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## **Integrating Ethics into CEE 486-Civil and Environmental Engineering Design Project**

CEE 486 is our capstone design course in which the students do a semester-long design project in groups, and we also study construction methods and management. The textbook I use for construction is: Nunnally, S.W., Construction Methods and Management, Fifth Edition, Prentice Hall, 2001, 549 pp. For each of the 23 homework assignments that comprise several problems, I ask the students to consider the ethical implications of one of the problems assigned from each set. In the list below, I reference the assignment number, the problem in the set that I refer to for ethical implications, the page number of the problem in the text, and the problem as stated in the text. I then pose the ethical questions. The students are encouraged to use the American Society of Civil Engineers Code of Ethics as appropriate. This code, with background materials and definitions, can be obtained at the ASCE website: [www.asce.org](http://www.asce.org) (Professional Issues/Ethics/Resources/Ethics, Standards of Professional Conduct (21pp)).

1. HmWk #1, Prob. 8, p. 15  
“Describe the principal objectives that a project manager should have when carrying out a construction project.”  
One of the principal objectives is worker safety. Discuss the ethical implications of this for a professional engineer.

2. HmWk#2, Prob. 3, p. 463

“How does the actual progress at the end of the second week in Figure 16-1 compare with the scheduled progress? Express your answer as the percentage of scheduled progress that has actually been achieved.”

The percent completed of a task is frequently used as a basis for paying the contractor for work performed. Does the project manager have an ethical duty to the contractor and/or the owner to be accurate in his/her judgment of the amount of work completed?

3. HmWk#3, Prob. 8, p. 465

“For the network of Problem 5, assign resources based on an early start schedule. Indicate the total resource requirements for each time period. Level the resource requirements as much as possible utilizing float...”

There is no single solution to leveling resources, and leveling resources dictates who works and who doesn't in a given interval of time. Is there anything wrong in the project manager soliciting a payback from workers who are assigned to work even if his/her solution for leveling is not influenced by the payback?

4. HmWk#4, Prob. 6, p. 488

“Calculate the average hourly owning cost for the first year of life of the tractor of Problem 1 if the tractor is operated 2000 hours during the year. The rate for interest, tax, and insurance is 12% and the rate for storage and miscellaneous costs is 2%. Use the sum-of-the-years-digits method of depreciation.”

Two thousand hours a year is 40 hours a week or full time. The amount of use has a large influence on the own/rent/lease decision and has important tax implications that must be reported. What responsibility do you have as project manager to assure that the tractor will in fact be used 2000 hours per year?

5. HmWk#5, Prob. 2, p. 502  
“What is bid shopping and, why is it considered bad practice?”  
Is it unethical for a project manager to bid shop? Is it immoral for a project manager to bid shop?
6. HmWk#6, Prob. 5, p.515  
“Identify the major categories of environmental health problems encountered in construction.”  
One of the categories is heat and cold. Limits to the working temperature are influenced by the efficiency of construction workers, particularly laborers. Do you as a project manager have a moral obligation to make sure that temperature limits are observed on your job?
7. HmWk#7, Prob. 3, p.536  
“Explain the effects of sustained overtime on the labor cost per unit of construction production.”  
If you referred to the text in answering this question, your answer probably did not reflect a worker’s perspective. Do you have a moral or ethical obligation to do so as a project manager? Is it good business practice to do so?
8. HmWk#8, Prob. 8, p.537  
“Briefly discuss the influence of human factors on construction productivity.”  
One of the most important human factors is safety. Does a project manager have an ethical obligation to provide a safe working environment for construction workers? Does he/she have a legal obligation? A moral obligation? Does it make good business sense to create a safe workplace?
9. HmWk#9, Prob. 5, p. 39  
“A 1000 ft long pipeline requires an excavation of 4 ft wide to an average depth of 5 ft. If the soil is dry common earth, what size spoil bank will be created by the excavation?”  
Note that in this problem the *average* depth was 5 ft so it is quite possible that positive steps would have to be taken to insure worker safety. Did you think of worker safety when you solved this problem?

10. HmWk#10, Prob. 9, p. 77

“The tower crane whose capacity chart is shown in Table 3-10 is equipped with a 265-ft boom. The crane is preparing to lift a load weighing 10,000 pounds. The weight of the slings and the spreader bar to be used is 1200 pounds. What is the maximum safe lift radius for this load?”

The answer to this problem is 206 ft. As project manager what is the basis of your obligation (legal, moral, ethical) to make sure that neither the radius nor the load as stated are not exceeded? Remember, the consequences of a mishap could well be lethal.

11. HmWk#11, Prob. 2, p. 120

“The tractor-scraper whose travel-time curves are shown in Figures 4-4 and 4-5 hauls its rated payload 4,000 ft up a 5% grade from the cut to the fill and returns empty over the same route. The rolling resistance factor for the haul road is 120 lb/ton. Estimate the scraper travel time.”

The estimated travel time is 8 minutes. As project manager you are responsible for safety. How can you be sure that the travel time does not result in excessive speed, and how can you assure that the travel time will not be reduced on the job?

