ISyE 3833

Final Report

James Moriarty, Michael Wang, and EJ Zhang

**Problem 2**

1. **Model**

For this model, we introduced four decision variables (, and three new parameters, . We have them defined below.

As we were aiming to minimize the costs for TruckCo, we constructed an objective function that took into account all the possible costs to run the business in every time period, and wrapped a min function around it. The objective function we constructed is as follows:

This function, explicitly, is the sum of cost of purchasing new trucks, restoring old trucks, and operating current trucks, with the salvage value subtracted from the total since it actually decreases the cost for that time period. A brief definition of each constraint is provided after each line, but we will go into more detail.

The first two constraints state that we must be operating within our business constraints and cannot operate past a certain limit and cannot restore a certain limit, respectively. The two the immediately follow model the limitations of restoring trucks. For trucks less than or equal to k = L, we say that we cannot restore those vehicles. For those above the age of k, we can restore as many vehicles as we had operating in the last time period, since restoration happens first in the new time period.

Following the constraints on restoration, we have two constraints that model the salvage business strategy. In the first of the two, we state that all trucks of age must be salvaged in that time period. In the second, we state that all trucks less than or equal to are allowed to operate in that time period, but all also have the option to be salvaged if that minimizes cost. In other words, we can salvage at most all the trucks we have before buying new ones in a time period.

Lastly, we have our operating constraints. In the first, we set the initial inventory of all trucks of type i to zero for the time period. That means, at time period , we begin the model with no initial inventory of trucks. In the second, arguably most important constraint, we bind our new variable to the number of trucks restored, salvaged, and bought in each time period. The third constraint states that all trucks newly bought have their age set to 0, and the last constraint states that our entire operation must meet the demand for each time period for each type of truck.

1. **Assumptions**

Our team’s largest assumption when starting this problem was the order in which we do each of the business operations in a given time step. We decided to order them as restoring, then salvaging, then buying new, then operating. Out of all the possible correct orders, this one yielded one of the simplest models, and we also believe it would be one of the most practical in real life. For instance, if a truck surpasses its maximum age, we would like the option to restore it before immediately salvaging it in that time period. This is why in the salvaging constraint, we have subtracted out the number of trucks restored in the time period for the right hand side. By putting buying new cars last before operating, we can simplify the model further by being able to set the number of trucks that are k = 0 to the number of new trucks bought in that time period.

Our team also assumed that the year we would start operating in is t = 1, and the time period before that, t = 0, would contain the information about incoming inventory and past operations. We thought this was most intuitive. Lastly, we assumed that monthly operational cost and monthly operational capacity are constant over months in the same year, and because of that we defined a yearly operational cost and monthly operational capacity.

1. **Solution**

Problem 3

1. **Model**

This model, its base, contains many of the same terms, variables, and constraints and the model presented in Problem 2. However, we are introducing a new decision variable:

In this new model, we also remove one of the constraints we had previously, and add two more.

These two constraints model the new system of demand, where we can choose not to meet the entire demand available. We’ve defined a new variable to represent the size we choose to meet, and constrain it to the maximum demand at that time period. That way, demand met can range anywhere from 0 to the demand available.

We also changed the objective function to include a new term representing the profit, and changed it to a maximization function that had a positive term for profit and a negative term for cost. Hence, our new objective function became as follows.

The new comprehensive list of constraints is now:

1. **Assumptions**

The assumptions in this model are presented in the problem. The first is that TruckCo is not required to accept all the available business anymore. Otherwise, the assumptions are the same as they were in the first model.

1. **Solution**

**Problem 4**