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On line-Real Time Systems for Customer Service Operations

Robert K. Zimmer

Getting the right man to the right place at the right time is in essence a scheduling problem. Here's the way one utility used an on line-real time system to improve service call procedures —

ON LINE-REAL TIME SYSTEMS FOR CUSTOMER SERVICE OPERATIONS

by Robert K. Zimmer

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One of the most difficult functions to manage in business is "in-the-field" customer service. A major problem is management's lack of direct supervision over the men providing the services. They work their eight hours with only infrequent communication with supervision. Because of the nature of the work, adequate control and effective direction of effort are difficult for small customer service operations—and almost impossible for large ones.

For proper scheduling and control company management should know at all times the progress the service force has made in the performance of assigned tasks, the estimated time needed to complete each type of service work, the serviceman most capable of filling each service request, the present company work load, the time commitment for the work to be performed and for the distance to be traveled, and the estimated future demand for services.

The purpose of this article is to outline a computer system that will eliminate many of the major problems facing company management in the development of an effective control system for customer service. Although the general problem exists in all large in-the-field customer service operations, the approach that was used in solving the problem for a large public utility in the gas industry is the basis for this discussion.

Utility customer service

The customer service function of a large public utility constitutes one of its major costs. It is often stated that these costs are also its least controllable. Many utilities have more than 500 servicemen operating in the field during a given day. Although the serviceman usually report periodically to a dispatch board, for the most part they are without first-line supervision during the work day. This is not caused by weak management but by the lack of an effective control tool.

The first step in developing a workable solution to the control of servicemen in the field was to determine the major problems in the customer service area. The second was to conduct a feasibility study to determine the economics of various alternative solutions to the problems.

Discussions with the customer

service personnel indicated that the principal cause of lack of control over the serviceman in the field was the break in communication with the serviceman during the work day. The serviceman's whereabouts and the exact status of completed and partially completed work were not available on a timely basis.[1]

Depending on the characteristics of the individual company, within this major problem were a number of subproblems, including those of repeat orders, duplicate orders, travel patterns, overtime utilization, initial scheduling, special handling, classification, commitment, problem anticipation, and combination of service orders.

Repeat orders—Many times more than one service call is required to satisfy one particular need of a customer. Recognition of a second or additional requests for the same service is essential to control the quality of workmanship and to avoid costly delay in the execution of a request.

Duplicate orders—Sometimes a second request is made for service before the execution of the original order is attempted. An example is when the husband and wife both telephone to have the range adjusted. In this case two servicemen may be dispatched to the customer's premises.

Travel patterns — The lack of knowledge of the work locations of the serviceman during the day, of the number of units of uncompleted work in his area, and of possible future service calls to be received reduces management's efficiency in scheduling servicemen. The travel pattern on any given day is likely to be a maze that results in excessive travel time and operating expense.

Overtime utilization—Because of the lack of up-to-date backlog data (including data on the type of work) and because of inability to forecast the next day's service load, many utilities require that all orders dispatched to the field should be executed the same day.[2] Naturally this causes wide fluctuation in daily service loads, creating overtime that otherwise might be avoided.

Initial scheduling—On the other hand, depending upon the company's service policy, up to 50 per cent of the service orders received one day are likely to be held for dispatch to the field on the following day. Thus, when the serviceman is sent into the field, he is allocated a certain number of service orders. The problem is to dispatch the right number of properly qualified servicemen to the areas of the city that will require their skills. This allocation depends upon the service request orders available in the morning and expectations about the next day's workload.

Special handling—Certain service requests require the skills of a particular union-classified serviceman. An example is the large industrial clients of a utility. The problem is the recognition of the need for special handling and the ability to send the proper serviceman to execute the service.

Classification—Unionized servicemen are generally classified according to skills and seniority. These classifications limit the extent of service work that each one can perform.[3] Therefore, service request orders must be first classified by type of work and then distributed to men who are authorized to perform the service.

Commitment—A very costly problem facing a public utility—and most companies making deliveries—is the fact that the serviceman frequently cannot execute the work because no one is at home. Failure to get inside the premises means a return trip and possibly a complaint from the customer. The most prevalent cause is the failure to make a commitment to the customer for a reasonable expected time of arrival.

Problem anticipation — An abnormal build-up of certain service requests can be an indication of a major problem. Prompt recognition of this problem can give the company time to take corrective action. An example is when, within a relatively small section of the city, there is a sudden increase in gas leak complaints (many customers think they smell gas).

