Management of Routing and Scheduling Company Trucks

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The author describes the use of the "Lokset method" for routing and scheduling deliveries, with special emphasis on data requirement.

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Higher prices for new equipment and escalating wage rates have resulted in rising distribution costs for firms in the food industry. With this trend, managers have been searching for better ways to evaluate their present distribution methods and to guide them in making decisions about possible changes in route operations.

Routing and scheduling is a key task in food distribution. If this is not done appropriately, more trucks and drivers will be required than necessary and thus the cost of distribution will be excessive. I think that many companies are more upset over a drop in miles per gallon than the discovery of a few poorly-routed trips. A few relatively minor misroutings by a dispatcher can be much more expensive than a major decrease in overall gas or diesel mileage.

Routing and scheduling is also a very difficult task for most food distributors because of the magnitude of the logistical task itself and because of the many restrictions imposed on the distribution problem – e.g., some customers may be located in congested metropolitan areas while others are located in rural areas so that driving conditions in different parts of the service area vary; some customers can be served only during certain times of the day and/or with only certain types of trucks; for many companies the fact that drivers are unionized may impose special restrictions on the distribution problem.

During the past few years researchers have developed a scientific method which can be used by management to determine efficient multiple-customer routes, determine the appropriate sequence of customers on each route, and allocate a specific delivery vehicle to each route while considering all of the special restrictions imposed on the distribution problem. This technique can be used without the aid of a computer on relatively small problems. However as the distribution task becomes more complex, a computer will be essential for its application.

Data Requirements

One technique, known as the "Lockset method," has been thoroughly described elsewhere[1] and will not be detailed here. The data requirements for an application of the technique, however, deserve special mention.

To do a good job of routing, a substantial amount of information is required and it must be as accurate and detailed as possible. This is true regardless of whether the routing task is accomplished manually or by computer. The information required falls into two general categories – fixed and variable.

Variable Data Requirements

This type of data consists of that information relating to the delivery problem which may well change from day-to-day or from routing-to-routing. It will include the quantity of product or products to be delivered to each customer, the time required to serve each customer, and any other special services required by each customer. The special services required by a given customer might include:

1. Delivery must be made within a certain period of the day,
2. Order must be delivered on a refrigerated truck, or
3. Only a certain size of truck can be used because of the customer location.

Fixed Data Requirements

The fixed data required consists of data that does not change in a relatively short period of time – information on delivery vehicles and drivers, list of customers, and customer and plant location.

Delivery Vehicles and Drivers.

The details required on delivery vehicles include the types and number of trucks available and their capacity. The fleet may contain trailers, straight-trucks, and panels. Some may be refrigerated while others are not. Some may have mechanical lifters while others may not. The capacity of some may be different than others.

One of the crucial decisions to be made by management concerns the units in which to express truck capacity – pieces, cases, pounds, or cube. As far as the use of the routing technique is concerned, any two of the three can be used. The choice, however, will be different for different applications and will depend on the number of different types, sizes, and/or weight of packages delivered. For example, if only milk is to be delivered the appropriate unit of measurement could be either weight, quarts, or cases. If, on the other hand, fresh vegetables are to be delivered on the same truck with milk, the appropriate unit of measurement might well be cube.

Another concern of management is to plan an appropriate work day for drivers – i.e., a full day's work for every deliveryman. In so doing any special restrictions imposed by union contracts will need to be considered: the number of stops a driver can make, the total pounds or pieces a driver can deliver in one day, a guaranteed minimum time for a day's work.

Consumer and Plant Location

It is obvious that to determine how and when customers are to be served, their location relative to each other and relative to the plant or distribution center must be known. The easiest way to reflect this type of information is to determine how far, either in terms of driving distance or minutes driving time, each customer is from all other customers and from the plant. This is precisely the type of information needed by the routing technique.

To appreciate the magnitude of this requirement, assume a delivery problem with only eight customers. The data required may be as indicated in Table 1.

