**Optimization Final Project (Updated)**

*Indexed Sets*

i = plant (i = 1...5)

~~m = product line (m=1....n)~~

j = warehouses (j = 1,...4)

k = retail center (k = 1,...8)

t = year (t = 1….10)

(I deleted the production line index here cause it looks like each plant can only open one line, so I think we can simply use the plant’s index to do the problem)

*Data:*

Dkt = demand for retail center k in year t

Ci = capacity (units) of plant i

Kit = construction cost of plant i in year t

Oit = annual operating cost of plant i in year t

Rit = reopening cost of plant/production line i in year t

Sit = shutdown cost of plant/production line i in year t

Aijt = cost of shipping a Flugel from Plant i to Warehouse j in year t

Bjkt = cost of shipping a Flugel from Warehouse j to Retail Center k in year t

Lit = cost of alloy of plant i in year t

Uit = cost of subassemblies of plant i in year t

Dit = cost of discounted subassemblies of plant i in year t

(I added ‘i’ for the last three elements cause we need to calculate the raw material costs for each plant separately)

*Objective:* minimize the total cost of meeting the expected demand over the next 10 years

min Aijt + Bjkt + Plant Costs + Cost of Alloy + Cost of Widget Subassemblies

*Decision Variables:*

zit = units of Flugels produced by plant i in year t (500 variables) (new variable, cause we need them to calculate raw material costs)

xijt = units of Flugels shipped from production line i to warehouse j in year t (200 variables)

yjkt = units of Flugels shipped from warehouse j to retail center k in year t (320 variables)

Ijt = amount of inventory stored in warehouse j in year t (40 variables)

~~How much alloy plant i should order in year t~~

~~W~~~~it~~ ~~= How many widget subassemblies should plant i order in year t~~ (I deleted them because I think they can be represented directly rather than setting a new variable!)

e1it and e2it = will be used for cost structure part. Let e1 = 1 if segment 1 is used; 0 otherwise; Let e2 = 1 if segment 2 is used; 0 otherwise. Each plant in each year have their own e (binary) (new variable, for cost structure)

λ1it,λ2it, λ3it = will be used for the cost structure when calculating the weighted units of purchased raw materials of plant i in year t. (new variable, for cost structure)

Pit = whether the plant i’s production line is open at the beginning of year t. 1: open, 0: close (binary) (I deleted the ‘m’ because I deleted the production line index before!)

Fit = whether the production line in the plant i is going to be shut down at the end of year t or not. 1: shut down, 0: close (binary) (new variable)

Git = whether the production line in the plant i was used to opened before year t or not. 1: opened before, 0: not opened before (binary) (new variable)

Hit = whether the production line in the plant i was never opened before year t or not. 1: not opened before, 0: opened before (binary) (new variable)

\*Note: the P F G H are all for the plant cost part. The H is actually the opposite of G (when H is 1, G is 0, when G is 1, H is 0). The reason why I set them separately is because I think they are both useful when we try to identify if we need reopening cost and construction cost. For example, when G = 1, it means the plant was opened before and so we will have reopening cost (now the H is 0). When H is 1, it means the plant was not opened before, and so we will have construction cost rather than reopening cost (now the G is 0)

***Plant Cost:***

+ + + (partial obj function)

\*Note:

First part: operating cost

Second part: shut down cost

Third part: reopening cost

Fourth part: construction cost

(\*\*We need to set constraints to identify the open/close conditions!)

Constraints:

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**Material cost:**

Widget:

a = total number of widget will be ordered

f(a) = cost function

f(a) = Uit\*a 0<=a<=9,000

9000\* Uit+ Dit\*(a-9000) 9,000<a<=1,000,000

Three boundaries: 0 9,000 1,000,000

a = 0 λ1it+9000 λ2it+1000000 λ3it  (number of widgets should be ordered by plant i in year t)

f(a) = (0\*Uit) λ1it+(9000\*Uit) λ2it+[9000\* Uit+ Dit\*(1000000-9000)] λ3it (partial obj function)

Constraints:

λ1it +λ2it +λ1it=1 for each i and t

λ1it<= e1it

λ2it<= e1it+e2it

λ3it<= e2it

e1it+e2it=1

0 λ1it+9000 λ2it+1000000 λ3it /3 = zit (the amount of widget purchased by plant i in year t divided by three equals to the unit of flugels produced by plant i in year t)

Alloy:

Lit\*zit (partial obj function)

Constraint:

4.7\* zit<=60000 for each i and t

**Shipping cost:**

+ (partial obj function)

Constraint:

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\*Note: At the end we add all of those 4 partial obj functions together to get a huge obj function!