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SEP 79 V R GILLOTH , J F OHL, W A WELLS  
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AN EVALUATION OF SEASONALITY IN THE  
 UNITED STATES AIR FORCE MEDICAL  
 MATERIEL MANAGEMENT SYSTEM

Vaden R. Gilloth, Captain, USAF  
 Jack F. Ohl, Jr., Captain, USAF  
 William A. Wells, Lieutenant, USN

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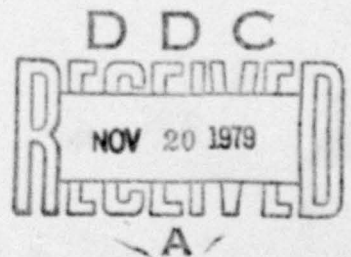
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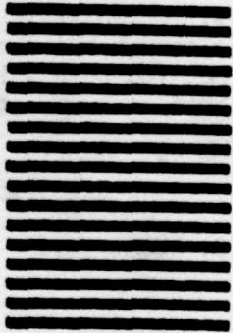


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Providing optimal logistical support to Air Force medical facilities is the main objective of the United States Air Force Medical Materiel Management System (MMMS). The inventory management and control procedures contained within this system have adequately met customer demands; however, the Surgeon General's Office feels that the same level of customer service could be achieved with a lower inventory investment. Previous studies on the MMMS have indicated that seasonal variation may be a significant contributing factor to the high cost of medical inventories. This research analyzed the existing computerized data to identify the extent of seasonality. The results of this analysis demonstrated that seasonality is significant, identifiable, and forecastable. Using the current forecasting method as the base, two additional techniques were tested for their ability to adjust for seasonality. Double Exponential Smoothing was demonstrated to be superior to the currently used Moving Average method.

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AN EVALUATION OF SEASONALITY IN THE  
UNITED STATES AIR FORCE MEDICAL  
MATERIEL MANAGEMENT SYSTEM

A Thesis

Presented to the Faculty of the School of Systems and Logistics  
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the  
Degrees of Master of Science in Logistics Management

By

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September 1979

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This thesis, written by

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Lieutenant William A. Wells

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(ACQUISITION LOGISTICS MANAGEMENT MAJOR)  
(Captain Vaden R. Gilloth)

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## Chapter I

### INTRODUCTION

#### Statement of the Problem

The main objective of the present United States Air Force Medical Materiel Management System (MMMS) is to provide optimal logistical support to Air Force medical facilities as prescribed by Air Force Manual 67-1, Volume V. The inventory control procedures outlined in this manual require a minimum of 95 percent fill-rate on customer demands, while maintaining an economical level of inventory (21:p.1-1). The United States Air Force (USAF) Surgeon General's Office believes customer requirements are being satisfied; however, key staff personnel have stated that the same level of customer service could be achieved with a lower inventory investment (7). Although AF Manual 67-1 establishes a firm guide for what is considered economical, the Surgeon General's Office and the Air Force Data Systems Design Center suggest that fluctuations in demand, possibly caused by seasonal variation, could be a significant contributing factor to the high cost of inventories. The problem for research is to identify these seasonal variations and their effect on the medical inventory system.

#### Justification

The Department of Defense has recognized that within the logistics support system certain commodities possess

peculiarities or characteristics that make them sufficiently distinctive to warrant separate management (20:11). The unique nature of medical supplies warrant this separate management. The critical features of rapid responsiveness, shelf life limitations, and climate control are characteristics of medical inventories. Many drug items require close monitoring to insure that their shelf life and temperature ranges are not exceeded. "In the medical sector, there are few inventories maintained that are not subject to expiration dates and perishable controls [13:735]." For these reasons, medical supplies have been segregated from nonmedical supplies and are managed under a separate inventory control system, the MMMS (21:p.1-1).

The importance of medical inventories requires that strict considerations be made by the Air Force in handling and managing such inventories. Basically, the management goals are to maintain as low an inventory as possible while still providing the customers a 95 percent fill on all line items demanded. To achieve such a level of service requires a substantial investment in inventory stocks. In fiscal year 1978, the Medical Materiel Management System consisted of 101 Air Force medical supply accounts. These accounts required the management of over 15,000 individual line items, with a total net sales of over \$93 million, and an average inventory investment of over \$10.5 million. The inventory turnover rate during this period was 8.8 (24). The large dollar values involved in this system suggest substantial potential savings

could be realized with even a small improvement to the inventory system.

### Background

The medical materiel inventory system involves many decision parameters. These parameters include such factors as safety levels, pipeline times, economic order quantities, daily demand rates, stock control levels, and seasonal influences. Previous studies in the area of medical materiel management have specifically addressed some of these factors. Peacock and Seale attempted to apply a variable safety level to the system in order to improve the service level (14:6). Ferguson addressed the Daily Demand Rate (DDR) computation and provided a formula for determining a new DDR factor which could ultimately affect the stock control level, the reorder point, and the safety level (8:22). In a related study, Bloss, Moccia, and Rowland designed a computerized inventory control system for the pharmacy at the Medical Center, Wright-Patterson AFB, Ohio (3:1). In all three studies, specific recommendations were made for continued research regarding seasonal effects on the medical supply inventory system. Peacock and Seale stated, "A model could be developed to evaluate the trends and seasonal factors upon the USAF Medical Materiel Management System [14:63]." Ferguson indicated that any development of a new inventory control system should include a seasonal factor. "If properly designed, the seasonal factor should be sensitive to a seasonal demand pattern and

insensitive to other demand patterns [8:18]." Bloss, Moccia, and Rowland also indicated in their research that demand data revealed drug items that appeared to have seasonal fluctuation patterns (3:34). They suggested future study in this area for system improvement. Recent interviews with Captain Larry B. Van Cleave, Staff Officer, Air Force Medical Materiel Field Office (23), Mr. Larry Prior, Systems Analyst, Air Force Data Systems Design Center (15), and Major Graden Casto, Chief, Materiel Management and Procedures, Headquarters United States Air Force Surgeon General's Office (7) strongly confirmed the need for continued research into the seasonal effects on medical inventories.

#### Objectives

Based on the research efforts previously mentioned and the guidance of those currently working in the Medical Inventory Management System, the specific objectives of this research were:

1. To establish criteria for identifying seasonality in medical materiel inventories.
2. To determine the extent of seasonality.
3. To develop changes to the current computer system to allow for adjustments for seasonality.

#### Research Questions

The major emphasis for this research was directed toward answering the following questions:

1. To what extent are seasonal variations present in

the medical inventory system?

2. Can seasonal variations be accounted for by  
modifications of the present computer system?

## Chapter II

### DEVELOPMENT OF CURRENT SYSTEM

#### Inventory Theory and Models

According to Turban and Meredith, the major reasons for maintaining an inventory include: protection against irregular demands and irregular supply, protection against inflation, and to allow firms to take advantage of large quantity discounts on orders (18:365-366). The two key problems that usually face any firm when attempting to establish an appropriate level of inventory are when to order, and how much to order (11:475). The amount of inventory on hand depends on the amount of consumption and the length of lead time needed to acquire replenishment of stocks. In a deterministic model, where it is assumed that demand is known and lead time is known, it becomes very easy to determine when an order should be placed and how much should be ordered. An order is placed when the balance will just be adequate to fill demands during the lead time. The order will then arrive at exactly the time that the inventory balance reaches zero. The quantity to be ordered will be the quantity needed to bring the stock up to the predetermined level. An illustration of the deterministic model is represented in Figure 1 (18:225).

In reality, however, managers are not fortunate enough to be able to determine with complete certainty what the demand

and lead time will be. Therefore, managers have developed safety levels designed to absorb variations in normal demands and normal lead times. The amount of the safety level limits to a large extent the number of times that a stock-out\* condition will occur. "No institution can afford to carry inventories for all items so large that it can protect itself against every situation [2:59]." Therefore, management must decide what amount of stock-outs is acceptable and set the safety level at a point where they can achieve this goal. This method is based on the probability that demands and lead time will fluctuate within certain limits, which makes this a stochastic model. An illustration of a stochastic model is depicted in Figure 2 (19:225). In this model, whenever the consumption drops on-hand inventory to zero, a stock-out condition exists. Figure 2 illustrates that the reorder point should occur at the time that consumption will cause the balance to fall just to the safety level during the anticipated lead time. The safety stock should be used only when demand or lead time exceeds the normal. The amount to order will always be the amount needed to bring the balance up to the predetermined level. The problems for the manager are to determine the level and at what percentage of that level the reorder point should be established. The MMMS approach to solving these problems has been to use the A-B-C method of inventory control.

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\* Stock-out--A condition when demand cannot be filled from existing stocks.

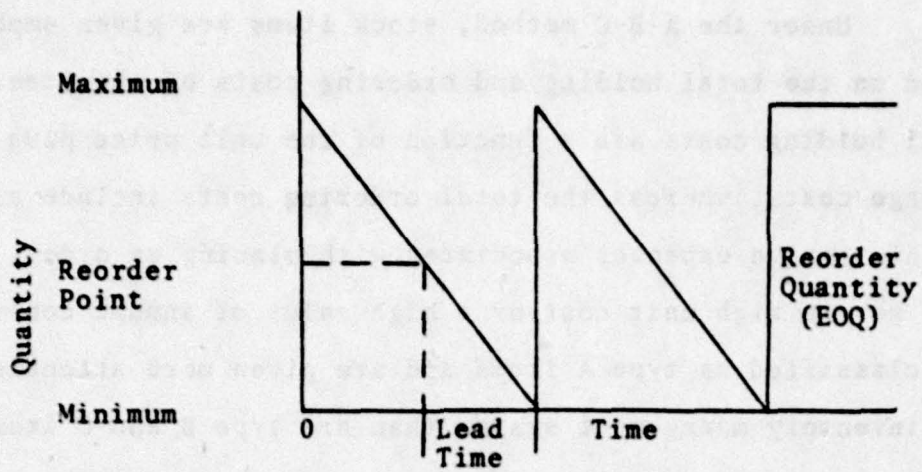


Figure 1. Deterministic Inventory Model

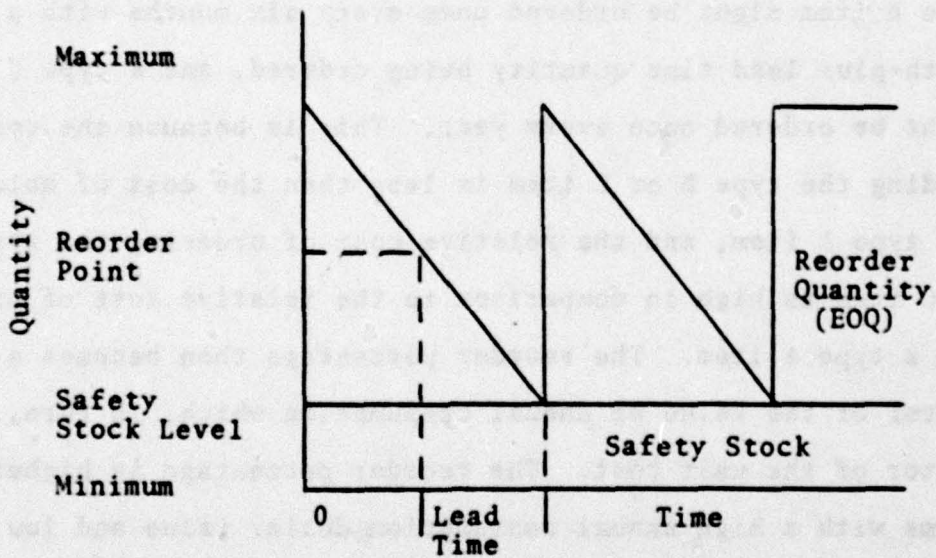


Figure 2. Stochastic Inventory Model

Under the A-B-C method, stock items are given emphasis based on the total holding and ordering costs of the item. Total holding costs are a function of the unit price plus storage costs, whereas the total ordering costs include all administrative expenses associated with placing an order. Items that have a high unit cost or a high value of annual consumption are classified as type A items and are given more attention in the inventory management system than are type B and C items, which have lower cost or consumption values. Under the A-B-C method of control, orders are placed more frequently and in smaller quantities for high dollar value consumption items. For example, a type A item might be ordered once a month with a one-month supply plus lead time being ordered, whereas a type B item might be ordered once every six months with a six-month-plus lead time quantity being ordered, and a type C item might be ordered once every year. This is because the cost of holding the type B or C item is less than the cost of holding the type A item, and the relative cost of ordering the type B or C item is high in comparison to the relative cost of ordering a type A item. The reorder percentage then becomes a factor of the value of annual consumption which, in turn, is a factor of the unit cost. The reorder percentage is higher for items with a high annual consumption dollar value and low for items with low annual consumption dollar value (9:65-67).

#### The Medical Inventory System

The MMMS operates similar to the stochastic inventory model. The system takes into account the possibility of random

variations in demands and delays in receipt of orders. In order for the system to operate, certain variables must be computed during each processing cycle. The Economic Order Quantity (EOQ), the Safety Stock Level (SSL), the Pipeline Time (PLT), the Daily Demand Rate (DDR), the Stock Control Level (SCL), the Reorder Percentage (ROP), and the Reorder Point (RP) are the variables used to determine the optimal inventory balance within each processing cycle (22:p.8-1 to 8-4). These variables are computed on an individual basis and are used to forecast one month in advance the expected demand for each line item and the appropriate levels associated with that demand. The operating period for computations is one month and the forecast uses as its basis the following parameters.

Moving Average Method. The moving average provides a means for determining the expected demand the following month and is expressed by the following formula:

$$ED_{t+1} = \frac{1}{m} \sum_{i=1}^m D_i$$

where:

- m = months of history consumption, not to exceed 12 months
- $ED_{t+1}$  = expected demands for next period
- $D_i$  = actual demand for the  $i$ th period (21:p.8-4)

Requirement Code. In the present system, the normal number of days between ordering of replenishment stock is determined by the annual dollar value of issues (22:p.8-3). The annual value of consumption is used to determine the Requirement Code for

each item in inventory. The Requirement Code then specifies the value of certain variables used to compute other parameters. The primary purpose of the Requirement Code is to incorporate the A-B-C inventory method into the system. The Requirement Codes, as specified in AFM 167-240, are shown in Table I.

TABLE I  
Requirement Codes

Annual Consumption	Requirement Code
Less than \$8.00	1
\$8.00 to \$47.99	2
\$48.00 to \$287.99	3
\$288.00 to \$1727.99	4
Non-medical items	5*
\$1728.00 and over	6
*Not subject to dollar value parameters	

Economic Order Quantity. The EOQ, as described by AFM 67-1, Volume V, was developed to consider a combination of cost factors. It indicates the optimum order quantity that will minimize the cost of ordering and the cost of holding an inventory. The EOQ affects the number of requisitions initiated during the year (21:p.8-3). A value known as the EOQ factor (EOQF) is generated based on annual consumption costs. This factor can range from 30 to 365 days and is used in determining the reorder percentage necessary to calculate the quantity to

be ordered each cycle.

Pipeline Time. The moving average method is used to determine the mean pipeline time of receipts. The number of pipeline times utilized in the computation is determined by the requirement code of the specific item. The number of pipeline values used according to each requirement code is shown in Table II (22:p.8-2).

TABLE II  
Pipeline Time Factors

Requirement Code	Pipeline Time Factors
1	2
2	3
3	4
4	6
6	6

The formula for computation of pipeline time is:

$$PLT = \frac{1}{PLF} \sum_{i=1}^{PLF} P_i$$

where:

PLT = Pipeline Time

PLF = Pipeline Time Factor as specified by the Requirement Code

$P_i$  = Most recent historical pipeline times

Daily Demand Rate. The DDR is computed using the sum of the issues in the available consumption history divided by the

number of days in the consumption history up to 365 days. The formula for computation is:

$$DDR = \frac{1}{D} \sum_{i=1}^D ISS_i$$

where:

DDR = Daily Demand Rate

$ISS_i$  = Daily Issues

D = number of days in consumption history, limited to a maximum of 365 days

It should be noted that once the item's consumption history has reached 12 months, the number of days in the consumption period is set at 365 days (22:p.8-2).

Safety Stock Level. In this system, the safety level is simply fixed at one month of stock based on the previous 12-month average. The safety stock level is figured as follows:

$$SSL = \frac{1}{m} \sum_{i=1}^m D_i$$

where:

m = months of history consumption, not to exceed 12 months

$D_i$  = actual demands for the ith month

Based on the annual dollar value of consumption, a Safety Level Factor (SLF) is provided in the computation of the Stock Control Level described below. This SLF is the number of days' supply to be ordered depending on the requirement code and the number of months of history consumption available. If the consumption

is less than 6 months, the SLF is equal to 15 days, and if the consumption history is for more than 6 months, the SLF is equal to 30 days (21:p.8-5).

Stock Control Level. After each of the above described variables has been determined, the SCL is then computed according to the following formula (21:p.8-4):

$$SCL = (SLF \times DDR) + (EOQF \times DDR) + (PLT \times DDR)$$

Reorder Percentage and Reorder Point. The Pipeline Time, Safety Level Factor, and EOQ Factor are used in the formula to compute the desired reorder percentage, which is subsequently used to determine the numerical reorder point. The ratio of factors for determining the ROP is:

$$ROP = \frac{PLT + SLF}{PLT + SLF + EOQF}$$

This value (ROP) is then applied against the SCL to determine the reorder point (RP):

$$RP = ROP \times SCL$$

### Seasonality

Most inventory systems allow for certain fluctuations in lead time and demand by incorporating a safety level. This works adequately for those items whose lead time and demand fluctuate according to random variations to a normal distribution. The safety level is designed to accommodate a certain standard deviation from this norm. There are, however, many items whose demand fluctuations follow other than a normal

distribution over a 12-month period (6:31-35). Some items are demanded only during certain months of the year and possibly only one or two months of the year. If this demand follows a pattern from year to year, the items should be considered to be seasonal and should be treated in a special manner. Retail businesses generally handle seasonal items on an exception basis. For example, a sporting goods store increases the level of ammunition on hand just prior to hunting season and allows the level to drop much lower during nonhunting seasons. Commercial department stores typically build up inventories just before Christmas in anticipation of increased sales during that season. These stores usually liquidate their seasonal assets at the end of the season by having clearance sales. By eliminating the inventory of off-season items, firms can then afford to invest in other areas of interest. It appears that most of these seasonal adjustments are done heuristically. If an inventory is managed by a computer, the manager must override the recommendations of the computer and establish levels based on the past year's history. AFM 67-1, Volume V, even specifies that "variations in stock control levels and EOQs may be necessary for certain items under certain conditions," such as "seasonal items with negligible off-season consumption [21:p.8-4]." With the number of line items being managed in the medical inventory, it becomes impossible to manually control all items that exhibit seasonal trends. This is exemplified in the case of Insect Sting Kits in the inventory at the USAF Medical Center, Wright-Patterson AFB, Ohio. These particular kits show a history consumption of

24 in April, 24 in June, 36 in July, 12 in August, and zero in the following eight months. The computer calculated the SCL to be 24; therefore, 24 kits remained on the shelf for eight months with no consumption. Another example relates to the demand for calamine lotion. With a stock control level of 113 bottles, the consumption history revealed that issues were made for only five months out of the year. Therefore, 113 bottles of lotion remained idle on the shelf for seven months (19).

The Medical Materiel Management System presently has no effective method of automatically adjusting levels for seasonal items. In this Air Force medical inventory system, funds are invested in inventories for all seasons at all times of the year. The same balance of stocks is carried in the inventory when known seasonal trends exist. There is little logic for maintaining a fixed safety stock on items in the inventory when seasonal trends exist. There is a

. . . tremendous opportunity for reducing investments and improving service in field stocks by basing safety stocks on a measurement of the errors actually experienced, in contrast to the naive methods of setting safety stocks as so many weeks of supply [5:44-45].

All stock levels are based on the probability that demands will not exceed availability based on historical records. For example, if a stock level of five items exists for a certain item in season and demands for six items occur, it is logical to conclude that this is a condition similar to having a level of zero in an off-season and experiencing a demand of one. In either case, arrangements must be made to procure the necessary item. Since all stock levels are based on a projection of the past, it is

reasonable to follow trends from previous years and adjust the levels accordingly, even if that requires maintaining a level of zero. The flexibility exists in the MMMS to maintain levels of zero by giving the materiel manager the authority to override the computer at his discretion (21:p.8-4). Therefore, it seems appropriate that some method be incorporated into the computer program to allow automatic adjustments to be made for seasonal items.

## Chapter III

### RESEARCH METHODS

#### Introduction

The data generated by the current MMMS inventory model are vital to this research effort. Therefore, the purpose of this chapter will be to identify the origin of the data, the specific data selected for analysis, and the data validity. This chapter will also be devoted to defining the criteria used in screening the data for seasonality and explaining some specific forecasting techniques that were applied to those seasonal items identified. The assumptions and limitations necessary for this study are included at the end of the chapter.

#### Population and Sample Description

The population of interest for this research consists of the various medical supply accounts Air Force-wide. Each of these accounts maintains computer products necessary for inventory control. The control system is updated daily using the base level Burroughs B-3500 computer. Each inventory account item has pertinent data stored in a master record on a computer tape. The information on the master record is maintained between processing cycles and can be accessed as needed by requesting a Stock Status Report. The report is a computer printout that arranges the data on the master record in a

logical form for management analysis. The key data on this report include the stock number, item identification, procurement source, historical issues for the past twelve months (demand data), reorder percentage and quantity, expendability code, requirement code, and the most current order lead times. The material manager for each account must review this data and insure it is properly updated and maintained.

The master record contains one year of past consumption history for each inventory item. This data is updated monthly by replacing the oldest month of data with the new. Because of this continuous updating process, vital historical data are removed from the computer from cycle to cycle. However, the historical events are preserved on monthly computer printouts, and these are maintained for one year by each account manager before being destroyed. The lack of year-to-year historical data in the medical inventory system has made it difficult to identify long-range trends in stock usage. The lack of this yearly historical data is also the primary reason why there have not been any known studies on seasonality in the MMMS structure. Captain Richard W. Ferguson indicates in his research that seasonal trends appeared to be present, but he could not confirm his hypothesis with only one year of data (8:18).

Based partially on Captain Ferguson's research recommendations and because of the growing interest in the high cost of managing the MMMS, the Air Force Data System Design Center (AFDSDC) requested computer tapes of the inventory master records from four Air Force Base Hospitals over two separate

years. The bases selected were Scott, Offutt, Blytheville and Whiteman. The time periods covered on the tapes were calendar years 1975 and 1977. Mr. Larry Prior, AFSDC, released the data tapes from Offutt and Whiteman for this research effort. Upon receipt of these tapes, the question arose about the one year gap in the data. Mr. Prior's response to this question was, "These are the only known data files that are from different time periods [15]." The same year gap was also present in the data tapes from Scott and Blytheville. Therefore, the information provided on the data tapes for Offutt and Whiteman will be the sample data used for this research. The extent to which the findings of this research can be generalized to the entire population may be limited because of the gap in the data and the fact that these bases do not represent a random sample. Although, the research findings may be representative of what could be expected at any of the stock fund accounts, since these accounts are constrained and operated in a similar fashion.

The data furnished by AFSDC was examined for all requirement codes in the drug and biological class (6505) only. The reason for selecting this particular class is that it is the largest, single class of inventory items and, partially, because of the need to narrow and limit the scope of this research. Also, it logically follows that if seasonality is present in this specific class, it is highly probable that it will be present in all others.

#### Validity

The data recorded on the tapes being used in this

research come from daily transactions and events. AFM 167-240 outlines the computer system utilized to accumulate this data. The mathematical model formulating the basis of the system has been tested previously for statistical accuracy and validity (8:34). Since the MMMS is the only source of such data, it is the most valid source available.

#### Analysis of Data

The initial approach that was taken to analyze the data tapes was to develop a FORTRAN program which could extract 6505 class data (see Appendices B & C). This program was designed to read through the data for 1975 and 1977, selecting only those items from the 6505 class for further analysis. Within the program it was also necessary to limit the data search to those stock numbers with at least twelve months of consumption history. The reason for this limitation is that in order to make viable comparisons between the years, complete consumption data must be available. This information is provided for each stock number as the History Begin Date (HBD). Only items with histories beginning December 1974 or earlier were considered.

The next critical step in analyzing the data involved establishing some criteria that could be used to select those items that exhibited seasonal variation. After close examination of several computer printouts of demand history, it was apparent that many of the stock numbers in the 6505 class exhibited demand fluctuations that very likely could be termed seasonal. Based on statistical estimation techniques, the maximum expected random variation in demand will generally not

exceed three standard deviations, since three standard deviations include 99.72 percent of all fluctuations during any time period (4:104). Research indicates that the standard deviation is the proper measure of demand error (5:45). Utilizing this concept, it was discovered heuristically that whenever the magnitude of demand for any one month was greater than two standard deviations from the mean, that particular stock number exhibited a discernable pattern of demand that could possibly be seasonal. Further evidence, supported statistically, indicates that almost two-thirds of all random fluctuations should fall within a range of one standard deviation from the mean and, therefore, the odds are heavily against purely random variations that consistently fall outside the range of one standard deviation (1:314). If the average demand does vary from the mean more than one standard deviation for several months running, the odds are that this is not a random fluctuation, but probably the result of some nonrandom factor, possibly seasonal in nature (1:315). With this understanding and considering the result of the heuristic evaluation, one standard deviation was established as the basic criteria for seasonal screening. Any stock number with average demand for several consecutive months exceeding one standard deviation from the mean demand was considered a seasonal item (26).

Several consecutive months could range from two months upward. However, for the purpose of this study, three months was determined to be the best discriminator of seasonality. By scanning several stock numbers that appeared to have seasonal

variation, the apparent trend occurred most often for three months in duration. This is supported logically, since many diseases occur with greater frequencies during the different natural seasons of the year, which are typically three months in duration. With this final criterion established, the original FORTRAN program was revised to identify any stock numbers whose average demand for three consecutive months exceeded one standard deviation. This selection criterion was formulated with the realization that there may be seasons of different lengths that may not have an average fluctuation exceeding one standard deviation; however, statistically and logically, this criterion should capture the bulk of those items which are seasonal.

#### Analysis of Forecasting

As stated in Chapter II, the MMMS uses the Simple Moving Average technique to forecast demand. The following formula is basic to all moving average models (16:87):

$$F_{n+1} = \frac{\sum_{i=1}^n \text{Demand}_i}{n}$$

where

$F_{n+1}$  = the forecast for the next period

$\text{Demand}_i$  = actual demand for period

$n$  = the number of periods of demand being considered

The simple moving average forecast ( $F_{n+1}$ ) is calculated by dividing the sum demands in the last  $n$  periods by  $n$ . This is

the simplest form of an estimate for the mean value of a stationary demand process (10:15). The overall effect of using the simple moving average is that demand fluctuations over the  $n$  periods are averaged out and the effects are not as noticeable. This means that any seasonal variations that may exist are largely smoothed out using the simple moving average technique. "A simple moving average is not sufficiently accurate to reflect what we truly can know about demand [4:85]." The failings of the moving average method can be overcome by using another forecast technique known as exponential smoothing.

"The exponential smoothing method of forecasting is a form of weighted averages and moving averages combined [8:26]." The disadvantages of the moving average method can be minimized by using exponential smoothing. Under the moving average method, equal weights are assigned to all data inputs in the forecasting of future demand. However, the exponential smoothing method uses varied weights and the data can be weighted depending on its importance. The following formula depicts the exponential smoothing process (16:91):

$$U_{t+1} = Y_t + (1 - \alpha) U_t$$

A smoothing constant ( $\alpha$ ) between 0 and 1 is used to add or subtract a fraction of the difference between the actual current demand ( $Y_t$ ) and the last forecast demand ( $U_t$ ). The sensitivity of the exponential smoothing forecast can be altered at any time by changing the value of  $\alpha$ . An increased value of  $\alpha$  gives more weight to recent data and, therefore, makes the forecast

more sensitive. Conversely, a smaller value of  $\alpha$  gives less weight to recent data. For the moving average method, the sensitivity can only be altered by changing  $n$ ; however, the forecast cannot be as significantly affected in the next period as it can be with the exponential smoothing method. Another important feature of exponential smoothing is that it only requires one piece of information to be retained from period to period. Also, past data are eliminated gradually rather than suddenly, as with the moving average (10:16).

