OPTIMIZATION FINAL REPORT

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PROBLEM OVERVIEW

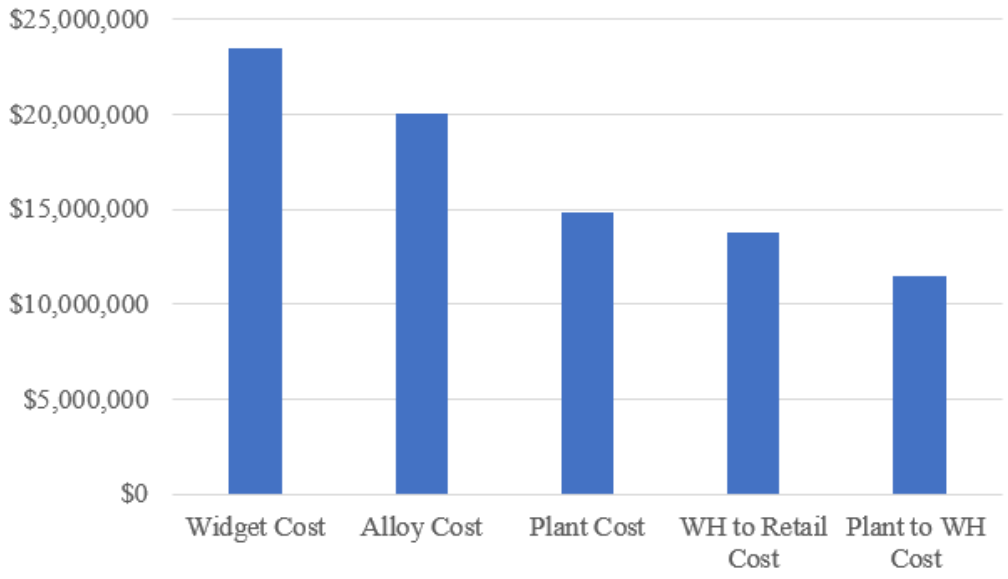
Our company, XYZ Manufacturing, is interested in producing and selling a new product called the Flugel. To ensure the success of this product development strategy, our team has been tasked with investigating XYZ's capabilities and constraints related to the production and distribution of the Flugel. The product will require new production lines at our manufacturing plants and will be stored in our existing warehouses. Based on forecasted yearly demand, Flugels will be shipped to eight different retail centers, where they will be sold to customers. Taking these factors into account, our goal for this project is to minimize the total cost of producing the Flugel, while meeting projected demand over the next ten years. While this is a large and potentially risky endeavor for XYZ Manufacturing, our analysis provides clarity and assurance on how the Flugel can be produced and distributed effectively.

SUMMARY OF ANALYSES

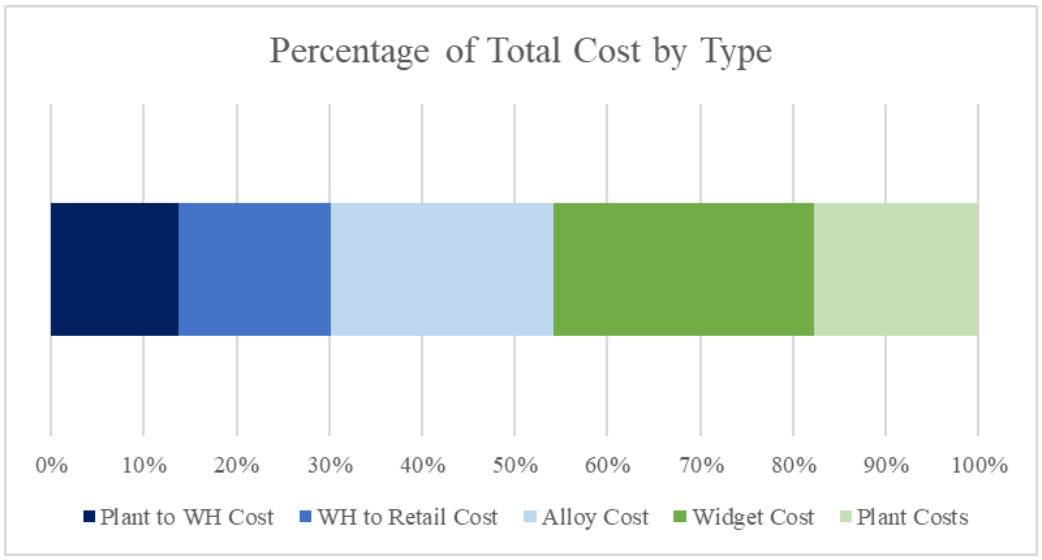
Accounting for all constraints related to resources, plant and warehouse capacity, and demand, our total minimized cost for this 10-year project is **$83,584,400**. The way in which we arrived at this solution can be found in our written formulation of the model in *Appendix A* and corresponding code in *Appendix B*.

