Advanced Business Modeling
CIS 418

The Toy Story Problem

The Toy-Story Problem

- Toy Story Company manufactures at its factory four types of unique high-quality collectable dolls: Woody, Jessie, Buzz and Rex. The average material costs for each of the products are:

Product	Woody	Jessie	Buzz	Rex
Material cost	$66	$85	$50	$80

- Each product is made in a delicate production process that includes decorating, dressing and finally packaging it for shipping. Woody and Jessie are processed in Department 1, while Buzz and Rex are processed in Department 2. The cost of production of one unit doll in Department 1 is $16, and the cost of production of one unit doll in Department 2 is $12.

- The company considers advertising for increasing sales.

Market Survey

- The company carried out a market survey that had the following results:

Product	Woody	Jessie	Buzz	Rex
Selling price (per unit)	$ 120.00	$ 150.00	$ 100.00	$ 160.00
Current demand	60000	20000	100000	35000
Max Advertising effect on demand (in %)	12	1	8	15

- According to the survey results that are given in the table, if the company sells Woody for $120, the current demand would be 60,000 units. However, if the company invests in advertising, it can increase the demand for Woody dolls by up to 12%. The price, demand and potential increase for the other dolls are given in the table above.

Advertisement to increase demand

- Assuming that the company is not interested in changing the sell prices, and that it is obligated to satisfy the current demand, the company considers increasing the demand by investing in advertising. The advertising costs for an increase of 1% in the demand for Woody is $5000, for Jessie is $5000, for Buzz is $3000, and for rex is $4000. The following table summarizes the advertising costs for an increase of 1% in the demand for each doll:

For every 1% increase in the demand	Woody	Jessie	Buzz	Rex
Advertising cost	$ 5,000.00	$ 5,000.00	$ 3,000.00	$ 4,000.00

- However, the company has a budget limit of $18,000 on the total amount to be spent on advertising among all four products.

Formulize the problem

- Objective:

  Maximize profit

- Decision Variables:

  By how much to increase sales per doll

- Constraints:

  Non-negative decision variables

  Advertising budget

- Calculations:

  - Production plan

  - Production cost

  - Advertising cost

  - Revenue

  - Profit

  To solve the problem, go to "Toy_story.xlsx"

Questions:

a. What is an optimal production plan for the company?

b. What is the shadow price of another dollar for advertising?

c. The company faces a problem of labor shortage. Department 1 cannot produce more than 90,000 units overall. Department 2 cannot produce more than 140,000 units. How does the labor shortage affect the production plan? Note that the advertising budget does not change and it remains $18000.