Another Brick in the Wall

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Project 1. “Another Brick in the Wall”

Schedule

- Distribution of project description: February 1
- Timing studies for wall construction: February 8 (scheduled 20 minutes/group)
- Submission of individual exercise: February 13, 2:30 PM
- Submission of group bid document: February 15, 11:30 AM
- Wall construction: February 15 and 17
- Presentation of oral reports: February 22
- Submission of written reports: February 29, 5:00 PM

Introduction

This project is an exercise in construction planning and scheduling. Your group is a construction company bidding on a project for Pink Floyd Properties; Professor Oppenheim is the President of Pink Floyd and Tim Lam (tglam@cmu.edu) is the Project Manager. Your group must choose a construction plan, prepare a cost estimate and schedule for the project, and then execute the construction. To generate the cost estimate your group must determine the tasks needed to complete the project, the sequence and durations of those tasks, the schedule of those tasks, and the material quantities. Remember that some tasks cannot be started until other tasks are completed (one task must precede the other), whereas some tasks can proceed in parallel. The construction schedule must be submitted as a Gantt chart prepared using Microsoft Project; the Gantt chart will identify when tasks are scheduled to start, when tasks are scheduled to end, and when the entire project will end.

From this project, you will learn some of the important aspects of construction planning and management. This project has four parts:

1. Determine cycle times for the tasks during a practice session.
2. Generate and evaluate alternate construction plans, select your proposed plan, and submit the cost estimate and schedule (the bid document) for your plan.
3. Perform the construction, competing against your own predicted schedule.
4. Conduct further study to determine if you would revise your schedule were you to repeat the project.

Problem Description

The project your group will bid and construct is a brick wall, depicted in Figure 1. It is nominally 64 inches long, equivalent to eight bricks positioned end-to-end, 8 inches thick, corresponding to two wythes of brick, and approximately 16 inches high, corresponding to six courses of brick. The owner (Pink Floyd Properties) wants the wall to be built at lowest cost, and requires that the project be completed within a specific time limit. As with any construction project, you will provide the owner with a sealed and confidential bid document that states how much it will cost and how long it will take to build the wall. The owner has obtained engineering estimates of the cost and time required for the construction process, which will not be revealed to the bidders, and the owner expects that all responsive bids should be near those estimates. In any event, you will be required to execute the project according to your own schedule and specifications.
The wall must be solid; you cannot leave out any bricks or blocks. Within each wythe the bricks must be staggered, meaning that the vertical joints (properly termed the head joints) should not line up; in masonry terminology, this means that you cannot use a “stacked bond” but must use a “running bond.” The two wythes must be interconnected by at least two header bricks in every second course of brick. These features are pictured in Figure 1.

Use of Microsoft Project 2010

In this activity you will use Microsoft Project 2010. That software program is installed in BH 140E, in Wean, and in the West Wing Collaborative clusters. Handout 4, together with the lecture on February 1, will introduce you to that application.

Resources – Materials

Two brick suppliers compete for your business. Local zoning authorities have established weight limits for trucks, permitting only a particular number of bricks per load. There may also be headway constraints, establishing a minimum time interval between pickups. The first supplier is Grant Building Supply and they are located near PH 101. For many years Grant has been the only local supplier, but now competition has entered the local market. The second supplier is Lee Products, and they are located near PH 107A, which is closer to the construction site. When all things are considered, it may not be immediately evident which supplier is less expensive.

Resources – Labor

Your team will require two different types of workers: truckers and masons. Truckers have the task of loading bricks at one of the suppliers and delivering them to the laydown area at the job site. Masons have the job of taking those bricks from the laydown area, moving them as needed on the job site, and laying them in place in the wall. Work rules limit masons to carrying no more than 6 bricks at a time. The pay scale for trucker is different than that for masons. Each trucker and each mason is paid for the time duration of their shift. For example, trucker A might start at t=0.0 min and end the shift at t=8.0 min, trucker B might start at t=3.0 min and end the shift at t=9.5 min, and mason C might start at t=4.0 min and end the shift at t=11.0 min. Truckerman A would be paid for 8.0 min, trucker B would be paid for 6.5 min, and mason C would be paid for 7.0 min. A trucker or a mason cannot split their shift, but a worker can complete one shift as a trucker, pay a $50.00 training fee, and then work another shift as a mason. Your group has four people\(^1\) in it, and you must decide how many workers to use. One trucker and one mason? Two truckers and one mason? Two truckers and two masons? Your company operates its own trucks