The exponential smoothing technique, as previously described, is superior to the moving average technique in many ways. However, this primary form of exponential smoothing is not as efficient as desired when forecasting seasonal variations or taking into account linear trends in the data (16:94). To develop an equation that takes into account seasonal trends in the data and uses the weighted average concept, it is possible to refine the first order exponential smoothing forecast by resmoothing the initial forecast in a similar equation. By doubly exponentially weighting this forecast, it is possible to predict future demands, trends within demand patterns, and seasonal variations, while, at the same time, eliminating the influences of random variations (8:27). The double exponential smoothing model is represented as follows (16:94):

$$U_{t+1}^2 = \alpha U_{t+1}^1 + (1 - \alpha) U_t^2$$

where

$U_{t+1}^1$  = the First Order Exponential Forecast

$U_{t+1}^2$  = the Double Exponential Forecast

$U_t$  = the Previous Double Exponential Forecast

The accuracy of double exponential smoothing can also be varied by changing the smoothing constant ( $\alpha$ ) to add more or less weight to recent data, thereby achieving the best possible forecast.

It is apparent when using exponentially weighted averages for forecasting that if the value of  $\alpha$  can be varied in sympathy with the demand situation, better forecasts are likely to result (25:34). For example, if the demand data are fluctuating rapidly, a large value of  $\alpha$  is necessary to achieve the best forecast. When the demand is more stable, a low value of  $\alpha$  is more appropriate. Considering these notions, Trigg and Leach have suggested a method of varying the value of  $\alpha$  automatically so that it tracks demand fluctuations (17:52). This automatic mechanism is formally called Trigg's tracking signal. Its computation is as follows (17:51):

$$T_t = \bar{e}_t / M_t$$

where

$T_t$  = Trigg's tracking signal

$\bar{e}_t$  = the Exponentially Weighted Average

$M_t$  = Mean Absolute Deviation

and

$$M_t = \alpha |e_t| + (1 - \alpha) M_{t-1}$$

$$\bar{e}_t = \alpha \cdot e_t + (1 - \alpha) \bar{e}_{t-1}$$

$M_{t-1}$  = Previous Mean Absolute Deviation

$\bar{e}_{t-1}$  = Previous Exponentially Weighted Average

$e_t$  =  $Y_t - \hat{Y}_t$

where

$Y_t$  = Actual Demand

$\hat{Y}_t$  = Estimated Demand

Since Trigg's tracking signal automatically adjusts to varying demand, it can be used to replace  $\alpha$  in the original exponential smoothing equation. By making this substitution, the model becomes adaptive in nature and has been named the Adaptive Response Rate Forecast (10:21). This method of forecasting is given by the formula below (10:22):

$$\tilde{U}_t = |T_t|Y_t + (1 - |T_t|)\tilde{U}_{t-1}$$

where

$T_t$  = Trigg's Tracking Signal

$Y_t$  = Actual Demand for Current Period

$\tilde{U}_t$  = Adaptive Response Rate Forecast

$\tilde{U}_{t-1}$  = Previous Adaptive Response Rate Forecast

This forecasting method is feasible since Trigg's tracking signal can only vary between 0 and 1, the same restriction placed on the smoothing constant  $\alpha$ . When the data are fluctuating rapidly, a relatively high value of the tracking signal will be evaluated and, thus, the adaptive response rate forecast should be very sensitive, and when the demand

data are stable, the resulting value of the tracking signal should be small, resulting in a very stable forecast (10:22).

In consideration of the attributes of these three forecasting models, one function of this research was to evaluate each technique in the context of the available forecast data. Each technique was incorporated into the original FORTRAN program and relative comparisons have been made between the ability of each technique to forecast the demand for 1977 using 1975 data. These forecasts have been evaluated specifically for those items that have met the seasonal criteria established in the previous section. The Mean Square Error (MSE) was used to discriminate between the efficiency of each forecasting technique. According to Sullivan and Claycombe, the model that minimizes the MSE is often regarded as the best model for future forecasting (16:25). The MSE is calculated as follows (16:26):

$$MSE = \frac{\sum_{i=1}^n (e - a)^2}{n}$$

where

e = Estimated Demand

a = Actual Demand

n = Number of months being evaluated

Using these three forecast techniques and choosing the best MSE forecast, comparisons were made for both Offutt and Whiteman. General trends in seasonal variation were evaluated for both bases and the efficiency of each model was tested. A secondary analysis was also made to evaluate how well each forecasting

technique performed on the demand data that did not meet the seasonal criteria to assure that no degradation occurred on nonseasonal forecasts.

#### Assumptions and Limitations

The following assumptions were made in evaluating the data for this research.

1. Future monthly demand patterns will be similar from year to year.
2. The distribution used in calculating the MSE of demands was assumed to be normal based on the central limit theorem.
3. The tapes furnished by AFSDC were accurate and valid as collected.
4. Delays due to inordinate lead times will be similar from year to year and will, therefore, balance each other.

The following limitations are provided to indicate potential problem areas:

1. Sporadic ordering by supply custodians in the hospital may have caused some distortion in the data.
2. Quarterly fund limitations could have distorted the data. These limitations exist annually and effects from year to year should be similar.
3. Physician turnover in the hospital may have forced a change in demand rates for varied medical items since some drug usage is a matter of physician preference.

4. Data are from 1975 and 1977, respectively, and it is unknown what happened in 1976.

#### Summary

In this chapter the source of the data has been identified, delimited and assumed valid. Specific data analysis criteria were established for screening seasonality and several forecasting techniques were presented, which were tested for their ability to forecast seasonal trends as well as normal demands. It should be emphasized again that the data sample, consisting of information from two specific Air Force bases over two separate years, is the only data of its kind available. The analysis of this unique data has allowed a meaningful study of seasonality in the MMMS and the realization of the objectives of this research. Various assumptions and limitations have also been presented to insure the proper perspective is taken toward this research.

## Chapter IV

### ANALYSIS

#### Introduction

The first section of this chapter comments on seasonal screening and the criteria used to identify seasonality. In the following section, the extent of seasonality is addressed using both figurative and graphic illustrations. The final section analyzes the performance of those forecasting models presented in Chapter III, and reports on the ability of each model to forecast seasonal demand as well as nonseasonal demand.

#### Criteria for Seasonality

Ammer states, "The simplest way to estimate seasonal fluctuation is to assume that the pattern that prevailed in the past will prevail in the future [1:311]." Almost every product or service is subject to some seasonal variation, and in most cases it is fairly easy to identify. Brown suggests that the past demand data be plotted and examined closely for seasonal trends (4:106). However, this is not always economical, especially when thousands of items are involved. One of the best ways to evaluate seasonal variation without plotting is to average the monthly data over one period and check for those months that deviate drastically from that average (1:312). The unanswered question that follows is: How much deviation is

drastic? The answer is not a precise one, although, as pointed out in Chapter III, it can be statistically and logically determined. The established seasonality criteria for data analysis states that, if the average demand for any three consecutive months has a fluctuation of more than one standard deviation from the mean demand, the item is classified as seasonal. This means that for three consecutive months, the demand is drastic enough and consistent enough to make it difficult to justify as a purely random fluctuation. This criteria provided a starting point for further seasonal analysis, however, it is not the optimum for discovering seasonality. The fact that certain inventory items meet this seasonal criteria is not a guarantee that they are, in reality, seasonal and will follow a similar month-to-month demand pattern year after year. This criteria can be tightened or loosened to achieve a spectrum of seasonal variation, and since this research team could not identify any particular knowledgeable source that could firmly establish the bounds of seasonal variation, this research method is just one of many possible approaches. Medical demand patterns can display seasonality for varying lengths, and it is impossible for one set of criteria to encompass all possible seasonal variations.

The seasonal criteria as described above were translated into the original computer program for initial data analysis (see Appendices A, B & C). This program was designed to scan the data tapes for both 1975 and 1977 and select those items in the 6505 class for a specified base (Offutt or Whiteman) that

met the criteria. The process was repeated until four temporary memory files were created with seasonal items corresponding to base and year combinations. These new memory files were scanned once again, selecting a random stock number from each file to visually verify seasonal fluctuations. The items selected by the computer have been graphed to illustrate the relative efficiency of the established seasonal criteria to identify seasonal variation (see Figures 3 - 6). By examining these randomly selected demand patterns, it is apparent that the established seasonal criteria is performing as it was theoretically hypothesized and actually desired.

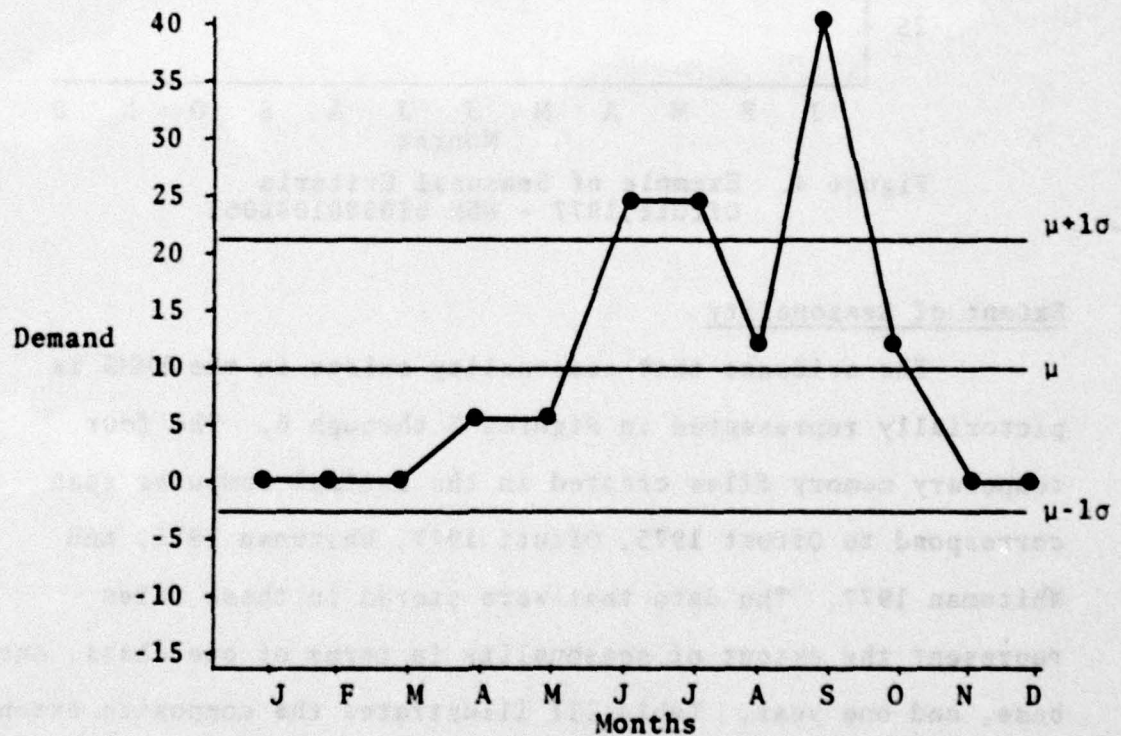


Figure 3. Example of Seasonal Criteria  
Offutt, 1975 - NSN 6505001182318

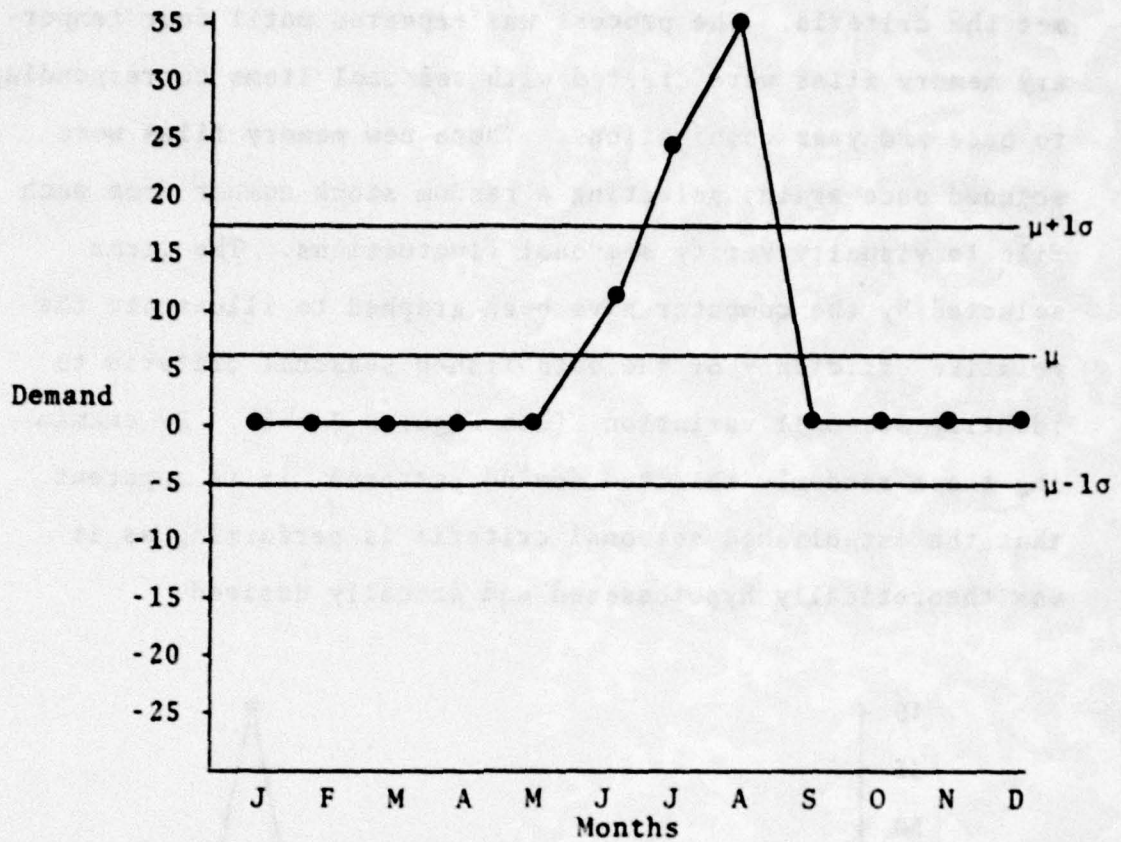


Figure 4. Example of Seasonal Criteria  
Offutt, 1977 - NSN 6505001048061

Extent of Seasonality

The evidence that seasonality exists in the MMMS is pictorially represented in Figures 3 through 6. The four temporary memory files created in the initial computer scan correspond to Offutt 1975, Offutt 1977, Whiteman 1975, and Whiteman 1977. The data that were stored in these files represent the extent of seasonality in terms of one class, one base, and one year. Table III illustrates the composite extent of seasonality.

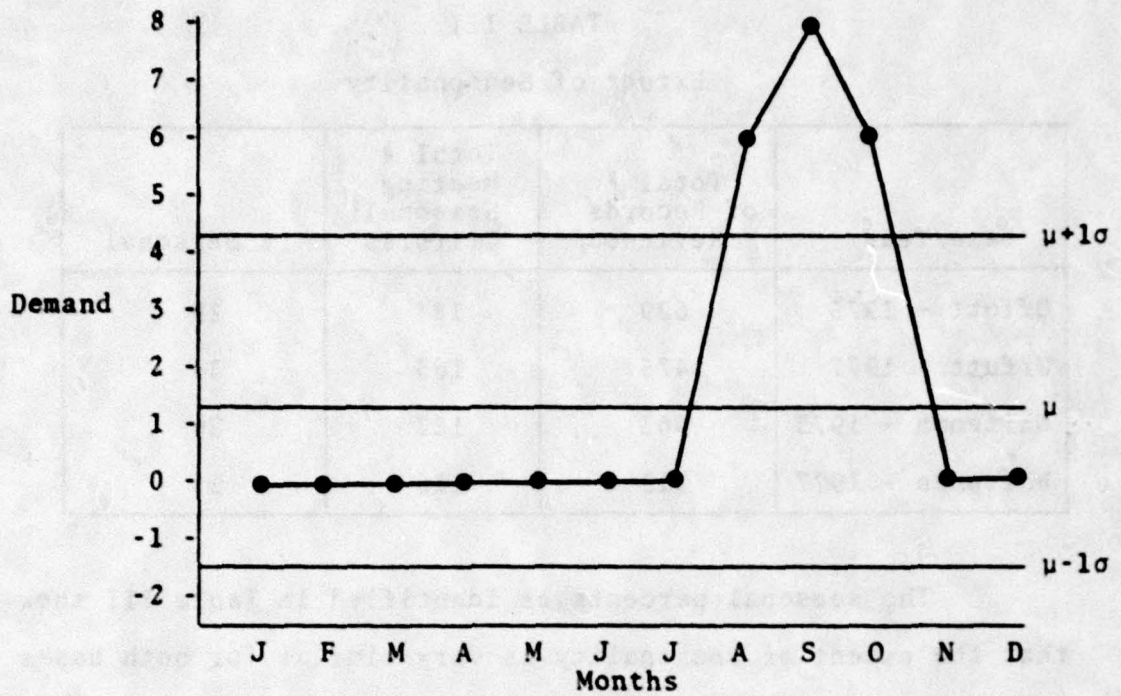


Figure 5. Example of Seasonal Criteria  
Whiteman, 1975 - NSN 6505008901573

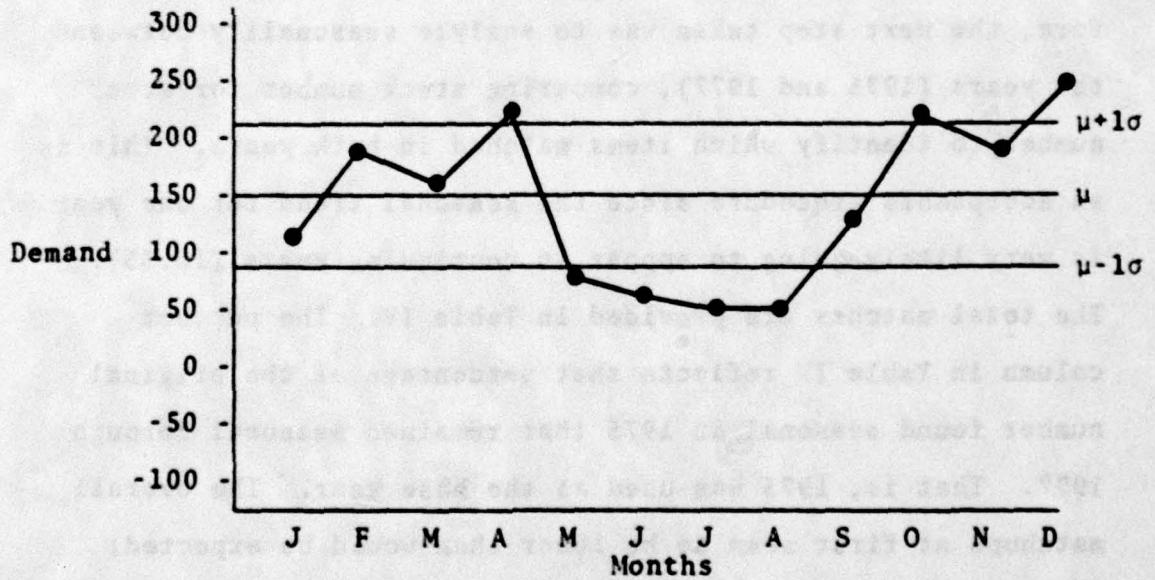


Figure 6. Example of Seasonal Criteria  
Whiteman, 1977 - NSN 6505009354095

TABLE III

## Extent of Seasonality

Base/Year	Total # of Records Reviewed	Total # Meeting Seasonal Criteria	% Seasonal
Offutt - 1975	629	184	29
Offutt - 1977	475	165	34
Whiteman - 1975	463	122	26
Whiteman - 1977	319	116	35

The seasonal percentages identified in Table III show that the extent of seasonality is very similar for both bases and both years (25-35% range), even though the original number of 6505 inventory records were significantly different. Therefore, the next step taken was to analyze seasonality between the years (1975 and 1977), comparing stock number for stock number to identify which items matched in both years. This is an acceptable procedure since the seasonal trend for one year is very likely going to appear in continuing years (16:55). The total matches are provided in Table IV. The percent column in Table IV reflects that percentage of the original number found seasonal in 1975 that remained seasonal through 1977. That is, 1975 was used as the base year. The overall matchups at first seem to be lower than would be expected; however, these percentages are for only one of several inventory classes and there is a year of missing data that could possibly explain the magnitude of similarity.

TABLE IV  
Comparison of Year to Year Seasonality

Offutt				
Year	Total Records Scanned	Total # Seasonal	Total # Seasonal Matches	Year to Year Percent Seasonal (1975 Base Year)
1975	629	184	58	9%
1977	475	165		
Whiteman				
Year	Total Records Scanned	Total # Seasonal	Total # Seasonal Matches	Year to Year Percent Seasonal (1975 Base Year)
1975	463	122	35	8%
1977	319	116		

The matchups made for each base between 1975 and 1977 were next transferred to another computer subprogram, where they were used to construct graphic illustrations of the demand pattern similarity from year to year. Figure 7 depicts the typical product from this computer analysis.

Sample graphic illustrations as observed in Figure 7 are available for each stock number that was identified as seasonal in 1975 and remained seasonal in 1977 (see Appendix D). These graphs are particularly pertinent since they indicate the percentage of demand in each month compared with the total demands for the year. This allows both years' demands to be displayed on the same scale for easy comparison of trends. By

