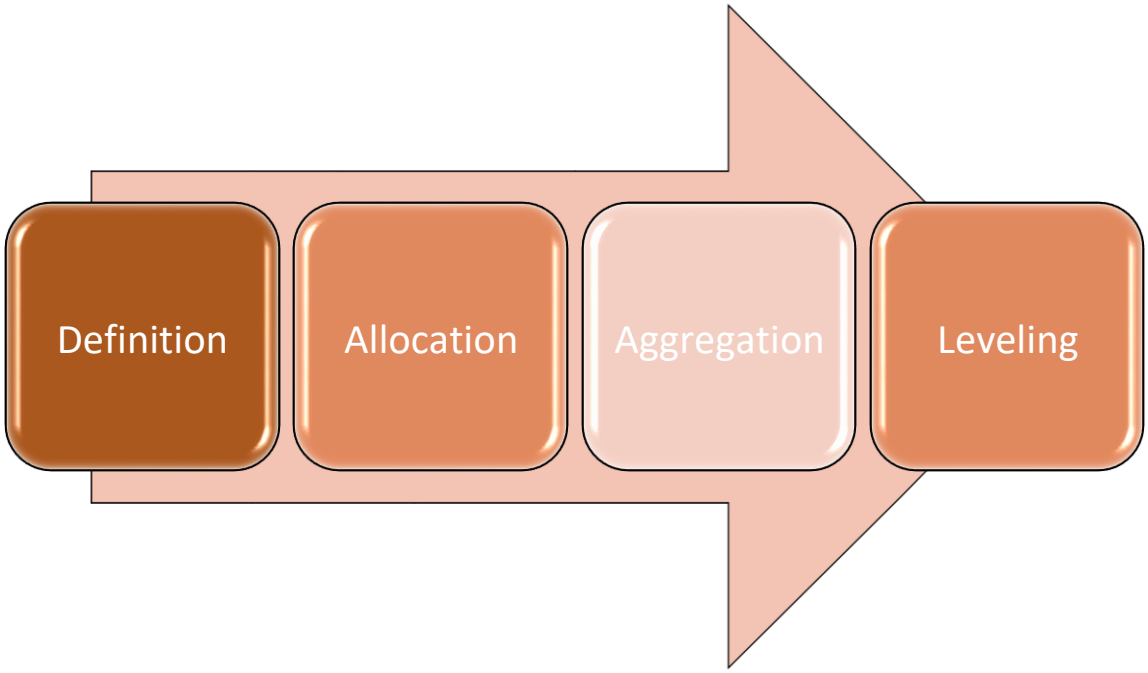
Resource Calendars

A resource calendar is a useful method of tracking resource availability. The resource calendar provides a list of working time and non-working time for people, equipment, and materials. Resource calendars contain information such as shift times, vacations, holidays, preventative maintenance downtime, and production shutdowns. A resource calendar may also prove beneficial to other project managers if you plan to share resources across multiple projects.

You can build resource calendars in most scheduling software programs. However, if you are not using scheduling software to create a schedule, you can create a basic calendar using Excel or Word. Be sure to include vacation, downtimes, course time, shift information, and working time in your calendar.

Stages of Resource Scheduling

There are four stages of resource scheduling:



Definition

This stage in the resource scheduling process is to determine and define the resources that will be modeled in the schedule. As previously mentioned, resources can include people, material, space in a facility, etc. If you anticipate that you might be constrained on any one resource, it is important to model it when you perform resource scheduling.

Allocation

Resource allocation is when the resources identified in the definition stage are assigned to each task/activity in your project plan. The number of resources required for each activity should be identified. Multiple resources of different types can be assigned to any activity. At this point, don't worry about the impact that assigning (or not assigning) resources will have on your project plan. The impact will be assessed during the leveling stage of the resource scheduling process.

Aggregation

Resource aggregation is the summation of all required resources during a set interval of time (hours, days, months, etc.). Resource aggregation is a technique that helps identify how efficiently resources are

being used. Once you've completed resource aggregation, you can perform resource leveling to properly balance resource utilization.

Leveling

Resource leveling is the process of examining the balance of required resources against actual resources over the duration of a project. Leveling helps prevent over (and under) allocation of resources. If the number of resources required never exceeds the availability, you do not have a resource issue.

However, if your demand exceeds your actual available resources, you can start the leveling process by looking at your highest resource demand to see if it's possible to reduce the number of resources required during the given time period.

- Are there any tasks can be performed in parallel?
- Is there float on tasks that you can leverage (i.e. start early or start late) to free up resources at alternate times?

Keep in mind that the goal of this step is to smooth resources so you aren't overworking some resources while others sit idle.

Resource leveling is not simple. There are two considerations that need to be addressed when leveling resources: time constraints and resource constraints.

Time-Constrained Project

If you have a mandated completion date for your project, emphasis needs to be placed on completing the project by a specific date. You may need to negotiate for additional resources or overtime, which will add additional cost to the project. If reducing the scope of the project is an option, you might want to look into this. You can also look at the float for non-critical path tasks to see if you can adjust the start/finish time.

Resource-Constrained Project

If you have a limited number of resources, emphasis needs to be placed on finishing the project with the given resources. You can only move the resources around so much before the critical path is affected and the end date of the project is altered. Another option would be to look into the float available to tasks that aren't on the critical path. Can a resource conflict be resolved by starting a task earlier or finishing it later?

As you can see, there are several options that will need to be considered as you step through resource leveling. There is no one right answer, as every project has different requirements.

Resource Turnover

Resources can come and go throughout the duration of a project. You will add new project members as the project evolves and you will lose members as phases and tasks get completed, or as other duties take precedence. Be aware that the dynamics of the project team will likely change as members join and leave the team. It often takes teams some time to develop a rapport with one another, to effectively make decisions, and to get to know the ins and outs of the project. As resources leave, they take project knowledge with them, leaving the new team member back at the starting gate. It is the remaining members who must orient the new member and help them gain the background they need. Due to the disruption in flow and cohesiveness, you should try to minimize resource turnover wheneverpossible.

Case Study: Planning an Outdoor Concert

This case study will consider the project of planning an outdoor concert and the resource requirements you will need to have a successful event.

Review this sample Work Breakdown Structure.

1. Planning an Outdoor Concert
1.1. Site
    1.1.1. Selection
    1.1.2. Council
    1.1.3. Environment
    1.1.4. Neighbors
    1.1.5. Clearing and Cleaning
    1.1.6. Handover
1.2. Promotion
    1.2.1. Print
    1.2.2. Radio
    1.2.3. Television
    1.2.4. Clubs
    1.2.5. Internet
    1.2.6. Other
1.3. Finance
    1.3.1. Sponsorship
    1.3.2. Grants
    1.3.3. Accountants
    1.3.4. Tickets
    1.3.5. Budget
    1.3.6. Audit and Report
1.4. Human Resources
    1.4.1. Planning team
    1.4.2. Concert team
    1.4.3. Security
    1.4.4. Tickets
1.5. Entertainment
    1.5.1. Selection
1.6. Amenities
    1.6.1. Food
    1.6.2. Washrooms
    1.6.3. VIP Seats

Now, create a list of resources that may be required.

Next, create an RBS for this project.

Level 1	Level 2	Level 3