Combination of service orders—Certain types of work are of a routine nature. These include the removal of meters for testing and certain preventive services determined by the service policy of the utility. The problem is to recognize the existence of routine work at the

[1] The use of radios in all the service vehicles would theoretically make timely reporting to the dispatch board possible. Practically, it is not feasible because of the limited number of radio channels generally available and the large amount of data that must be transmitted to the dispatch center.

[2] Although some categories of service work are of high priority and must be executed as soon as possible (gas leaks and no heat), most service requests could be executed the next day without inconvenience to the customer.

[3] For the purposes of illustration in this article, four classifications from most skilled to least skilled are assumed—Class I to Class IV.

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. . . servicemen to those areas of the city that will require their skills.

time a service request order is to be dispatched to the serviceman. In this way the necessity of making a separate service call to accomplish the routine work can often be avoided.[4]

System objectives

This analysis of the major problems facing the customer service function of a public utility makes it possible to define the objectives of a new system. These are as follows: assignment of the "right" serviceman; improvement of forecasting; gaining knowledge of the whereabouts of servicemen on a real-time basis; gaining access to the service orders for each serviceman, each grid, and each period of time (i.e., 90 days); reducing the nonproductive time of the servicemen; and integration of the entire customer service function.

The satisfaction of each objective depends upon the economics of any given utility. For the purposes of this article, it will be assumed that economical justification can be made.[5]

Assignment of "right" serviceman—The system to be developed should assign the proper serviceman to the job. The assignment must take into consideration the present location of the serviceman, his classification, his work load in relation to the time the order is dispatched, and the commitment requirement of the service request.

Improvement of forecasting—Three levels of forecasting must be improved. First is the weekly forecast needed to determine the number of servicemen required daily to handle service requests. Some latitude exists here because the two days off per week per serviceman can often be changed, and other duties, including training sessions or, in some utilities, meter reading can be assigned with considerable flexibility.

Second is the forecasting of the next day's demand for service. This forecast preferably should be by small sections of service area.

Third is the ability to recognize each day the miscalculations in the second level of forecasting. The ultimate objective here would be to forecast hourly throughout the day.

Gaining knowledge of whereabouts of servicemen on a real time basis—Not only for the purpose of scheduling but also for improved control over the serviceman, real-time knowledge of the whereabouts of the serviceman is one of the most important objectives of the new system. The objective would be to know within a specified confidence level where the serviceman is located at any given time.

Gaining access to service orders for each serviceman, each grid, each period of time—The ability to retrieve data about service orders is of primary importance. For previously executed orders it is important so that repeat orders can be recognized. For unexecuted orders, it is important to recognize duplicate orders, to determine which serviceman is working on a particular order, and to determine which orders are to be executed

[4] The combining of orders might be disadvantageous during the peak demand weeks. During these periods the routine work should be postponed.

[5] For large utilities (more than 700,000 customers), not only would there be a significant improvement in customer service but there would probably also be more than ample cost savings to justify the investment in the system.

Sometimes a second request for service is made before the execution of the original order is completed, as when both husband and wife telephone in to have the range adjusted.

within a certain grid (a defined subdivision of the city).[6]

Reducing nonproductive time of the serviceman—Another objective of the new system is control of travel time and transportation costs to eliminate unnecessary repeat or duplicate service calls. This requires the development of standardized times to perform service at the customer's premises.[7]

Integration of the entire customer service function—To minimize duplication of effort, all of the customer's service history should be directly accessible. This means that the clerk taking the customer's telephone call should have access to all pertinent customer data, the servicemen's records, and, when required, the specific serviceman who is or will be handling any given service request for a given customer.

On line-real time system

The development of the new system can best be explained in four segments. First, the development of an on-the-premises time-budgeting system will be described; second, an on line-real time retrieval system; third, a forecasting system; and fourth, the route and serviceman scheduling system. It should be kept in mind that these segments are not independent but are, in fact, quite interdependent.

Time-budgeting system — Most companies engaged in service operations have attempted to set standards for the time required to service the customer. For repairs on automobiles, for example, there are "flat-rate" manuals. For repairs on gas or electric appliances, however, where the repair time is on the customer's premises and where travel time is required (including time to park the truck and walk to where the service work is needed), standardized rate books are more difficult to develop.

Nevertheless, standards development for service work is essentially the same as for any budgeting problem. One method is to utilize historical data on performance, adjusted according to what can be expected in the future. Another method is to utilize time study and similar measurements.