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.....
BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505006561466
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC DFC
      1977 0 12 04 0 24 156 12 148 48 0 0 24
          0 0 12 0 0 24 0 24 12 0 0 0
          .....
          MOVING-AVERAGE FORECAST FOR 1977
          632.17 42 42 41 35 35 33 22 21 11 8 0 0 0
          .....
          MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
          147.77 19 11 5 7 5 2 11 0 14 14 0 4
          .....
          MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
          136.33 20 24 7 0 10 9 4 10 9 14 13 10
          .....
          40
          38
          36
          34
          32
          30
          28
          26
          24
          22
          20
          18
          16
          14
          12
          10
          8
          6
          4
          2
          0
          .....
  
```

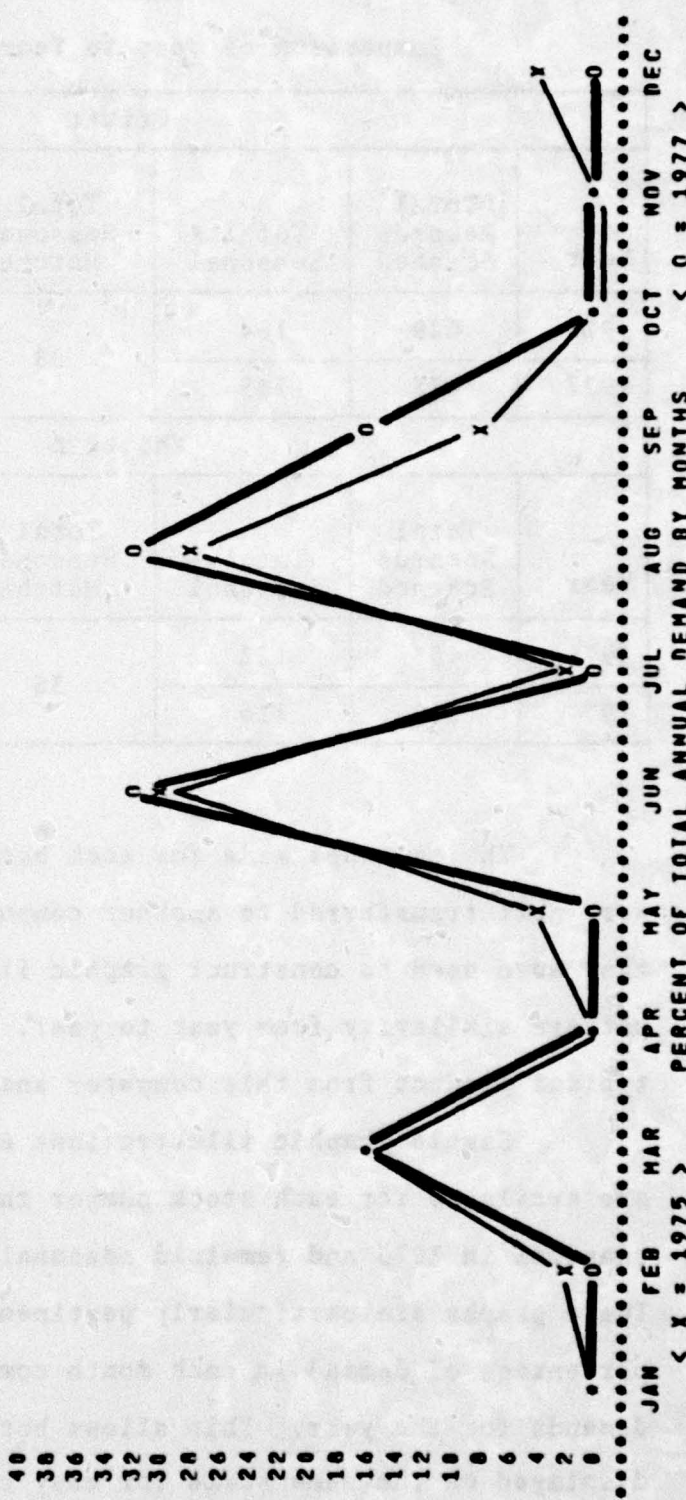


Figure 7. Sample Seasonal Output

close observation of these graphs, it can be seen that some items follow a very obvious trend in both years that can be equated as typical seasonal variation. Other graphs have a vertical gap between the yearly patterns, yet the peaks and valleys coincide exactly. Then, there are those that have a horizontal as well as a vertical variance between years. Closer examination of these graphs often shows that the peaks and valleys are off by just one time period, which is a common occurrence in reality, since seasons are not always exactly the same year after year. This is a reflection of the fact that flu seasons, for example, or similar disease seasons, vary somewhat from year to year, depending on numerous variables among which natural seasonal changes are the most important.

The one-for-one correlations between years of seasonally selected items is not as substantial as expected (8-9%), however, there are some explanations for such a variance. The obvious explanation was hinted at earlier and relates directly to the one year gap in the data base. It is impossible to ascertain the exact effect of this data void, although it is highly probable that the effect is not favorable. The missing data for 1976 makes it difficult to evaluate trends through the 1975 to 1977 time frame. The underlying reasons for the variations observed in Appendix D could be better explained if the 1976 data were available for comparison.

During the 1975 to 1977 time frame, new items were being added to the inventory and old ones were eliminated on a continuous basis. This changing nature is centered around two

basic occurrences. The first relates to new medical technology which is constantly improving medical supplies, resulting in the replacement of older stock with more advanced items. The second occurrence deals with the high changeover rate of Air Force medical doctors, which creates instability in drug usage. As new doctors come into the clinics, they bring their biases, not only in terms of drug prescription, but the use of other medical supplies. This change in usage causes the demand for certain drugs to drop off enough to make it uneconomical to continue an item in the inventory system. Closely associated with the doctor turnover rate is the changing of specialists, who require new and different equipment, drugs, and supplies. The ultimate result of these occurrences is a changeover of demand from one type of stock to another. This characteristic change is not as violent for a one-year period, but there can be significant differences over a two-year time frame. The researchers feel this can explain a large portion of the variance in the extent of seasonality between 1975 and 1977. The gap in this data represents a quantum leap in demand patterns, and this would not be expected in a continuous sequence of events.

Another underlying cause for the lack of continued seasonality, which is increased due to the data gap, relates to the procedures used in ordering stock and the level in the organization where ordering is accomplished. The demand data used for this study was intermediate in nature. The data do not reflect actual customer demands for a certain period, but

rather, they represent clinic demands on the central warehouse. The ordering policies are uniformly outlined in the operations manual, however, it is hard to discount human intervention within the system. For example, some clinic stock clerks feel it is appropriate to order one month's worth of supplies at a given order point, then at the very next order point, will often double or triple the order to prevent having to order so often. If this convenience method of ordering goes unchecked, it will have a substantial effect on the MMS demand patterns, reflecting spurious inputs that could be mistaken for seasonal variation. Yearly and quarterly fiscal constraints can also cause demand changes from period to period, even though there is not actually that level of customer demand to support such a change. This spurious demand is depicted graphically in the data as a dropping-off of demand in December, followed by a rapid spike in January when more money is available. Similar results can be observed at other quarterly intervals (see Appendix D). Generally, it is expected that these variations will average out and represent a relative picture of the demand, however, this cannot be substantiated by the data analyzed.

In summary, the extent of seasonality has been determined by analysis of available data, although the results appear to be impaired significantly by the gap in the data. Based on the analysis findings, it can be inferred that about 9% of the stock numbers in the 6505 class display some sort of seasonal variation on a consistent basis. Had the data been continuous, the researchers speculate that this percentage would

be noticeably greater. Considering that the resulting extent of seasonality is for the 6505 class only, this implies that there is a potential for higher levels and that significant savings in inventory stock can be made if these seasonal variations can be accounted for. The next section will address forecasting based on this perception.

#### Evaluation of Forecasting

Under the current MMMS operating structure, the Medical Supply Officer and his staff must manually manage inventory items that exhibit unusual seasonal trends and fluctuation (21: p.8-3). However, the evidence of seasonality within the MMMS suggests that this must be an extensive and time consuming task to efficiently perform. Suitable adjustments can be made through the forecasting mechanism to automatically account for seasonality (17:59). Currently, the only forecasting mechanism in the MMMS model is the simple moving average technique, using an average of the previous twelve months' demand as its forecast. This is not the most efficient forecast mechanism. The simple moving average can be adjusted by varying the number of periods that are averaged. Although it cannot account for random fluctuation and actual seasonal trends and variations at the same time. The forecasting technique that is more suitable is the exponential smoothing method. The first order exponential smoothing model outperforms the moving average. And, when this initial smoothed forecast is resmoothed or doubly exponentially smoothed, the new forecast has a greater ability

to forecast trends and seasonal variations. Both forms of exponential smoothing can be adjusted for sensitivity by changing the smoothing constant. Yet, there is another forecasting technique, referred to as the Adaptive Response Rate, that has all the attributes of exponential smoothing, plus the ability to automatically adjust to demand fluctuations. All three of these forecasting techniques have been discussed and fully explained in Chapter III. The forecasting ability of each (Moving Average, Double Exponential Smoothing, and Adaptive Response Rate) has been tested and the following paragraphs outline the results.

Those stock numbers that were screened as seasonal in both 1975 and 1977 are the basis for the forecasting evaluations conducted. The primary focus of this analysis was to demonstrate the ability of each of the above techniques to take the actual demand data from 1975 and forecast 1977 demand. The formulas for these three forecasting techniques were studied in detail. The moving average model tested was the same twelve-period model now used for the MMMS. The double exponential smoothing model was used because of its ability to handle seasonality. A range of smoothing constants from .05 to .95 was evaluated for this model in increments of .05. The adaptive response rate technique was used in a similar manner, where a variation was added to the tracking signal. It was also given a range of smoothing constants from .05 to .95. The main computer program with these forecasting subprograms was linked with the matched seasonal data from both bases.

TABLE V

## Best Seasonal Forecaster

Base	Simple Moving Average		Double Exponential Smoothing		Adaptive Response Rate	
	#	%	#	%	#	%
Offutt	6	10%	27	47%	25	43%
Whiteman	5	14%	11	32%	19	54%
Both	11	12%	38	41%	44	47%

Note: For replication of the results from the Double Exponential Smoothing and Adaptive Response Rate forecasts, it is necessary to point out that a priming forecast value was required in the initial stage of implementation. This estimated value was obtained by averaging the first three months of demand in 1975 (16:93).

The actual forecast values for each stock number evaluated are available for review in Appendices D and E. The triple asterisk (\*\*\*) was used to identify the best performing model based on the minimum MSE. Table V depicts the cumulative results of all forecast models to predict seasonality.

By examination of Table V, it is apparent that the Adaptive Response Rate model was best 47% of the time for both bases. This model outperformed both of the competing models with the Double Exponential Smoothing model being a very close second. However, a more significant point in this evaluation is that when comparing Double Exponential Smoothing to Moving Average alone or Adaptive Response Rate to Moving Average alone, they both are better by a vast margin (84% and 64% respectively).

TABLE VI  
Seasonal Moving Average Comparisons

Base	Simple Moving Average		Double Exponential Smoothing	
	#	%	#	%
Offutt	8	14%	50	86%
Whiteman	7	20%	28	80%
Both	15	16%	78	84%

Base	Simple Moving Average		Adaptive Response Rate	
	#	%	#	%
Offutt	22	38%	36	62%
Whiteman	12	34%	23	66%
Both	34	36%	59	64%

See Table VI for these comparisons. Almost as significant to this research as Table VI is, is the fact that when the Moving Average was the better model, there was a Double Exponential Smoothing model as good or very close to being as efficient. Table VII depicts this comparison, showing a relatively small difference in the MSE for each case.

When using the Double Exponential Smoothing model to forecast seasonal variation, a relatively larger smoothing constant is generally necessary to produce the best forecast. Brown has indicated that the value of  $\alpha$  used in forming an exponentially weighted forecast should not usually exceed .3 and if it appears that a higher value of  $\alpha$  is required, the

TABLE VII  
 Double Exponential and Moving Average  
 Comparison

Offutt NSNs	Moving Average MSE	Double Exponential MSE	Difference	%* Difference
6505002261203	80.00	80.75	.75	.9%
6505002998279	389.67	420.17	30.50	8%
6505008901633	63.75	67.42	3.67	7%
6505008902172	77.08	77.58	.50	.6%
6505009269202	46.75	50.78	3.83	8%
6505008718307	2.08	2.08	-0-	-0-
<u>Whiteman NSNs</u>				
6505008901573	8.50	8.92	.42	5%
6505008901657	1062.75	1229.33	166.58	15%
6505009984381	100.00	101.67	1.67	2%
6505007643366	.50	.50	-0-	-0-
65059040119	.58	.58	-0-	-0-
* Moving Average MSE was used as the base				

assumption of seasonality is likely to be more valid (4:101). Figure 8 illustrates the number of times a given smoothing constant was required to produce the best double exponential model. The higher occurrence (54%) of the larger alphas ( $\alpha > .3$ ) suggests that demand predominately had periods of fluctuations that were most likely seasonal. Figure 8 also depicts that a large percentage of smaller alphas were used in forecasting seasonal

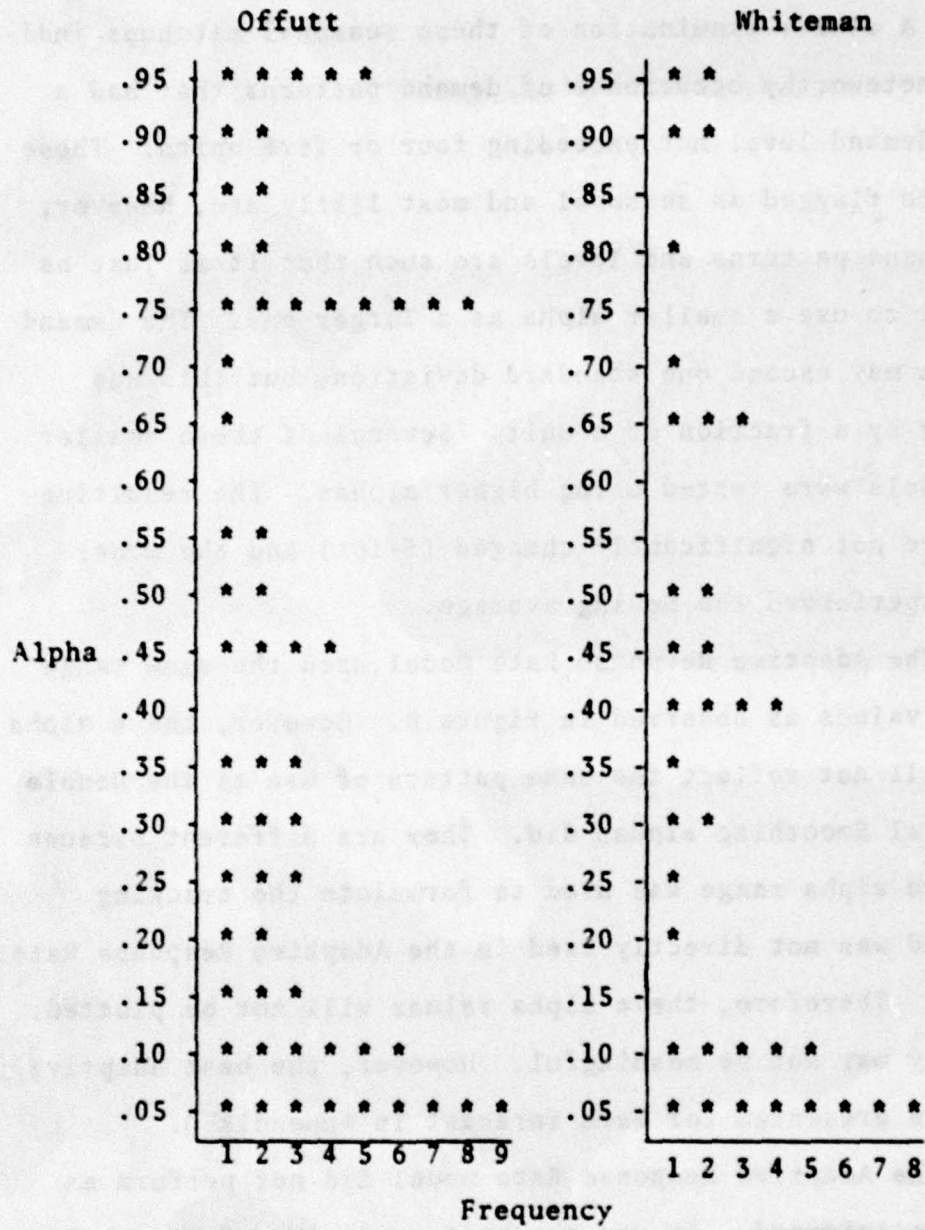


Figure 8. Seasonal Frequency of Smoothing Constant Occurrence (Double Exponential Smoothing)

demand. A closer examination of these seasonal matchups indicates a noteworthy occurrence of demand patterns that had a maximum demand level not exceeding four or five units. These items were flagged as seasonal and most likely are, however, their demand patterns and levels are such that it is just as efficient to use a smaller alpha as a larger one. The demand variation may exceed one standard deviation, but this was typically by a fraction of a unit. Several of these smaller alpha models were tested using higher alphas. The resulting MSE's were not significantly changed (5-10%) and the model still outperformed the moving average.

The Adaptive Response Rate model used the same range of alpha values as observed in Figure 8. However, these alpha values will not reflect the same pattern of use as the Double Exponential Smoothing alphas did. They are different because the varied alpha range was used to formulate the tracking signal and was not directly used in the Adaptive Response Rate forecast. Therefore, these alpha values will not be plotted, since they may not be meaningful. However, the best adaptive alphas are presented for each forecast in Appendix D.

The Adaptive Response Rate model did not perform as well as anticipated. It was the best predictor of seasonality, yet the Double Exponential Smoothing model was almost as good. Based upon the literature reviewed, the researchers felt the Adaptive Response Rate model would be the best of the three techniques used, however, the Double Exponential Smoothing model proved to be superior overall. Why the adaptive model

did not perform well is difficult to explain. When the adaptive model was compared directly with the moving average, it was better 64% of the time, but Double Exponential Smoothing was better 84% of the time. Further comparisons, similar to those presented in Table VII, indicate that the Adaptive Response Rate model is substantially worse than the Moving Average model when the Moving Average is better.

It appears from reviewing Appendix D that the adaptive method worked best when very sudden and extensive changes occurred in the demand. This model reacted quicker than the other competing models to these sudden changes, however, by doing so it may have responded to random fluctuations in demand, resulting in less accurate forecasts. Also, when the demand fluctuation dropped, the Adaptive Response Rate was slow to return. The most probable cause for this inefficient performance is that the data are limited in their extent and, for the most part, the items evaluated are not carried in sufficiently large quantities for the adaptive method to adjust correctly. Research of the Adaptive Response Rate literature also supports this contention. Data were evaluated for periods of five to ten years and heavy demand levels were observed (17:58). Although this model has its limitations, it remains a more efficient model than the moving average.

The results of the forecasting analysis clearly shows that for seasonal demand patterns the moving average is inadequate. Double Exponential Smoothing and Adaptive Response Rate models are the most promising techniques. Figure 9 shows

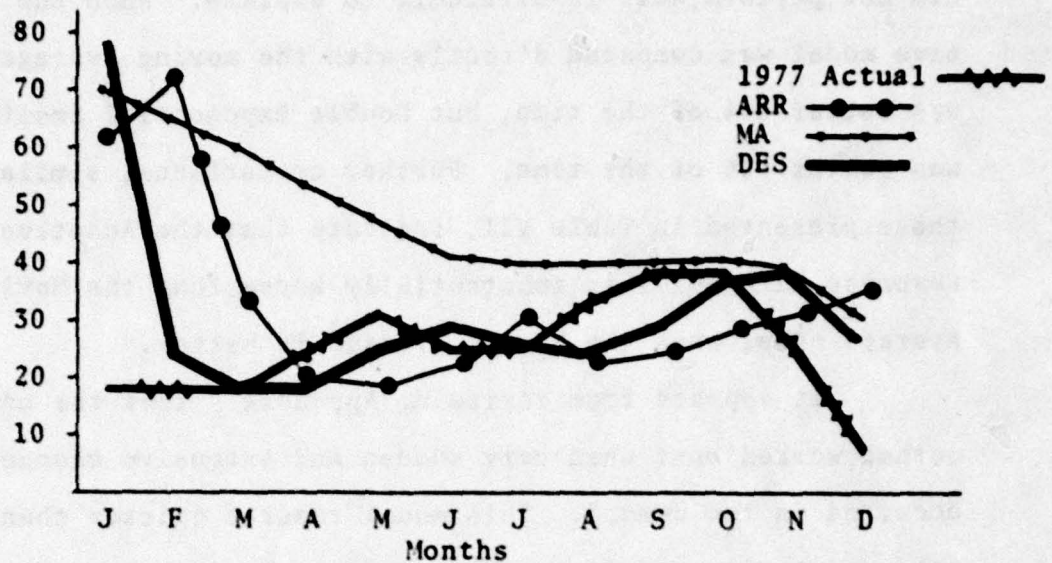


Figure 9. Seasonal Forecasting  
Offutt, 1977 - NSN 6505002998598

