Continuing Integrative Class Project

It is now time to construct the project schedule. You may do this by hand or using a software package for project management as mentioned in Chapter 1. Begin with your WBS and determine the precedence relationships among the activities at the most detailed level of your project's WBS. Next, develop the three time estimates for each activity. Based on the precedence relationships and time estimates, create a network diagram for your project. Develop a simulation model for your project and determine the distribution of project completion times for your project. Finally, analyze your project and determine what deadlines will provide you and your team a 75 percent and 90 percent chance of completing the project on time.

Bibliography

Badiru, A. B. "Activity-Resource Assignments Using Critical Resource Diagramming." *Project Management Journal*, September 1993.

Evans, J. R., and D. L. Olson, *Introduction to Simulation and Risk Analysis*, Upper Saddle River, NJ: Prentice-Hall, 1998.

Goldratt, E. M. *Critical Chain*. Great Barrington, MA: North River, 1997.

Hulett, D. T. "Schedule Risk Analysis Simplified." *PM Network*, July 1996.

Levine, H. A. "Risk Management for Dummies, Part 2." *PM Network*, April 1996.

Moder, J. J., C. R. Phillips, and E. W. Davis. *Project Management with CPM, PERT, and Precedence Diagramming*, 3rd ed. New York: Van Nostrand Reinhold, 1983.

Project Management Institute. *A Guide to the Project Management Body of Knowledge*, 5th ed. Newtown Square, PA: Project Management Institute, 2013.

Sandberg, J. "Rise of False Deadline Means Truly Urgent Often Gets Done Late." *Wall Street Journal*, January 28 2007.

Wheatly, M. "Up for Adaptation." *PM Network*, July 2010.

Wilkens, T. T. "Are You Being Misled by Your Progress Gantt Chart?" *PM Network*, August 1997.

Williams, T. M. "What Are PERT Estimates?" *Journal of the Operational Research Society*, Vol. 44, No. 12, 1995.

The following case presents a real project (in aggregate form) that allows the student to compare the critical path solution approach for both completion time and cost as well as a simulated solution for time variability and then also for both time and cost variability. The student should better understand the risk of projects running late and overbudget after this exercise.

Case

NutriStar Energy, Inc.[9] S. Shafer

Wesley James had recently arrived in Boston from Manchester, UK for a position as Project Owner at NutriStar Energy, Inc. He was now meeting with Ava Smith, President of NutriStar, to discuss his upcoming duties and responsibilities associated with their latest product, the Nutri-Sports Energy Bar.

As Ava explained: "NutriStar produces a line of vitamins and nutritional supplements. We recently introduced our Nutri-Sports Energy Bar, which is based on new scientific findings about the proper balance of macronutrients in the body. Fortunately, the energy bar has quickly become popular among elite athletes and others who focus on eating an optimal balance of macronutrients. One distinguishing feature of the Nutri-Sports Energy Bar is that each bar contains 50 milligrams of eicosapentaenoic acid (EPA), a substance strongly linked to reducing the risk of cancer but found in only a few foods, such as salmon. We were able to include EPA in our sports bars because we had previously developed and patented a process to refine EPA for our line of fish-oil capsules."

"Because of the success of the Nutri-Sports Energy Bar in the United States, we are considering offering it in Latin America. With our domestic facility currently operating at capacity, we have decided to investigate the option of adding approximately 10,000 square feet of production space to our facility in Latin America, at a cost of $5.1 million."

[9]Copyright S. Shafer

"This is where you come in, Wesley. The project to expand the Latin American facility involves four major phases: (1) concept development, (2) definition of the plan, (3) design and construction, and (4) start-up and turnover. During the concept development phase, a project owner, that will be you, is chosen to oversee all four phases of the project and given a budget to develop a plan. The outcome of the concept development phase consists of just a rough plan, feasibility estimates for the project, and a rough schedule. Also, a justification for the project and a budget for the next phase will be needed."

"In the plan definition phase, the project owner selects and works with a project manager to oversee the activities associated with this phase. Plan definition consists of four major activities that are completed more or less concurrently: (1) defining the project scope, (2) developing a broad schedule of activities, (3) developing detailed cost estimates, and (4) developing a plan for staffing. The outputs of this phase are combined into a detailed plan and proposal for management specifying how much the project will cost, how long it will take, and what the deliverables are."

"If the project gets management's approval and provides the appropriations, the project progresses to the third phase, design and construction. This phase consists of four major activities: (1) detailed engineering, (2) mobilization of the construction employees, (3) procurement of production equipment, and (4) construction of the facility. Typically, the detailed engineering and the mobilization of the construction employees are done concurrently. Once these activities are completed, construction of the facility and procurement of the production equipment are done concurrently. The outcome of this phase is the physical construction of the facility."