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\(^1\) If your group has only three people in it, you can draft a TA to become the fourth worker.
(which look like buckets) and your workers must begin and end their shift at the jobsite where your construction office is located, at the laydown area. Your bid price should be the total cost that you estimate, plus 10% to represent your profit. On February 8 you will practice the three individual tasks (truck cycle to Grant, truck cycle to Lee, mason cycle) to obtain the cycle times.

**Other Constraints**

Construction is often performed on sites that offer limited area for storage; in this project, there may be a constraint on the number of bricks that can be stored in the laydown area at any time. Moreover, truck drivers are not permitted to run, which would be the equivalent of speeding, and therefore only a walking pace is permitted. Police will be patrolicking! (Masons are not permitted to run either, by union rules.) The job site, laydown area, and brick-source areas have been laid out, and you can only place bricks on those prepared areas. The clock stops when the wall is completed and all workers have returned to the construction office, at the laydown area.

**Cycle Times (Productivity data)**

On February 8 your group will have a 20-minute slot in which you are to practice the three different work cycles. You are to obtain an average time for each cycle, and you must use those three cycle times for project planning. (For planning purposes, you may make an engineering decision to round up, adding a small margin in your cycle times as protection against unforeseen delays, and as protection against a penalty for failing to finish on schedule.) You cannot use different times for different group members. When you execute the project you will not have a time manager, and you will not be able to adjust your work to the clock. Your group should therefore fill in the following blanks, and show these times in your reports.

Trucker, laydown area to Grant, load, return, and unload  _____  seconds

Trucker, laydown area to Lee, load, return, and unload  _____  seconds

Mason cycle, laydown area to wall site, masonry work, and return  _____  seconds

**Material Unit Costs, Labor Wage Rates, and Site Information**

The wall must conform to the dimensions specified. It will be constructed from brick, available to you at the two locations specified. In order to estimate the cost of the structure to be built, you have to compute the costs of the materials in the structure and estimate the cost of the labor to build it. The material and labor unit costs, as well as site information and project restrictions, are summarized below.

This project will consider three different geographical settings. Groups 1 through 5 will use one set of unit costs and zoning restrictions, groups 6 through 10 will use a second set, and groups 11 through 16 will use a third set.
Unit Costs and Zoning Restrictions for Groups 1 through 5

The jobsite is an open, undeveloped industrial park in the western part of the country. The distance between the jobsite and the two supply locations is great, which we will simulate physically by tripling the travel distance, requiring the trucker to make an extra trip on each leg. (That is, the trucker goes jobsite to supply location, back to jobsite, back to supply location, and only then picks up the material. That same trucker then goes to jobsite, back to supply location, back to jobsite, and only then delivers the material.) Brick costs are high in this part of the country, because the materials are not manufactured nearby and must be shipped in from afar.

Contract Requirement:

Project Time Limit 13:30 (min:sec)

Material Costs:

Brick, Grant Building Supply $0.85/unit
Brick, Lee Products $0.75/unit

Labor Costs:

Mason $7.20/min
Truck Driver $4.20/min

Zoning Restrictions:

Maximum Truck Load (Grant) 8/truck
Maximum Truck Load (Lee) 8/truck
Minimum Truck Headway (Grant) None
Minimum Truck Headway (Lee) None
Maximum Storage at Laydown Area No limit
Maximum Mason Load 6 bricks
Unit Costs and Zoning Restrictions for Groups 6 through 10

The jobsite is a crowded inner city location on the East Coast, severely limiting the storage at the laydown area. Brick costs are high, because the supply locations have high real estate costs. The masons are unionized, and the mason load (the number of bricks placed in one mason cycle) is less than in other parts of the country.

