BLDG. '6581 INSTRUCTOR: T. Stathopoulos

Assignment 3

1) A large apartment complex for low-income renters is being considered. The choice must be made between conventional steel construction and using an innovative scheme of "pushup" construction that promises to cost less. There is uncertainty in the cost estimates in both of the proposals, but clearly it is greater in the case of the latter, untried, system of construction.

Assume that the best estimate of the conventional cost is x_0, with uncertainty in the estimate being summarized by saying there is a 50-50 chance that the true cost will be within $x_0 \pm 0.05x_0$. Assume that the best estimate of the pushup cost is $0.8x_0$, but that the "probable error" is $0.10x_0$; that is, there is a 50-50 chance that the true cost will be within $0.8x_0 \pm 0.1x_0$. Assume (for simplicity in your computations) that in both cases the engineer is prepared to state that his uncertainty in the costs can be described by symmetrical triangular distributions, centered on the "best estimates".

a) As the technical representative of the nonprofit developer, decide which alternative to take if the project is being carried out with funding under government regulations which place a maximum rent on the units and which require that the rent be set so that no profit is made by the developer. The implication to the (charitable) developer is that he will make no money no matter what the construction cost, but he will lose money from his own "pocket" if the construction cost exceeds that value c which the maximum rents (minus interest, etc.) will just cover. This value can be accurately calculated to be $c = 1.10x_0$. Sketch the function of utility to the developer versus the cost.

b) As the technical representative of an association representing the steel industry, decide whether your industry should underwrite the pushup project by guaranteeing that it will pay any cost in excess of c. Your industry gains nothing if the pushup project is not undertaken, but gains information on a potentially profitable new development , no matter what its final cost. Assume that this benefit to the industry is judged to be worth $0.02x_0$, independently of the final cost, plus an amount which decreases linearly from $0.05x_0$ at 40 percent of conventional construction cost to zero at the cost of conventional construction x_0. Sketch the utility to the industry versus true cost.

2) A home-owner is building a house on the outskirts of a town and is considering the alternatives between drilling his own well on a one-acre property and subscribing to the city water. It costs \$500 to drill a well and \$200 to complete the necessary facilities if water is found in adequate quantity. The probability of striking a water-bearing stratum is estimated to be 0.4 in the vicinity. However, if the first well is dry, it may be assumed that any other well on the property will yield the same result. The city requires an immediate payment of \$500 to make a connection. The present worth of water payments to the city is estimated at \$1000, whereas, the present worth of operation and maintenance on a successful well is only \$300. Answer the following questions, and draw the corresponding decision trees wherever appropriate.

(a) What should the engineer do if he is an EMV decision maker?

(b) An ultrasonic device to detect the presence of water can be rented. Although the device will indicate "wet" if there is a water-bearing stratum, it may fail to indicate "dry" in the absence of a water-bearing stratum. In this latter case, the device will read "wet" 30% of the time. How much should the engineer pay to rent the ultrasonic device to obtain additional information on the presence of water beneath his property?

(c) At most, how much should perfect information be worth (i.e., certain knowledge about whether or not a water-bearing stratum is present)?

(d) Suppose the probability of striking a water-bearing stratum in the vicinity can only be estimated within the range 0.4 ± 0.1. Will the engineer still insist on his optimal decisions previously obtained in (a)? Justify.