CE 3201
Lab 1 - Assignment 3

Assigned Week: 9/24/2007
Due Week: 10/1/2007 (by email prior to next lab)

Objective:

This assignment helps students to understand the effects of road construction on traffic and how to evaluate alternatives of network construction. Students will be policy makers and decide how to adapt the traffic of a road network to the development of a city.

Instructions:

We use the Sioux Falls network as the background. Imagine that severe traffic jams occurred because of the growth of the city and the increased travel demand on the network. The existing road network may require improvement. As a planner of the Sioux Falls City, you are supposed to propose improvement on the network in order to adapt the traffic to the development of the city.

The total budget allocated for this project is $12,000,000. Your objective is to maximize the benefit/cost ratio of your proposal subject to this budget.

1. Investigate the existing network

Sioux Falls network is the network you are going to work on. The trip generation rate and trip attraction rate increased to 1.3 because of the growth of the city and increased economic activities. Suppose all other global variables have been calibrated by the modeler and as a planer you are *NOT* allowed to make any change to them. Set the trip generation rate and trip attraction rate to the new value, look at the outputs of the model and identify the problem of the existing network.

2. Expand the existing network

Suppose due to various constraints, you are ***NOT*** allowed to build any new road. Instead, you can only add new lanes to the existing roads to improve the network. Note that the expansion cost per lane.kilometer is $3,000,000, including land acquisition cost and construction cost. You have a total budget of $12,000,000, which is equivalent to a maximal capacity addition of 4 lane.kilometers. You can either invest all the money in one link or allocate your money to several links. You don't have to use up the budget but make sure you spend no more than $12,000,000, otherwise your project proposal will be surely turned down by the city government.

3. Calculate the benefit /cost ratio of your proposed expansion

Evolve the model after you expand the given Sioux Falls network. Examine the benefit and cost from proposed expansion in the statistics output.

3.1 Cost

Suppose the life cycle of your project is ten years. You need to calculate all the costs of your project over its entire life. These costs include the initial expansion cost, which has been given in the statistics output, and a series of annual costs, including the costs of maintenance and operation. Costs that occur at different times may be placed on a

comparable basis by reducing the future amounts to their present value.

According to (5.7) of the textbook (Fricker and Whitford, p.269), the total present value of a project can be given by

$$C = C_0 + [P \mid A, d, N] C_A - S[P \mid F, d, N]$$

where

C_0=the initial investment

C_A=the annual cost

S=Salvage value after N years

N=the life of the project

According to Figure 5.4 in the textbook, for a uniform series of cost, the present value factor is:

$$[P \mid A, d, N] = \frac{(1+r)^N - 1}{r(1+r)^N}$$

In your project of road expansion, suppose:

C_0= the expansion cost

C_A=($100,000/lane.kilometer)*added lane.kilometers

S=0

r=0.05

N=10

Please calculate the life-cycle cost (C) for your proposed expansion

3.2 Benefit

To save your time, we have calculated the life cycle benefit of proposed expansion and list it in the statistics output for you. The life cycle benefit of a proposed expansion can be calculated as:

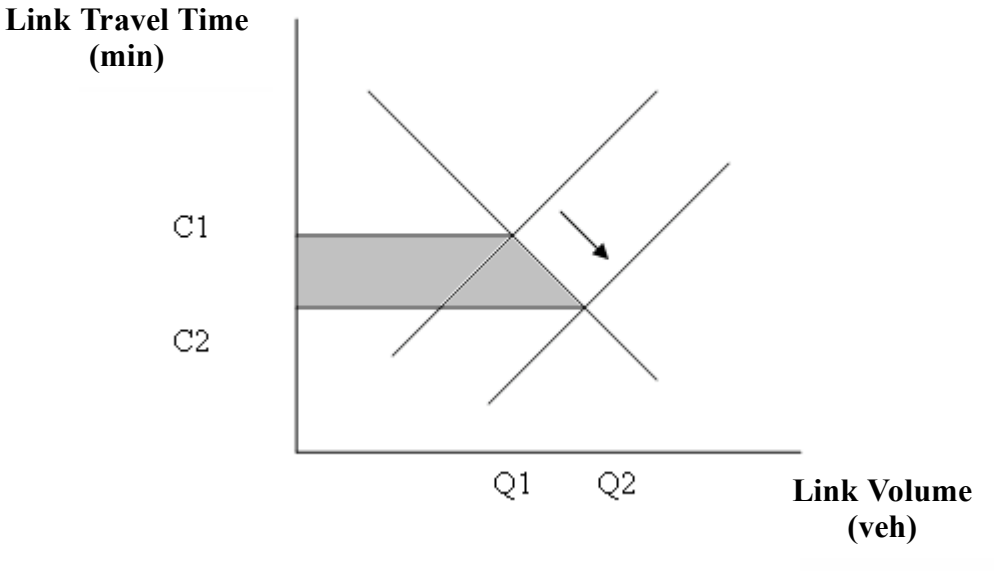
$$B = K * \sum_i \Delta CS_i$$

Where

ΔCS_i =the vehicle travel time saving during peak hour on link *i*, which can be calculated as the change in consumer surplus on this link due to your improvements.

K= a coefficient that converts the vehicle travel time saving during peak hour to the present value of life cycle benefits of proposed expansion. It is calculated for this particular project as:

K=2*Auto occupancy*VOT*life cycle length*days of year.



The change in consumer surplus is equal to the area of the shaded trapezoid in the above figure. The area (ΔCS) can be calculated as:

$$\Delta CS = 0.5*(Q1+Q2)*(C1-C2)$$

Where:
C1 = Cost in terms of link travel time on any link *i*
C2 = Cost in terms of link travel time on any link *i* on the improved network
Q1 = Total number of trips passing link *i* on the original network
Q2 = Total number of trips passing link *i* on the improved network

We sum up the consumer surplus on all the existing roads to the total travel time (minutes*veh) saved on the network due to proposed expansion.

3.3 Benefit-Cost ratio

Calculate the benefit-cost ratio of your proposed expansion as
R=B/C

4. Repeat steps 2-3 to develop alternatives of road expansion and calculate their respective benefit-cost ratios.

Tasks:

1. Read Section 5.2-5.4 of Fricker and Whitford' textbook for life cycle cost analysis, the calculation of consumer surplus and benefit-cost analysis;
2. You are asked to submit a formal proposal of 3-5 pages to the funding agency. In the report you need to 1) describe the background of this project 2) present at least three alternatives of road expansion on the given Sioux-Falls network 3) write up the benefit-cost analysis you conducted for the alternatives 4) propose only one of them for the budget and explain your choice with figures and tables.
3. You may work in groups and turn in a report as a group (no more than 4 members).