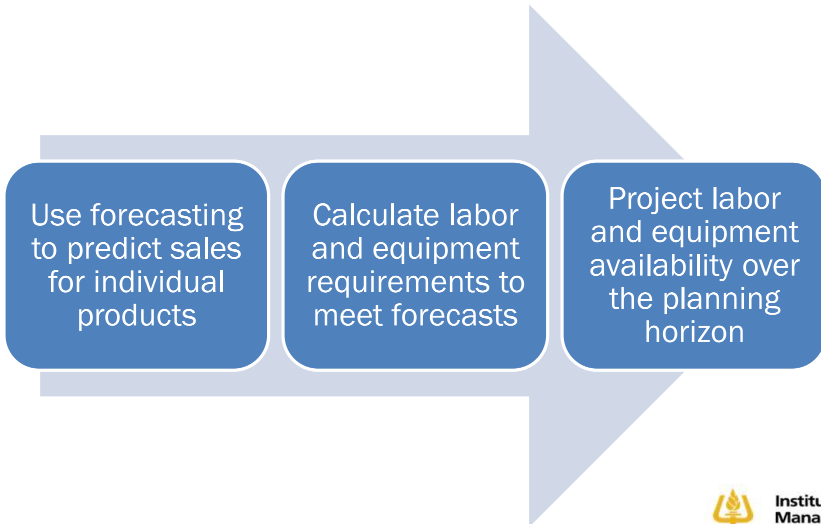
# Determining Capacity Requirements

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# Example 5.1—Determining Capacity Requirements

- Stewart Company produces two flavors of salad dressing
  - Paul's and Newman's
- Each is available in bottles and single-serving bags
- Have three machines that can package 150,000 bottles each year
  - Each machine requires two operators
- Have five machines that can package 250,000 plastic bags per year
  - Each machine requires three operators
- What are the capacity and labor requirements for the next five years?

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# Step 1: Use Forecast to Predict Sales for Individual Products

| | Year 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Paul's** | | | | | |
| Bottles (000s) | 60 | 100 | 150 | 200 | 250 |
| Plastic bags (000s) | 100 | 200 | 300 | 400 | 500 |
| **Newman's** | | | | | |
| Bottles (000s) | 75 | 85 | 95 | 97 | 98 |
| Plastic bags (000s) | 200 | 400 | 600 | 650 | 680 |

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# Step 2: Calculate Equipment and Labor Requirements

Bottling Operation

- Capacity: 450,000
  - 150,000 x 3
- Operators: 6
  - 2 x 3
- Year 1
  - $Capacity\ utilization = \frac{135}{450} = 0.3$
  - $Machine\ requirement = 0.3 \times 3 = 0.9$
  - $Labor\ requirement = 0.9 \times 2 =$ 1.8

Bagging Operation

- Capacity: 1,250,000
  - 250,000 x 5
- Operators: 15
  - 3 x 5
- Year 1
  - $Capacity\ utilization = \frac{300}{1,250} =$ 0.24
  - $Machine\ requirement = 0.24 \times 5 = 1.2$
  - $Labor\ requirement = 1.3 \times 3 = 3.6$

| | Year 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Bottles (000s) | 135 | 185 | 245 | 297 | 348 |
| Plastic bags (000s) | 300 | 600 | 900 | 1,050 | 1,180 |

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# Step 3: Project Equipment and Labor Availabilities over the Planning Horizon

| | Year 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Bottle Operation** | | | | | |
| Percentage capacity utilized | 30 | 41 | 54.4 | 66 | 77.3 |
| Machine requirement | 0.9 | 1.23 | 1.63 | 1.98 | 2.32 |
| Labor requirement | 1.8 | 2.46 | 3.26 | 3.96 | 4.64 |
| **Plastic Bag Operation** | | | | | |
| Percentage capacity utilized | 24 | 48 | 72 | 84 | 94 |
| Machine requirement | 1.2 | 2.4 | 3.6 | 4.2 | 4.7 |
| Labor requirement | 3.6 | 7.2 | 10.8 | 12.6 | 14.1 |







