MGSC660 Group Project 1

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Part A. Merton Truck Company (1-5)

1.

a. The best product mix for Merton is to have 2000 units of model 101 and 1000 units of model 102 per month. Doing so will maximize the profit for the company, which is 2.4M dollars per month. The assumption we have is that the cost includes fixed overhead, variable overhead, direct materials, and direct labor.
b. The best product mix if engine assembly capacity were raised by one unit is to have 1999 units of model 101 and 1001 units of model 102. One extra unit of engine assembly capacity is worth 2000 dollars.
c. The increase in contribution from part b was 2000, and the increase in contribution from part c was 200000. Therefore, 200000 divides 2000 is 100. The increase in contribution is 100 times that in part b.
d. When the constraint for engine assembly is 4500, the shadow price is changed to 0 dollars. It means increasing one unit of constraint of engine assembly will not add any additional value for the company. For double checking purposes, when the constraint for engine assembly is 4499, the shadow price is still 2000 dollars. Therefore, the maximum number of units of engine assembly capacity to be added before there is a change in the value of an additional unit of capacity is 4500.

2. From question 1, we learned that the increase in contribution is 2000 dollars for 1 unit of engine assembly constraint, therefore the maximum rent it should be willing to pay for a machine-hour if engine assembly capacity is 2000 dollars. Also, from question 1 part d, the increase in number of units to be added before a change in the value of an additional unit of capacity is 500 (=4500-4000), so the maximum number of machine-hours it should rent is 500. By doing so, the company will still be able to create 1500 model 101 and 1500 model 102 per month, and make a profit of 3400000 dollars per month. This is equivalent to making engines by the company itself with the constraint of 4500 machine-hours per month, holding everything else constant.

3.

a. Merton should not produce Model 103 trucks according to the optimal solution.

b. The contribution of each Model 103 truck should be greater than 2000+350 = $2350 before it became worthwhile to produce the new model.

4.
From Sensitivity analysis of Q1 (d), we could see that the shadow price is 0, meaning no more units of engine capacity could be added before any changes in additional values per unit. Also, at a capacity of 4500 hours, we could tell from the result of Q1 that the new profit would be 3400000, where the production level for Model 101 is 1500 machine-hours and for Model 102 is 1500 machine-hours (previously for Model 101 is 2000 and for Model 102 is 1000)

Therefore:
Increase in production cost = increase in fixed overhead + increase in lab cost due to overtime
= 750000 + (1500-1000)*1200*1.5 = 1650000
Reduction in production cost = saving in labor cost for Model 101 = (2000-1500)*1200=600000

Total profit = 3400000-1650000+600000=2350000

This is lower than the original plan, where the profit = 2400000 shown in Q1(a). So Merton should not assemble engines during the overtime period.

5.

Model 101	Model 102	Total
2250	750	1900000

The optimal mix is : Model 101:2250, Model 102:750, with a total revenue with 1900000

Part B. Capital Budgeting at the McGill Corporation

a. The optimal solution is to have
    i. **P1**-Implement a new information system.
    ii. **P3**-Build a state-of-the-art recycling facility.
    iii. **P4**-Move the receiving department to new facilities on site.

This combination hits the budget limit, which is 160 million, and generates maximum NPV = 34 million.

b. The optimal solution after considering all constraints is to have:
    i. **P1**-Implement a new information system.
    ii. **P3**-Build a state-of-the-art recycling facility.

This combination consumes 128 out of 160 million budget, and generates 26 million NPV.