"The final phase, start-up and turnover, consists of four major activities: pre-start-up inspection of the facility, recruiting and training the workforce, solving start-up problems, and determining optimal operating parameters (called *centerlining*). Once the pre-start-up inspection is completed, the workforce is recruited and trained at the same time that start-up problems are solved. Centerlining is initiated upon the completion of these activities. The desired outcome of this phase is a facility operating at design requirements."

"The cost to complete an activity depends on both the amount of time required to complete the task and the cost rate of performing the activity. I have compiled two tables here for you. Table A provides optimistic, most likely, and pessimistic time estimates for the major activities. Table B provides similar estimates for the cost rates to complete the activities. Like time estimates, the cost rate to complete the facility expansion project can vary for a number of reasons such as using more or less expensive resources, price changes in labor and materials, the need to outsource work that was expected to be performed in-house, and so on. According to the data in Tables A and B, Concept Development is expected to cost $24,000, 12 months at $2,000/month."

TABLE A Three Time Estimates for NutriStar Production Facility Expansion Project

Activity	Optimistic Time (months)	Most Likely Time (months)	Pessimistic Time (months)
A: Concept Development	3	12	24
Plan Definition			
B: Define project scope	1	2	12
C: Develop broad schedule	0.25	0.5	1
D: Detailed cost estimates	0.2	0.3	0.5
E: Develop staffing plan	0.2	0.3	0.6
Design and Construction			
F: Detailed engineering	2	3	6
G: Facility construction	8	12	24
H: Mobilization of employees	0.5	2	4
I: Procurement of equipment	1	3	12
Start-up and Turnover			
J: Pre-start-up inspection	0.25	0.5	1
K: Recruiting and training	0.25	0.5	1
L: Solving start-up problems	0	1	2
M: Centerlining	0	1	4

TABLE B Three Cost Rate Estimates for NutriStar Production Facility Expansion Project

Activity	Optimistic Cost Rate ($/Month)	Most Likely Cost Rate ($/Month)	Pessimistic Cost Rate ($/Month)
A: Concept Development	1,900	2,000	2,300
Plan Definition			
B: Define project scope	23,750	25,000	28,750
C: Develop broad schedule	15,200	16,000	18,400
D: Detailed cost estimates	28,500	30,000	34,500
E: Develop staffing plan	27,000	30,000	33,000
Design and Construction			
F: Detailed engineering	360,000	400,000	440,000
G: Facility construction	112,500	125,000	156,250
H: Mobilization of employees	270,000	300,000	330,000
I: Procurement of equipment	360,000	400,000	440,000
Start-up and Turnover			
J: Pre-start-up inspection	90,000	100,000	110,000
K: Recruiting and training	540,000	600,000	660,000
L: Solving start-up problems	90,000	100,000	110,000
M: Centerlining	45,000	50,000	55,000

"Well, that's it Wesley! We're glad to have you on board and look forward to working with you. Do you have any questions?"

Questions

1. Draw a network diagram for this project. Identify which path you expect to be the critical path and its expected completion time. Which paths are most likely to threaten this path in terms of becoming critical?
2. Simulate the completion of this project 1,000 times assuming that activity times follow a triangular distribution and that the cost rates are known with certainty and equal to the most likely cost rate. Estimate the mean and standard deviation of the project completion time and the project cost. How does the time compare to your previous answer based solely on the critical path?
3. Develop histograms for both the project completion time and the cost to complete the project. What do these histograms tell you?
4. Using the results of your simulation analysis, calculate the probability that the project can be completed within 30 months. What is the probability that the project will take longer than 40 months? What is the probability that the project will take between 30 and 40 months? What is the probability the project will cost $5.1 million or less to complete? The probability the project will cost between $5 and $6 million to complete?
5. Modify your simulation model to determine the probability that the path you expected to be the critical path actually was the critical path? What are the managerial implications of this?
6. Simulate the completion of this project 1,000 times assuming that the activity times follow a triangular distribution and that the cost rates are also triangularly distributed. Estimate the mean and standard deviation of the project completion time and project cost. How do these results compare to the results you obtained in Question 2?
7. Would you expect there to be a relationship between the duration of an activity and the cost *rate* to complete the activity? If so, how could your simulation model be modified to reflect this relationship?

This brief reading illustrates the kinds of things that can go wrong in a project and delay it, but also the kinds of remedies PMs can come up with to keep the project on schedule. The types of creative remedies available to PMs are then summarized.

Reading

Without Further Delay[10] M. Bowles

A resourcing delay is hard enough to handle at sea level. High in the Andes mountains, it can potentially doom a project.

On a recent mining project in that South American range, procurement of the main equipment wasn't going to happen on time. Because it was an activity in the critical path, the entire schedule would be compromised.

