

## 1.011 Project Evaluation

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### Assignment 2 Cost & Revenue Functions

**Assigned:** Monday, February 10, 2003

**Due:** Tuesday, February 18, 2003

#### Problems from Text

1 Be sure that you understand all of the elements of 2-3 and 2-37 (basic terminology).

2 Do the following problems and be sure that you get the correct answers:

2-8, 2-16, 2-22, and 2-38

3 Do the following problems and submit them for grading (10% each)

2-9 Determining optimal level of output, using calculus and graphical techniques

2-13 Evaluating alternatives

2-19 Cost-based design

2-33 Risk analysis

4 Fixed Costs, Variable Costs, and Design of a Network (60%)

Suppose you are designing a new transport network for a region that has a uniform population density. The transportation capabilities are defined by four major factors:

- a. Fixed cost per mile per year to the owner (FC)
- b. Variable cost to the owner for maintenance (VC per vehicle-mile)
- c. Average speed (S)
- d. User Cost on the new network, which is a function of time T and distance D (User cost =  $U_1 \cdot T + U_2 \cdot D$ ) (U1 might be the average hourly wage and U2 might be average per mile cost of using an auto)
- e. User Access cost, which is a function of time and distance from the user's home to the new network and from the new network to the users destination (Access cost =  $A_1 \cdot T_A + A_2 \cdot \text{Access distance}$ , where the access distance is expected to be  $G/2$  and the access speed is AS)

Two additional parameters relate to the potential travel demand:

- f. Trip density (trips per year per square mile = TD)
- g. Average trip length (D)

Let's assume that the network will be a grid with roads running east to west or north to south at intervals of a uniform distance G. Let's further assume that the objective is to minimize the annual costs of the system to the owner (FC + VC) plus the costs to the users (e.g. the system could be built by the taxpayers for the taxpayers and offered to the public without tolls).

Questions (20% each):

- a. In qualitative terms, how will G vary with increases in FC, VC, S, U1, U2, TD and D?
- b. Formulate a cost function for the system, defining any additional parameters that you need
- c. Using calculus, find an expression for the optimal value of G as a function of the other variables.

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## 1.011 Assignment 2

### Extra Credit (up to 20%):

d. Structure a spreadsheet where you can

i) Plug in values for each of the inputs, i.e.

	Option A	Option B	Option C etc.
Speed on new net S	20	50	200
Value of time for user U1	\$5	\$5	\$10
Average Distance (D)	5	50	400
Average cost per user U2	\$0.20	\$0.20	\$0.20

ii) In one or a series of steps, calculate the optimal value of G

Travel time (hours) = Distance / Speed	0.25	1.00	2.00
Value of trip time to user	\$1.25	\$5.00	\$20.00
etc.			
Optimal Grid	G1	G2	G3

c. Estimate G for a system of arterial roads circa 2000 using estimates of reflecting road and user costs today (e.g. \$1 million per mile to build the road, \$0.20/car-mile to drive on the road, \$0.02/car-mile for road maintenance, average trip length of 10 miles)

d. Estimate G for a system of limited access highways in the Northeast and in the West (make reasonable assumptions about trip density and any other inputs that you need)