The development of travel standards is more complex. It is first necessary to know how far the serviceman will have to travel from one job to the next, taking into consideration times of the day and seasons of the year. Distances traveled can be determined by the use of a block coordinate system, which pinpoints the serviceman's last service call to within a block. The block coordinate system, which will be further explained in the discussion on scheduling, requires that blocks traveled be converted to miles traveled and that miles traveled then be converted to minutes traveled. In the latter calculation the time of day, the season of the year, and the location of the work become important.

For planning, the new system requires an estimated time to execute orders and an estimated completion time for each job. The use of historical standards and variances from normal appears to be the most logical source for these estimates and for travel time estimates as well. There are some obvious limitations to this approach, and the service company should expect to revise these standards after the new system becomes operational. Necessary data for revision of the standards, when required, can be found within the new system.

Retrieval system—Because of the large volume of data to be handled by a large utility or other service company it is usually necessary to think in terms of a third generation computer, one that has the necessary storage capabilities and an on line-real time capability. Exactly which computer is required would depend on the input volume, storage, and analytical requirements for this system and on the overall computer needs of the company.

Data retrieval

The ideal system would provide all customer service data on direct access files. Thus, when the customer called in for service, the service clerk could retrieve the data required by means of a display unit. For instance, if the customer requested a range adjustment, the clerk would type the customer's name and address and the request code into the visual display unit. From the computer the following data would be retrieved and shown on the display unit:

A. *At the time of the service request*

1. The duplicate service request would be recognized by a search of the customer's records. Each request would be coded on the customer's record when received.

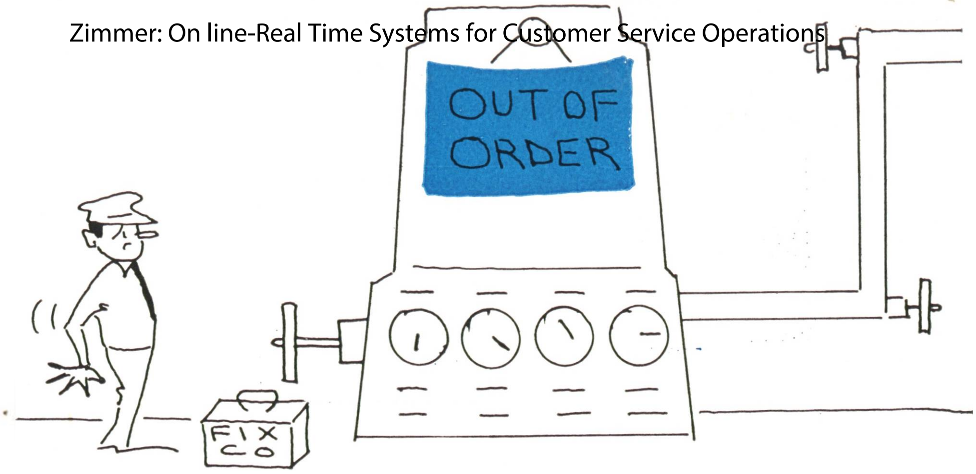
2. The repeat service request would be recognized by a search of the customer's records. All service requests would be recorded on tape for a period of 90 days. Each incoming service order executed would be matched against this tape. When the second order to be executed for the same work was received, the duplicate work would be noted on the customer's record. (In the test of the new system, it was found uneconomical to keep all service orders on direct access for the 90-day period.)

3. The special service requirements would be recognized by a search of the customer's records. Special service requirements (school, hospital, large manufacturing plant, etc.) would be flagged by the system.

4. The serviceman and commitment time for the order would be determined by a series of subroutines. The data to be ana-

[6] The grid is a specified part of the service area. Many cities have been developed in one-square-mile grids.

[7] The use of predetermined standards for each classification of service work is being employed successfully by a few utilities. Nevertheless, the deviations in the standards that are possible in normal situations make the system extremely difficult to operate effectively.



Certain requests—for example, those from large industrial clients of a utility—cause problems because they require the skills of a particular union-classified serviceman.

lyzed would include the following:

a. location of each serviceman

b. work load assigned to each serviceman

c. standard times for each service request

d. block coordinate for each customer

e. formula to determine miles between each coordinate

f. priority of each service request

g. status of each order dispatched or in process of dispatching

h. all routine work (routine meter removals).