# Using Decision Trees to Evaluate Capacity Alternatives

- A decision tree is a schematic model of the sequence of steps in a problem – including the conditions and consequences of each step
- Decision trees help analysts understand the problem and assist in identifying the best solution
- Decision tree components include the following:
  - Decision nodes – represented with squares
  - Chance nodes – represented with circles
  - Paths – links between nodes
- Work from the end of the tree backwards to the start of the tree
- Calculate expected values at each step

## Example 5.2: Decision Trees

- The owner of Hackers Computer Store is evaluating three options – expand at current site, expand to a new site, do nothing
- The decision process includes the following assumptions and conditions
  - Strong growth has a 55% probability
  - New site cost is $210,000
    - Payoffs: strong growth = $195,000; weak growth = $115,000
  - Expanding current site cost is $87,000 (in either year 1 or 2)
    - Payoffs: strong growth = $190,000; weak growth = $100,000
  - Do nothing
    - Payoffs: strong growth = $170,000; weak growth = $105,000

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## Calculate the value of each alternative

| ALTERNATIVE | REVENUE | COST | VALUE |
|---|---|---|---|
| Move to new location, strong growth | $195,000 × 5 yrs | $210,000 | $765,000 |
| Move to new location, weak growth | $115,000 × 5 yrs | $210,000 | $365,000 |
| Expand store, strong growth | $190,000 × 5 yrs | $87,000 | $863,000 |
| Expand store, weak growth | $100,000 × 5 yrs | $87,000 | $413,000 |
| Do nothing now, strong growth, expand next year | $170,000 × 1 yr + $190,000 × 4 yrs | $87,000 | $843,000 |
| Do nothing now, strong growth, do not expand next year | $170,000 × 5 yrs | $0 | $850,000 |
| Do nothing now, weak growth | $105,000 × 5 yrs | $0 | $525,000 |

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## Diagram the Problem Chronologically

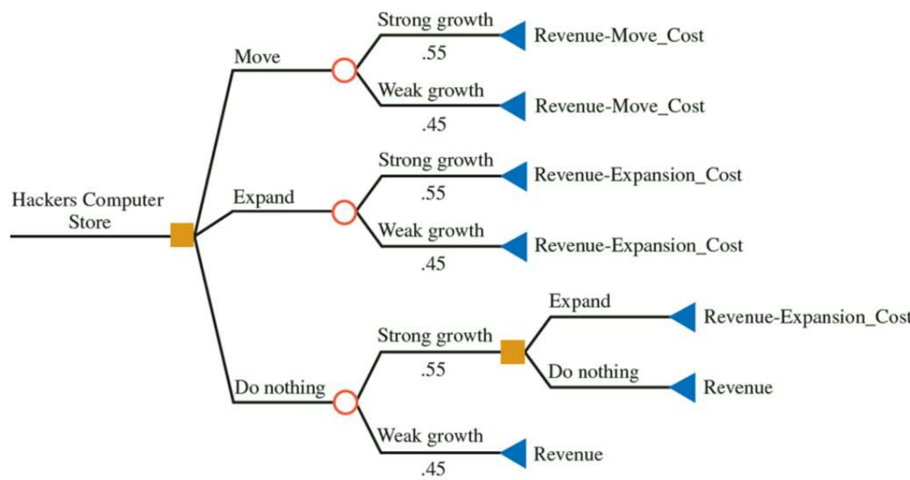


Exhibit 5.3

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## Calculate Value of Each Branch