Table 1. Minutes Driving Time Between Indicated Customers and Plant

		Customer						
Customer	Plant	1	2	3	4	5	6	7
1	60							
2	80	100						
3	20	20	40					
4	50	60	100	20				
5	40	80	100	30	50			
6	10	30	50	10	30	20		
7	30	90	40	20	40	50	20	
8	70	50	100	70	60	80	30	50

In Table 1 it is seen that to travel from Customer 2 to Customer 7 requires 40 minutes and to travel from the plant to Customer 4 requires 50 minutes.

In this example only 36 measurements were required. However for 20 customers 210 measurements would be required, for 200 customers 20,100 measurements would be required, and for 1,000 customers 500,500 measurements would be required.[2] Thus even for medium sized routing problems, the task is not a simple one.

Fortunately, these data will need to be obtained only once. That is, this basic set of data will be used for the initial as well as all subsequent routing problems. Indeed this is why it is categorized as fixed data. It will only need to be modified as new customers are added or as old customers are dropped.

There are several shortcuts that can be used to obtain these data. In the first place it may be known before hand that certain customers are not to be linked together on the same route. If this is the case, the distance or driving time separating these customers may be ignored altogether since these data are only useful in determining the sequence of customers on routes.

Rarely are exact distances or times necessary. Thus a second shortcut would be to approximate these data by (1) locating each customer and the plant by X-Y coordinates or by longitude-latitude coordinates, and (2) calculating "crow-fly" distances between customers and between customers and the plant.[3]

Finally, there is available a computerized technique for calculating the shortest distance between two points through a network of straight-line segments. Thus if well-defined road network with road intersections scattered throughout and with customers located at intersections is available, the distance data may be obtained accurately and efficiently by computer.

Applications

The routing technique we have been discussing is not a panacea – it will not eliminate all your distribution problems. Nor will it necessarily eliminate the need for a dispatcher. It will, however, make the dispatcher's job much easier, and help management to better control costs. This it will do by serving as a tool with which to consistently design the most efficient local delivery system.

In addition to designing efficient routes for actual deliveries, the routing technique can be used by management to examine the impact of various changes in the delivery system. For example, what would be the impact of adding different types of trucks to the fleet? If the service time of a few key customers was changed, could we design more efficient routes? Is it really worth serving that one customer located 20 miles farther from the warehouse than any other customer? Could we save money by paying our drivers overtime to run the newly-organized routes? What would be the impact of changing the frequency of delivery?

We have used both manual and computer routing techniques. Several applications included ice cream, retail milk delivery, bulk milk assembly and grocery products distribution. The results have been encouraging. Routes discovered by the scientific routing method have produced potential savings. In one grocery chain, for example, deliveries for a specific day were accomplished with one less truck and driver, plus 160 minutes less driving time for the remainder of the fleet. The $70 savings obtained for that day were immediate and the benefits required no additional capital outlay.

Distance savings of 12 percent in milk assembly routes were found in work with a Pennsylvania dairy. This relatively small dairy estimates a $3,000 annual savings for bulk milk assembly.

In another dairy 10 home delivery routes were examined. The technique was used to reorganize the entire delivery system into new routes to see what savings, if any, could be achieved in retail home delivery of milk. A delivery system was designed assuming that the deliveries were made to each customer twice-a-week as opposed to three-times-a-week. The advantages of the reorganized system over the existing delivery system were achieved by:

1. eliminating the use of two trucks principally by utilizing trucks more efficiently
2. eliminating two drivers, and
3. reducing the number of miles driven to serve the customers.

Similarly the advantages of the two-day-per-week delivery system over the reorganized delivery system were achieved by:

1. eliminating one more truck,
2. eliminating the relief driver, and
3. further reducing the number of miles driven.

LITERATURE CITED

[1] See M. C. Hallberg and G. T. Gentry. "Efficient Routing Systems for Retail Milk Delivery." Dept. of Agr. Econ. and Rural Soc., The Pennsylvania State University, A.E. & R.S. #91, June 1970.

[2] The number of measurements required is determined by the formula $N(N+1)/2$ where $N =$ the number of customers.

[3] That is, using the fact that the hypotenuse of a right triangle is equal to the square root of the square of its base plus the square of its height.

[4] We have been discussing the routing techniques applicability to delivery systems only. Nevertheless it can be applied to pickups as well. It will not design routes involving both pick-ups and delivery.