Contract Requirement:

Project Time Limit 12:00 (min:sec)

Material Costs:

Brick, Grant Building Supply $0.80/unit
Brick, Lee Products $0.70/unit

Labor Costs:

Mason $7.20/min
Truck Driver $5.40/min

Zoning Restrictions:

Maximum Truck Load (Grant) 6/truck
Maximum Truck Load (Lee) 8/truck
Minimum Truck Headway (Grant) 40 seconds
Minimum Truck Headway (Lee) 40 seconds
Maximum Storage at Laydown Area 8 bricks
Maximum Mason Load 4 bricks
Unit Costs and Zoning Restrictions for Groups 11 through 16

The jobsite is in the midwest. Material costs and labor costs are relatively low.

Contract Requirement:

Project Time Limit 11:00 (min:sec)

Material Costs:

Brick, Grant Building Supply $0.60/unit
Brick, Lee Products $0.50/unit

Labor Costs:

Mason $7.20/min
Truck Driver $4.20/min

Zoning Restrictions:

Maximum Truck Load (Grant) 6/truck
Maximum Truck Load (Lee) 6/truck
Minimum Truck Headway (Grant) None
Minimum Truck Headway (Lee) 40 seconds
Maximum Storage at Laydown Area 20 bricks
Maximum Mason Load 6 bricks
Project 2 Grading

Individual Scheduling Exercise (due 2:30 PM, February 13)

In the first part of this project your group must select four alternate construction plans, and in the two group submissions (the Bid Document and the Final Report) your group must explain why those particular alternatives were selected for study. Each member of the group must also, as an individual, study one alternative and generate a cost estimate and a project task schedule, and you must submit your individual scheduling exercise, in the form of an individual report, by 2:30 PM on February 13. The task schedule must include an activity precedence table and a Gantt chart produced using Microsoft Project. Your report on your individual scheduling exercise will be worth 20 points toward your individual score on Project 1.

Bid Document (due 11:30 AM, February 15)

Your group must analyze and discuss the four different alternatives that were studied, choose one as the basis for your bid, and then document that alternative in your bid document, which is to be submitted by 11:30 AM on February 15. Your submission, with the grading sheet as its cover sheet, must present the “as-bid” information: the total cost for the project, the work breakdown for each task, and a detailed task schedule. The task schedule must include an activity precedence table and a Gantt chart produced using Microsoft Project. This part of the document must be short and concise; the task schedule will be used for field inspection purposes by the owner’s representatives. You must also include a brief description of each alternative, perhaps a paragraph in length, a cost and time estimate for each alternative, perhaps best represented in a table, your justification for the alternative you chose to bid, as well as the detailed cost and time breakdown for your bid. The bid document will be worth 20 points.

Wall Construction (February 15 and 17)

Timekeepers will control the two supply locations, and truckers must identify their group number and name to receive clearance to receive each load of bricks. The construction activity will be worth a total of 10 points. Five points are earned for completing the project within the prescribed time limit. Five points are assigned for project quality; lack of quality would include irregular brick placement in the wall, accidents during construction, bricks placed outside the laydown or job site (cardboard) areas, speeding tickets, and so on. Five points are awarded by comparing the cost and time of your actual construction to that of your bid and to that of the engineer’s estimate. The scoring process is relatively complex; it will depend upon whether your bid is near the engineering estimate, below the engineering estimate, or above the engineering estimate, and if your completed project is below, near, or above your own bid. The purpose of this scoring system will be discussed in class, and you should refer further questions to the Project Manager (t glam@cmu.edu).