Graph 1 shows a summary of total costs by type from most to least, and **Graph 2** shows the percentage that each cost type contributes to the total cost. As shown in the graphs, XYZ Manufacturing's resource costs are significant. Purchasing alloy and widget subassemblies for each Flugel accounts for 52% of the $83.5 million. If possible, we recommend that management explore other suppliers or try negotiating with current suppliers to reduce these costs in an effort to further minimize total costs for the 10-year period. Shipping costs from plant to warehouse and warehouse to retail center are similar and relatively low. The remaining cost portion is the result of constructing and operating Flugel production lines at the plants, which we assume to be relatively inflexible.

Graph 1: Cost Type Summary



Graph 2: Cost Type Percentages



To achieve a minimized cost of $83,584,400, we recommend that XYZ Manufacturing produce the number of Flugels per plant per year listed in **Table 1**. Plant 1 should operate for the entire period given that it has the highest production capacity of 16000 units. Then, production lines at Plant 2 should open in Year 3 and lines at Plant 3 in Year 8. Our model does not recommend conducting Flugel production in Plant 4 or Plant 5 in order to save on construction and operating costs.

Table 1: Flugels Produced per Plant per Year

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total
Plant 1	10,200	12,480	12,766	12,766	12,766	12,766	12,766	12,766	12,766	12,766	124,808
Plant 2	0	0	1,994	4,274	6,554	8,834	11,114	628	2,908	5,188	41,494
Plant 3	0	0	0	0	0	0	0	12,766	12,766	12,766	38,298
Plant 4	0	0	0	0	0	0	0	0	0	0	0
Plant 5	0	0	0	0	0	0	0	0	0	0	0
Total	10,200	12,480	14,760	17,040	19,320	21,600	23,880	26,160	28,440	30,720	

The following **Charts 1, 2, and 3** provide a more detailed look at the costs XYZ Manufacturing will incur in particular years in order to construct, start up, and operate the Flugel production line at a plant. It is important to plan for this significant investment in construction and reopening (i.e. start-up) costs. It is worth noting that Plant 3's operating cost for 2 years was over one-third of Plant 1's operating cost for 10 years, which supports our finding that Plant 1 is open for the entire 10-year period. Since Plant 1 is operating at such a high level, we recommend that management also prepare for the risk of unexpected maintenance costs due to overuse.

Charts 1, 2, and 3: Costs Associated with Plant Operations

Construction Cost per Plant		
Construction	**Year**	**Total Cost**
Plant 1	1	$2,000,000.00
Plant 2	3	$1,697,440.00
Plant 3	8	$2,213,772.96

Chart 1

Reopening Cost per Plant		
Reopening	**Year**	**Total Cost**
Plant 1	1	$190,000
Plant 2	3	$159,135
Plant 3	8	$196,779.82

Chart 2

Operation Cost per Plant			
Operation	**Year**	**Total Years**	**Total Cost**
Plant 1	1 to 10	10	$4,814,829.31
Plant 2	3 to 10	7	$3,584,874.14
Plant 3	8 to 10	2	$1,748,651.88