Almost every project professional has been there. It's how you handle such a crisis that makes the difference between success and failure.

In this case, Edwin Monzón, PMI-RMP, PMI-SP, PMP, project scheduler for Antamina, a mining company in San Marcos, Peru, identified the holdup as quickly as possible.

This was accomplished by analyzing the variation between baseline dates and forecast dates from purchase status reports and expediting status reports for every purchase order. The project control group created a "traffic light" tool that identified the variances by color.

"This let us identify, quickly and easily, the procurement delays in a project with a lot of purchase orders," Mr. Monzón says.

The project risk management plan had a cost contingency for change in the method of transportation for delayed purchase orders.

"In my project, it was better to pay for air transportation than pay for a contractor claim for stopped resources—both people and equipment," he adds.

By switching the method of transporting the supplies from sea to air, his project team was able to make up the time.

But just as that scheduling conflict was under control, another cropped up.

"As soon as the equipment began to arrive at the mine, we had a strike led by the local community, which delayed the equipment installation," Mr. Monzón says.

There are seemingly endless glitches that can throw off a project's schedule—stakeholder issues, poor planning and lack of resources, to name a few. So it's no wonder many projects fail to deliver on time.

While some scheduling challenges can't always be avoided, project managers can regain lost time and get their projects back on track without sacrificing quality or team morale.

In Mr. Monzón's case, he built a time contingency into the schedule to account for possible risks.

"According to our project risk-management plan, we had assigned schedule contingency to the equipment installation activity that helped the project be completed on time," he says.

Danger: Scheduling Pitfalls Ahead

There may not be a single reason why a project gets thrown off-kilter. There are, however, plenty of mistakes that practically ensure a project will fall behind schedule—poor initial planning being a prime culprit.

"We usually say, 'If you failed to plan, you planned to fail,'" says Lofty Sabry, CAPM, PMI-RMP, PMI-SP, PMP, PgMP, owner of the project management consultancy EMP (Experts Project Management) in Dubai, United Arab Emirates.

In many cases, project sponsors or company executives push to start the project quickly rather than dedicate time to good planning, according to Don Wessels, PMP, senior consultant and instructor on the project and program management business unit of Management Concepts, a training firm in Vienna, Virginia, USA.

Scheduling problems can quickly result from several issues, Mr. Monzón says, including:

- Deficient scope definition
- Poor stakeholder identification
- Lack of a resource usage plan
- No risk-management plan
- Poor constraint identification

Some sort of project planning must take place at the start, Mr. Wessels says. Bring together key stakeholders, team members and a facilitator to discuss requirements and scope.

"The project launch or rapid project planning process doesn't have to take a long time, but it's a crucial step," he says. "It's important to get everyone on board at the start. If you don't have full participation from stakeholders and team members, you won't have full buy-in. This could cause serious problems and might not be reconciled until much later in the project."

Another common scheduling pitfall: lack of clear executive mission. Without it, project priorities are established based on individual politics or agendas rather than the organization's goals, says Harold "Mike" Mosley Jr., PMP, program director of the nuclear construction division of Zachry, a project management, engineering, procurement and construction contractor in San Antonio, Texas, USA. He is also the committee chair for PMI's *Practice Standard for Scheduling* – Second Edition.

Mr. Mosley was part of a project with an engineering team in Boston, Massachusetts, USA that worked for several years before construction work began on the project. The project sponsor refused to bring together the two remote teams. As a result, they never developed a good working relationship, he says.

"The executive's priorities were on short-term cost savings rather than the long-term benefit," Mr. Mosley adds. "The project and cost and schedule suffered as a result."

Instead, Mr. Wessels says, a clear executive mission should be communicated at the start of the project and reinforced throughout.

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Prevention Is the Best Medicine

Avoid scheduling delays in the first place by incorporating these five strategies:

1. **Create the project plan well in advance.**
   "If you don't start planning the project until you're ready to go, you'll always be in recovery," says Harold "Mike" Mosley Jr., PMP, Zachry, San Antonio, Texas, USA.
2. **Get a good grasp of stakeholders' requirements.**
   Gather six to eight key stakeholders to not only discuss their requirements but also to better understand the rationale behind them. "Ask, 'What will you gain? How does that tie back to the organizational mission?'" says Don Wessels, PMP, Management Concepts, Vienna, Virginia, USA.
3. **Involve more than just the key stakeholders in the planning.**
   "A lot of times, one group or person will do it and expect everyone to follow it," Mr. Mosley says. But even the lowest-ranked team member can offer valuable insight. "You don't have to be an expert on the topic to give a possible solution or idea. Sometimes a fresh set of eyes can be the solution," he says.
4. **Conduct a schedule risk analysis as part of the planning.**
   Create a contingency plan based on the specific project risks, says Edwin Monzón, PMP, PMI-RMP, PMI-SP, Antamina, San Marcos, Peru. "For example, in a mining project in South America, the time contingency plan should be aligned with risks like community strikes, complex procurement in remote locations and low performance for work in high altitudes," he says.
5. **Establish a team operating agreement.**
   In it, include how team members will work together, how they will handle issues and, if an issue can't be resolved, who will handle it, Mr. Wessels says.

