

# Transportation Models

Management 560: Management Science

Tuesday, March 24, 2009

<b>Learning Objective</b>	<b>Active Learning Activity</b>
Learn what transportation models are.	Lecture / Discussion
Learn how to formulate transportation problems.	Worksheet problem.
Build our expertise and experience with transportation models	Quiz
Learn how transportation models can be useful for problems not really involving transporting things.	

### Goals of this class meeting

- Learn how to formulate models involving transporting goods from suppliers to destinations.
- Continue to perfect our linear programming skills!

### Transportation Models

- **Transportation Models:** class of problems involving transporting goods from suppliers to destinations, usually at minimum cost.
- Assumptions:
  - Each source has a fixed supply (not essential).
  - Each destination has a fixed demand (not essential).
- The cost of transporting goods differs between points.
- Meeting demand at each location typically requires supply from multiple sources.

### Example: Getting grain to mills

- We have three different grain elevators scattered around the Great Plains that can supply grain:
  1. Kansas City supplies 150 tons of grain.
  2. Omaha supplies 175 tons of grain.
  3. Des Moines supplies 275 tons of grain.
- We have three different grain mills that need grain:
  1. Chicago needs 200 tons of grain.
  2. St. Louis needs 100 tons of grain.
  3. Cincinnati needs 300 tons of grain.

### Transportation Costs

Differing distances between locations, and different gasoline prices along the routes, lead to different costs for transportation.

Source Cities	Destination Cities		
	(A) Chicago	(B) St. Louis	(C) Cincinnati
(1) Kansas City	\$6	\$8	\$10
(2) Omaha	\$7	\$11	\$11
(3) Des Moines	\$4	\$5	\$12



4. Write down all the constraints.

5. Use Excel Solver to find the solution. What is the minimum cost?

### Model Balance

- A **balanced transportation model** is one where total demand is equal to total supply.
  - All supplies will be used  $\rightarrow$  supply constraints have  $=$ .
  - All demands are satisfied  $\rightarrow$  demand constraints have  $=$ .
- If demand exceeds supply (**unbalanced transportation model**):
  - All supplies will be used  $\rightarrow$  supply constraints have  $=$ .
  - Not all demands can be satisfied  $\rightarrow$  demand constraints have  $\leq$ .

- If supply exceeds demand (**unbalanced transportation model**):
  - Not all supplies will be used  $\rightarrow$  supply constraints have  $\leq$ .
  - All demands can be satisfied  $\rightarrow$  demand constraints have  $=$ .

### **Homework**

- Pages 240 - 265: problems 13 through 17.
- For presentation next class: problems 15, 16, and 17.

## Quiz!

A large manufacturing company is downsizing amid tough economic times and seemingly permanent changes in the profitability of the manufacturing sector in the United States. The company is closing three plants: Pittsburgh, PA; Gary, IN; and Detroit, MI. There are some highly skilled employees working at these plants they would like to keep and send to their overseas plants in Bangladesh, Thailand, and India.

The number of skilled employees who have agreed to transfer overseas at each plant are as follows:

<b>Closing Plant</b>	<b>Transferable Employees</b>
Pittsburgh, PA	60
Gary, IN	105
Detroit, MI	70

The number of employees that can be accommodated at each of the overseas plants are as follows:

<b>Oversees Plant</b>	<b>Employees Demanded</b>
Bangladesh	45
Thailand	90
India	35

Due to differences in the type of manufactured goods produced at each plant and the differences in the manufacturing processes, not all transferable employees will be equally productive at the various overseas operations. The increase in profitability per year at the overseas plants that results from transferring a highly trained American employee depends on what plant she/he is coming from and what plant she/he is going to. The following table shows how much annual profit will increase by for each employee depending on their experience and their new assignment:

<b>Employee's Original Plant</b>	<b>Oversees Plant Assignment</b>		
	Bangladesh	Thailand	India
Pittsburgh, PA	\$50K	\$80K	\$60K
Gary, IN	\$100K	\$90K	\$120K
Detroit, MI	\$70K	\$60K	\$80K

The company wants to transfer the employees so as to maximize profits.

1. What are your decision variables? How many do you have? Carefully define the notation you decide to use.
2. What is your objective function?
3. There are two sources for constraints. Describe them. Do you have a balanced or an unbalanced model?

4. Write down all of your constraints.

5. Solve the problem in Excel. Print out the results. Point out how many employees are transferred between plants, and what the maximum profit is for the manufacturing company.