a typical seasonal item, drawn from Appendix D, and illustrates how each model predicts the demand.

Figure 9 clearly demonstrates that seasonal variations can be accounted for by using the proper forecasting technique. However, to foster a change in the MMMS structure, it is important that the selected forecasting model not only have an ability to accurately forecast seasonality, but at the same time be able to forecast nonseasonal items with sufficient accuracy. In order to evaluate this requirement, the FORTRAN computer program was modified to select only those 6505 class items that did not meet the established seasonal criteria. Once these stock numbers were identified for each base for the two years, a one-for-one stock number comparison was made. After the matches were made and placed in memory, a random

generator picked a number from one through ten, and every fifth thereafter was identified. These randomly selected nonseasonal items were next read into each of the forecasting subprograms to determine once again which model was best. The MSE was again used as the discriminator. The results of this analysis are highlighted in Table VIII. A total of 56 items were selected from both bases. Appendices F and G contain a print-out for each nonseasonal item evaluated.

TABLE VIII  
Best Nonseasonal Forecaster

Base	Simple Moving Average		Double Exponential Smoothing		Adaptive Response Rate	
	#	%	#	%	#	%
Offutt	2	6%	24	73%	7	21%
Whiteman	4	17%	15	66%	4	17%
Both	6	11%	39	70%**	11	19%
** Best model						

The Double Exponential Smoothing model was again superior to both competing models. The Adaptive Response Rate was the second best. Figure 10 illustrates the typical demand pattern of a nonseasonal item and how each of the forecasting methods responded. Continuing analysis of these random nonseasonal items illustrates the fact that Double Exponential Smoothing is best 89% of the time when compared directly with the Moving Average. Moving Average was second best (see Table IX).

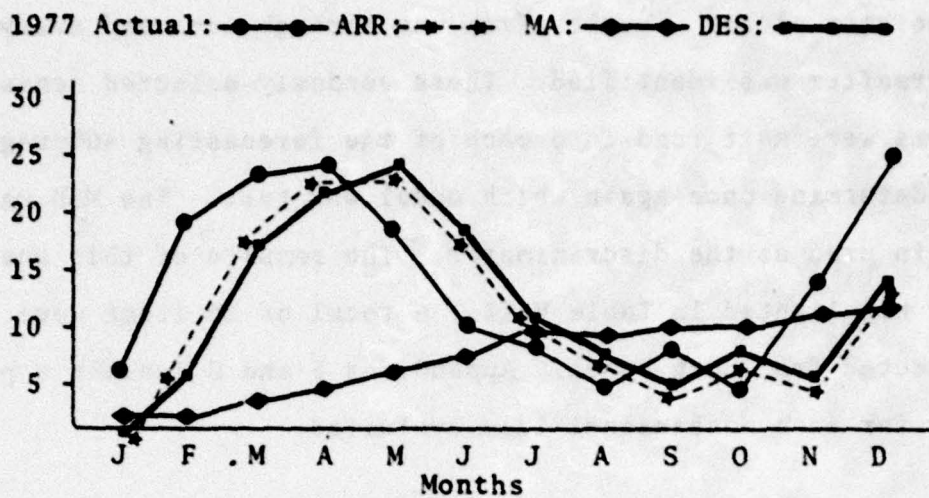


Figure 10. Nonseasonal Forecasting  
Offutt, 1977 - NSN 6505007218899

TABLE IX

Nonseasonal Moving Average Comparisons

Base	Simple Moving Average		Double Exponential Smoothing	
	#	%	#	%
Offutt	2	6%	31	94%
Whiteman	4	17%	19	83%
Both	6	11%	50	89%
Base	Simple Moving Average		Adaptive Response Rate	
	#	%	#	%
Offutt	20	60%	13	40%
Whiteman	15	65%	8	35%
Both	35	63%	21	37%

Once again, when the moving average was best, there was a double exponential model that came very close to the same predictive ability. Table X shows these relative differences.

TABLE X  
 Double Exponential and Moving Average  
 Nonseasonal Comparisons

Offutt NSNs	Simple Moving Average MSE	Double Exponential Smoothing MSE	Difference	% <sup>*</sup> Difference
6505000797453	9.17	9.67	.50	6%
6505000765589	2.25	2.25	-0-	-0-
<u>Whiteman NSNs</u>				
6505001405150	3.08	3.08	-0-	-0-
6505001601500	1.33	1.33	-0-	-0-
6505002998617	.33	.33	-0-	-0-
6505005843470	49.58	54.25	4.67	9%
* Simple Moving Average MSE was used as the base				

The best alpha smoothing constants for the double exponential smoothing model are referenced in Figure 11. Analysis of these constants indicates that the smaller alphas were used 66% of the time. This result is what was expected since the demand patterns for nonseasonal items should be fairly constant over the year. In addition, the reverse criteria used for seasonal selection was used to randomly select these nonseasonal

items. It is apparent that the criteria works in reverse as well as directly.

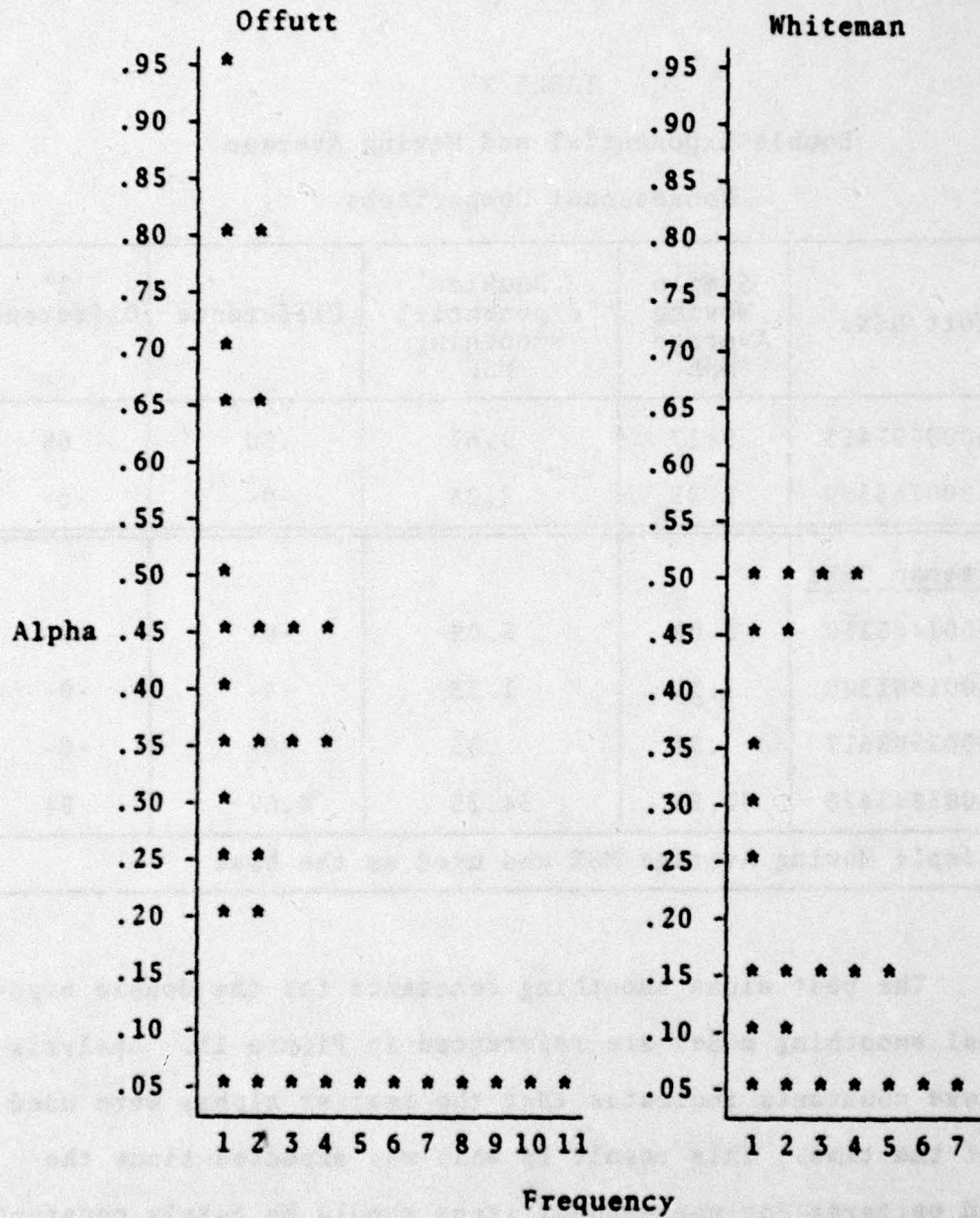


Figure 11. Nonseasonal Frequency of Smoothing Constant Occurrence (Double Exponential Smoothing)

Although the Adaptive Response Rate was the second best predictor for nonseasonal demand, it was actually the weaker model when compared directly with the moving average. Moving Average forecasts were better 63% of the time for both bases combined. This result is not surprising, since the Adaptive Response Rate is not designed to predict nonseasonal demand as efficiently as other models. If a spurious fluctuation is detected by the adaptive model, it rapidly adjusts to that demand level and this ultimately results in a higher MSE, which is undesirable. Considering these factors, the tabular comparisons of the Adaptive Response Rate with the Moving Average will not be presented.

One of the key assumptions that was made in analyzing these forecasting results is that demand patterns that were initially observed would continue into the future. This assumption would be easier to support if more than two years of consecutive data were available. The one year gap in the data used may have detracted somewhat from the forecasting efficiency. Despite this gap, the forecasting techniques used actually appeared to do an adequate job of forecasting 1977 using 1975 data. This lends credibility to the key assumption made. The researchers feel that a better forecast would be possible if 1975 data were used to predict 1976 demand and then using the continuous data for the 1977 forecasts. Nonetheless, the researchers are confident that the evaluations made on the three forecasting techniques are indicative of their relative ability to predict demand.

### Summary

In this chapter the research data has been examined in support of the research objectives. As was mentioned earlier, the basic assumption for determining future seasonal trends and variations is based on the concept that trends which occurred in the past will occur again. Although the overall analysis was limited by having only two years of data from nonconsecutive years, seasonal trends were apparent from the data.

It was interesting to find that the most advanced forecasting technique, Adaptive Response Rate, did not prove to be superior to the other methods. Although the logic behind the Adaptive Response Rate leads one to believe it is the best, the Double Exponential Smoothing method was the better forecaster across the board. The automatic screening of smoothing constants is a feature that was made possible by the computer and ultimately improved the ability of the Double Exponential Smoothing model to forecast varying demand patterns.

The analysis in this chapter supports the fact that a Simple Moving Average is not adequate to handle the demand variation observed in the MMMS. Both of the competing forecast methods accentuated this lack of efficiency. By incorporating advanced computer techniques with a more refined forecasting method, the need to manually account for seasonal trends and variations within the MMMS could be eliminated.

## Chapter V

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### Summary

The purpose of this research effort was to examine the demands for medical supplies within the Medical Materiel Management System to determine if seasonality exists, the degree to which it exists, and to offer suggestions for a better method of adjusting for it. This study was conducted at the suggestion of the USAF Surgeon General's Staff and the Air Force Data System Design Center, Medical Division. Previous studies of the medical inventory management and control procedures have not addressed seasonality specifically. The study was initiated with the idea that a more efficient management control system could be developed.

The initial step taken to resolve the seasonality issue required an indepth investigation into the medical inventory management and control system, inventory management concepts and theory, and forecasting techniques in general. The MMMS, as it currently operates, was described in context with long accepted inventory practices, and the research methods that would be used to analyze data for seasonality were explained.

The only data available for such a study was provided by the Air Force Data System Design Center, and consisted of

the master record tapes from Offutt and Whiteman AFBs for the calendar years 1975 and 1977. The data were assumed to be valid since they were actual demands recorded from daily base transactions. A utility FORTRAN program was developed to read the tapes, extract the necessary data, make comparisons, forecast future demand, and plot desired seasonal information. This computer program and its primary output products are available in Appendices C through G. Appendices A through B provide a list of variables and the computer logic used in the programming process.

Analysis of these results indicates that a significant amount of seasonality is present within the medical materiel inventories evaluated. Further evaluation of forecasting methodologies has demonstrated that Double Exponential Smoothing forecasts are superior to the current Moving Average forecasts 84% of the time when forecasting seasonal items and 89% of the time when forecasting nonseasonal items. These percentages followed the same pattern for each base analyzed. The similarity that exists between these nonrandom Air Force bases provide an indication that it would be useful to investigate the application of the results to the overall population.

### Conclusions

The analysis of results obtained from this study indicate other areas that may be advantageous to MMMS and that could very likely reduce operating costs.

1. A change of algorithm for forecasting demands from

the Moving Average to Double Exponential Smoothing will provide superior demand estimates and should ultimately reduce cost since Double Exponential Smoothing provides better results most of the time. When Double Exponential Smoothing does not provide better results, they are no worse than Moving Average.

2. To provide for a thorough study of seasonality, at least three years of demand data should be retained for future research.

#### Recommendations for Future Study

During the pursuit of this research analysis, there were areas identified that could benefit from future study:

1. A more comprehensive examination should be conducted to identify savings associated with using Double Exponential Smoothing in the MMMS.

2. Because of the inherent problem with using non-consecutive data, replication of this seasonality study using consecutive data may provide a more precise picture of the total effects of seasonality.

3. A separate study should be undertaken to identify the effects of doctor changeover and their preferences for new or substitute medical supplies.

4. A closer examination should be made of the effects of fiscal constraints on this process.

5. The effect that inconsistent ordering practices have on the demand histories should be studied.

APPENDIX A  
LIST OF VARIABLES

LIST OF VARIABLES

A ALPHA READING OF ALL 12 MONTHS DEMAND HISTORY FOR BOTH YEARS DATA

AATO NATO DESIGNATOR WITHIN STOCK NUMBER IN ALPHA FORM

ABD HISTORY BEGIN DATE IN ALPHA FORM

ACL STOCK CONTROL LEVEL IN ALPHA FORM

AFSC FEDERAL STOCK CLASS IN ALPHA FORM

AHOLD HOLDING VARIABLE TO RETAIN LOWEST VALUE OF MSE FOR DOUBLE EXPONENTIAL SMOOTHING FORECAST

AIIN NATIONAL IDENTIFICATION INDEX NUMBER IN ALPHA FORM

ALFAOP OPTIMAL ALPHA FOR ADAPTIVE RESPONSE FORECAST

ALPHA SMOOTHING COEFFICIENT USED IN EXPONENTIAL SMOOTHING AND ADAPTIVE RESPONSE FORECASTING FORMULAS

ALPHOP OPTIMAL ALPHA FOR DOUBLE EXPONENTIAL SMOOTHING

AM VARIABLE USED TO FIND MAX PERCENTAGE OF 1975 DEMAND TO PRINT ON GRAPH

AMD MAD (MEAN ABSOLUTE DEVIATION) FOR ADAPTIVE RESPONSE RATE FORECASTING FORMULA

AN USED TO FIND MAX PERCENTAGE OF 1977 DEMAND TO PRINT ON GRAPH

AO MAXIMUM VALUE FOR 1975 AND 1977 FOR GRAPH SCALE

AVG MEAN ANNUAL DEMAND USED IN DETERMINING STANDARD DEVIATION FOR CRITERIA FORMULA

AVG3 AVERAGE DEMAND FOR FIRST THREE MONTHS OF 1975, USED FOR PRINTING IN DOUBLE EXPONENTIAL SMOOTHING AND ADAPTIVE RESPONSE FORECASTING FORMULAS

AZ PLOTTING CHARACTER FOR SPACE, X, O, OR \*

B USED TO CALCULATE INDIVIDUAL MEANS FOR 3 MONTH PERIODS FOR CRITERIA FORMULA

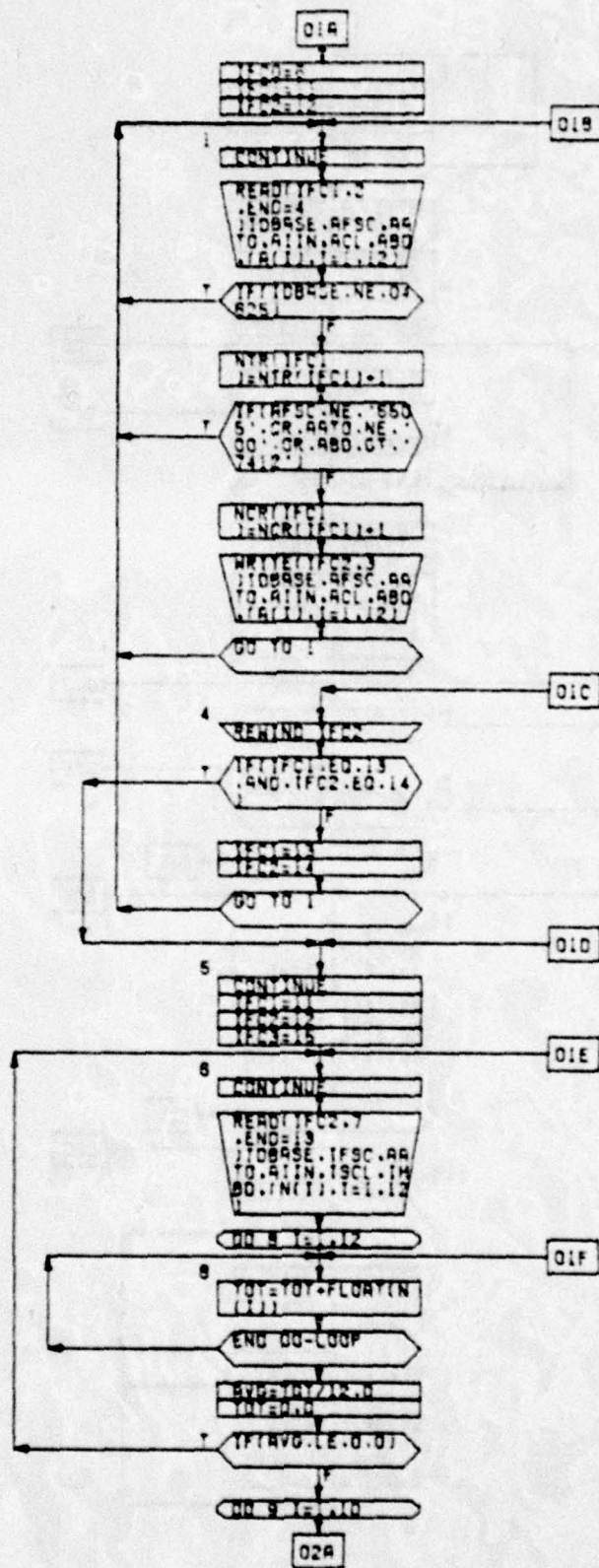
BATO 1977 VALUE FOR NATO, USED IN COMPARISON TO 1975 DATA

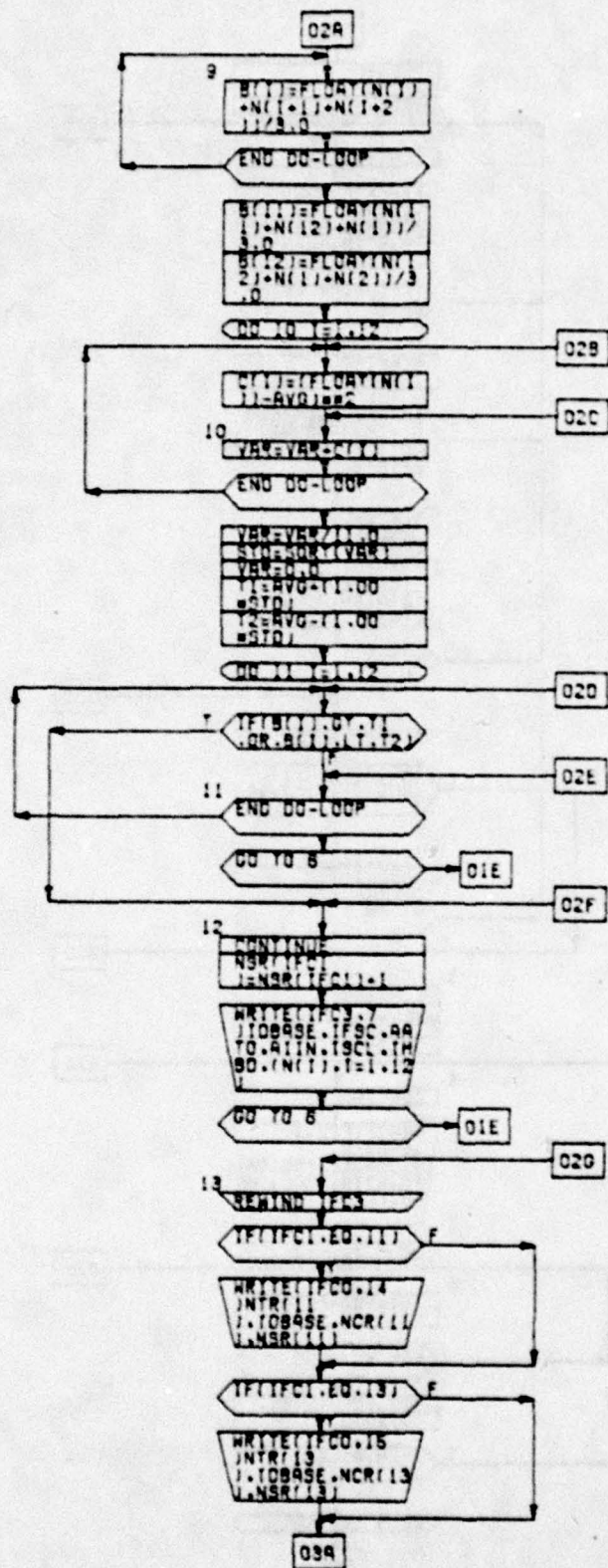
BEST USED TO DETERMINE BEST FORECASTING METHOD  
 BETA 1-ALPHA IN DOUBLE EXPONENTIAL SMOOTHING  
 AND ADAPTIVE RESPONSE FORECASTING FORMULAS  
 SHOLD HOLDING VARIABLE TO HOLD LOWEST VALUE OF MSE  
 FOR ADAPTIVE RESPONSE FORECASTING  
 BIIN 1975 VALUE FOR NATO USED IN COMPARISON TO 1977 DATA  
 C USED TO FIND VARIANCE FOR COMPUTATION OF STD DEV  
 CC PERCENTAGE VALUES FOR GRAPH  
 D DEMAND PER MONTH FOR 1975, USED TO FIND PERCENTAGE  
 OF ANNUAL DEMAND FOR GRAPH  
 DD PERCENTAGE VALUES FOR GRAPH  
 DX DOUBLE EXPONENTIALLY SMOOTHED FORECAST ESTIMATE  
 E DEMAND PER MONTH FOR 1977, USED TO FIND PERCENTAGE  
 OF ANNUAL DEMAND FOR GRAPH  
 ENAV USED IN FINDING MSE IN MOVING AVERAGE FORMULA  
 ERRAR MEAN SQUARED ERROR FOR ADAPTIVE RESPONSE  
 ERDDX MEAN SQUARED ERROR FOR DOUBLE EXPONENTIAL  
 ERRMA MEAN SQUARED ERROR FOR MOVING AVERAGE  
 ERROR ACCUMULATES ERROR FOR DOUBLE EXPONENTIAL  
 ERRRR ACCUMULATES MSE VALUES FOR ADAPTIVE RESPONSE  
 EWA EXPONENTIALLY WEIGHTED AVERAGE FOR ADAPTIVE  
 RESPONSE  
 EX SINGLE EXPONENTIALLY SMOOTHED FORECAST ESTIMATE  
 FOR DOUBLE EXPONENTIAL  
 I DO LOOP INDEX  
 IAR FORECAST FOR ADAPTIVE RESPONSE  
 IARSAV FORECAST VALUES FOR 1977 ADAPTIVE RESPONSE  
 FORECAST SAVED FOR PRINTING  
 IDBASE BASE DESIGNATOR IN INTEGER FORM  
 IFC0 INDICATES DEVICE CODE 6  
 IFC1 FILE CODE FOR TAPES

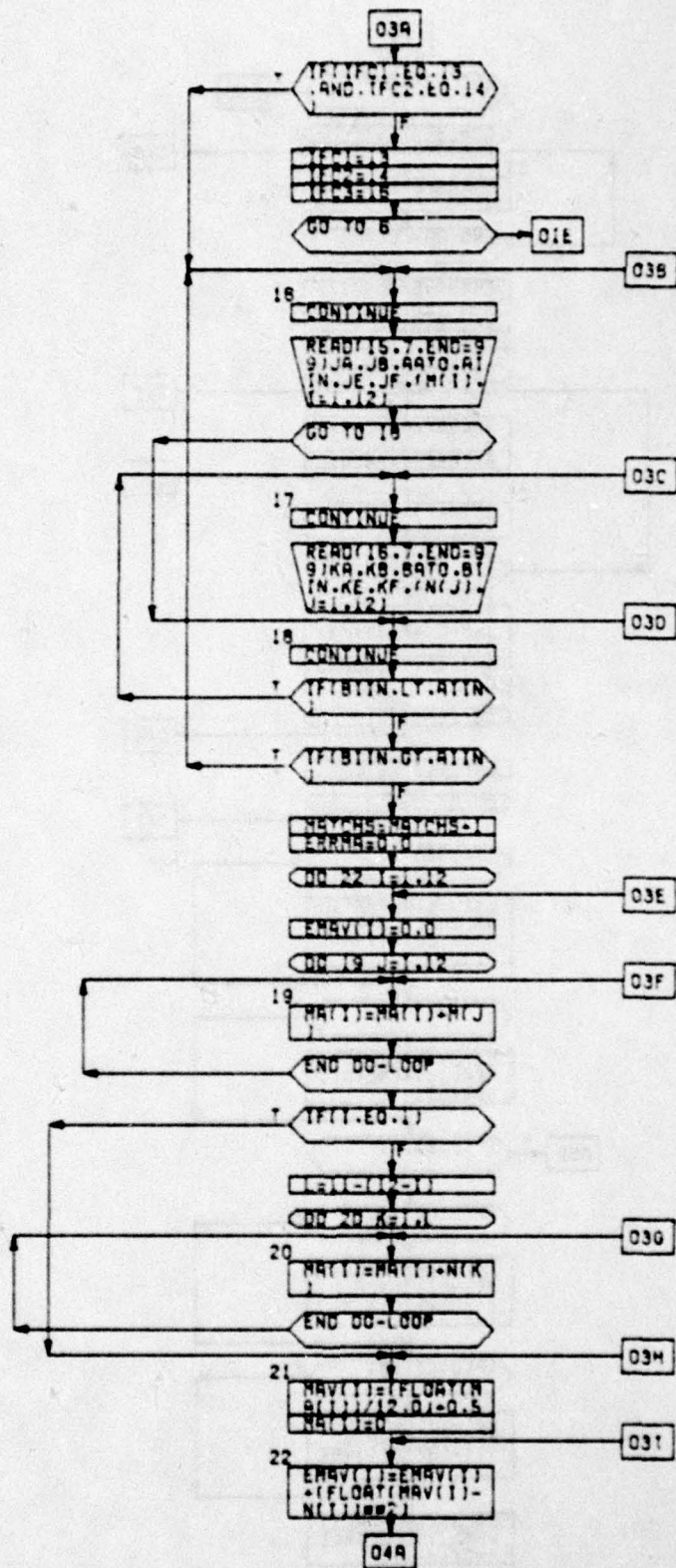
IFC2	FILE CODE FOR TEMP FILES
IFC3	CODE FOR INTERMEDIATE FILE FOR SEASONAL ITEMS
IFEROR	ABSOLUTE VALUE OF FORECAST ERROR IN ADAPTIVE RESPONSE RATE FORECAST FORMULA FORECASTING
IFERRR	ACTUAL VALUE OF FORECAST ERROR IN ADAPTIVE RESPONSE RATE FORECAST FORMULA FORECASTING
IFSC	INTEGER FORM FOR FEDERAL STOCK CLASS
ISAVE	RETAINED VALUE FOR THE BEST DOUBLE EXPONENTIAL SMOOTHING MSE
ISCL	INTEGER FORM FOR STOCK CONTROL LEVEL
ISCALE	SCALE USED FOR GRAPH, 0-100 OR 0-40 PERCENT
IX	INTEGER FOR THE DOUBLE EXPONENTIAL SMOOTHING FORECAST
J	DO LOOP INDEX
JA	BASE ID FROM 75 FILE
JB	FEDERAL STOCK CLASS FROM 75 FILE
JE	STOCK CONTROL LEVEL FROM 75 FILE
JF	HISTORY BEGIN DATE FOR 75 FILE
K	DO LOOP INDEX
KA	BASE ID FROM 77 FILE
KB	FEDERAL STOCK CLASS FROM 77 FILE
KE	STOCK CONTROL LEVEL FROM 77 FILE
KF	HISTORY BEGIN DATE FROM 77 FILE
L	USED TO CALCULATE MOVING AVERAGE UPPER LIMIT
LABEL	CONVERTS IDBASE TO OFFUTT OR WHITENAM
LABEL1	PRINTS FLAG FOR BEST MOVING AVERAGE MSE
LABEL2	PRINTS FLAG FOR BEST DOUBLE EXPONENTIAL MSE
LABEL3	PRINTS FLAG FOR BEST ADAPTIVE RESPONSE MSE

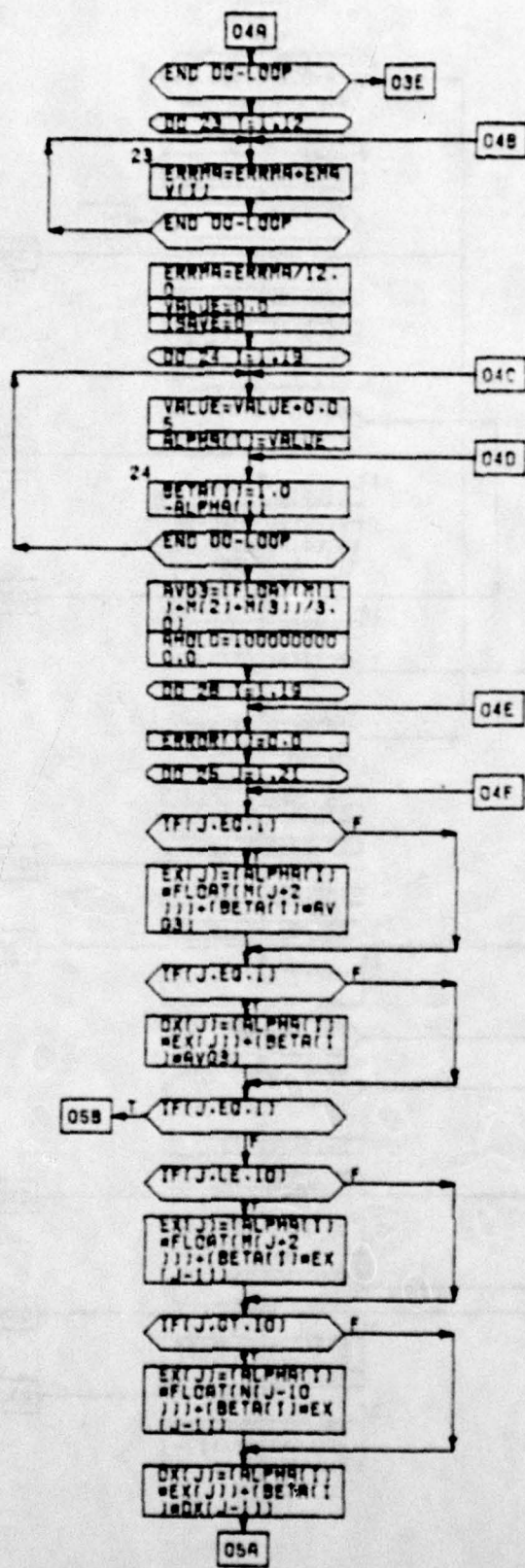
M ACTUAL MONTHLY DEMAND HISTORY FOR 75  
 MA USED IN CALCULATING MOVING AVERAGE  
 MAV MOVING AVERAGE FORECAST VALUE  
 MATCHS COUNTS NUMBER OF MATCHES FOR BOTH YEARS  
 N ACTUAL MONTHLY DEMAND HISTORY FOR 77  
 NCR COUNTER FOR NUMBER OF RECORDS THAT MEET SEASONAL  
 CRITERIA IN 6505 CLASS FROM EACH BASE WITH  
 HISTORY BEGIN DATE OF 7412 OR EARLIER  
 NSR COUNTER FOR NUMBER OF RECORDS THAT ARE SEASONAL  
 FROM EACH BASE  
 NTR COUNTER FOR TOTAL RECORDS FOR EACH BASE  
 STD STANDARD DEVIATION USED IN CRITERIA  
 TOT TOTAL DEMANDS FOR YEAR USED IN CALCULATING STD  
 TOT1A TOTAL 1975 DEMAND PER STOCK NUMBER, USED TO FIND  
 PERCENTAGE OF DEMAND PER MONTH FOR GRAPH  
 TOT2A TOTAL 1977 DEMAND PER STOCK NUMBER, USED TO FIND  
 PERCENTAGE OF DEMAND PER MONTH FOR GRAPH  
 TRCK TRACKING SIGNAL FOR ADAPTIVE RESPONSE FORECAST  
 VALUE INCREMENT FOR SMOOTHED FORECAST IN DOUBLE EXPONENTIAL  
 SMOOTHING, VARIES ALPHA VALUE  
 VAR VARIANCE OF ACTUAL DEMAND USED TO CALCULATE STD

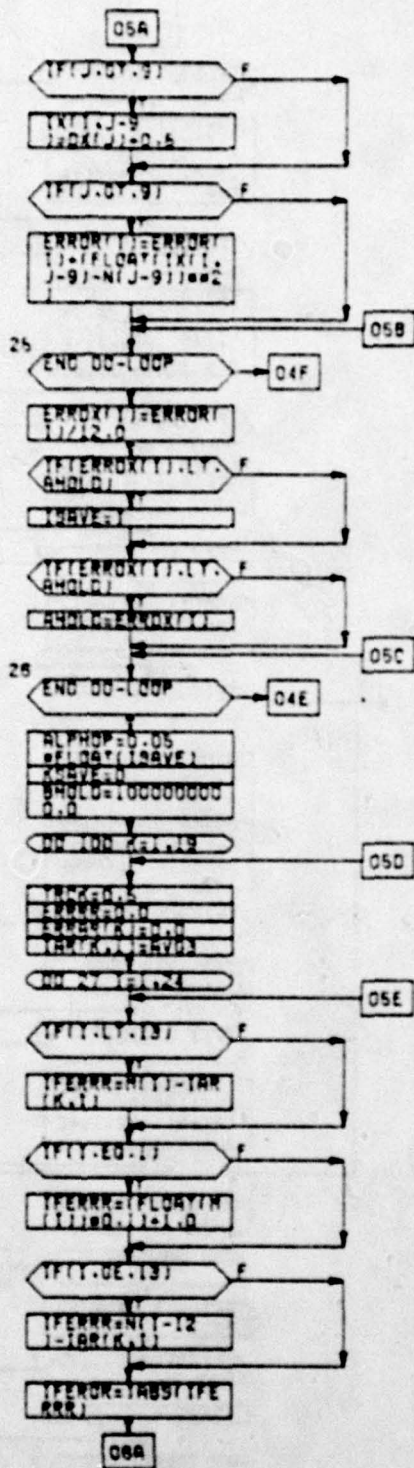
APPENDIX B  
FORTRAN FLOWCHART

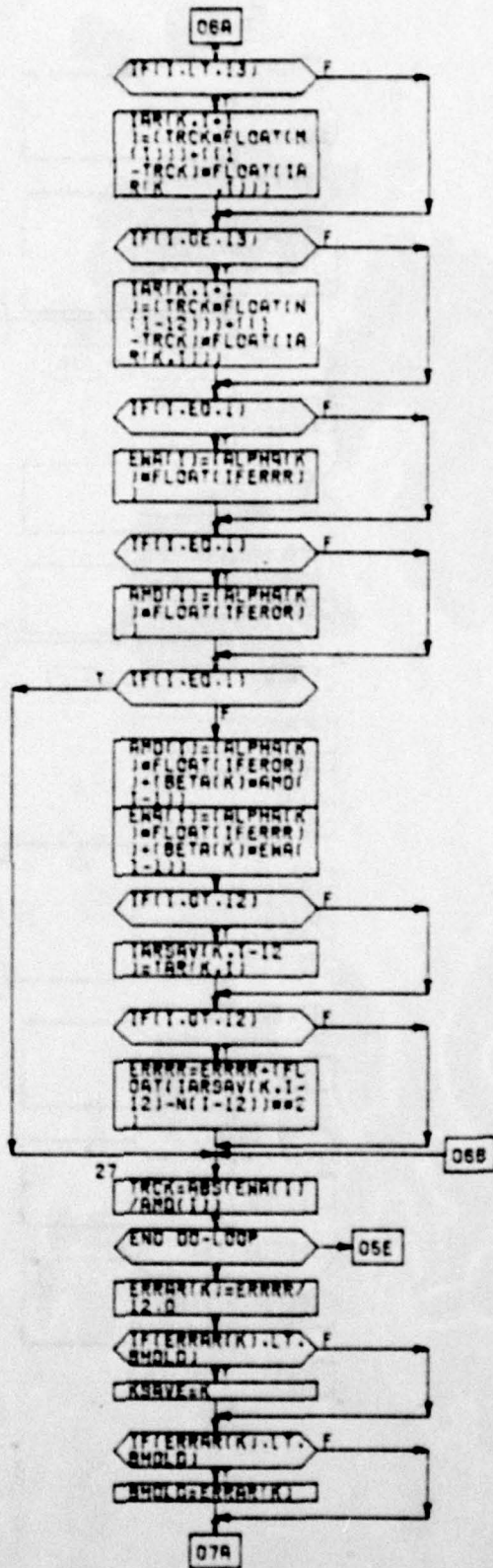


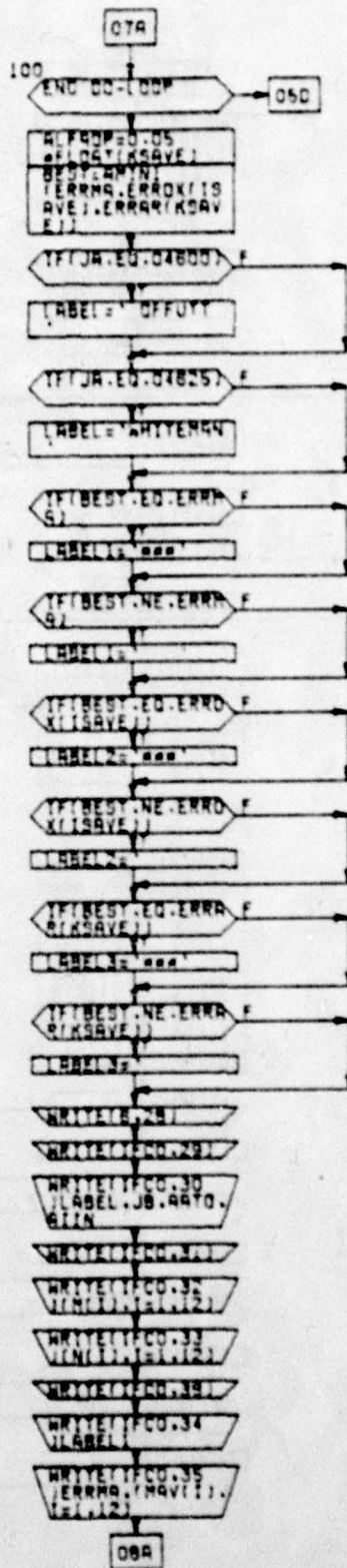


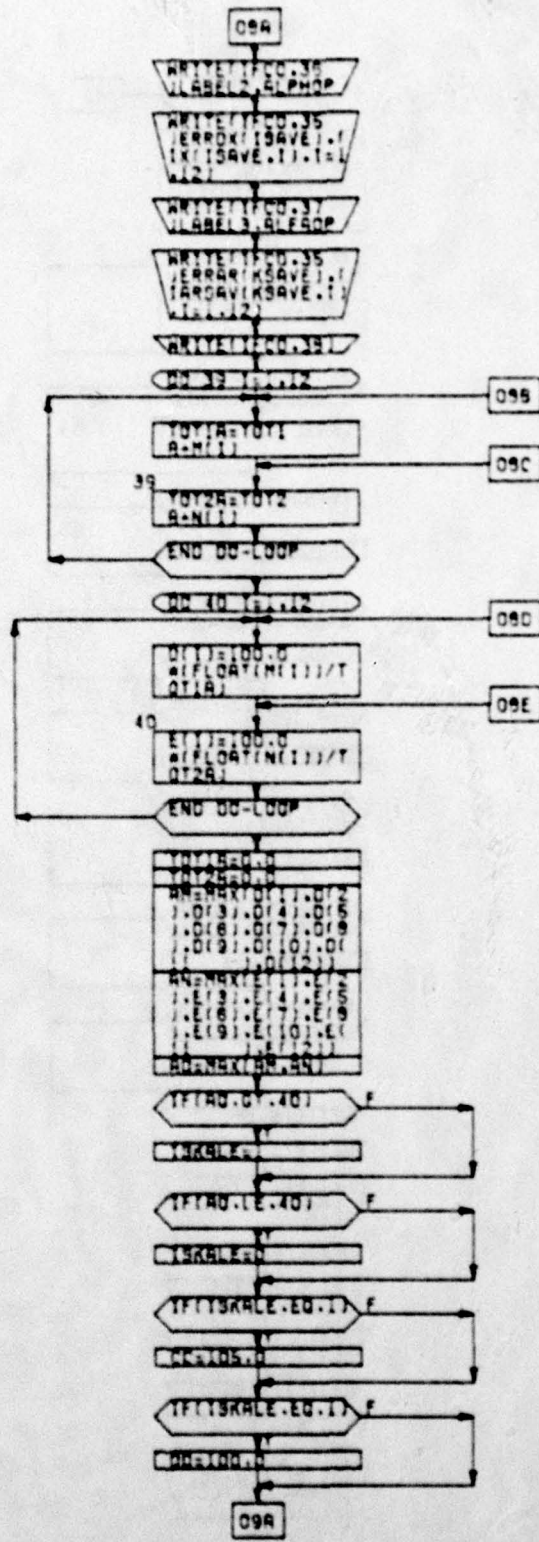


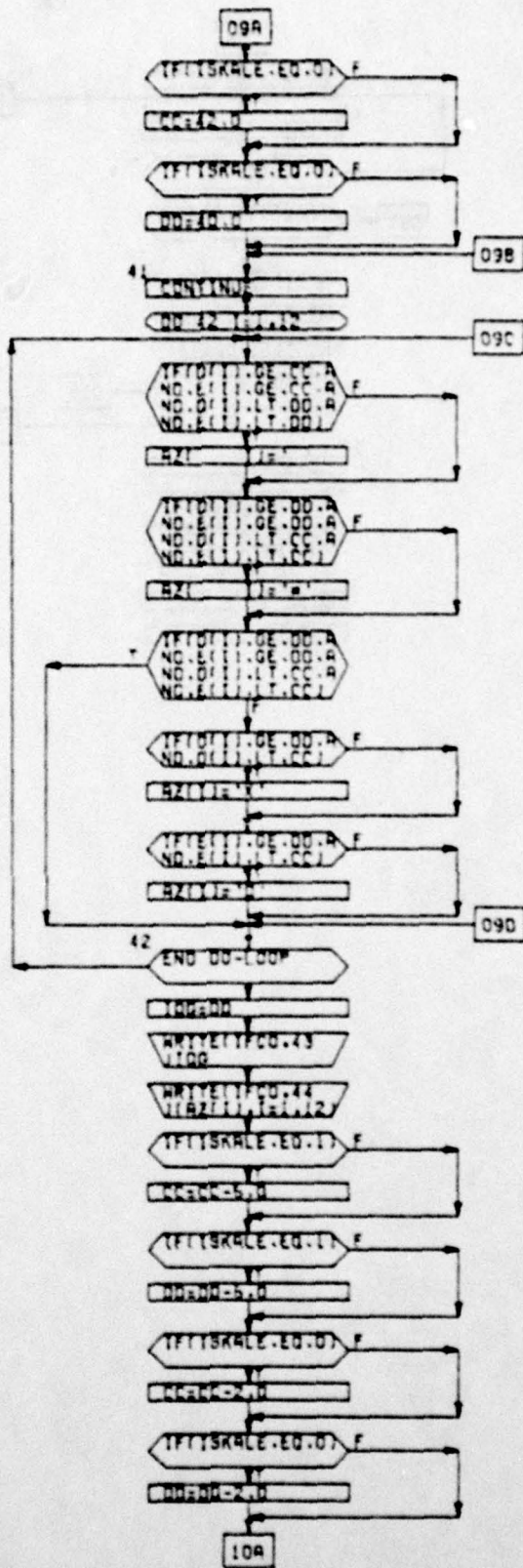


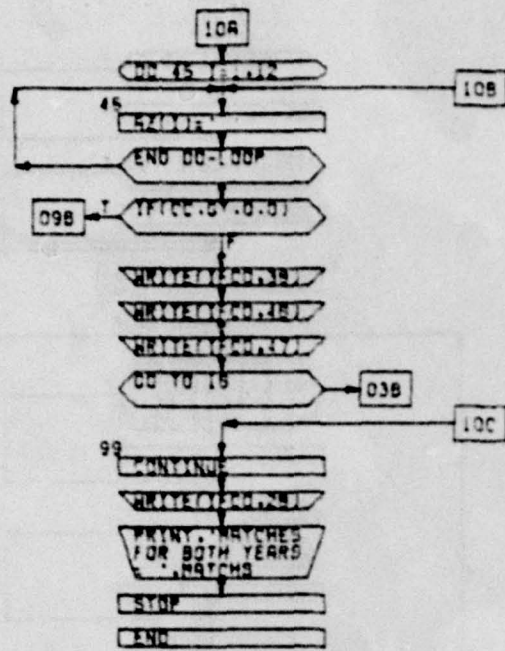












APPENDIX C  
FORTRAN PROGRAM