"At the end of each major piece of work, a control gate review of deliverables should be conducted to ensure the project is performing as planned and is still aligned with the mission of the organization and delivering the value for which the project was started," he says. "It's a periodic opportunity to stress the mission and determine if the mission has changed."

Poor resourcing can also be detrimental to a project's schedule.

"When there aren't enough resources, the project team is forced into overtime, and morale drops dramatically," Mr. Wessels says.

Improperly skilled resources can be just as problematic.

"'Availability' is not a skill set. You can't just use the next available body," he says. "In addition to quality and inefficiency issues, team morale will suffer because they know they aren't doing well."

The immediate reaction to the first sign of a schedule delay is often to have teams work harder, longer, faster. But that's not always the best answer.

For one thing, overworking team members—even with financial compensation—will likely take a toll on morale and quality.

"Even though team members are working longer hours, productivity can drop 60 percent, especially after six to eight weeks of overtime," Mr. Wessels says. "Then team members get burned out, jump ship to another project or leave the organization altogether."

Save the Team, Save the Schedule

Sometimes there's just no way to get a project back on track other than to involve an extra surge from team members, Mr. Sabry says.

One of the most traumatic scheduling complications of his career occurred when he was managing a project in the United Arab Emirates and then-president Sheikh Zayed bin Sultan Al Nahyan died. The entire country, including its government offices, immediately shut down for nearly two weeks.

Mr. Sabry leveraged the schedule compression technique to shorten the project schedule without minimizing scope, and employed fast-tracking to expedite certain project tasks by completing them simultaneously.

This involved team members putting in some extra hours. To maintain morale, he made sure to reward and recognize their efforts through bonuses, time off, certificates of achievement, and training opportunities.

"If I know we have a big push coming up, I might give the team a day or an afternoon off," Mr. Wessels says. "That's a strong incentive. People come back with more vigor and energy."

To ensure team morale stays intact as the schedule is restored, project managers must maintain clear lines of communication.

"Project leaders should inform the team of the recovery plan and keep them updated on the status," Mr. Monzón says.

During the schedule recovery period, project managers should discuss with team members what is needed and how each new task is going to get it done, Mr. Mosley adds.

Communication also involves getting out in the trenches, talking to team members and looking for clues that morale may be suffering.

"When you talk to team members, are they with you in the conversation and paying attention, or are they looking out the window and zoning out?" Mr. Mosley asks. "If they come in dragging in the morning and in the evening, you've got a problem."

Institute quality-control measures as the project gets back on track. That doesn't necessarily mean a large quality-assurance

team must be hired, according to Mr. Mosley. "It starts with the team member, his or her supervisor, and the supervisor's supervisor," he says.

Quality monitoring should be conducted throughout the project life cycle—not just until the schedule is restored. Track deliverables to assure they meet specifications and requirements, as well as how often the same work must be repeated because of quality issues.

Finally, it never hurts to infuse some humor in the schedule recovery plan, Mr. Mosley advises. He managed a construction project for a national power provider in Florida, USA that was running behind schedule, largely due to bad weather. The project team hadn't taken into account rain drainage issues at the work site, and it became flooded.

"The project sponsor came down for a monthly meeting and told me that 'Not even a bucketful of fairy dust could get this project back on schedule,'" he says. To keep up team morale, he bought a keychain depicting Tinker Bell, the fairy from *Peter Pan*, and hung it on the wall.

The team set about modifying the site layout to keep it dry. In the end, the project came back in a month ahead of schedule.

"I took the picture of the Tinker Bell keychain, framed it and presented it to the project sponsor," Mr. Mosley says.

Most of the time, though, there's nothing funny about project schedule delays. In an effort to salvage the schedule, project managers can inadvertently kill their team's energy and toss quality out the door.

But that doesn't have to be the case, Mr. Mosley says.

Just keep it simple. "Focus your corrective measure on what is wrong and what you can affect," he advises. "It may be an issue beyond the scope of what you can address. Once you figure out what the issue is, then you can look for workarounds."

Questions

1. List all the tips in the article for avoiding scheduling delays.
2. List all the methods for recovering in the article from scheduling delays.
3. In the sidebar "Prevention Is the Best Medicine," which strategy seems the most important? Which is second most important? Why?
4. The article states that stakeholders push to start the project work quickly rather than spend the time planning. What would this have resulted in for the earlier PMIP "Massachusetts' Instant Bridges" sidebar?