INDUSTRIAL & SYSTEMS ENGINEERING
TEXAS A&M UNIVERSITY

ISEN 615 Project Report

Production Planning and Inventory Control for MSC Corporation

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1 Introduction

1.1 Management Information

MCS corporation is a manufacturer of a toy named DinoBall and has 8 retail stores dedicated to selling this product. MCS has 3 production facilities across the United States, each having multiple production lines. Currently MCS has enough workers to run production lines at each production facility for 160 hours a month or 40 hours a week and follows ‘balanced’ and ‘equal wear and tear’ policies. These policies constraint them in producing one-third of the total demand at each production facility and running each production line of each production facility for same amount of time respectively. Distribution of DinoBall is carried out by LM trucking which charges MCS corporation 20% premium to the transportation costs they incur in transferring toys from their production facility to retail stores.

1.2 Objectives

(1) Since the cost for the present scenario is higher for MCS corporation, it wants to remove the policy of producing the same number of toys at each production facility and optimize the production at different facilities, to minimize total production and transportation costs. Since, MCS corporation is skeptical about the restructuring of the workers among their facilities, it would like to determine the total amount of savings this optimized ‘New Plan’ can bring to their firm when compared to their current system of use.

(2) Apart from the optimized production planning at different facilities, MCS corporation would also like to get suggestions and advice on an potential opportunity to update all of its production lines with the new technology ‘FastProd’, which would increase the production rate and decrease the overall production cost of all the production lines. However, the life cycle of such technology is only 3 years. MCS would like to know the maximum amount that can be paid to upgrade all production lines with ‘FastProd’ technology.

1.3 Approach

Both objectives described in section 1.2 can be achieved by formulating and solving Linear Programming (LP) models.

Since MCS currently follows an ‘equal wear and tear’ policy, we can combine the total energy cost incurred by production lines as they would run the same amount of time. This gives us the total cost of a production facility for operating any amount of time.

According to the ‘balanced’ policy, each production facility will produce around one-third of the total demand. Since the cost for shipping is different from each facility to retail stores, we build an LP model per month to accommodate demands at retail store and minimize the shipping cost.

Since the production capacity and cost at each facility is different, we can optimize the monthly production at each facility considering the shipping cost from the facility location and the demands using LP models. This would help us achieve the first objective. For the second objective, we consider the same approach with different production capacity and cost according to the ‘FastProd’ technology and the facility location respectively.

2 Model Formulation

2.1 Data

The below Data is provided by the MCS corporation.

(a) Monthly demand of previous year for each retail store.
(b) Per unit transportation costs from each production facilities to each retail store.
(c) Energy utilized per unit produced by each production line at each production facility and associated energy costs.
(d) Energy utilized per unit produced by ‘FastProd’ technology and associated costs based on the location of production facility.

2.2 Assumptions

Based on the available data following assumptions are made while solving the LP model:

(a) There are no restrictions related to emissions from the production lines.
(b) There is no upper limit on the energy consumed by any production line.
(c) The cost of the workers is equal at each production facility.
(d) There is a constant workforce available for the production and there is no hiring and firing of the workers.
(e) Future demand would be the same as historical demand and demand would remain constant for the next 3 years.
(f) The only costs that would matter in production and shipment are the costs incurred due to energy consumption and costs incurred for distributing product from production facility to the retail stores respectively.
(g) Each truck carries approximately 250 units of DinoBall product, and even if a route involves carrying production units which are not a multiple of 250, the overall per unit transportation cost would remain the same.

2.3 LP Formulation

The constants, decision variables, constraints and objective functions used for the formulation of LP models are given below. The notation i refers to production facility [1,3] and j refers to retail store [1,8]. Since LM trucking charges 20% Premium, we multiply the shipping cost to 1.2 to calculate the shipping cost for MCS. The LP is formulated and solved 12 times for 12 months of a year for all production plans. We find the total yearly cost by adding optimized monthly production and shipping cost.