B. *At the time of dispatch*

1. The service work assigned to each serviceman would be shown to the dispatcher.

2. The standard work that should be completed based on the dispatch time would be shown.

3. A list of the new orders to be dispatched to a particular serviceman would be displayed, including the following:

a. identification for future reference to the order

b. address of the customer

c. service request

d. estimated time of arrival

e. classification of work

f. comments (repeat order, duplicate, special handling, etc.).

A by-product of this system would be the availability of "account inquiry" information. The clerk taking the customer's call would also have the following customer information immediately available:

a. the last period's consumption

b. the current accounts receivable balance

c. the last payment received

d. the current month's consumption

e. the credit status

f. the amount owed on appliance purchases

g. the gas meter number and date set

h. the classification of the customer

The visual display unit could be utilized not only to receive information from the computer but also to place information into it. If on-line capabilities were not necessary at the time of input, a scannable device would probably prove advantageous.[8] Batches of information might be placed into the computer every two or even six hours by means of a scannable document. The use of the scannable device would thus free other input devices for data that must be entered immediately.

Depending upon the service policy, the proportion of service calls that must be executed on the same day varies among utilities. Possibly future orders could be printed by the computer and assigned automatically to servicemen for future work days. The assignments would probably be made to loads designated by certain classifications and not to specific servicemen. Because of sickness, etc., the exact serviceman available could not be anticipated, at least in the case of the utility studied.

Variance reports

The retrieval system also could be used to compare actual service call times with standard times and to print out management variance reports. The computer could store data about the service order at the time of request, but the execution data either could be placed into the computer at the time the serviceman called in for additional work or it could be placed by the use of a scannable document used in the field.

The scannable document would contain the identification number of the service request, the serviceman's load number, and the date. The last two items would become a batch identification card. Thus, the scannable document should contain the following data: identifi-

[8] The scanner is an input device that can translate pencil marks on a special document to digits usable by the computer.

cation number; service request code; date; work executed (coded); number of units of work required; traveling work units required; and supplies used to execute the work.

Once filled out, the scannable service order document, with a header card containing the employee's number and the truck number, date, and work shift, would be submitted to the foreman. These cards would be scanned and matched with the data stored in the computer. The management reports on variance could be issued as frequently as daily by serviceman, by foreman responsibility center, by service district, by entire work force, or by request category.

The tie-in to the on line-real time system would be advantageous for a number of reasons. First, the amount of information required on the scannable document would be reduced substantially. Second, the accuracy and speed of reports would be increased.

The timely reporting of variances in both travel and job execution should create in management a feeling of control, of confidence that it knows where the servicemen are and what they are doing. The knowledge thus gained could be used to evaluate and improve the performance of the servicemen. Variances from standard might indicate a need for additional serviceman training.

Forecasting system—For an effective scheduling and control system, it is necessary to forecast future demand accurately. At the lowest level one might use the previous day's demand to estimate the next day's demand. Or demand might be forecast by the use of historical records of demand in relation to degree days and to various climatological data. But there are other forecasting methods that are more scientific and sophisticated.

One relatively scientific approach is the use of multiple correlation analysis. The technique involves the correlating of demand (preferably by categories) to various independent variables that have a logical cause-effect relationship with demand. Two examples are as follows:

Dependent Variable	Independent Variable
Gas leaks	per cent of odor in lines
	wind speed
	degree days
	yesterday's gas leaks
	leak demand for the last hour
No Gas Heat[9]	degree days
	yesterday's demand
	day of week
	humidity

The independent variables must be data that are readily available and can be used in the computer. This might require direct input of data by another department. For instance, the percentage of odor in the gas lines might be determined hourly by the computer and placed directly into the customer service computer system.

This more scientific approach should be considered as a dynamic forecasting method. The equations would be internally reviewed, and when unacceptable variances between forecast and actual performances began to appear, the multiple correlation analysis would be repeated.

Research indicates that substantial improvement in forecasting can be achieved by use of the procedure described. The big problem is to obtain data for the correlation analysis and to recognize the proper independent variables.

Another forecasting method that could be used to project demand requirements is the "smoothing technique."[10] In certain cases smoothing was found to be more effective than multiple correlation. Actually, however, the solution to forecasting service orders does not lie with one technique but with a combination of techniques. Depending on the nature of some of the categories of demand, multiple correlations or smoothing might do most to shed light on future demand. The choice of forecasting method must be made individually for each category of demand.