```

100000,R(1ZL) 1,8,16
10100:IDENT:WP1185,AF17/LSC GIL OHL WEL
10200:OPTION:FORTRAN,NOMAP
10300:FORTY:NFORN,NLNO,NLSTIN,XREF
1040C
1050C *****
1060C *
1070C *           A FORTRAN PROGRAM DESIGNED TO PERFORM           *
1080C *
1090C * AN EVALUATION OF SEASONALITY IN THE UNITED STATES *
1100C * AIR FORCE MEDICAL MATERIEL MANAGEMENT SYSTEM *
1110C *
1120C *****
1130C
1140 DIMENSION NTR(20),NCR(20),N(12),C(12),NSR(20),N(12),D(12),E(12)
1150 DIMENSION MA(12),MAV(12),EMAV(12),ALPHA(20),BETA(20),ERRAR(12)
1160 DIMENSION EX(24),DX(24),ERROR(10),ERRDI(10),IX(20,12)
1170 DIMENSION AMD(24),EMA(24),IAR(20,24),IARSAV(10,12),B(12)
1180 CHARACTER AFSC*4,AATO*2,AIIN*7,ACL*6,ADD*4,A*6(24),LABEL1*3
1190 CHARACTER LABEL*8,BATO*2,BIIN*7,AZ*1(12),LABEL2*3,LABEL3*3
1200C
1210C     INITIALIZE READ & WRITE FILE/DEVICE CODES (IFC0 = 6, WHICH IS THE
1220C     LINE PRINTER; IFC1 = 11, WHICH IS THE TAPE CONTAINING 1975 DATA;
1230C     IFC2 = 12, WHICH IS THE FIRST SCRATCH-FILE TO STORE 1975 DATA THAT
1240C     MEETS THE FOLLOWING CRITERIA: BASE = OFFUTT; STOCK-CLASS = 6505
1250C     NATO DESIGNATION = 00; HISTORY BEGIN DATE LESS THAN 7412)
1260C
1270 IFC0=6
1280 IFC1=11
1290 IFC2=12
1300C
1310 1 CONTINUE
1320C
1330C     READ DATA TAPE AND WRITE THOSE RECORDS MEETING THE ABOVE CRITERIA
1340C     TO A SCRATCH-FILE FOR FURTHER PROCESSING LATER
1350C
1360 READ(IFC1,2,END=4)IDBASE,AFSC,AATO,AIIN,ACL,ADD,(A(I),I=1,12)
1370 2 FORRAT(14,2X,A4,A2,A7,10X,A6,300X,A4,70X,12A6)
1380 IF(IDBASE.NE.04400)GO TO 1
1390C
1400C     COUNT THE NUMBER OF DATA RECORDS FOR EACH BASE FOR BOTH YEARS
1410C
1420 NTR(IFC1)=NTR(IFC1)+1
1430 IF(AFSC.NE."6505".OR.AATO.NE."00".OR.ADD.GT."7412")GO TO 1
1440C
1450C     COUNT NUMBER OF DATA RECORDS (FROM SPECIFIC BASE) MEETING CRITERIA
1460C
1470 NCR(IFC1)=NCR(IFC1)+1
1480 WRITE(IFC2,3)IDBASE,AFSC,AATO,AIIN,ACL,ADD,(A(I),I=1,12)
1490 3 FORMAT(15,1X,A4,1X,A2,1X,A7,1X,A6,1X,A4,12A6)
1500C
1510C     RETURN TO '1 CONTINUE' TO READ THE NEXT RECORD
1520C
1530 GO TO 1

```

```

1540C
1550C   WHEN THE END-OF-FILE FOR THE DATA TAPE IS ENCOUNTERED, REWIND THE
1560C   NEWLY CREATED SCRATCH-FILE TO ALLOW IT TO BE READ AT A LATER POINT
1570C
1580 4 REWIND IFC2
1590C
1600C   DETERMINE IF BOTH TAPES (1975/1977) HAVE BEEN SCREENED (SEE BELOW)
1610C   AND, IF SO, TRANSFER TO '5 CONTINUE' TO PROCEED WITH THE ANALYSIS
1620C
1630 IF(IFC1.EQ.13.AND.IFC2.EQ.14)GO TO 5
1640C
1650C   AFTER THE FIRST DATA TAPE (1975) HAS BEEN SCREENED, REPLACE READ &
1660C   WRITE FILE/DEVICE CODES (TO READ FROM 1977 TAPE AND WRITE TO A NEW
1670C   SCRATCH-FILE) AND RETURN TO '1 CONTINUE' TO PROCESS SECOND TAPE
1680C
1690 IFC1=13
1700 IFC2=14
1710 GO TO 1
1720C
1730 5 CONTINUE
1740C
1750C   AT THIS POINT, THE DATA TAPES FOR BOTH YEARS HAVE BEEN SCREENED;
1760C   THE READ & WRITE FILE/DEVICE CODES IFC1 & IFC2 ARE RETURNED TO THE
1770C   INITIAL STATES (INDICATING THAT 1975 DATA WILL BE PROCESSED FIRST)
1780C   AND A NEW SCRATCH-FILE (IFC3) IS INITIALIZED (TO RETAIN THE DATA
1790C   THAT HAS MET THE CRITERIA OF SEASONALITY AS ESTABLISHED BELOW)
1800C
1810 IFC1=11
1820 IFC2=12
1830 IFC3=15
1840C
1850 6 CONTINUE
1860C
1870 READ(IFC2,7,END=13)IDBASE,IFSC,AATO,A1IN,ISCL,1HBD,(N(I),I=1,12)
1880 7 FORMAT(15,15,A3,A8,17,15,1218)
1890C
1900C   FOR EACH ITEM IN THE FILE, TOTAL THE ANNUAL DEMAND FOR THE ITEM
1910C
1920 DO 8 I=1,12
1930 8 TOT=TOT+FLOAT(N(I))
1940C
1950C   DIVIDE TOTAL ANNUAL DEMAND BY TWELVE TO FIND MEAN ANNUAL DEMAND
1960C
1970 AVG=TOT/12.0
1980 TOT=0.0
1990C
2000C   IF THE MEAN DEMAND FOR THE ITEM IS ZERO, EXCLUDE THIS RECORD
2010C
2020 IF(AVG.LE.0.0)GO TO 6
2030C
2040C   DETERMINE THE MEAN DEMAND FOR EACH POSSIBLE THREE-CONSECUTIVE-
2050C   MONTH PERIOD THROUGHOUT THE YEAR (JAN-FEB-MAR; FEB-MAR-APR; etc)
2060C
2070 DO 9 I=1,10

```

```

2080 9 B(I)=FLOAT(N(I)+N(I+1)+N(I+2))/3.0
2090 B(11)=FLOAT(N(11)+N(12)+N(1))/3.0
2100 B(12)=FLOAT(N(12)+N(1)+N(2))/3.0
2110C
2120C   TO FIND THE STANDARD-DEVIATION OF THE DATA, FIND (AND SQUARE) THE
2130C   INDIVIDUAL MONTHLY DEVIATIONS FROM THE MEAN (PREVIOUSLY COMPUTED),
2140C   SUM THESE SQUARED DEVIATIONS, AND DIVIDE BY 'N-1', OR ELEVEN, TO
2150C   DETERMINE THE VARIANCE; THEN TAKE THE SQUARE-ROOT OF THE VARIANCE
2160C   TO ARRIVE AT THE STANDARD-DEVIATION OF DEMAND FOR EACH ITEM
2170C
2180 DO 10 I=1,12
2190 C(I)=(FLOAT(N(I))-AVG)**2
2200 10 VAR=VAR+C(I)
2210 VAR=VAR/11.0
2220 STD=SQRT(VAR)
2230 VAR=0.0
2240C
2250C   DEVELOP A CONFIDENCE-INTERVAL AROUND THE MEAN BY ADDING THE VALUE
2260C   OF ONE STANDARD-DEVIATION UNIT TO THE MEAN (UPPER LIMIT) AND ALSO
2270C   SUBTRACTING ONE STANDARD-DEVIATION UNIT TO THE MEAN (LOWER LIMIT)
2280C
2290 T1=AVG+(1.00*STD)
2300 T2=AVG-(1.00*STD)
2310C
2320C   DETERMINE WHETHER ANY OF THE ABOVE CALCULATED THREE-MONTH AVERAGE
2330C   VALUES LIE OUTSIDE THE CONFIDENCE REGION; IF NOT, RETURN TO THE
2340C   STATEMENT '6 CONTINUE' AND READ THE NEXT RECORD; IF SO, GO TO THE
2350C   STATEMENT '12 CONTINUE' WHERE THIS RECORD WILL BE COUNTED AND THEN
2360C   WRITTEN ONTO THE SCRATCH-FILE (IFC3) FOR FURTHER ANALYSIS
2370C
2380 DO 11 I=1,12
2390 IF(B(I).GT.T1.OR.B(I).LT.T2)GO TO 12
2400 11 CONTINUE
2410 GO TO 6
2420C
2430 12 CONTINUE
2440C
2450 NSR(IFC1)=NSR(IFC1)+1
2460 WRITE(IFC3,7)IDBASE,IFSC,AATO,AIIN,ISCL,INBD,(N(I),I=1,12)
2470C
2480C   RETURN TO '6 CONTINUE' TO READ THE NEXT RECORD
2490C
2500 GO TO 6
2510C
2520C   WHEN THE END-OF-FILE FOR THE INITIAL SCRATCH-FILE IS ENCOUNTERED,
2530C   REMIND THE NEWLY CREATED SCRATCH-FILE (IFC3) CONTAINING SEASONAL
2540C   RECORDS TO ALLOW THIS FILE TO BE READ LATER IN THE PROGRAM
2550C
2560 13 REMIND IFC3
2570C
2580C   WRITE OUT THE TOTALS (FOR EACH YEAR) THAT HAVE BEEN ACCUMULATED
2590C
2600 IF(IFC1.EQ.11)WRITE(IFC3,14)NTR(11),IDBASE,MCR(11),NSR(11)
2610 IF(IFC1.EQ.12)WRITE(IFC3,15)NTR(12),IDBASE,MCR(12),NSR(12)

```

2620 14 FORMAT(1X,"THERE WERE",I7," TOTAL RECORDS FOR BASE",I5,  
 26300" IN 1975, OF WHICH",I5," WERE IN FSC 6505.",//,1X,I6,  
 26400" OF THESE RECORDS WERE FOUND TO BE SEASONAL.",//////)  
 2650 15 FORMAT(1X,"THERE WERE",I7," TOTAL RECORDS FOR BASE",I5,  
 26600" IN 1977, OF WHICH",I5," WERE IN FSC 6505.",//,1X,I6,  
 26700" OF THESE RECORDS WERE FOUND TO BE SEASONAL.",//////)  
 26800  
 26900 DETERMINE IF BOTH INITIAL SCRATCH-FILES HAVE BEEN EXAMINED AGAINST  
 27000 THE CRITERIA OF SEASONALITY; IF SO, TRANSFER CONTROL TO STATEMENT  
 27100 '16 CONTINUE' TO PROCEED WITH FURTHER ANALYSIS  
 27200  
 2730 IF(1FC1.EQ.13.AND.1FC2.EQ.14)GO TO 16  
 27400  
 27500 AFTER THE FIRST INITIAL SCRATCH-FILE HAS BEEN EXAMINED FOR THOSE  
 27600 RECORDS DETERMINED TO BE SEASONAL, REPLACE FILE/DEVICE CODE AND  
 27700 RETURN TO '6 CONTINUE' TO EXAMINE THE 1977 DATA SCRATCH-FILE  
 27800  
 2790 IFC1=13  
 2800 IFC2=14  
 2810 IFC3=16  
 28200  
 28300 RETURN TO '6 CONTINUE' TO READ THE NEXT RECORD  
 28400  
 2850 GO TO 6  
 28600  
 2870 16 CONTINUE  
 28800  
 28900 AT THIS POINT, THE DATA FOR BOTH YEARS HAS BEEN EXAMINED AND THOSE  
 29000 SEASONAL ITEMS FOR 1975 ARE RESIDING ON SCRATCH-FILE FIFTEEN (15)  
 29100 & THE 1977 SEASONAL ITEMS ARE ON SCRATCH-FILE SIXTEEN (16); THE  
 29200 TASK NOW IS TO LOOK FOR THOSE STOCK NUMBERS WHICH OCCUR FOR BOTH  
 29300 YEARS (i.e. FIND THOSE NSN'S THAT WERE SEASONAL IN 1975 & 1977)  
 29400  
 2950 READ(15,7,END=99)JA,JB,AATO,AIIN,JE,JF,(N(I),I=1,12)  
 2960 GO TO 18  
 2970 17 CONTINUE  
 2980 READ(16,7,END=99)KA,KB,BATO,BIIN,KE,KF,(N(J),J=1,12)  
 2990 18 CONTINUE  
 3000 IF(BIIN.LT.AIIN)GO TO 17  
 3010 IF(BIIN.GT.AIIN)GO TO 16  
 30200  
 30300 ONLY THOSE STOCK-NUMBERED ITEMS WHICH WERE SEASONAL FOR BOTH YEARS  
 30400 FALL THROUGH THE ABOVE TWO 'IF' STATEMENTS AND ARE NOW COUNTED AND  
 30500 PROCEED ON THROUGH THE PROGRAM WHERE VARIOUS FORECASTING METHODS  
 30600 WILL BE EMPLOYED & EXAMINED FOR THEIR ABILITY TO RESPOND TO THE  
 30700 SEASONAL VARIATIONS PRESENT WITHIN THE DATA  
 30800  
 3090 NATCHS=NATCHS+1  
 31000  
 31100 THE FIRST FORECASTING METHOD EXAMINED IS THE TWELVE-MONTH MOVING-  
 31200 AVERAGE---THE CURRENT METHOD EMPLOYED WITHIN THE U.S. AIR FORCE'S  
 31300 MEDICAL MATERIEL MANAGEMENT SYSTEM (MMMS); THIS METHOD BASICALLY  
 31400 PREDICTS NEXT MONTH'S DEMAND AS THE AVERAGE (MEAN) OF THE TWELVE  
 31500 PRECEEDING MONTHS DEMAND FOR THE ITEM

```

3160C
3170C THE NEXT THREE 'DO-LOOPS' ACCUMULATE THE HISTORICAL DEMAND FOR THE
3180C ITEM OVER THE PREVIOUS TWELVE-MONTHS CONSUMPTION HISTORY ADVANCING
3190C ONE MONTH EACH INCREMENT FOR EACH FORECAST PERIOD AND DROPPING THE
3200C OLDEST (THIRTEENTH MONTH BEHIND) DATA ELEMENT SIMULTANEOUSLY;
3210C CLOSE ATTENTION IS CALLED TO THE 'DO-LOOP' INDICIES TO ACCOMPLISH
3220C THIS TWELVE-MONTH FORWARD-MOVING FORECASTING TECHNIQUE
3230C
3240 ERRMA=0.0
3250 DO 22 I=1,12
3260 EMAV(I)=0.0
3270 DO 19 J=1,12
3280 19 MA(I)=MA(I)+N(J)
3290 IF(I.EQ.1)GO TO 21
3300 L=11-(12-I)
3310 DO 20 K=1,L
3320 20 MA(I)=MA(I)+N(K)
3330 21 MAV(I)=(FLOAT(MA(I))/12.0)+0.5
3340 MA(I)=0
3350C
3360C THE ACTUAL MONTHLY DEMAND (FOR EACH MONTH OF 1977) IS NOW COMPARED
3370C WITH THE FORECASTED VALUE FOR THAT MONTH; THE DIFFERENCE BETWEEN
3380C THE TWO SQUARED, ACCUMULATED, AND DIVIDED BY TWELVE TO ARRIVE AT
3390C THE 'MEAN-SQUARED-ERROR' OR 'MSE' FOR THE YEAR; THIS MSE GIVES
3400C AN INDICATION OF 'GOODNESS-OF-FIT' OF THE FORECASTED VALUE TO
3410C THE ACTUAL DEMAND ENCOUNTERED FOR EACH RESPECTIVE MONTH
3420C
3430 22 EMAV(I)=EMAV(I)+(FLOAT(MAV(I)-N(I))**2)
3440 DO 23 I=1,12
3450 23 ERRMA=ERRMA+EMAV(I)
3460 ERRMA=ERRMA/12.0
3470 VALUE=0.0
3480 ISAVE=0
3490C
3500C THE NEXT TWO FORECASTING TECHNIQUES USE A SMOOTHING-CONSTANT KNOWN
3510C AS ALPHA TO WEIGHT THE VARIOUS FACTORS IN THEIR COMPUTATIONAL EQNS
3520C THEREFORE, WE GENERATE, AT THIS POINT, NINETEEN VALUES OF ALPHA &
3530C BETA (1-ALPHA) FROM ALPHA = 0.05 TO ALPHA = 0.95 IN 0.05 INTERVALS
3540C
3550 DO 24 I=1,19
3560 VALUE=VALUE+0.05
3570 ALPHA(I)=VALUE
3580 24 BETA(I)=1.0-ALPHA(I)
3590 AVCS=(FLOAT(N(1)+N(2)+N(3))/3.0)
3600 ANCLD=100000000.0
3610C
3620C THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD WILL BE EXAMINED NEXT;
3630C THE COMPUTATIONS FOR THIS METHOD ARE 'NESTED' WITHIN AN OUTER 'DO-
3640C LOOP' WHICH ALLOWS THE ENTIRE DOUBLE-EXPONENTIAL-SMOOTHING METHOD
3650C TO BE REPEATED NINETEEN TIMES---ONCE FOR EACH VALUE OF ALPHA THAT
3660C WAS PREVIOUSLY GENERATED
3670C
3680 DO 26 I=1,19
3690 ERROR(I)=0.0

```

3700C  
 3710C THE TEXT OF THIS REPORT EXPOUNDS UPON THE PROCEDURE EMPLOYED BY  
 3720C THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD---SUFFICE IT TO SAY HERE  
 3730C THAT THE VALUE 'EX' IS THE SINGLE-EXPONENTIALLY-SMOOTHED VALUE  
 3740C THAT IS PLACED IN THE 'DX' EQUATION WHERE IT IS SMOOTHED AGAIN;  
 3750C THE VALUE 'IX' IS NOTHING MORE THAN AN 'INTEGER-FORMATTED' COPY OF  
 3760C THE VALUE 'DX' THAT IS NOT RETAINED UNTIL THE PROGRAM HAS ADVANCED  
 3770C ITSELF THROUGH THE 1975 DATA AND IS FORECASTING 1977 DATA, AND IS  
 3780C SUBSCRIBED TO RETAIN THESE VALUES FOR ALL VALUES OF ALPHA USED  
 3790C

```

3800 DO 25 J=1,21
3810 IF(J.EQ.1)EX(J)=(ALPHA(I)*FLOAT(N(J+2)))+(BETA(I)*AVG3)
3820 IF(J.EQ.1)DX(J)=(ALPHA(I)*EX(J))+(BETA(I)*AVG3)
3830 IF(J.EQ.1)GO TO 25
3840 IF(J.LE.10)EX(J)=(ALPHA(I)*FLOAT(N(J+2)))+(BETA(I)*EX(J-1))
3850 IF(J.GT.10)EX(J)=(ALPHA(I)*FLOAT(N(J-10)))+(BETA(I)*EX(J-11))
3860 DX(J)=(ALPHA(I)*EX(J))+(BETA(I)*DX(J-1))
3870 IF(J.GT.9)IX(I,J-9)=DX(J)+0.5
3880 IF(J.GT.9)ERROR(I)=ERROR(I)+(FLOAT(IX(I,J-9)-N(J-9)))*0.2)
3890 25 CONTINUE
3900 ERRODX(I)=ERROR(I)/12.0
3910 IF(ERRODX(I).LT.AHOLD)ISAVE=I
3920 IF(ERRODX(I).LT.AHOLD)AHOLD=ERRODX(I)
3930 26 CONTINUE
3940 ALPHOP=0.05*FLOAT(ISAVE)
3950 KSAVE=0
3960 BHOLD=1000000000.0
3970C
  
```

3980C AS OUTLINED IN THE TEXT, THE ADAPTIVE-RESPONSE METHOD IS A FORM OF  
 3990C EXPONENTIAL SMOOTHING, THE PRINCIPAL DIFFERENCE BEING THAT THE  
 4000C 'ALPHA' TERM IS USED MONTHLY TO WEIGHT TWO 'ERROR' TERMS, WHICH  
 4010C ARE USED, IN TURN, TO COMPUTE A TRACKING-COEFFICIENT WHICH IS THEN  
 4020C USED TO WEIGHT THE FORECASTING EQUATION, AS OPPOSED TO DOING THIS  
 4030C WEIGHTING DIRECTLY WITH A FIXED ALPHA; THIS METHOD, AGAIN, IS  
 4040C 'NESTED' WITHIN AN OUTER 'DO-LOOP' TO EXAMINE THE METHOD FOR EACH  
 4050C AVAILABLE VALUE OF ALPHA; 'IAR' IN THIS METHOD CORRESPONDS TO THE  
 4060C VALUE 'IX' USED IN THE DOUBLE-EXPONENTIAL-SMOOTHING METHOD  
 4070C