2.3.1 Constants

Demand at retail store	$\mathbf{D_j}$
Cost to ship one product from production facility to retail store	$\mathbf{C_{ij}}$
Cost of operating production facility for an hour	$\mathbf{P_i}$

2.3.2 Decision Variables

Number of units transferred from production facility to retail store	$\mathbf{X_{ij}}$
Production hours of facility	$\mathbf{H_j}$
Number of units produced by the facility	$\mathbf{U_j}$

2.3.3 Constraints

Number of shipping products should be integer	**Should be Integer**
Number of production units in each facility integer	**Should be Integer**
Sum of shipping products from any facility should be equal to manufactured units	$\sum \mathbf{X_{ij}} = \mathbf{U_i}$ **for all i**
Total number of shipped products to any retail store should be equal to demand	$\sum \mathbf{X_{ij}} = \mathbf{D_j}$ **for all j**
Production hours in any month should not be higher than 160	$\mathbf{P_i} \leq \mathbf{160}$ **for all i**

2.3.4 Objective Functions

(A) <u>Current ‘balanced’ Plan LP objective function:</u>

Minimize Shipping Cost per month = $\mathbf{1.2 \times \sum S_{ij}\, X_{ij}}$

(B) <u>New ‘optimized’ Plan LP objective function:</u>

Minimize Production and Shipping Cost per month = $\mathbf{1.2 \times \sum S_{ij}\, X_{ij} + \sum P_i\, H_i}$
Where P_1 = \$109.5, P_2 = \$133.2, and P_3 = \$67.95
This New plan is the optimized production plan as opposed to current ‘balanced’ plan

(C) <u>FastProd Plan LP objective function:</u>

Minimize Production and Shipping Cost per month = $\mathbf{1.2 \times \sum S_{ij}\, X_{ij} + \sum P_i\, H_i}$
Where P_1 = \$135, P_2 = \$162, and P_3 = \$81
This FastProd plan is the production plan if all production lines will be upgraded with ‘FastProd’ lines.

3 Results and Conclusion

After solving the above-mentioned linear programming models, we obtained the monthly production and shipping cost for different production plans as shown in below Table.

Month of the year	Current Plan Cost		New Plan Cost		FastProd Plan Cost	
	Production	Shipping	Production	Shipping	Production	Shipping
January	17991.42	502.27	13609.50	722.11	5315.63	722.11
February	18635.32	505.47	14217.83	717.44	5596.88	717.44
March	19279.22	552.61	14826.17	763.58	5878.13	763.58
April	19885.25	617.09	15434.50	809.09	6159.38	809.09
May	18332.31	568.74	13913.67	786.62	5456.25	786.62
June	18711.07	555.60	14278.67	718.39	5625.00	718.39
July	18067.17	1153.97	13670.33	786.78	5343.75	786.78
August	18938.33	629.50	14522.00	788.61	5737.50	788.61
September	16438.47	496.23	12088.67	705.15	4612.50	705.15
October	18635.32	500.23	14217.83	704.06	5596.88	704.06
November	23672.92	625.47	19084.50	828.35	7846.88	828.35
December	29051.40	865.46	24255.33	1057.54	11306.25	1753.98
Annual Cost	237638.20	7572.64	184119	9387.72	74475	10084.17
Total cost	**$ 245,210.85**		**$ 193,506.72**		**$ 84,559.17**	

Based on the total annual production and shipping costs incurred by the MCS corporation in their available plans, we can conclude following.

(a) We can see in the table that the annual cost of new production plan is very less than the current plan. Thus, MCS should remove ‘balanced’ policy and aim for optimized unbalanced production plan. However, according to the new plan, production facility at Harrisburg, PA would run at nearly the full load, while the facility at Newark, NJ can be closed down as no production would happen there. The reason for that is the production cost at Newark, NJ is very high. Furthermore, for each month the demand that cannot be met by the production at the Harrisburg facility, should be produced at Troy, NY. The reason for such a high imbalance is that the production cost of DinoBall is significantly higher than the shipping cost and LP would try to optimize the production cost first. By adapting the new production plan, MCS can save $ 51,704.13 per year if the demand is assumed to be same as previous year.

(b) If MCS considers upgrading all production lines with the new ‘FastProd’ technology given that MCS is unsure about how much they can earn by selling old production lines, the reserve price for this contract would be $ 481,955.04 (3×245,210.85 – 3×84,559.17). This reserve price is the same as the amount MCS would save in 3 years if ‘FastProd’ technology is utilized. If MCS considers FastProd plan over new proposed optimized plan, then it should not pay more than $346,842.65 (3×193,506.72 – 3×84,559.17) as a reserve price. Also, according to the FastProd plan, the facility at Harrisburg, PA would run at full capacity and the Newark, NJ facility would not be producing at all, while excess demands would be met by facility at Troy, NY.