IESE
International Graduate School of Management
University of Navarra
Barcelona-Madrid

0-692-002
PN-289-E

APPLYING STUDENT MacLINDO TO A TRANSPORTATION PROJECT

Class Subject: MINIMIZING TRANSPORT COSTS THROUGH THE USE OF LINEAR PROGRAMMING (LP)

Objectives:
1. Evaluation of an existing linear program
2. Sensitivity analysis of existing LP's

Needs: A diskette with at least 400K free space. Having read this introduction, the technical note «The Transportation Method in Logistics» and the Bay Area bakeries excercise.

Introduction

You will need two (brief) sessions to the computer room for this assignment.

The first one will last about half an hour, and will enable you to answer the following questions.

1. How did the program arrive to this solution?
2. What does the information tell you?
3. How realistic is the solution?

The second session will last for about 1 hour. This one can take place only after you have thought about the implications of the program for a while, and (perhaps) come to the conclusion that some solutions may not be too realistic. Thus, you may want to instigate some changes in the program itself. After your second encounter with the Bay Area exercise, you should be able to answer the following questions:

1. Do you need any additional constraints in the Linear Program?
2. As manager of Transport and Customer Service, would you concur in the proposal to build a new bakery facility in San José?

Technical note of the Research Department at IESE.
Prepared by Professors Jan Zantinga. July 1991.

Software: Student MacLINDO
(Not very user-friendly, so please read this note first, and if needed, refer to the user's manual)

Files:

BAYTRANSPCURRENT;	BAYTRANSPSJCURRENT
BAYFULLCURRENT;	BAYFULLSJCURRENT
BAYTRANSP5;	BAYTTRANSSJ5
BAYFULL5	BAYFULLSJ5

Introduction: What is a linear program.

Theory

A linear program minimizes or maximizes an objective function, taking a number of constraints into account.

The Objective Function

Theory

The objective function is the mathematical expression of a number of variables.

Applied to the Bay Area Bakeries Excercise:

In the Bay Area Bakeries excercise, we want to minimize the cost of transporting bread from a number of bakeries to a number of markets.

The variables used refer to the routes from a specific bakery to a specific market (in order to save space, the bakeries have been renamed B1 to B7, and the markets have been renamed M1 to M11). We want to minimize the (transport or full) cost of all possible bakery-market routes (B1M1 + B1M2.......+ B2M1 + B2M2 +........ B6M11).

The coeficients before each variable in the objective function refer to the cost figures in exhibit 4.

Obviously, we cannot produce everything at the bakery with the lowest transport costs, and send it to the closest market. We have a number of *constraints.*

Constraints:

Theory:

A constraint is a linear function that gives a definite value that a number of variables have to comply with.

Applied to the Bay Area Bakeries Excercise.

There are two types of constraints in the Bay Area Bakery exercise. They are the production capacity of each bakery, and the demand in each market. Recall that the variables are set up as a bakery-market pair e.g. B1M6 denotes that we want to transport bread from Bakery #1 to Market #6.

Bakery Constraints

The constraint for each bakery is its capacity in Cwt (an American abbreviation to measure weight, called hundredweight = 100 pounds = ±50 kgs), already taking each market into account. Exhibit 2 of the case shows, for example that for bakery #1 (Santa Rosa), the capacity is 500 Cwt. The constraint in the linear program has been formulated as follows: B1M1 + B1M2 + B1M3 + B1M4 + B1M5 + B1M6 + B1M7 + B1M8 + B1M9 + B1M10 + B1M11 < 500.

All the *coeficients* are set at 1 (i.e. 1 B5M7), because this variable refers to weight, and not cost. The *right hand side* (RHS) refers to the capacity constraint for this bakery.

This type of formula has to be repeated for each of the six bakeries. Rewriting Exhibit 2, the the following constraints have been developed: (Rows 2 through 6 in the LP program, with Row 19 for the proposed San José bakery)

B2M1 + B2M2 + B2M3....... + B2M11 < 1000 (Sacramento Bakery)
B3M1 + B3M2 + B3M3....... + B2M11 < 2700 (Richmond Bakery)
B4M1 + B4M2 + B4M3....... + B2M11 < 2000 (San Franscisco Bakery)
B5M1 + B5M2 + B5M3....... + B2M11 < 500 (Stockton Bakery)
B6M1 + B6M2 + B6M3....... + B2M11 < 800 (Santa Cruz Bakery)

Market Constraints

The market demand for bread in each location is another constraint. The exact quantity will have to be supplied to each market. Exhibit 3 of the case gives current, average daily sales per market. Rewriting this using the bakery-market combinations, the following constraints have been developed for the LP program:

(Rows 7 through 18 in the program)

B1M1 + B2M1 + B3M1 + ... + B6M1 = 300 (Santa Rosa market)
B1M2 + B2M2 + B3M2 + ... + B6M2 = 500 (Sacramento market)
B1M3 + B2M3 + B3M3 + ... + B6M3 = 600 (Richmond market)
B1M4 + B2M4 + B3M4 + ... + B6M4 = 300 (Berkeley market)
B1M5 + B2M5 + B3M5 + ... + B6M5 = 300 (Oakland market)
B1M6 + B2M6 + B3M6 + ... + B6M6 = 300 (San Franscisco mkt).
B1M7 + B2M7 + B3M7 + ... + B6M7 = 300 (San José market)
B1M8 + B2M8 + B3M8 + ... + B6M8 = 300 (Santa Cruz market)
B1M9 + B2M9 + B3M9 + ... + B6M9 = 300 (Salinas market)
B1M10 + B2M10 + B3M10 + ...+ B6M10 = 300 (Stockton market)
B1M11 + B2M11 + B3M11 + ...+ B6M11 = 300 (Modesto market)