Chapter 6 Facility Location

CENTER finds the location for a distribution center that minimizes the costs of shipping to customers.

6.1 Center-of-gravity method for locating distribution centers (CENTER)

Before the computer age, distribution centers were located using the following procedure: First, place a map of the region to be served on a table top. Drill holes in the table top at the locations of customers. Run a string through each hole and attach a bag of fishing weights to the end of the string (below the table). The number of fishing weights placed in each bag corresponds to the volume shipped to that customer. Additional weights can be added to account for the costs of shipping to different locations. Tie the strings together so that the knot is free to move on the table top. The point at which the knot comes to rest is known as the center of gravity. This location minimizes the sum of the weighted straight-line distances from each customer location to the distribution center. Of course, the center of gravity may rest at an infeasible location, but the procedure does give a starting point for determining a good location for the distribution center.

The CENTER model in Figures 6-1 and 6-2 gives a good approximation to the solution found with the physical procedure. Certainly the model requires less time and effort than the physical procedure.

CENTER was recently used by Villone Dairies to locate a milk plant to serve five Northeast Texas cities. The first step in applying the model is to lay out a grid on a map and mark the coordinates of the customers. The origin of the grid is at zero. Customer locations are indicated by X, Y coordinates indicating the number of miles from the zero point. The second step is to enter the names of customers in column B, the volume to be shipped from the plant in column C, and transportation rates in column D. If you don't have data on transportation rates, you can still use the model if you are willing to assume that rates are approximately equal to each customer location. Simply enter 1.00 as the rate to each location, as Villone did. Finally, enter the X,Y coordinates in columns E and F.

When data entry is complete, the coordinates of the center of gravity are automatically computed in E17..F17. The solution turns out to be quite simple. The X coordinate of the center of gravity is the sum of column H divided by the sum of column G. The Y coordinate is the sum of column I divided by the sum of column G. These coordinates place the plant in a pasture just west of Tyler, Texas.

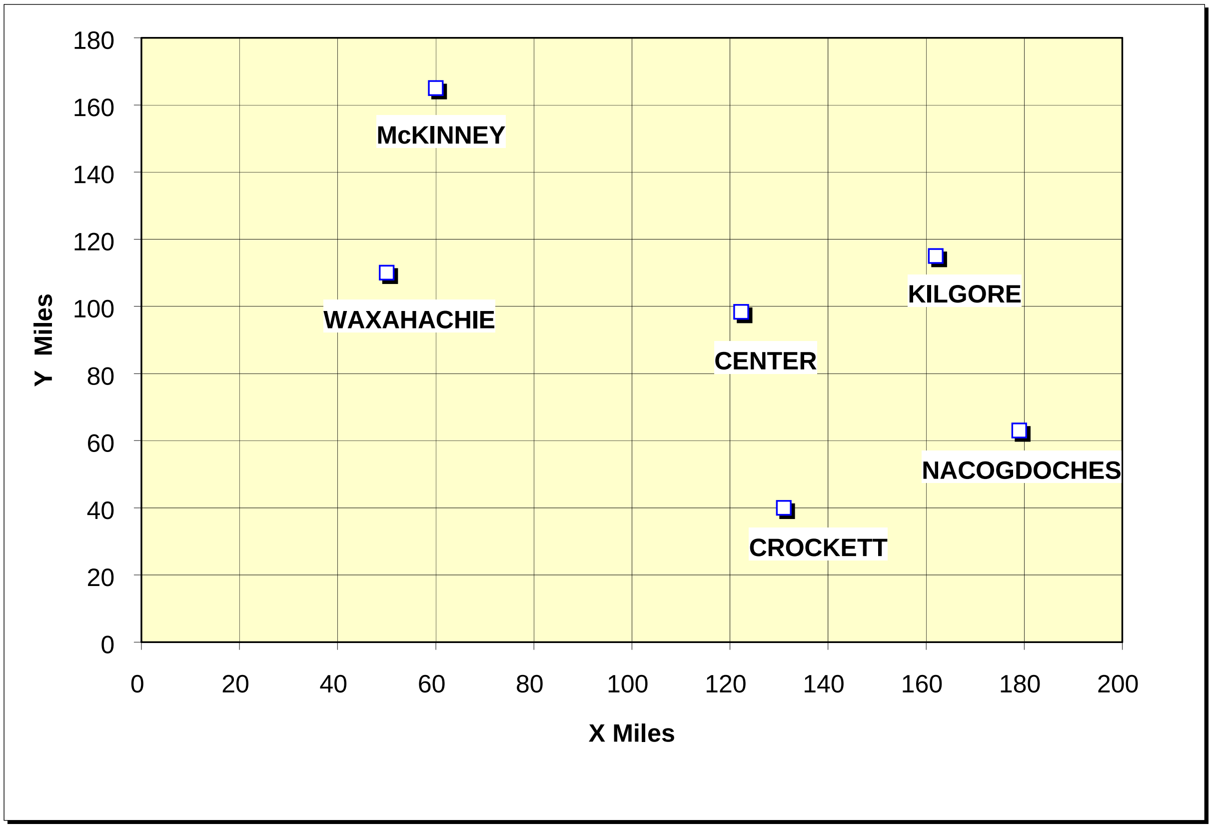
Section B of the model, Figure 6-2, computes distribution costs from the center of gravity to each customer. Since we don't have data on transportation rates, the only information of interest here is column E, the distance from each customer to the center.