12. HmWk#12, Prob. 9, p. 149

“Twelve miles of gravel road require reshaping and leveling. You estimate that a motor grader will require two passes at three mph, two passes at four mph, and one pass at five mph to accomplish the work. How many grader hours will be required for this work if the job efficiency factor is 0.83?”

It is not reasonable to shut down the road during reshaping and leveling operations. What safety measures should you take to insure that the grader operations would not result in accidents involving the traveling public? Are you legally, morally, and/or ethically required to provide safety measures as the project manager?

13. HmWk #13, Prob. 1, p. 178

“Using the data of Example 6-2, determine the minimum size screen required for the 2-in screen. The stone weighs 100 lb/cu ft.”

Quarrying is a dangerous business with many interconnected moving parts. Shutting down part of the process of sorting aggregate may require the whole operation to be halted.

Because of this, there may be a temptation to adjust malfunctioning screens on the fly. So that this doesn't happen because of your 2-in screen design, what precautions would you take to ensure this screen will not become ‘the weakest link?’

14. HmWk#14, Prob. 2, p. 194

“How does a slipform paver produce the desired concrete shape without the use of forms?”

How would you go about assessing the safety of slipform pavers vs. form-riding equipment? Is it your responsibility as project manager to make such a study?

15. HmWk#15, Prob. 3, p. 222

“Trial blasting operations indicate that a rectangular pattern with holes 24 ft deep spaced on six ft centers will yield a satisfactory rock break with an effective depth of 22 ft.

Determine the rock volume produced per foot of drilling.”

Given your background in blasting, would you as an engineer feel comfortable ethically in making such calculations as in problem 3? Refer to appropriate section(s) of the ASCE Code of Ethics.

16. HmWk#16, Prob. 5, p. 251

“What minimum air pressure is usually required in order for pneumatic tools to deliver their rated performance? What is the effect on rock drill performance and operating cost when air pressure is increased above this minimum (see Chapter 8)?”

As project manager you are responsible for the pneumatic system on the job. Are there factors other than machine performance and cost with which you would be concerned?

17. HmWk#17, Prob. 7, p. 284

“When sloping the sides of an excavation in type A soil, what maximum slope may be used if the excavation will be 15 ft deep and will be open less than 24 hours?”

This clearly is a safety driven calculation. Under what circumstances would you as project manager retain the services of a geotechnical engineer rather than to rely on a table prepared by OSHA?

18. HmWk#18, Prob. 4, p. 319

“What are the principal requirements that concrete formwork must satisfy?”

Safety is the most important requirement in designing and constructing concrete formwork. Collapsing forms kills every year construction workers. What legal requirements does a project manager need to satisfy with respect to formwork? What ethical requirements?

19. HmWk#19, Prob. 4, p. 348

“Calculate the maximum allowable span for  $\frac{3}{4}$  inch Class I Plyform decking with face grain across supports carrying a design load of 150 lb/sq ft. Assume that the decking is continuous over three or more spans and limit deflection to  $\frac{1}{240}$  of span length.”

It is customary to space supports for decking in six inch increments so that the design engineer will space supports at 18 inches if the maximum calculated allowable span is more than 18 inches but less than 24 inches. But what spacing would you use if the calculation gave a maximum spacing of 11.9 inches? Defend your answer from both technical and moral/ethical perspectives. Think about the consequences of failure of a concrete floor.

20. HmWk#20, Prob. 5, p. 348

“Determine the maximum allowable spacing of nominal 2x4 inch studs for a wall form sheathed with nominal 1 inch lumber. Assume that the sheathing is continuous over three or more spans and in Hem-Fir. Limit deflection to 1/240 of the span length. The design load is 600 lbs/sq ft.”

It is customary to space supports for walls in six inch increments so that the design engineer will space supports at 18 inches if the maximum calculated allowable span is more than 18 inches but less than 24 inches. But what spacing would you use if the calculation gave a maximum stud spacing of 11.9 inches? Defend your answer from both technical and moral/ethical perspectives. Think about the consequences of failure of a concrete wall.

21. HmWk#21, Prob. 6, p. 388

“Explain the major safety hazards involved in erecting the roof trusses for a 2-story frame building.”

One major hazard is worker falls from elevated positions. What precautions must you, as project manager, take to satisfy *legal* requirements with respect to worker falls safety. Are you obligated from an *ethical* point of view to insist on even more stringent requirements?

22. HmWk#22, Prob. 7, p. 407

“When erecting a steel building structure, what is the maximum height that the erection deck can be above the highest completed permanent floor?”

OSHA mandates a maximum of eight stories. Is this a legal, moral, or ethical requirement? What is the basis for this requirement?

23. HmWk#23, Prob. 6, p. 435

“Find the maximum safe unsupported height of an 8 inch solid brick wall exposed to a wind velocity of 80 mph.

Are there circumstances in which you as construction manager could ethically and legally order a brick wall be constructed taller than the 3.6 feet calculated? Think about the consequences of failure under different scenarios.