Final Report (due 5:00 pm, February 29)

The final report should be prepared following the outline given on the attached grading sheet, which is to be used as the cover page for the report. Your construction work will be monitored by timekeepers, and you will receive the as-built data for your project from which you will calculate
the actual cost and duration. In this final report, you must discuss your reasons for choosing a particular alternative, and provide the details of this alternative; you must then discuss in detail what happened during the construction process. This should include a discussion of any accidents, confusion, or anything that was not anticipated in your planning. What was your completed cost, and how was this cost computed? What was your completed construction time? How did your completed timeline compare to what you predicted? (You should include one Gantt chart for the original bid and another Gantt chart for the completed project, both using Microsoft Project). If your cost and timeline were different from those predicted, why do you think they were different? Moreover, you should return to the study of alternatives; if you were to submit a new bid, how would it be different? Make appropriate changes in your cycle times, choose and evaluate additional alternatives, and present an updated bid for the “next” construction project. The report must include a Table of Contents with the items listed on the grading sheet. The final report is worth 50 points.

**Oral Reports, Groups 1, 2, 6, 7, 11, and 12 (February 22)**

This semester, each group will make a verbal presentation of one project. The six groups listed above are designated to present oral reports for Project 1. You should describe the overall project, the alternative plans considered, the key aspects of your bid, and the performance of your group in meeting cost, schedule, and quality objectives. Every member of the group is required to speak, and the presentation should be organized and developed by the whole group. The presentation must be between 6 and 8 minutes in length. PowerPoint presentations are required; submit your PowerPoint files via the digital drop box in Blackboard by 11:00 AM on the day of the presentation.
Project 1. “Another Brick in the Wall”

Grade Sheet for Individual Scheduling Exercise (20 pts) Due February 13, 2:30 PM

Group Number: _____ Name: ________________________________

Description of alternative being studied 5 points _____

Describe, in words, the alternative for which you are providing a schedule; outline, in words, the three other alternatives that your group is considering; tabulate the cycle times you (and your group) are using

Detailed cost estimate 5 points _____

Detailed schedule 10 points _____

Gantt chart
- activity precedence table
- duration of each task
- critical path highlighted
- chart properly presented
- chart shown on one page
- legends etc. properly labeled

TOTAL 20 points _____
Project 1. “Another Brick in the Wall”

Grading Sheet for Bid Document (20 points) [Due February 15, 11:30 AM]

Group Number: ____  Members: ____________________________________________
                        ____________________________________________
                        ____________________________________________
                        ____________________________________________

Alternatives 10 points _____

Describe the possible alternatives that were considered
- tabulate the cycle times your group is using
- explain the engineering reasons for the alternatives that you selected to study
- briefly describe the specific characteristics of each alternative
- summarize the time and cost estimates

Detailed cost estimate of selected alternative 5 points _____

Explain or discuss why the alternative is economical

Detailed schedule 5 points _____

Gantt chart
- activity precedence table
- duration of each task
- critical path highlighted
- chart properly presented
- chart shown on one page
- legends etc. properly labeled

TOTAL 20 points _____
**Project 1. “Another Brick in the Wall”**

**Final Project Report (50 points) + Construction (10 points)  Due: February 29  5:00 PM**

<table>
<thead>
<tr>
<th>Group Number: ____</th>
<th>Members: _______________________________</th>
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</thead>
<tbody>
<tr>
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### REPORT GRADING

**General**
- Title page; neatness, table of contents: 3 points

**Introduction**
- Objective: Describe the purpose of the report
- Description: Describe the items addressed
- Describe the role of team members
- Describe the organization of the report
- 7 points

**Narrative description of construction project**
- (when?, what?, where? and how? the different stages of the project were conducted): 10 points

**Actual project cost and schedule**
- Detailed cost estimate (breakdown of materials, time, labor, unitary costs and final cost)
- Detailed schedule (Gantt chart using MS Project)
- 10 points

**Discuss differences between estimated and actual**
- Table comparing times and costs (breakdown of materials, time and labor, unitary costs and total final cost for estimated and actual)
- 10 points

**New Project Bid**
- New cost estimate (breakdown of materials, time and labor, unit costs and total cost as estimated and as actually constructed)
- New schedule (Gantt chart using MS Project)
- Final conclusions
- 5 points
- 3 points
- 2 points

**REPORT TOTAL**
- 50 points

### CONSTRUCTION GRADING

**Completion within time limit**
- 5 points

**Project quality**
- 5 points

**CONSTRUCTION TOTAL**
- 10 points