Chart 3

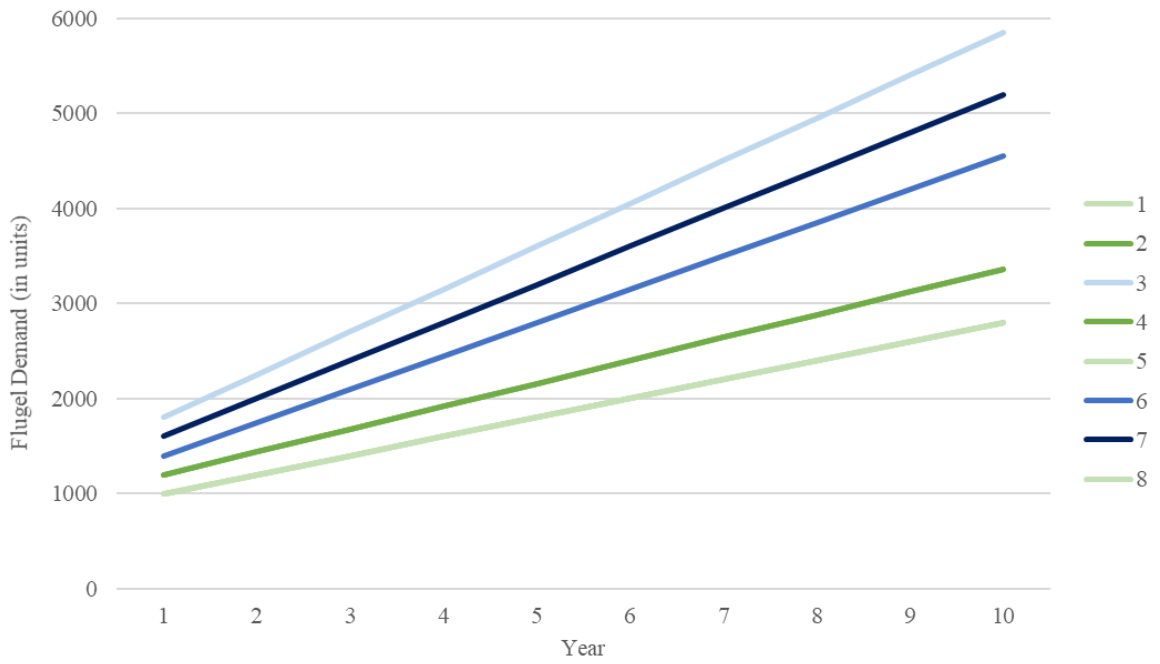
Following production, all Flugels are shipped and stored in one of our four existing warehouses, which have a capacity of 12,000 Flugels per year. **Table 2** shows the assignment of Flugels to warehouses per year. Warehouse 3 is utilized the least, while Warehouse 2 is at maximum capacity for most years.

Table 2: Flugels Stored per Warehouse per Year

	year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	year 9	year 10	Total
Warehouse 1	1,000	0	3,080	8,800	3,960	12,000	11,880	2,160	12,000	12,000	66,880
Warehouse 2	9,200	12,000	11,680	8,240	12,000	2,000	12,000	12,000	12,000	12,000	103,120
Warehouse 3	0	0	0	0	0	7,600	0	0	4,440	2,250	14,290
Warehouse 4	0	480	0	0	3,360	0	0	12,000	0	4,470	20,310
Total	10,200	12,480	14,760	17,040	19,320	21,600	23,880	26,160	28,440	30,720	

Our team does not recommend storing any Flugels in inventory from one year to the next, so all Flugels in each warehouse for a particular year will be used to satisfy demand for that year. With the above production recommendations from our model, XYZ Manufacturing is able to meet increasing yearly demand of each retail center, which is visualized in **Graph 3**. Based on our projections, demand for Flugels increases at a constant rate of either 20% or 25%. Retail Centers 1, 5, and 8 have the same demand (light green line), and Retail Centers 2 and 4 have the same demand (dark green line). Management should consider the possibility that these forecasts are incorrect and what effect that would have on production costs in order to continue satisfying demand. We recommend that management review the amount of Flugels ordered by each retail center at the end of every year and adjust accordingly. Our model can be updated to reflect any drastic changes in demand in order to continue meeting our objective.

Graph 3: Retail Center Yearly Demand



CONCLUSION

In conclusion, we hope that management will implement our model to help achieve its goal of Flugel production and distribution over the next 10 years. Our team's recommendations enable XYZ Manufacturing to minimize its total production, operation, and resource costs for the time period to equal $83,584,400, while always satisfying retail center demand.

APPENDIX

Appendix A

Model Formulation_Team 13 (.pdf)

Appendix B

Final Project Code_Team 13 (.py)

Appendix C

Final Project Model_Team 13 (.lp)

Appendix D

Final Project Data_Team 13 (.xlsx)

Appendix E

Final Project Values_Team 13 (.xlsx)