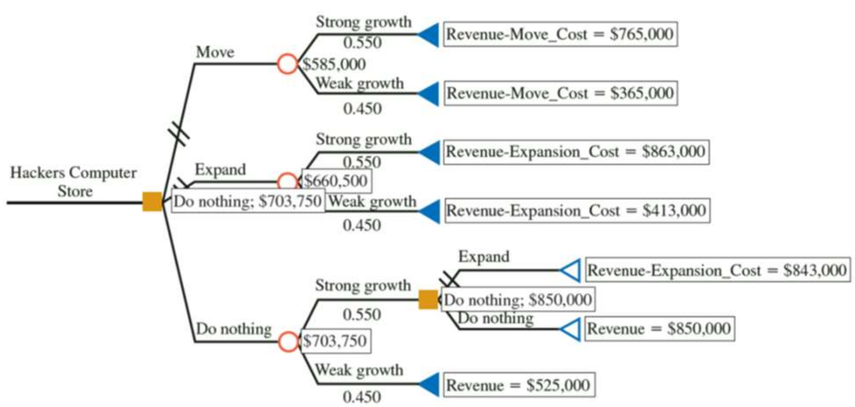


Exhibit 5.4

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# Decision Tree Analysis with Net Present Value Calculations

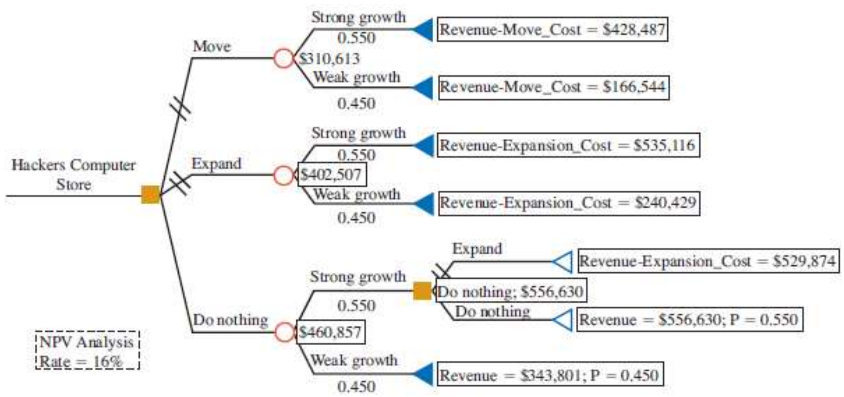


Exhibit 5.5

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## Planning Service Capacity

| Manufacturing Capacity | Service Capacity |
|---|---|
| Goods can be stored for later use | Capacity must be available when service is needed – cannot be stored |
| Goods can be shipped to other locations | Service must be available at customer demand point |
| Volatility of demand is relatively low | Much higher volatility is typical |

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# Capacity Utilization and Service Quality

- The relationship between service capacity utilization and service quality is critical
  - Arrival rate: the average number of customers that come to a facility during a specific period of time
  - Service rate: the average number of customers that can be processed over the same period of time
  - Best operating point is near 70 percent usually
- Optimal levels of utilization are context specific
  - Low rates are appropriate when the degree of uncertainty (in demand) is high and/or the stakes are high (e.g., emergency rooms, fire departments)
  - Higher rates are possible for predictable services or those without extensive customer contact (e.g., commuter trains, postal sorting)

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# Relationship Between the Rate of Service Utilization and Service Quality

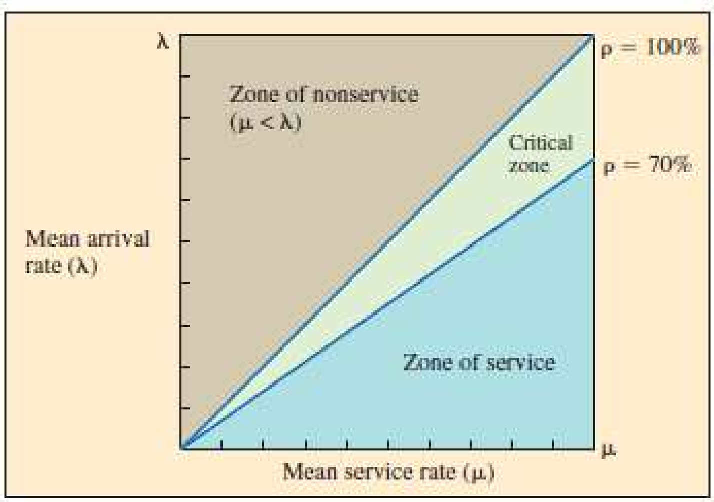


Exhibit 5.6

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