For the updating of demand requirements throughout the day the use of frequency distributions of hourly demand for ranges of daily demand is a promising forecasting technique. Once the demand forecast is made (say, 7,000 orders), one can review the hourly build-up of orders for past days and end up within the same range of orders (say, 6,950 to 7,050). With the use of confidence intervals, a utility can then state with some degree of confidence what the chances are on an hourly basis to obtain the 7,000 orders.

Service demand doesn't just happen. It is caused. Thus, it can be forecast with some degree of confidence. Many of the categories of demand that were forecast for the utility studied were items that were originally felt to be unpredictable.

Scheduling system — Scheduling is a generally recognized problem. There have been, however, many valid reasons for inefficient scheduling in the past. Some of these, as was indicated earlier, center around the inability of management to recognize the exact location of each request and at the same time to know where each serviceman will be located, his classification, the estimated work load, and the expectations for future work.

The development of a scheduling system will be discussed in four parts: the development of a block coordinate system, the assignment of servicemen to districts, the initial assignment of service orders, and the daily order asignment being dipatched.

The development of a block coordinate system—The goal of the block coordinate system is not only

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[9] Customer complaints that are caused by the malfunctioning of the space heating equipment of the customer.

[10] New Average = (new demand) + (1 − old average).

Union classifications limit the extent of work that each serviceman can perform. Service requests must be distributed only to those authorized to perform the service.

to pinpoint each customer request in the city but also to develop a means of calculating mileage between each service request. At the utility studied this initially was done by the use of a one-mile grid system. The entire service area was divided into one-mile grids. The next step was to list each street and range of house numbers for each grid. Once this was directly accessible from the computer, the pinpointing could be calculated by the numbering system of the grids, as shown in the diagram at right.

Further analysis indicated that although one-mile grids were of ample size for the data accumulation part of the scheduling scheme, smaller grids would provide even better scheduling. For example, if five service requests came in for grid 10-20(A), the computer could not distinguish among the locations of the orders. Consequently, assuming like priorities, the service orders would be scheduled on a random basis. For this utility, the smaller grid system was shown to be more economical (because it provided more consistently correct scheduling) than the one-mile-square grid.

It is interesting to note that many cities have been numbered on a block coordinate system by the city planning groups. This means that the numbers assigned to the streets are a function of the block location. Thus, streets running north and south have the same range of numbers. This makes the task of assigning block coordinates to the customer accounts relatively easy.

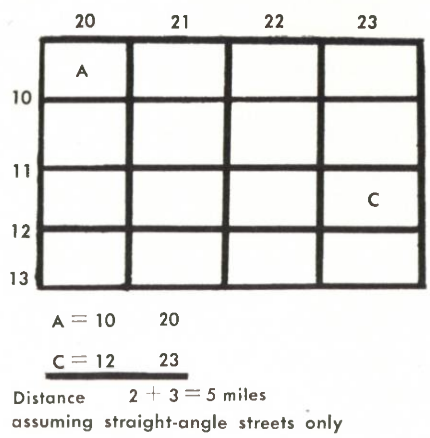
The assignment of servicemen to districts—For control purposes and for better routing, servicemen are usually assigned to districts. Sometimes the district boundaries make sense, for example, an expressway with very few crossing bridges. But other division lines are quite arbitrary.

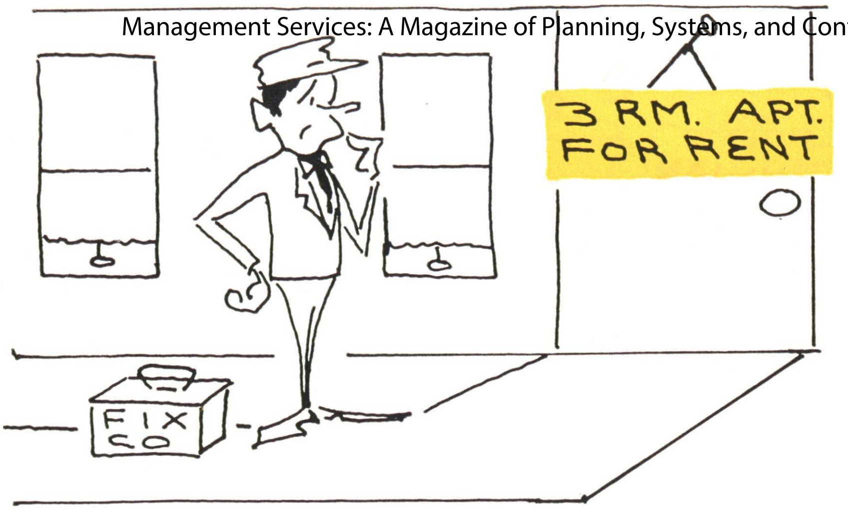
Although most utilities recognize the necessity for shifting servicemen among districts to meet fluctuating demands for service, the movement is far from free. The problem results from inability to assess the work load in each district at any given time and the loss of control when servicemen are shifted among districts.