```

4080 DO 100 K=1,19
4090 TRCK=0.5
4100 ERRRR=0.0
4110 ERRAR(K)=0.0
4120 IAR(K,1)=AVG3
4130 DO 27 I=1,24
4140 IF(I.LT.13)IFERRR=N(I)-IAR(K,I)
4150 IF(I.EQ.13)IFERRR=(FLOAT(N(I))*0.1)+1.0
4160 IF(I.GE.13)IFERRR=N(I-12)-IAR(K,I)
4170 IFERR=ABS(IFERRR)
4180 IF(I.LT.13)IAR(K,I+1)=(TRCK*FLOAT(N(I)))+(1-TRCK)*FLOAT(IAR(K,I))
4190 IF(I.GE.13)IAR(K,I+1)=(TRCK*FLOAT(N(I-12)))+(1-TRCK)*FLOAT(IAR(K,I))
4200 IF(I.EQ.13)EWA(I)=(ALPHA(K)*FLOAT(IFERRR))
4210 IF(I.EQ.13)AND(I)=(ALPHA(K)*FLOAT(IFERRR))
4220 IF(I.EQ.13)GO TO 27
4230 AND(I)=(ALPHA(K)*FLOAT(IFERRR))+(BETA(K)*AND(I-1))
  
```

AD-A076 922

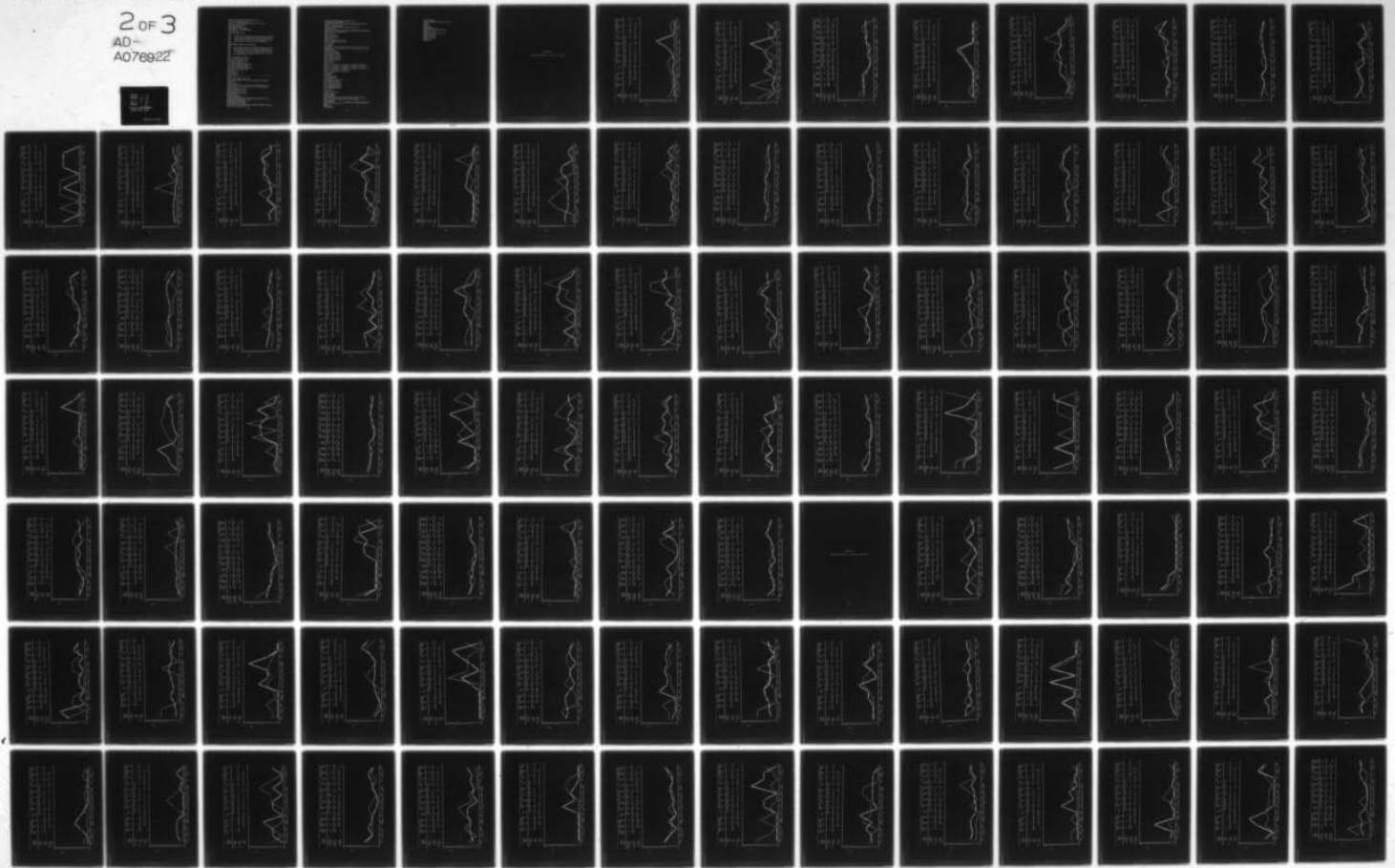
AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5  
AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MED--ETC(U)  
SEP 79 V R GILLOTH , J F OHL, W A WELLS

UNCLASSIFIED

AFIT-LSSR-13-79B

NL

2 OF 3  
AD-A076922



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4240 EMA(I)=(ALPHA(K)*FLOAT(I*ERRR))+(BETA(K)*EMA(I-1))
4250 IF(I.GT.12)IARSAV(K,I-12)=IAR(K,I)
4260 IF(I.GT.12)ERRRR=ERRRR+(FLOAT(IARSAV(K,I-12)-N(I-12))*2)
4270 27 TRCK=ABS(EMA(I)/AND(I))
4280 ERROR(K)=ERRRR/12.0
4290 IF(ERROR(K).LT.BHOLD)KSAVE=K
4300 IF(ERROR(K).LT.BHOLD)BHOLD=ERROR(K)
4310 100 CONTINUE
4320 ALFAOP=0.05*FLOAT(KSAVE)
4330C
4340C   AT THIS POINT, ALL THREE METHODS OF FORECASTING HAVE BEEN EXAMINED
4350C   AND THEIR ASSOCIATED FORECASTING ERROR TERMS (NSE) WILL NOW BE
4360C   COMPARED TO FIND THE MINIMUM ERROR---WHICH CORRESPONDS TO THE MOST
4370C   ACCURATE METHOD OF FORECASTING FOR THAT PARTICULAR DATA
4380C
4390 BEST=ANINI(ERRMA,ERRDI(ISAVE),ERROR(KSAVE))
4400C
4410C   THE REMAINDER OF THE PROGRAM IS DEDICATED TO FORMATTING, PRINTING,
4420C   AND PLOTTING THE RESULTS FOR INCLUSION WITHIN THE APPENDICES OF
4430C   THE FINAL REPORT; THE PLOTTING PORTION OF THE OUTPUT IS PROVIDED
4440C   TO ALLOW THE READER TO EXAMINE THE DEMAND PATTERNS OF THE ACTUAL
4450C   DATA FOR BOTH YEARS (1975 & 1977)
4460C
4470 IF(JA.EQ.04600)LABEL=" OFFUTT "
4480 IF(JA.EQ.04625)LABEL="WHITEMAN"
4490 IF(BEST.EQ.ERRMA)LABEL1="000"
4500 IF(BEST.NE.ERRMA)LABEL1=" "
4510 IF(BEST.EQ.ERRDI(ISAVE))LABEL2="000"
4520 IF(BEST.NE.ERRDI(ISAVE))LABEL2=" "
4530 IF(BEST.EQ.ERROR(KSAVE))LABEL3="000"
4540 IF(BEST.NE.ERROR(KSAVE))LABEL3=" "
4550 WRITE(6,28)
4560 28 FORMAT("1",//////////)
4570 WRITE(1,FC0,29)
4580 29 FORMAT(21X,"-----")
4590C-----]
4600 WRITE(1,FC0,30)LABEL,JB,A00,A1IN
4610 30 FORMAT(37X,"BASE: ",A0,10X,"MONTHLY DEMAND HISTORY",4X,"NSM: ",
4620015,A2,A7)
4630 WRITE(1,FC0,31)
4640 31 FORMAT(26X,"YEAR",7X,"JAN",3X,"FEB",3X,"MAR",3X,"APR",3X,"MAY",
465003X,"JUN",3X,"JUL",3X,"AUG",3X,"SEP",3X,"OCT",3X,"NOV",3X,"DEC")
4660 WRITE(1,FC0,32)(R(I),I=1,12)
4670 32 FORMAT(26X,"1975",4X,1216)
4680 WRITE(1,FC0,33)(N(I),I=1,12)
4690 33 FORMAT(26X,"1977",4X,1216)
4700 WRITE(1,FC0,30)
4710 WRITE(1,FC0,34)LABEL1
4720 34 FORMAT(22X,A3,1X,"NSE",28X,"MOVING-AVERAGE FORECAST FOR 1977")
4730 WRITE(1,FC0,35)ERRMA,(NAV(I),I=1,12)
4740 35 FORMAT(21X,F9.2,4X,1216,/)
4750 WRITE(1,FC0,36)LABEL2,ALPHOP
4760 36 FORMAT(22X,A3,1X,"NSE",9X,"DOUBLE-EXPONENTIAL-SMOOTHING (OPTIMAL ALP
477000HA =",F6.2,"> FORECAST FOR :977")

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4780 WRITE(IFC0,35)ERRR(IISAVE),(IX(IISAVE,I),I=1,12)
4790 WRITE(IFC0,37)LABEL3,ALFAOP
4800 37 FORMAT(22X,A3,1X,"RSE",14X,"ADAPTIVE-RESPONSE (OPTIMAL ALPHA =",
4810CF6.2,") FORECAST FOR 1977")
4820 WRITE(IFC0,35)ERRR(KSAVE),(IARS(KSAVE,I),I=1,12)
4830 WRITE(IFC0,38)
4840 38 FORMAT(21X,"*****")
4850*****
4860 DO 39 I=1,12
4870 TOT1A=TOT1A+N(I)
4880 39 TOT2A=TOT2A+N(I)
4890 DO 40 I=1,12
4900 D(I)=100.0*(FLOAT(N(I))/TOT1A)
4910 40 E(I)=100.0*(FLOAT(N(I))/TOT2A)
4920 TOT1A=0.0
4930 TOT2A=0.0
4940 AN=MAX(D(1),D(2),D(3),D(4),D(5),D(6),D(7),D(8),D(9),D(10),D(11),D(12))
4950 AE=MAX(E(1),E(2),E(3),E(4),E(5),E(6),E(7),E(8),E(9),E(10),E(11),E(12))
4960 AQ=MAX(AN,AE)
4970 IF(AQ.GT.40)ISKALE=1
4980 IF(AQ.LE.40)ISKALE=0
4990 IF(ISKALE.EQ.1)CC=105.0
5000 IF(ISKALE.EQ.1)DD=100.0
5010 IF(ISKALE.EQ.0)CC=42.0
5020 IF(ISKALE.EQ.0)DD=40.0
5030 41 CONTINUE
5040 DO 42 I=1,12
5050 IF(D(I).GE.CC.AND.E(I).GE.CC.AND.D(I).LT.DD.AND.E(I).LT.DD)AZ(I)=" "
5060 IF(D(I).GE.DD.AND.E(I).GE.DD.AND.D(I).LT.CC.AND.E(I).LT.CC)AZ(I)=" "
5070 IF(D(I).GE.DD.AND.E(I).GE.DD.AND.D(I).LT.CC.AND.E(I).LT.CC)GO TO 42
5080 IF(D(I).GE.DD.AND.D(I).LT.CC)AZ(I)="X"
5090 IF(E(I).GE.DD.AND.E(I).LT.CC)AZ(I)="0"
5100 42 CONTINUE
5110 IQC=DD
5120 WRITE(IFC0,43)IQC
5130 43 FORMAT(21X,I3)
5140 WRITE(IFC0,44)(AZ(I),I=1,12)
5150 44 FORMAT(1H+,20X,12A7)
5160 IF(ISKALE.EQ.1)CC=CC-5.0
5170 IF(ISKALE.EQ.1)DD=DD-5.0
5180 IF(ISKALE.EQ.0)CC=CC-2.0
5190 IF(ISKALE.EQ.0)DD=DD-2.0
5200 DO 45 I=1,12
5210 45 AZ(I)=" "
5220 IF(CC.GT.0.0)GO TO 41
5230 WRITE(IFC0,38)
5240 WRITE(IFC0,46)
5250 46 FORMAT(26X,"JAN",4X,"FEB",4X,"MAR",4X,"APR",4X,"MAY",4X,"JUN",
526064X,"JUL",4X,"AUG",4X,"SEP",4X,"OCT",4X,"NOV",4X,"DEC")
5270 WRITE(IFC0,47)
5280 47 FORMAT(29X,"( I = 1975 )",5X,"PERCENT OF TOTAL ANNUAL DEMAND BY MONTH
52906NS",5X,"( O = 1977 )")
5300 GO TO 16
5310 99 CONTINUE

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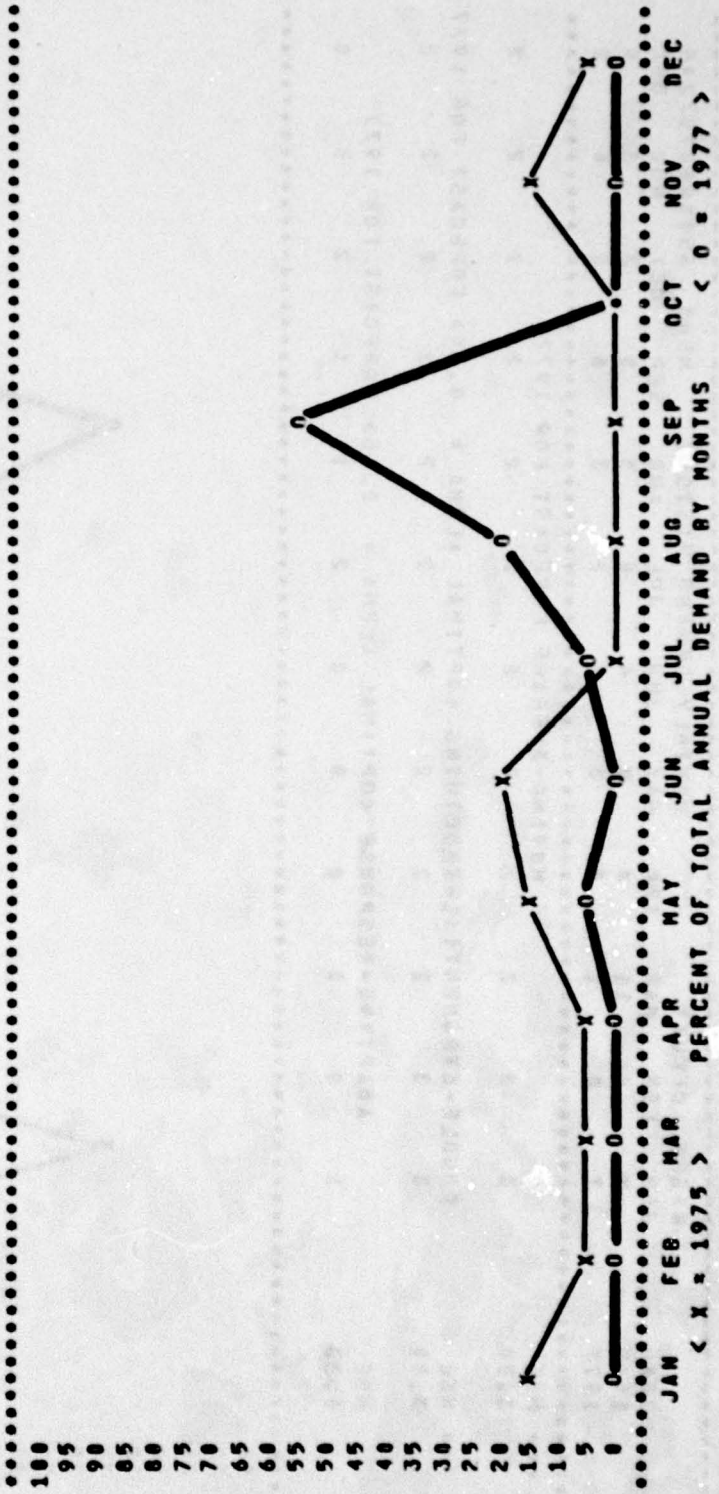
5320 WRITE(LFC0,28)  
5330 PRINT,"MATCHES FOR BOTH YEARS = ",MATCHS  
5340 STOP  
5350 END  
53600:EXECUTE  
53700:LIMITS:40,42K,,10K  
53800:TAPE:11,X1D,,7:249,,SEA1976-INPUT  
53900:FILE:12,X2D,10L  
54000:TAPE:13,X3D,,76964,,SCA1973-INPUT  
54100:FILE:14,X4D,10L  
54200:FILE:15,X5D,10L  
54300:FILE:16,X6D,10L  
54400:ENDJOB

APPENDIX D  
COMPUTER PRODUCTS, SEASONAL (OFFUTT)

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.....
BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSM: 4505000592760
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  12   6   6   4   12  18   0   0   0   0  15   6
1977  0   0   0   1   2   0   2   6  14   0   0   0
.....
MSE   7   6   5   5   4   4   2   2   3   4   4   3
      MOVING-AVERAGE FORECAST FOR 1977
.....
MSE   6   5   4   3   3   2   2   2   2   2   4   4
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977
.....
MSE   3   6   3   1   0   0   0   0   1   5  13   0
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....

```



BASE: OFFUTT MONTHLY DEMAND HISTORY NSM: 6505000797245

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	2	11	0	0	4	0	5	0	3	3	0
1977	2	0	1	0	3	1	2	3	6	0	0	2

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	3	3	2	2	2	2	2	2	2	2	2	2

MSE 3.50

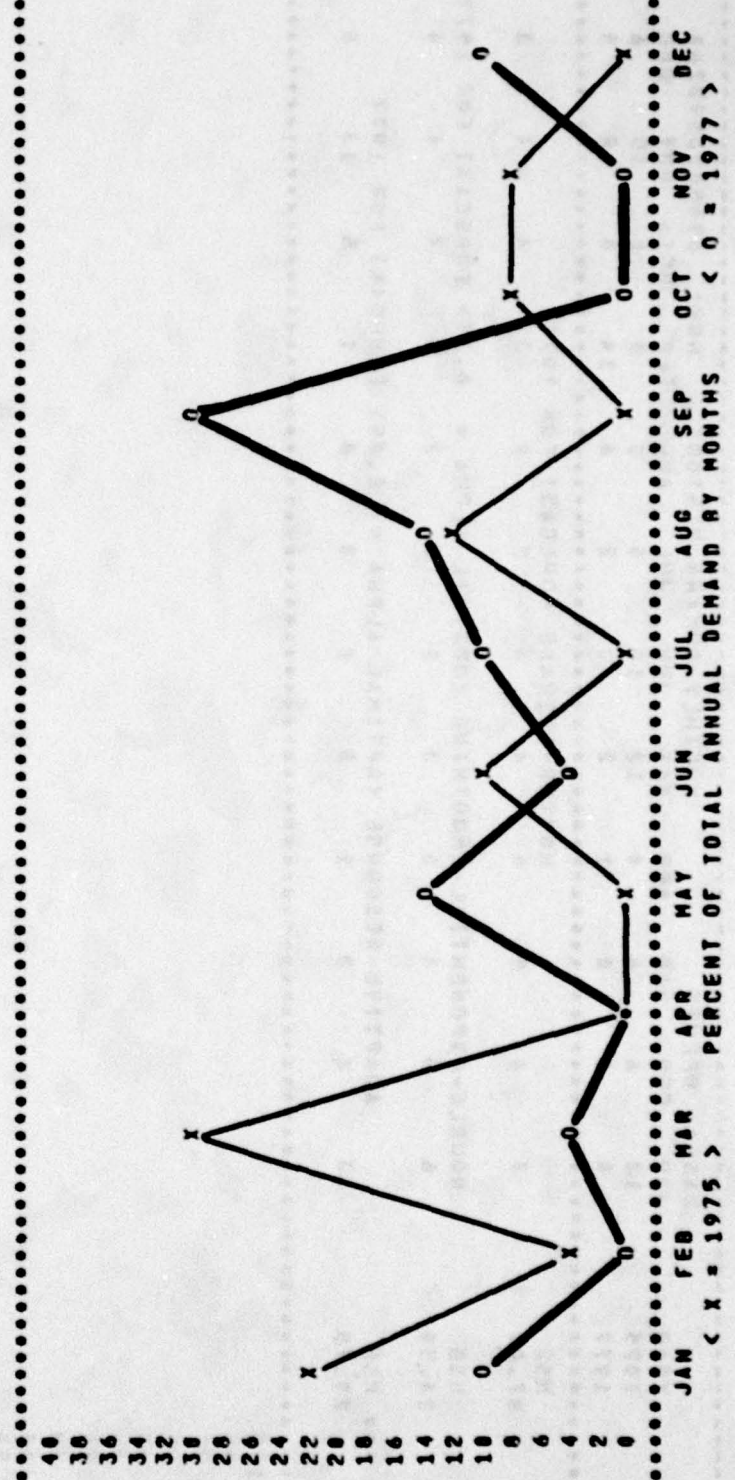
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	3	3	2	2	2	2	2	2	2	2	2	2

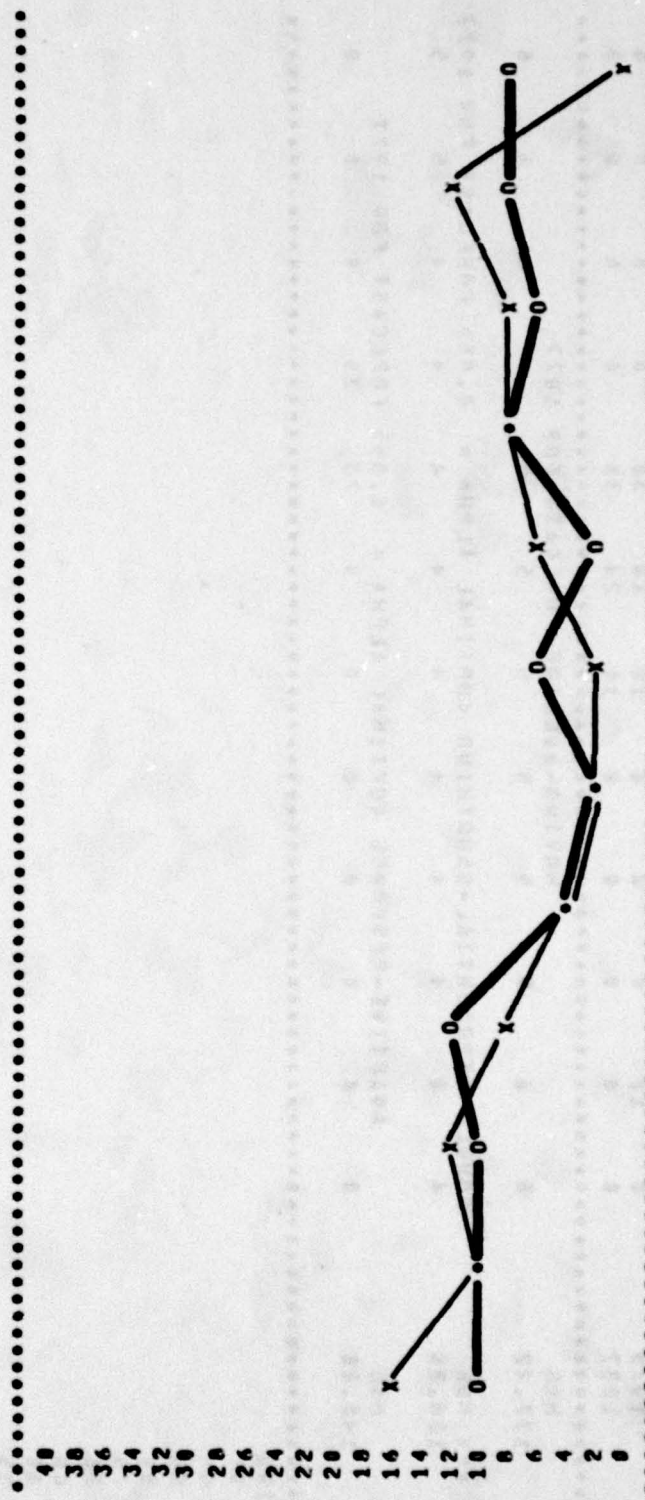
MSE 3.50

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	1	0	0	0	0	0	2	1	1	2	5	0



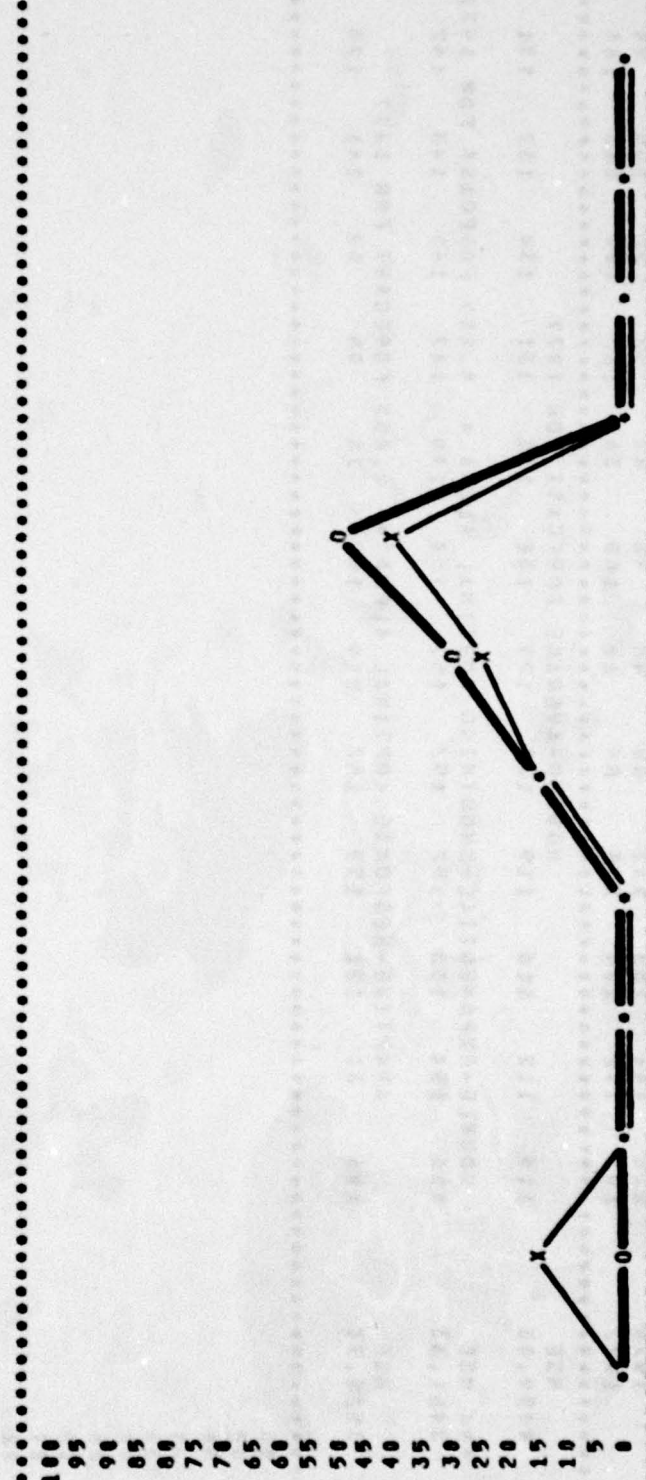
-----													
BASE1		MONTHLY DEMAND HISTORY										MSM:	
YEAR	OFFUTT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	228	144	160	132	60	48	48	84	84	132	132	180	24
1977	192	192	204	228	84	60	108	36	36	168	189	168	168
MSE													
4459.00	115	112	116	119	127	129	130	135	131	134	132	131	
...	MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977											
3481.33	156	154	153	152	152	152	150	149	147	145	143	142	
MSE		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
3525.50	126	31	121	153	187	219	100	78	98	92	141	128	
.....		.....											



YEAR	MONTHLY DEMAND HISTORY												MSM: 6905001040061
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	0	12	0	0	0	12	18	30	0	0	0	0	
1977	0	0	0	0	0	11	24	36	0	0	0	0	
MSE	MOVING-AVERAGE FORECAST FOR 1977												
137.42	6	6	5	5	5	5	5	5	6	6	6	6	6

\*\*\* MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 136.25 4 4 4 4 4 4 4 4 4 4 4 4 5 5

MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 145.00 0 0 0 0 0 0 9 23 35 0 0 0 0

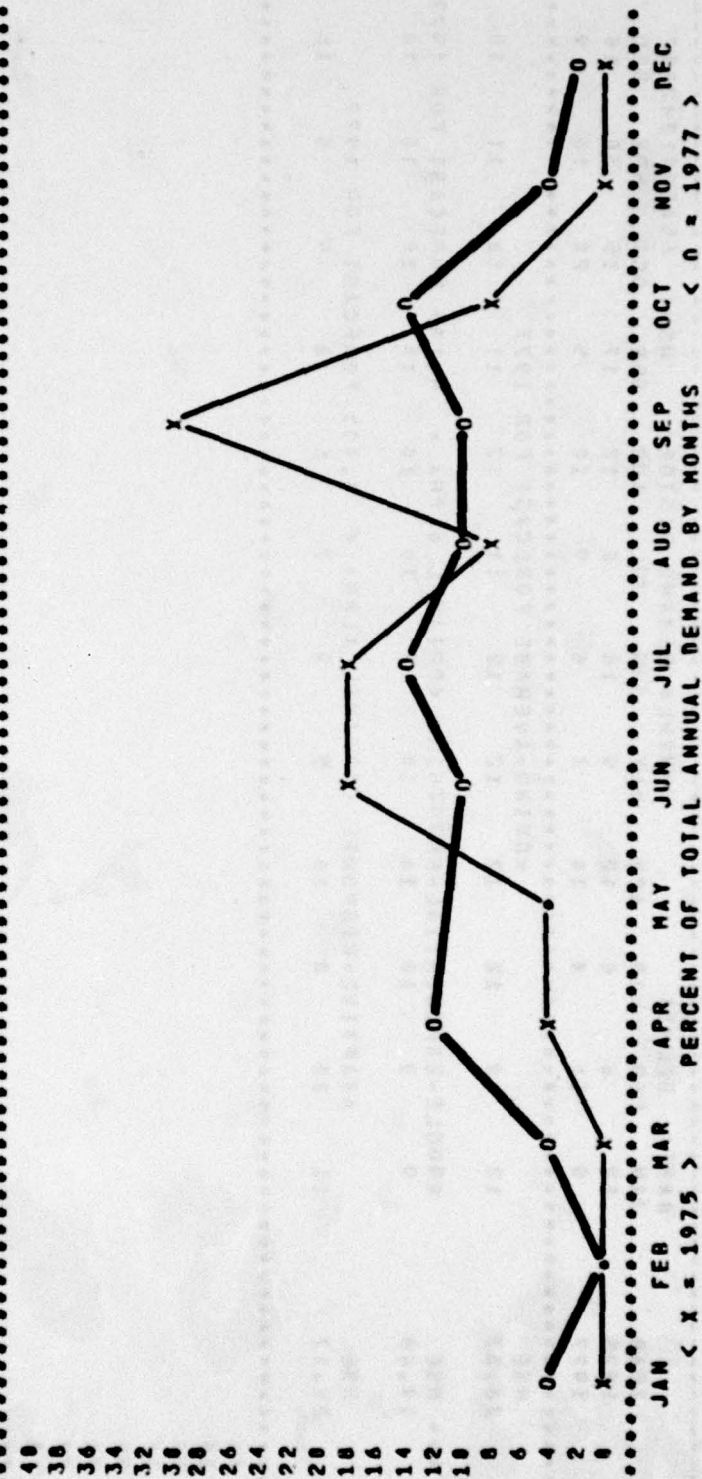


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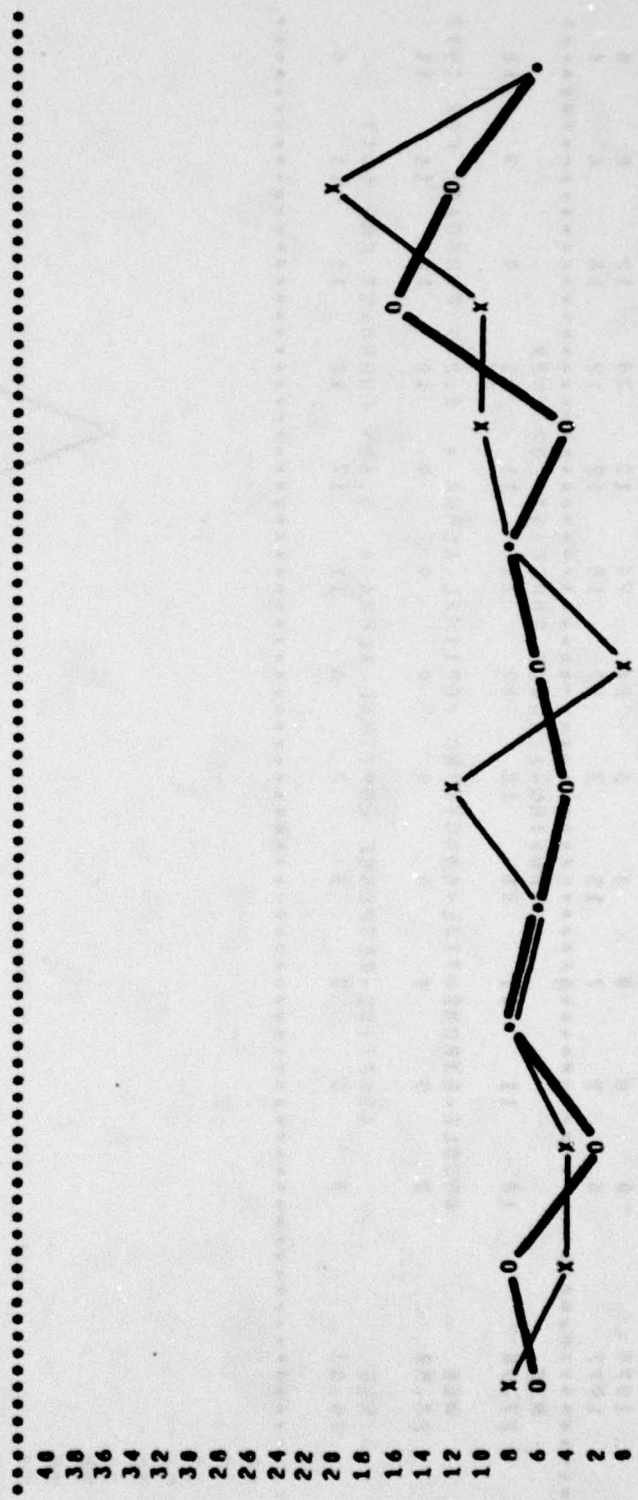
.....
BASE: OFFUTY      MONTHLY DEMAND HISTORY      MSN: 6505001182318
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  0    0    0    6    6    24   24   12   38   12   0    0
1977  6    2    7    15   7    12   18   12   12   18   6    4
MSE   10   11   11   11   12   12   11   11   11   9    9    10
      27.50
      MOVING-AVERAGE FORECAST FOR 1977
      .....
```