The solution shown in Figure 6-1 is an approximation that can be refined using an iterative search procedure which we won't bother with here. The refinement usually does not change the solution appreciably. Furthermore, the aim of the CENTER model is to give management a starting point for determining a reasonable facility location. Certainly many other factors must be considered in addition to the center of gravity.

Figure 6-1

	A	B	C	D	E	F	G	H	I
1	**CENTER.XLS CENTER-OF-GRAVITY MODEL**								
2									
3		PART A: DISTRIBUTION CENTER LOCATION							
4			INPUT:					OUTPUT:	
5									
6		Customer	Volume	Rate	X Miles	Y Miles	V*R	V*R*X	V*R*Y
7	1	**McKINNEY**	**2,100**	**1.00**	**60**	**165**	2,100	126,000	346,500
8	2	**WAXAHACHIE**	**1,900**	**1.00**	**50**	**110**	1,900	95,000	209,000
9	3	**KILGORE**	**1,400**	**1.00**	**162**	**115**	1,400	226,800	161,000
10	4	**CROCKETT**	**1,000**	**1.00**	**131**	**40**	1,000	131,000	40,000
11	5	**NACOGDOCHES**	**3,600**	**1.00**	**179**	**63**	3,600	644,400	226,800
12	6						0	0	0
13	7						0	0	0
14	8						0	0	0
15	9						0	0	0
16	10						0	0	0
17		CENTER			**122**	**98**	10,000	1,223,200	983,300
18									
19		PART B: TOTAL DISTRIBUTION COSTS							
20		Customer	Volume	Rate	Distance		V*R*D		
21	1	McKINNEY	2100	1.00	91		191,649		
22	2	WAXAHACHIE	1900	1.00	73		139,185		
23	3	KILGORE	1400	1.00	43		60,255		
24	4	CROCKETT	1000	1.00	59		58,972		
25	5	NACOGDOCHES	3600	1.00	67		240,442		
26	6	0	0	0.00	0		0		
27	7	0	0	0.00	0		0		
28	8	0	0	0.00	0		0		
29	9	0	0	0.00	0		0		
30	10	0	0	0.00	0		0		
31		TOTAL COST =					690,504		

Figure 6-2



180
160
140
120
100
80
60
40
20
0
Y Miles
McKINNEY
WAXAHACHIE
KILGORE
CENTER
NACOGDOCHES
CROCKETT
0
20
40
60
80
100
120
140
160
180
200
X Miles

Exercises

6-1 Mrs. Lugo's Bakery is planning a new flour manufacturing plant to supply its three bakeries in Illinois. The location of the bakeries with their coordinates and volume requirements is given in the following table:

Plant Location	Coordinates (x,y)	Volume (Thousands of lbs./year)
Peoria	300,320	4,000
Decatur	375,470	6,000
Joliet	470,180	3,000

Use the center of gravity method to determine the best location for this new facility.