QUANTITATIVE MANAGEMENT MODELING
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Assignment 1

Question 1:

A. Clearly define the decision variables

C = The number of Collegiate backpacks to produce per week.
M = The number of Mini backpacks to produce per week.

B. What is the objective function?

The objective is to maximize the Total Profit (TP) generated by producing Collegiate and Mini backpacks.

Objective Function: Maximize TP (Total Profit)
$TP = 32C + 24M$

C. What are the constraints?

Material Constraint: The total square footage of nylon used cannot exceed the 5000 square feet available each week.

$3C + 2M \leq 5000$

Demand Constraint for Collegiate: The number of Collegiate backpacks produced cannot exceed 1000 per week.

$C \leq 1000$

Demand Constraint for Mini: The number of Mini backpacks produced cannot exceed 1200 per week.

$M \leq 1200$

Labor Constraint: The total labor hours used cannot exceed the available labor hours (35 laborers, each providing 40 hours per week)
.
$45C + 40M \leq 35 * 40$

Non-negativity Constraint: The number of each type of backpack produced cannot be negative.

$C \geq 0,$
$M \geq 0$

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D. Write down the full mathematical formulation for this LP problem.

The linear programming problem can be formulated as follows:

Objective Function:
Maximize $TP = 32C + 24M$

Subject to the following constraints:

Material Constraint: $3C + 2M \leq 5000$
Demand Constraint for Collegiate: $C \leq 1000$
Demand Constraint for Mini: $M \leq 1200$
Labor Constraint: $45C + 40M \leq 35 * 40$
Non-negativity Constraint: $C \geq 0, M \geq 0$

This formulation defines the objective of maximizing Total Profit (TP) while adhering to material availability, demand, labor, and non-negativity constraints.

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Question 2:

A. Define the decision variables

To maximize the Weigelt Corporation's profit, we need to determine the quantity of the new product, irrespective of its size, to be manufactured at each plant.

Key Definitions: Xi represents the number of units produced at each plant, where i = 1 (Plant 1), 2 (Plant 2), 3 (Plant 3).

L, M, and S denote the product sizes, with L representing large, M representing medium, and S representing small.

Decision Variables:

XiL signifies the number of large-sized items produced at plant i.

XiM signifies the number of medium-sized items produced at plant i.

XiS signifies the number of small-sized items produced at plant i.

B. Formulate a Linear Programming for this Problem:

Maximize Profit (Z) by producing different sizes at each plant:

$Z = 420(X1L + X2L + X3L) + 360(X1M + X2M + X3M) + 300(X1S + X2S + X3S)$

Constraints:

Total number of size units produced regardless of the plant:

$L = X1L + X2L + X3L$
$M = X1M + X2M + X3M$
$S = X1S + X2S + X3S$

Production Capacity Constraints for Each Plant:

Plant 1: $X1L + X1M + X1S \leq 750$
Plant 2: $X2L + X2M + X2S \leq 900$
Plant 3: $X3L + X3M + X3S \leq 450$

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In-Process Storage Constraints for Each Plant:

Plant 1: $20X1L + 15X1M + 12X1S \leq 13{,}000$
Plant 2: $20X2L + 15X2M + 12X2S \leq 12{,}000$
Plant 3: $20X3L + 15X3M + 12X3S \leq 5{,}000$

Sales Forecast Constraints:

Large Size: $L \leq 900$
Medium Size: $M \leq 1{,}200$
Small Size: $S \leq 750$

Non-negativity Constraints:

$XiL \geq 0$
$XiM \geq 0$
$XiS \geq 0$ *(for* $i = 1, 2, 3$*)*

Percentage Utilization Constraint:
To ensure the same percentage of excess capacity utilization for each plant, introduce a new decision variable, Y, and set it equal to the percentage of excess capacity used. Here's how you can express this constraint:

$Y = (X1L + X1M + X1S) / 750$
$Y = (X2L + X2M + X2S) / 900$
$Y = (X3L + X3M + X3S) / 450$

These equations ensure that the percentage of excess capacity used is the same for all three plants.

This formulation defines the objective of maximizing Total Profit (Z) while adhering to production capacity, in-process storage, sales forecasts, and the requirement for the same percentage of excess capacity utilization at each plant to avoid layoffs