

Back Savers is a company that produces backpacks primarily for students. They are considering offering some combination of two different models—the Collegiate and the Mini. Both are made out of the same rip-resistant nylon fabric. Back Savers has a long term contract with a supplier of the nylon and receives a 5000 square-foot shipment of the material each week. Each Collegiate requires 3 square feet while each Mini requires 2 square feet. The sales forecasts indicate that at most 1000 Collegiates and 1200 Minis can be sold per week. Each Collegiate requires 45 minutes of labor to produce and generates a unit profit of \$32. Each Mini requires 40 minutes of labor and generates a unit profit of \$24. Back Savers has 35 laborers that each provides 40 hours of labor per week. Management wishes to know what quantity of each type of backpack to produce per week.

- Clearly define the decision variables
- What is the objective function?
- What are the constraints?
- Write down the full mathematical formulation for this LP problem

There are two different Models: The Collegiate and The Mini

Material available as per contract: Nylon: 5000 sft/week

	Product information		Production hours available	
	Products			
Specification	Collegiate	Mini		
Nylon Required (Sft)	3	2	Labor(number)	35
Orders/Week(count)	1000	1200	Labor hours/head	40
Time Required(mins)	45	40	Total Labor mins	84000
Profit(dollars)	\$32	\$24		

The central objective of the Back Savers is to identify the maximum quantity of backpacks that it can produce per week. This can be done by finding a right combination of the collegiate and Mini models. Production is calculated to maximize the profit. Hence we consider the profit of the organization alongside the quantity. The resources required for producing the backpacks is Nylon and Back Savers gets 5000 square feet of Nylon per week. This indicates that they must make a right combination of both the models within the 5000 square feet Nylon every week.

The decision Variables for this problem are the two models:

The Collegiate Model(A)

The Mini Model(B)

The objective function is the maximum production output per week

$$A + B = 2200$$

Maximum production means profit maximization that Back Savers can make per week. From each product the profit maximization can be given as

$$32A + 24B = P \text{ where } P \text{ is Profit}$$

The Constraint for the problem is the material required to produce the backpacks. We have 5000 Square Feet. Collegiate takes 3sft Nylon whereas the Mini takes 2sft. So, the mathematical expression for constraints is

$$3A + 2B = 5000$$

The second constraint is the labor availability. The collegiate takes 45 mins for production whereas the mini takes 40 mins. The total labor hours available are

$$35\text{people} * 40\text{hours} = 1400 \text{ hours/week}$$

$$45A + 40B = 84000 \text{ mins/week}$$

The final mathematical formulation for this linear programming model is as follows

A is the number of collegiate backpacks produced per week

B is the number of mini backpacks produced per week

P is the Profit from the products.

$$\text{Max Production } (A + B) = 2200$$

$$\text{Max: } P(\text{dollars}) = 32A + 24B$$

Subject to

$$A \leq 1000 \text{ Square feet}$$

$$B \leq 1200 \text{ square feet}$$

$$A, B \geq 0$$

$$45A + 40B \leq 84000 \text{ mins}$$

$$3A + 2B \leq 5000 \text{ square feet}$$