```

.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977
MSE   9    9    9    9    9    9    9    9    9    10   10   11   11
      28.50
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977
MSE   3    5    3    5    7    6    11   17   12   11   11   11   6
      26.83
.....
```

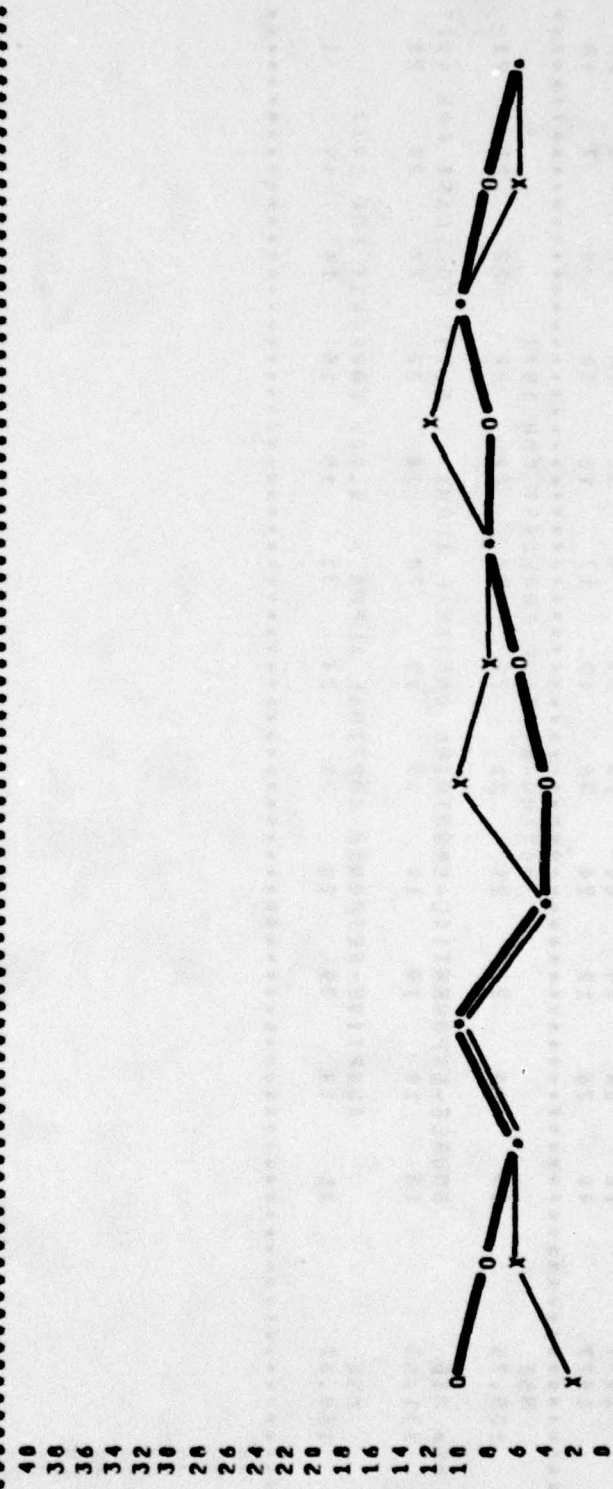


BASE1 OFFUTT		MONTHLY DEMAND HISTORY												NSM:
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975	12	6	6	12	9	18	0	12	17	15	38	10		
1977	8	11	4	18	7	6	9	18	5	20	16	9		
MSE	12	12	12	12	12	12	11	12	11	10	11	10	11	
26.33														
*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977													
19.08	9	10	10	10	10	10	10	10	10	10	10	10	10	
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977													
25.17	11	10	8	10	5	9	7	6	8	9	5	18		



.....  
 < X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < n = 1977 >  
 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 .....

BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM: 4505001352703
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975		12	20	24	36	18	36	30	30	42	36	24	24	
1977		31	25	19	31	18	18	20	30	29	36	30	22	
	MSE	MOVING-AVERAGE FORECAST FOR 1977												
	51.33	28	29	30	29	29	29	27	27	27	25	25	26	
	MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977												
	39.00	25	25	26	26	26	26	26	25	25	25	26	26	
	MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977												
	42.75	25	24	29	25	21	30	20	18	19	25	28	35	



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 4505001376154

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	18	24	24	25	35	0	12	24	17	6	24
1977	40	26	19	24	36	12	17	18	30	0	7	18

MSE 135.75

MOVING-AVERAGE FORECAST FOR 1977

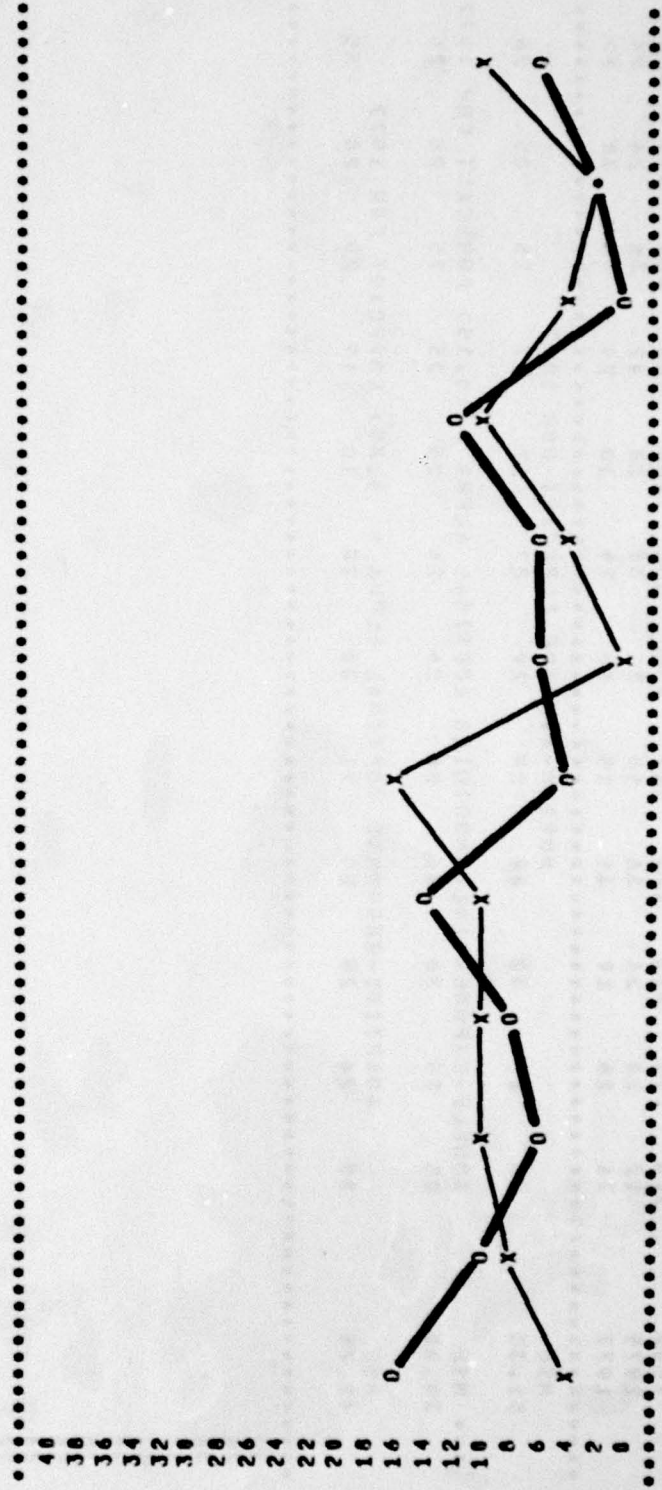
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
18	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
11	14	35	26	25	24	31	15	16	16	19	1											

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
11	14	35	26	25	24	31	15	16	16	19	1											



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 6505001403100

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	1	0	1	1	1	0	0	0	0	0
1977	1	0	0	0	0	1	0	0	1	1	1	0

MOVING-AVERAGE FORECAST FOR 1977

MSE	0	0	0	0	0	0	0	0	0	0	0	0
0.42												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977

MSE	0	0	0	0	0	0	0	0	0	0	1	1
0.40												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

MSE	0	0	0	0	0	0	0	0	0	0	1	1
0.33												

40

38

36

34

32

30

28

26

24

22

20

18

16

14

12

10

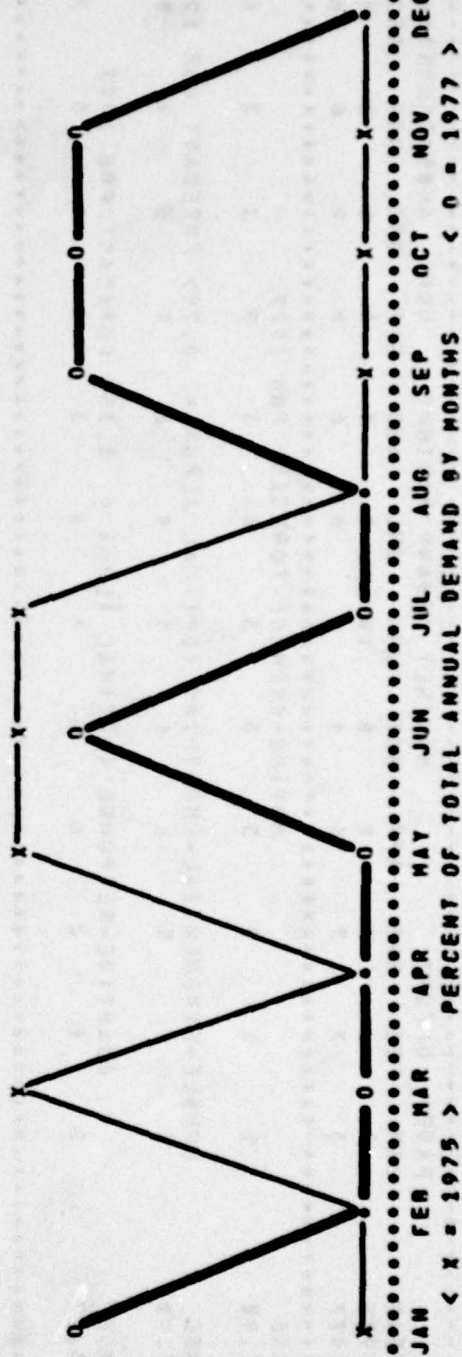
8

6

4

2

0



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 650500055716

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	10	0	4	0	0	0	0
1977	3	7	7	6	4	3	0	0	9	2	6	0

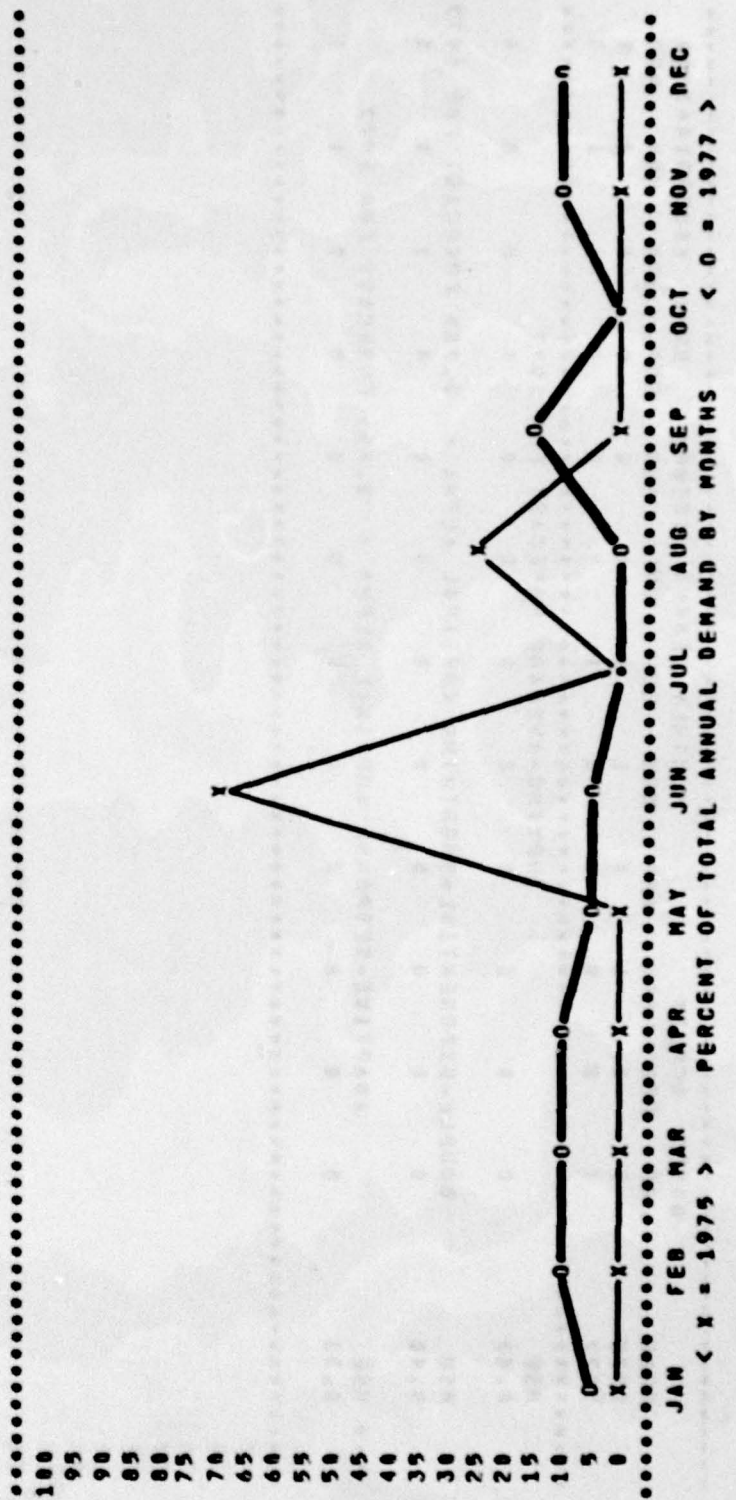
MSE 12.92 1 1 2 3 3 3 3 3 3 3 3 3 4

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

MSE	2	5	6	6	5	4	2	1	5	4	5
-----	---	---	---	---	---	---	---	---	---	---	---

MSE 15.17 0 2 6 6 4 4 3 0 0 0 2

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977



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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001405150

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	3	7	0	5	5	3	6	6	0
1977	3	4	0	5	2	3	4	7	4	4	2	3

MSE 5.25 3 3 4 4 4 3 4 3 4 4 4 4

MOVING-AVERAGE FORECAST FOR 1977

.....

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

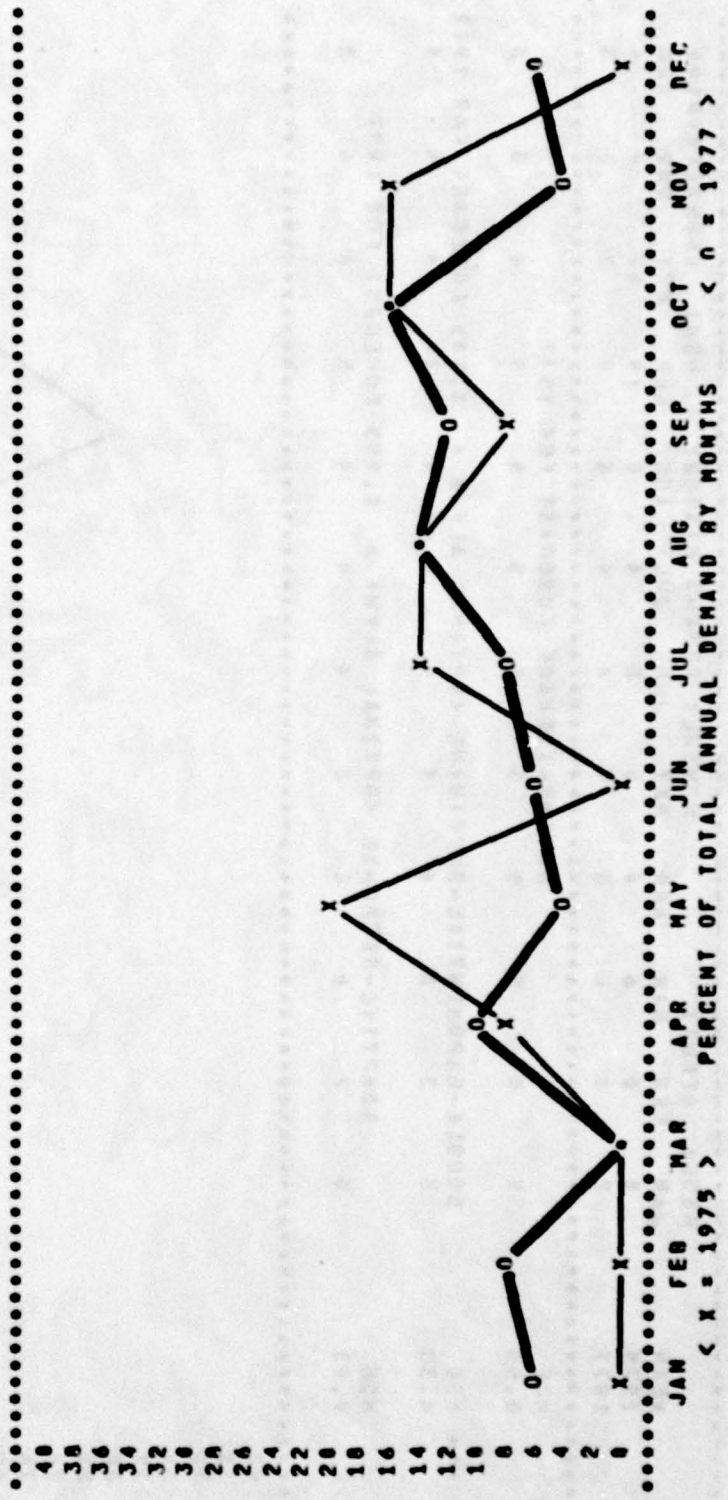
MSE	1	2	3	4
5.17	3	3	3	3

.....

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	1	0	1	0	1	2	3	6	7
7.42	1	0	1	0	1	2	3	6	7

.....



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 6505001490109

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	0	4	8	19	12	0	6
1977	2	0	0	3	5	4	4	6	0	7	3	3

MSE 0.58 5 5 5 5 5 5 5 5 5 4 3 3

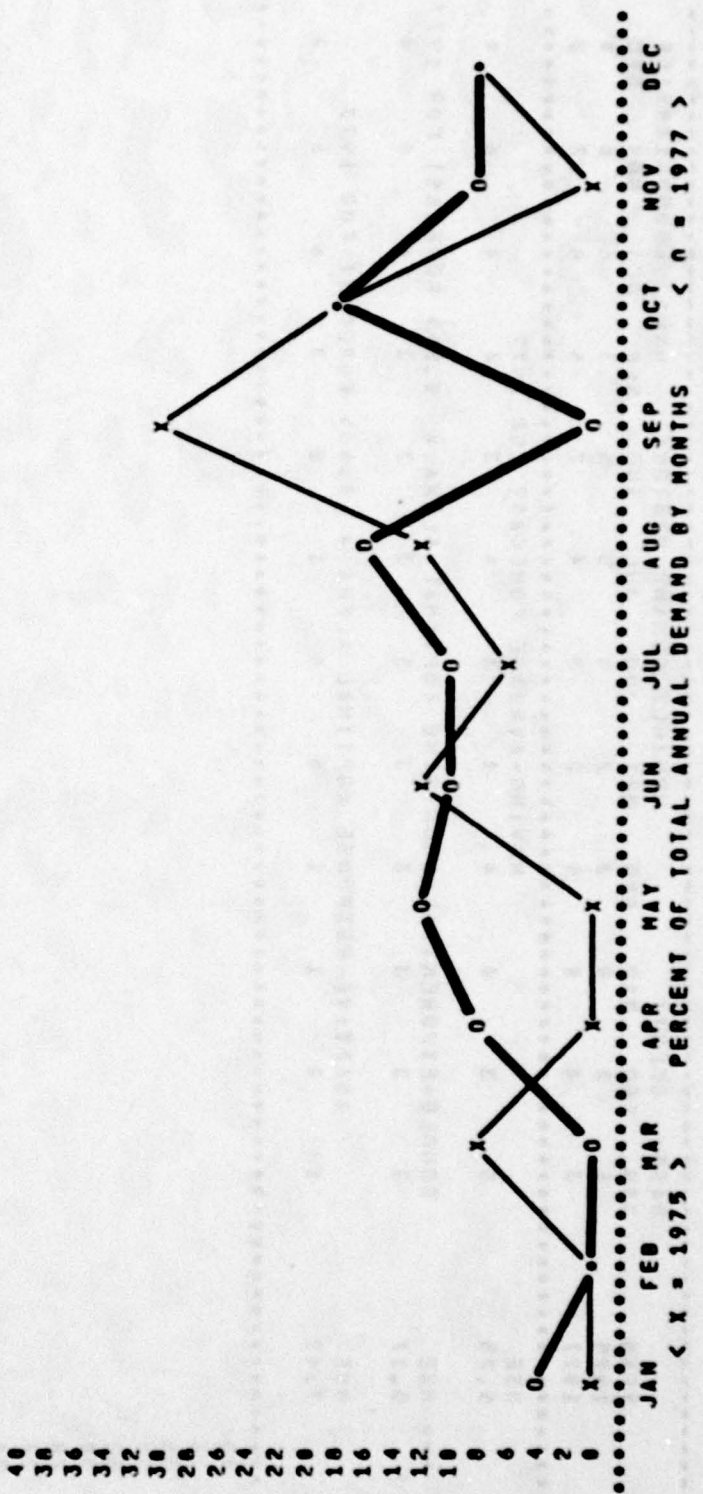
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE 4.33 3 3 3 4 4 4 4 4 4 4 4 4

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE 9.03 5 2 0 0 2 4 4 4 4 5 0 6 3



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 650500149A705

YEAR	JAN	FEB	MAR	APP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	3	0	4	2	13	0	0
1977	1	0	0	0	0	4	3	3	2	0	1	0

MOVING-AVERAGE FORECAST FOR 1977

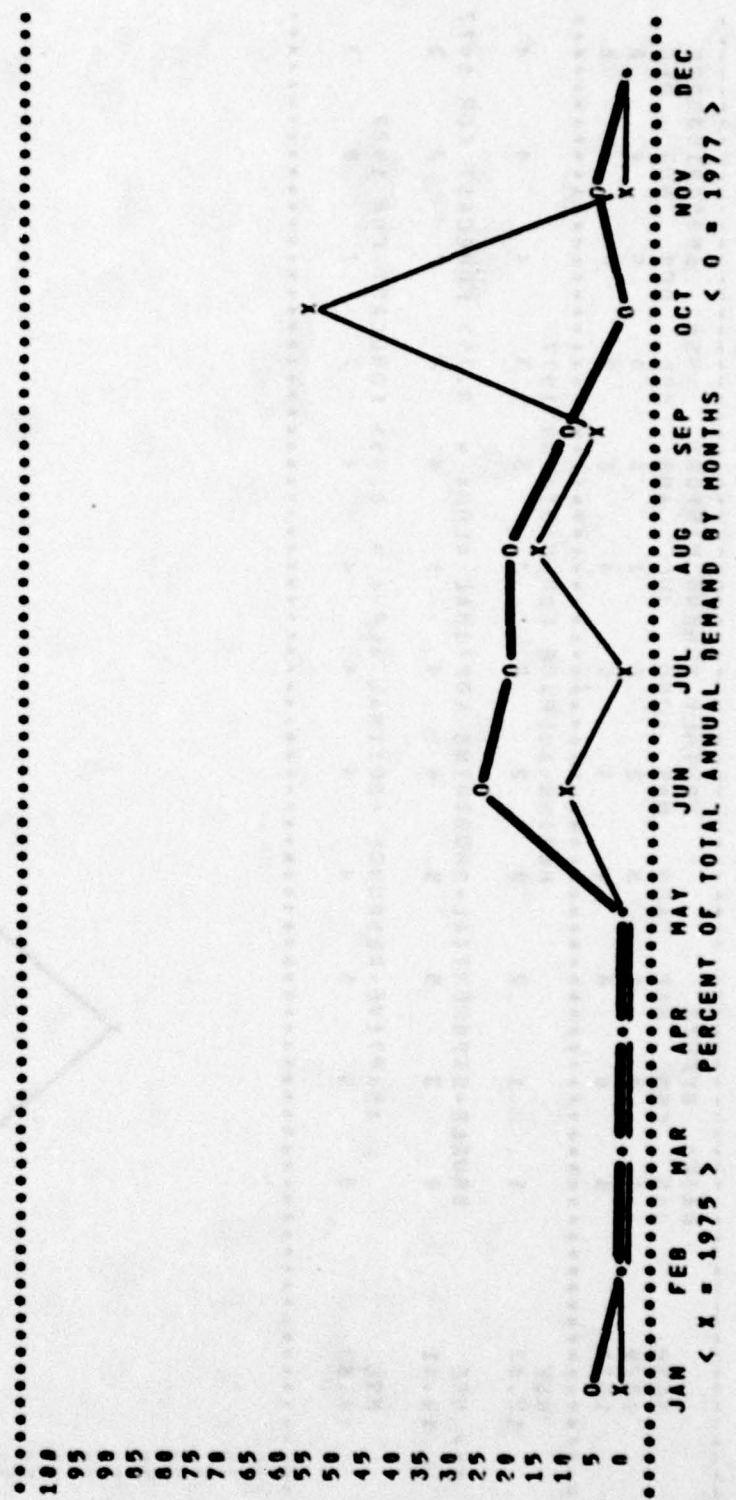
MSE	2	2	2	2	2	2	2	2	2	2	2	1
2.33												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE	1	1	1	1	1	1	1	1	1	1	1	1
2.00												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977

MSE	0	0	0	0	0	0	0	0	0	0	0	0
1.92												



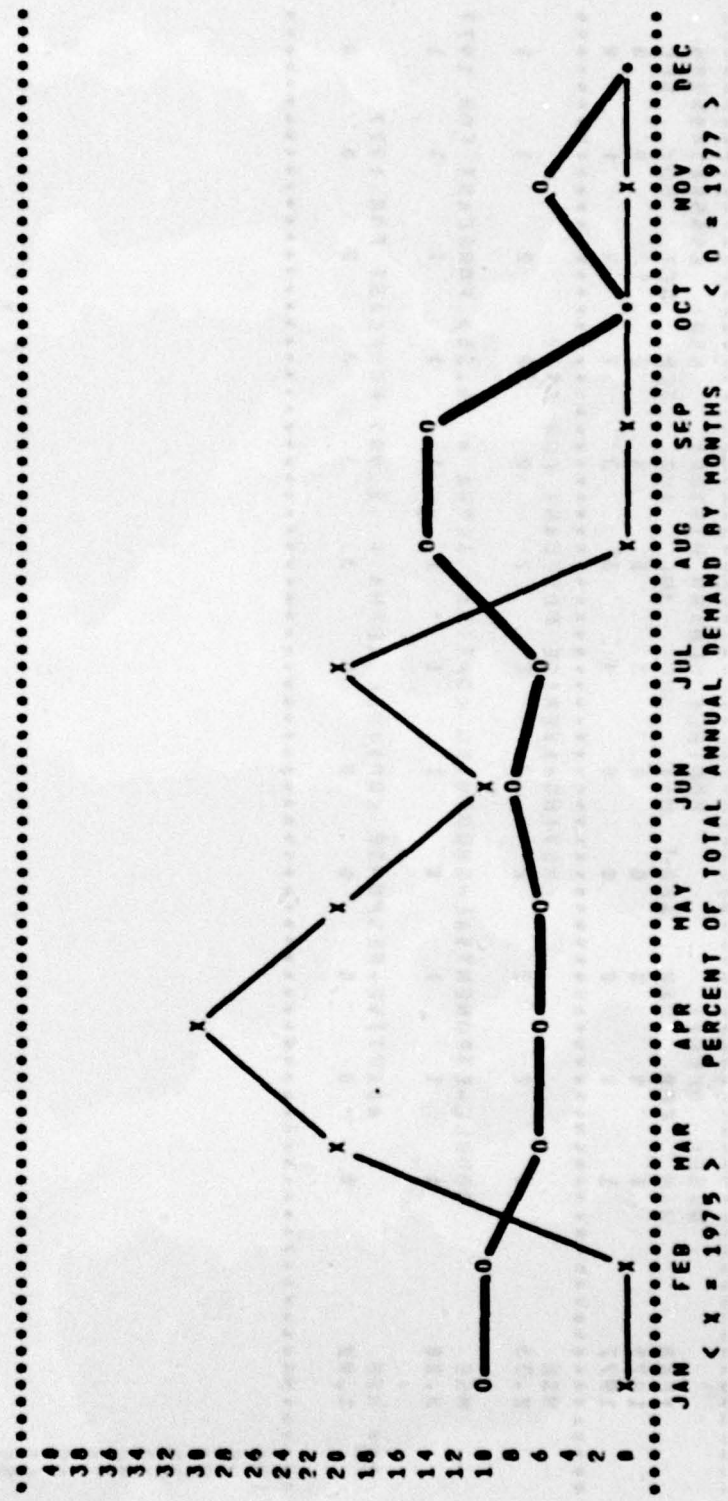
BASE: OFFUTT		MONTHLY DEMAND HISTORY												NSM: 6505001530225			
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC				
1975	0	0	2	3	2	1	2	0	0	0	0	0	0				
1977	6	6	4	4	4	5	4	0	0	0	0	0	0				
MSE		1	1	2	2	2	2	3	3	3	3	4	4				
12.03																	

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

0	3	5	5	4	4	5	4	4	6	7	3	3
---	---	---	---	---	---	---	---	---	---	---	---	---

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

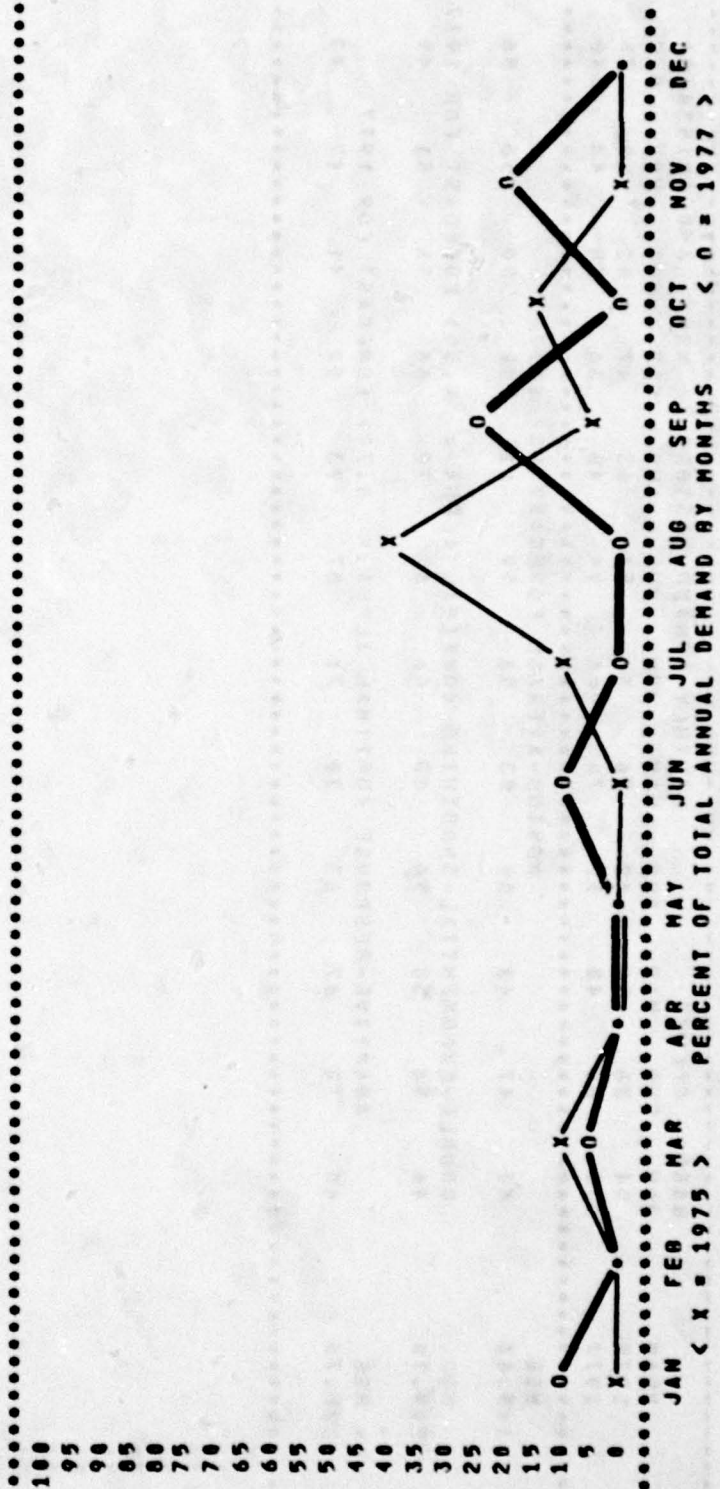
0	5	5	4	4	4	4	4	4	7	7	0	3
---	---	---	---	---	---	---	---	---	---	---	---	---



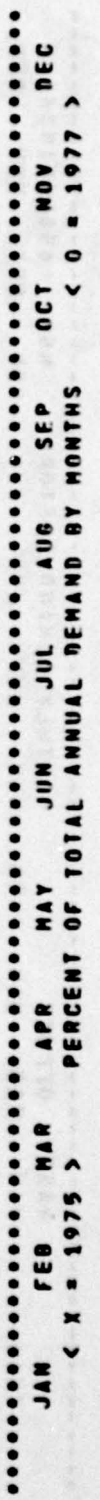
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.....
BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSN: 6505001538278
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  0    0    3    0    0    0    3    9    2    4    0    0
1977  8    2    4    0    1    9    1    0    17   3    13   3
.....
MSE   2    2    3    3    3    3    4    3    3    4    4    5
.....
MOVING-AVERAGE FORECAST FOR 1977
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
2    3    3    3    2    3    3    3    3    3    5    6    7
.....
MSE   0    0    3    2    2    0    0    2    1    0    2    2
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....
.....