With an on line-real time system there is little reason to think in terms of districts so far as scheduling is concerned. The total number of servicemen by classifications available to the home base can be assigned by use of one-mile grids within each district. The use of a linear programming technique such as the transportation (allocation) model permits the optimum assignment to be made and the optimum number of servicemen and classifications by district to be determined.

If the assignment of servicemen to districts is not correct, the linear programming model will require shifts of servicemen among districts. By analyzing these shifts, it is possible to make permanent transfers of the servicemen from one district to another. In this way the optimum number of servicemen and their mix of classification can be established.

One of the constraints on the linear programming model is that at least one serviceman of each classification must be located within each specified area. This was necessary at the utility studied because emergencies might require a certain classification of serviceman to arrive at a given location within a relatively short period of time. Without this constraint, it would be possible to have an area of, for example, 18 square miles without





The most common cause for repeated trips on a service call is failure to make a firm commitment to a customer for a reasonable time of arrival.

a single serviceman with the proper classification and skill to repair a gas leak at an industrial plant.

The initial assignment of service orders—At the beginning of each day service orders can be automatically sorted by one-mile grid locations, by classification of work, and by priority. The problem is to distribute the orders to the servicemen that will be working on that particular day. The goal is to minimize both the travel between orders and the execution of orders by overclassified servicemen (high-classification servicemen doing low-classification work).

Assuming a world of certainty, that is, ability to forecast the day's demand properly, to estimate the standard times, to perform service work and travel time at standard, and to foresee all contingencies, the solution would still involve a very complicated simulation or linear programming formulation. Fortunately, the manager can justify a less sophisticated solution in the real world; and, although he may not arrive at the optimum solution, there are some relatively simple procedures that can be utilized to improve initial assignment.

The problem of assignment of orders to servicemen can be solved roughly by computing the number of standard minutes of each class of work for each grid. Expected dispatched service calls can be estimated by analysis of historical patterns of calls and should be included with the backlog of service calls in the morning. Starting with the lowest classification of work, the men can be assigned to the grids having the largest number of standard minutes of work. The next step is to consider the remaining service work at the lowest classification as one classification higher and assign to it the next higher classification of servicemen — and so on until all servicemen are assigned. More sophisticated methods can be used, but the method described will at least place the serviceman in the areas most saturated with work to be done.

The problem of sequencing of work orders is a function of priorities and the attempt to minimize travel between orders. The branch and bound method[11] and various other methods can be used. At the utility studied workers[12] developed their own method, one that appeared superior to the methods previously mentioned.

The daily order assignment being dispatched—As the service calls are received, they can be placed directly into the computer. The computer evaluates the present workload and determines when the commitment can be made, taking into consideration the priority of the work. Assuming that the work can be completed on the day received, it is assigned to the best serviceman, based on his classification, location, work load, and special skills. These orders are batched, and when the serviceman makes his regular call to the dispatch board, the orders are integrated into the unexecuted orders held at that time by the serviceman. All of the orders are then sequenced, using the procedure described previously.

All orders before being dispatched are checked against the routine work file. If routine work is required at the same premises, both orders are dispatched at the same time.

The system in operation

Not all the segments of the system proposed in this article are economically justifiable in all utilities. In fact, the actual system developed for the utility studied differed somewhat from the one described because of modifications necessitated by the utility's unique characteristics and by the economics of certain segments of the system.

The system discussed in this paper is unusual in that all pertinent data required for decision making by the department are directly accessible from the computer. Furthermore, the data are manipulated by the computer so that certain types of decisions can be made by the computer.

The most important element of the system is its ability to improve control over the servicemen in the field. Many of its benefits stem from the fact that servicemen for the first time are aware that management can evaluate their performance promptly and accurately.

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11 See for example Norman Agin, "Optimum Seeking With Branch and Bound," *Management Science,* December, 1966, pp. B176-185.

12 Thomas Sarowski, Arthur Andersen & Co., and Dennis Berry, Michigan Consolidated Gas Co.