

The cost of subcontracting in stage 1 adds 20% to the regular production cost.

The Spring Company wants to establish a production schedule for regular and overtime production in each stage and for the number of tool heads subcontracted, at the minimum cost.

Formulate a linear programming model for this problem and solve the model using the computer. Which resources appear to be most critical in the production process?

Case Problem

SUSAN WONG'S PERSONAL BUDGETING MODEL

After Susan Wong graduated from State University with a degree in management science, she went to work for a computer systems development firm in the Washington, DC, area. As a student at State, Susan paid her normal monthly living expenses for apartment rent, food, and entertainment out of a bank account set up by her parents. Each month they would deposit a specific amount of cash into Susan's account. Her parents also paid her gas, telephone, and bank credit card bills, which were sent directly to them. Susan never had to worry about things like health, car, homeowners', and life insurance; utilities; driver's and car licenses; magazine subscriptions; and so on. Thus, while she was used to spending within a specific monthly budget in college, she was unprepared for the irregular monthly liabilities she encountered once she got a job and was on her own.

In some months Susan's bills would be modest and she would spend accordingly, only to be confronted the next month with a large insurance premium, or a bill for property taxes on her condominium, or a large credit card bill, or a bill for a magazine subscription, and so on the next month. Such unexpected expenditures would result in months when she could not balance her checking account; she would have to pay her bills with her bank credit card and then pay off her accumulated debt in installments while incurring high interest charges. By the end of her first year out of school, she had hoped to have some money saved to begin an investment program, but instead she found herself in debt.

Frustrated by her predicament, Susan decided to get her financial situation in order. First, she sold the condominium that her parents had helped her purchase and moved into a cheaper apartment. This gave her enough cash to clear her outstanding debts, with \$3,800 left over to start the new year with. Susan then decided to use some of the management science she had learned in college to help develop a budget. Specifically, she decided to develop a linear programming model to help her decide how much she should put aside each month in short-term investments to meet the demands of irregular monthly liabilities and save some money.

First, Susan went through all her financial records for the year and computed her expected monthly liabilities for the coming year, as shown in the following table:

| Month | Bills | Month | Bills |
|----------|---------|-----------|---------|
| January | \$2,750 | July | \$3,050 |
| February | 2,860 | August | 2,300 |
| March | 2,335 | September | 1,975 |
| April | 2,120 | October | 1,670 |
| May | 1,205 | November | 2,710 |
| June | 1,600 | December | 2,980 |

Susan's after-taxes-and-benefits salary is \$29,400 per year, which she receives in 12 equal monthly paychecks that are deposited directly into her bank account.

Susan has decided that she will invest any money she doesn't use to meet her liabilities each month in either 1-month, 3-month, or 7-month short-term investment vehicles rather than just leaving the money in an interest-bearing checking account. The yield on 1-month investments is 6% per year nominal; on 3-month investments, the yield is 8% per year nominal; and on a 7-month investment, the yield is 12% per year nominal. As part of her investment strategy, any time one of the short-term investments comes due, she uses the principal as part of her budget, but she transfers any interest earned to another long-term investment (which she doesn't consider in her budgeting process). For example, if she has \$100 left over in January that she invests for 3 months, in April, when the investment matures, she uses the \$100 she originally invested in her budget, but any interest on the \$100 is invested elsewhere. (Thus, the interest is not compounded over the course of the year.)

Susan wants to develop a linear programming model to maximize her investment return during the year so she can take that money and reinvest it at the end of the year in a longer-term investment program. However, she doesn't have to confine herself to short-term investments that will all mature by the end of the year; she can continue to put money toward the end of the year in investments that won't mature until the following year. Her budgeting process will continue to the next year, so she can take out any surplus left over after December and reinvest it in a long-term program if she wants to.

- Help Susan develop a model for the year that will meet her irregular monthly financial obligations while achieving her investment objectives and solve the model.
- If Susan decides she doesn't want to include all her original \$3,800 in her budget at the beginning of the year, but instead she wants to invest some of it directly in alternative longer-term investments, how much does she need to develop a feasible budget?