```



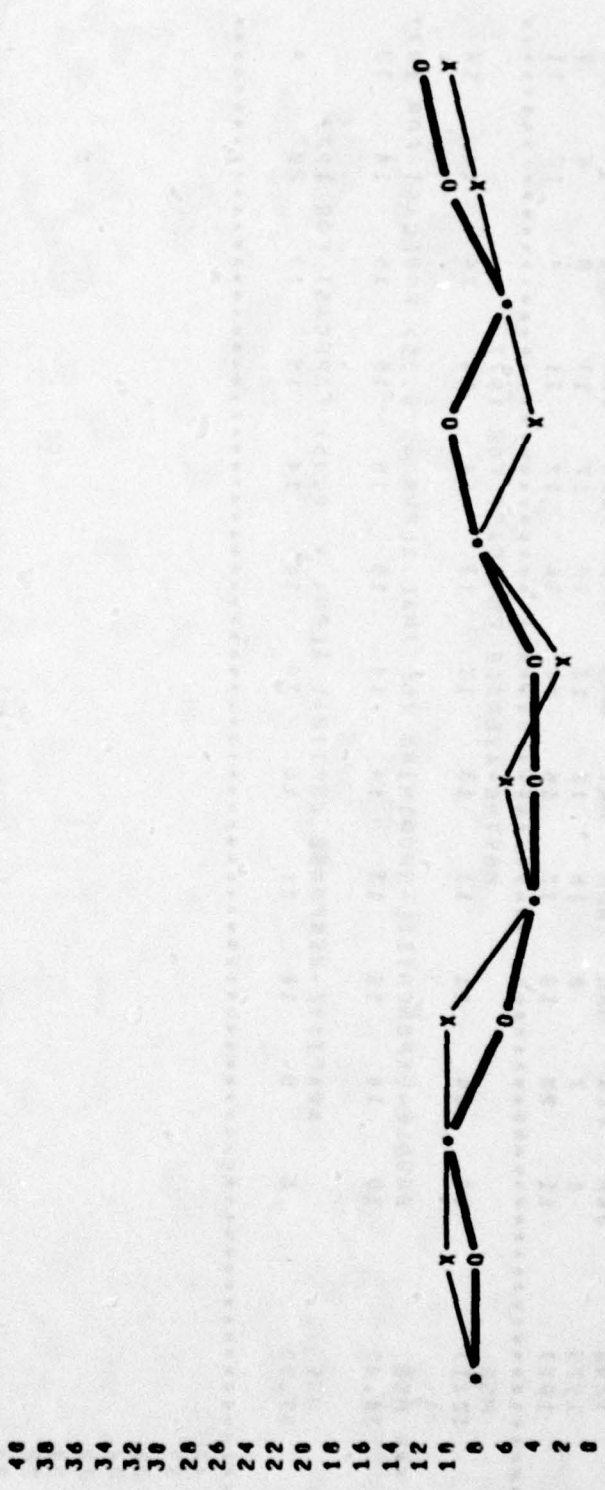
BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSN: 6505001530400
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975		54	30	39	42	36	30	54	63	47	62	50	28	
1977		70	63	48	72	76	66	84	48	36	48	48	48	
	MSE	MOVING-AVERAGE FORECAST FOR 1977												
	345.03	45	47	49	50	53	56	59	61	60	59	50	50	
	MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977												
	299.70	46	54	50	56	60	66	67	72	66	56	51	49	
	MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977												
	220.75	48	74	67	63	70	71	67	73	52	41	47	47	



< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM: 6505001530750	
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975		31	36	34	36	16	23	12	29	14	21	25	35		
1977		16	14	18	18	7	8	7	14	14	13	18	20		
MSE		26	25	23	22	19	19	17	17	16	16	15	15		
		67.50													
MSE		38	22	17	17	13	9	8	8	11	15	14	16		
40.40															
		23	34	16	14	17	10	7	7	6	11	17	13		
26.67															

.....  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977  
 .....  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977  
 .....



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 4505001596625

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	7	8	18	12	10	10	17	13	8	6	9
1977	11	22	16	17	16	14	16	12	21	4	12	11

MSE 32.17      MOVING-AVERAGE FORECAST FOR 1977

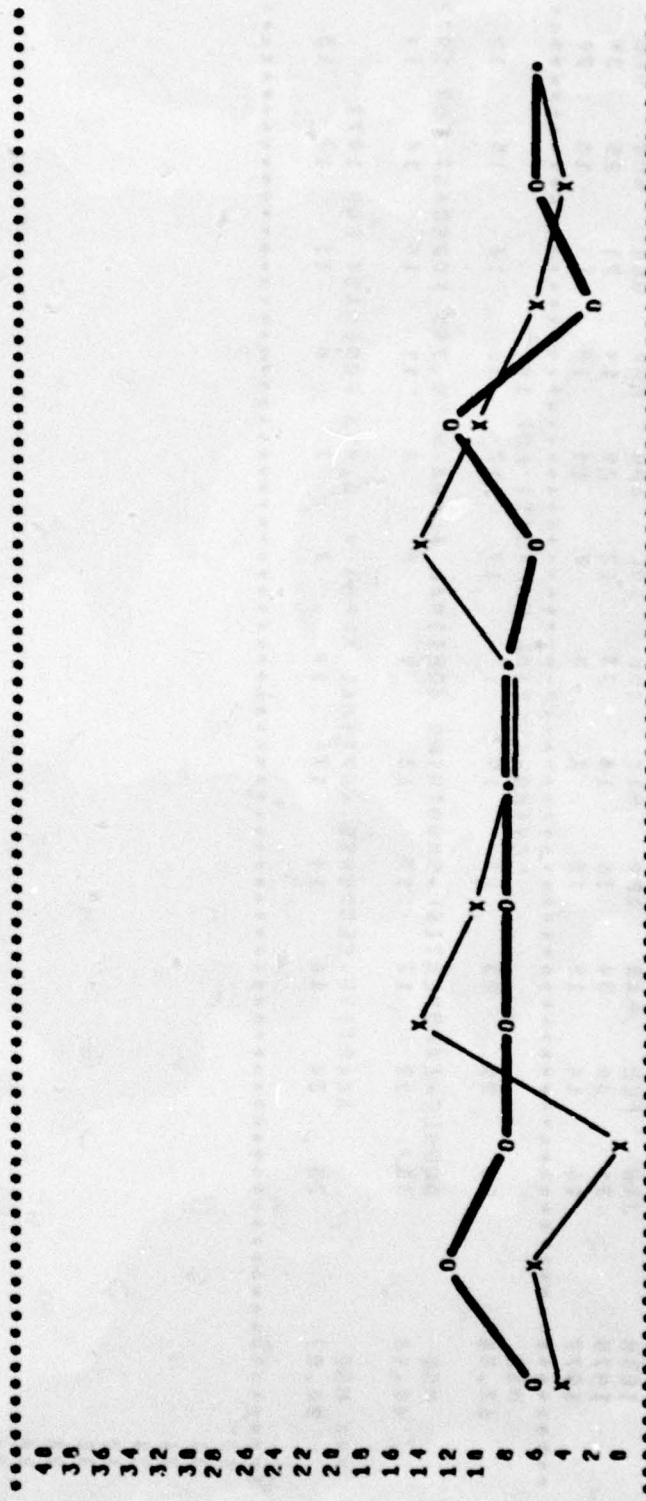
	10	11	13	13	13	14	14	14	14	14
10	10	11	13	14	14	15	15	15	15	15

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

MSE	10	10	11	13	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15
30.42	10	10	11	13	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

MSE	0	8	10	21	16	16	16	16	14	15	15	12	20	4
35.92	0	8	10	21	16	16	16	16	14	15	15	12	20	4



BASE1 OFFUTT MONTHLY DEMAND HISTORY NSM: 6505001R06372

YEAR	JAN	FEB	MAR	APP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	4	4	5	6	8	2	3	9	6	6	2
1977	3	2	3	4	2	3	3	2	5	5	4	1

MSE 2.88

MOVING-AVERAGE FORECAST FOR 1977

MONTH	FORECAST
JAN	4
FEB	4
MAR	4
APP	4
MAY	4
JUN	3
JUL	4
AUG	4
SEP	4
OCT	3
NOV	3
DEC	3

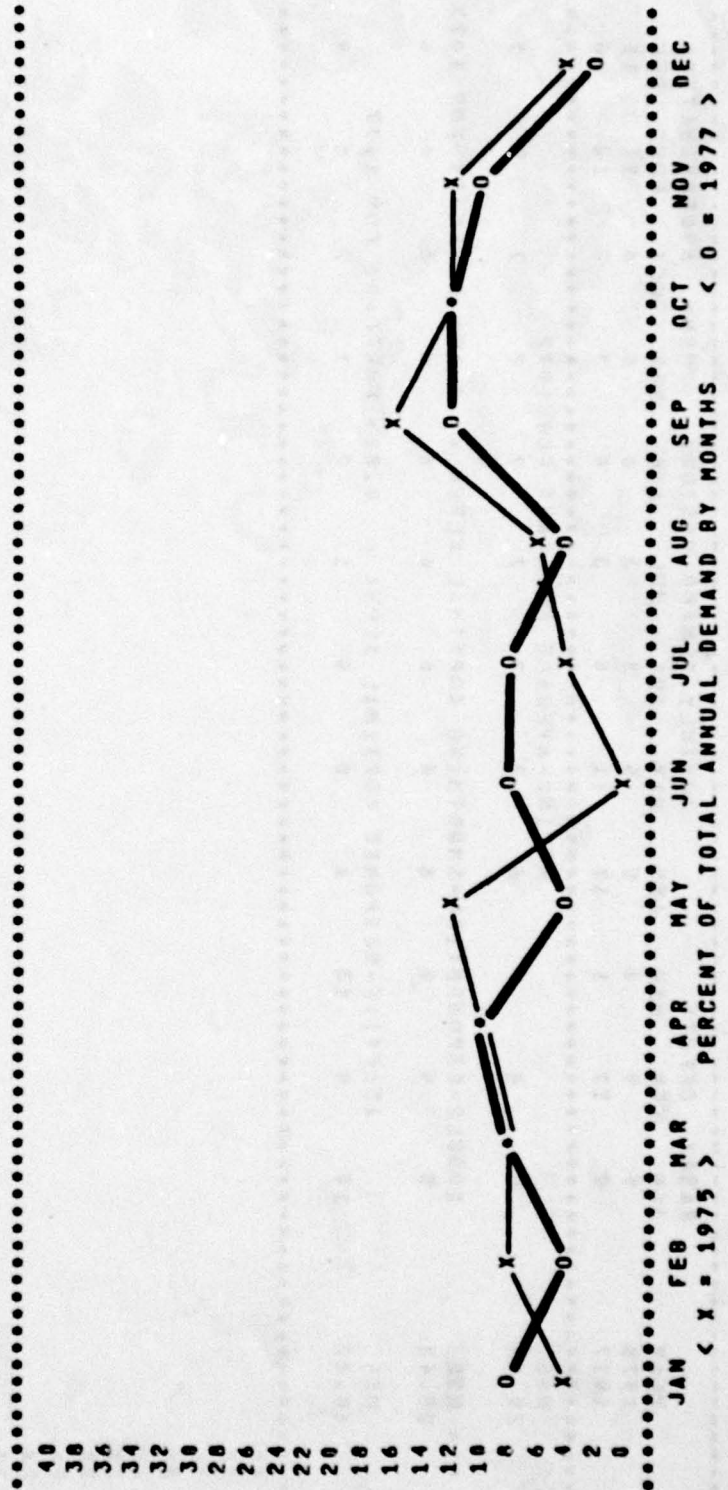
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MONTH	FORECAST
JAN	3
FEB	3
MAR	3
APP	3
MAY	3
JUN	3
JUL	3
AUG	3
SEP	3
OCT	3
NOV	3
DEC	3

MSE 1.42

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977

MONTH	FORECAST
JAN	2
FEB	5
MAR	3
APP	2
MAY	2
JUN	3
JUL	2
AUG	2
SEP	2
OCT	2
NOV	2
DEC	4



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001017296

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	5	5	4	5	5	3	3	0	6	6	11	10
1977	9	17	1	11	11	0	3	0	3	9	10	6

MSE 29.83

MOVING-AVERAGE FORECAST FOR 1977

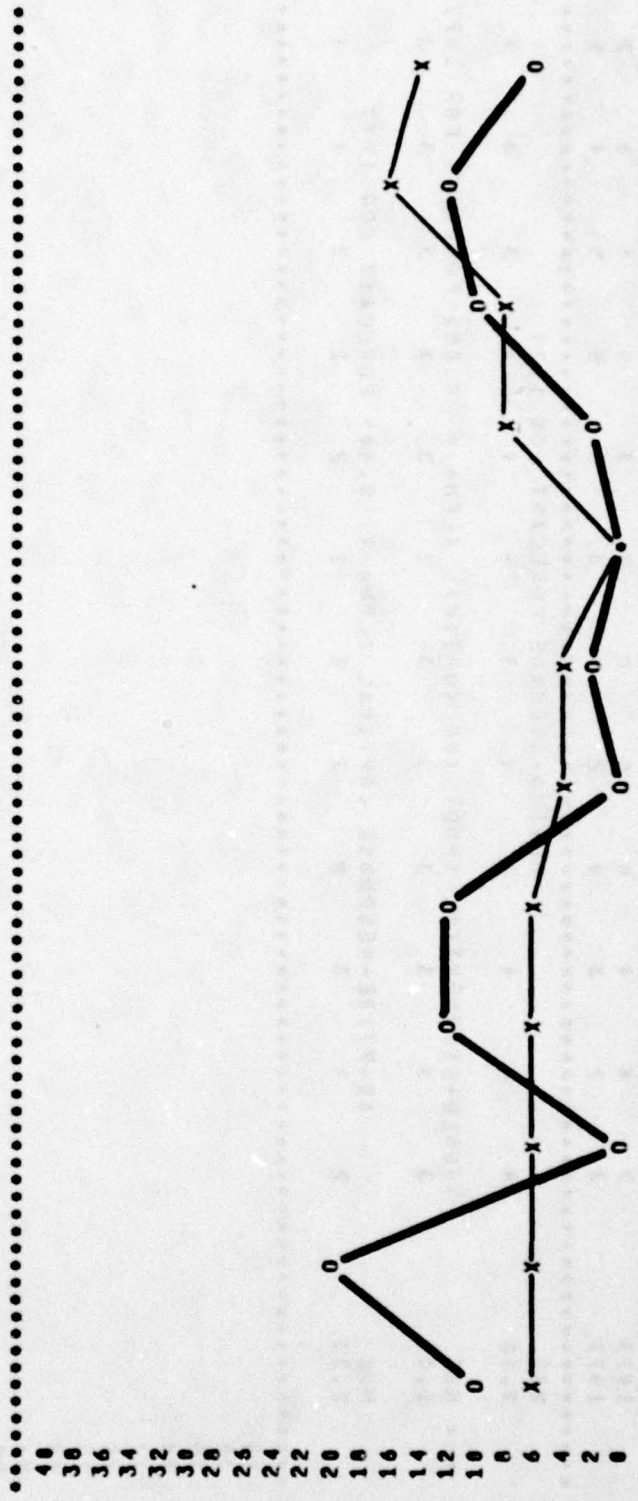
7	6	7	7	7	7	7
5	6	7	6	7	7	7

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

6	6	6	6	6	6	6
5	5	5	6	6	6	6

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

13	1	8	9	1	2	1	2	6	9
10	9	13	1	8	9	1	2	1	2



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505002126189

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	12	18	22	21	16	22	14	21	0	6
1977	1	1	1	4	8	3	1	4	2	6	3	4

MSE

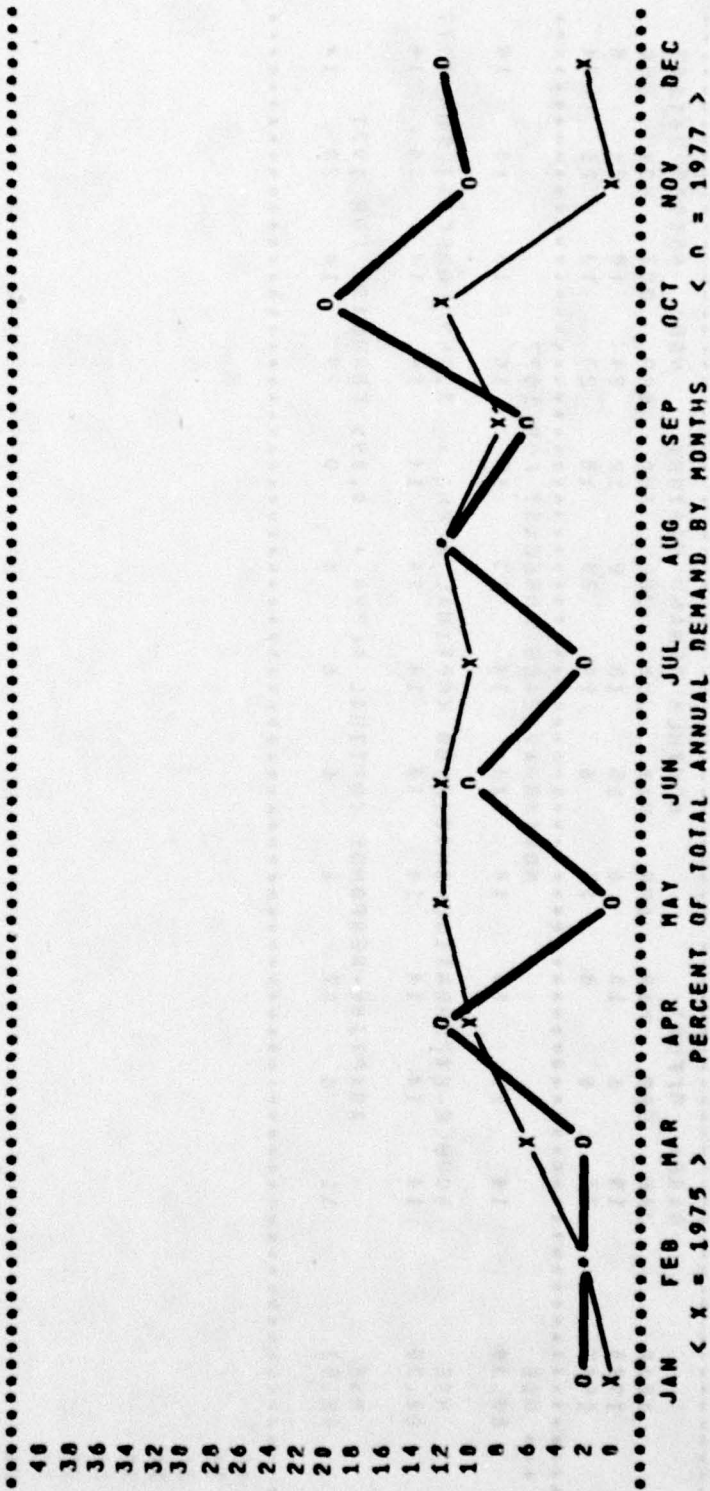
MSE	13	13	13	12	11	9	7	6	5	4	2	3
59.00												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

MSE	6	3	2	1	3	1	2	2	3	2	4	4
7.75												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE	5	2	1	1	3	0	2	1	3	2	4	3
6.00												



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505002261203

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	6	18	6	15	18	2	12	24	18	24	6
1977	33	0	0	13	6	14	22	18	23	13	21	24

MOVING-AVERAGE FORECAST FOR 1977

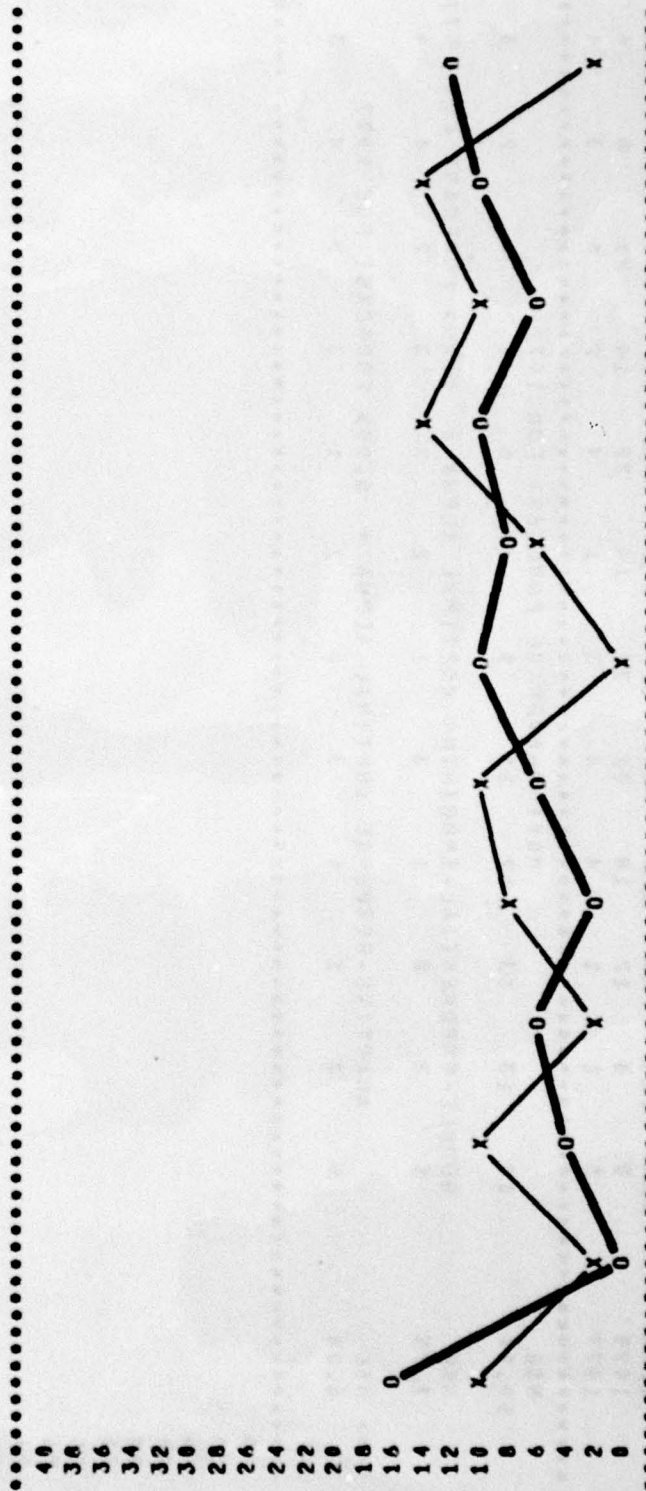
	14	15	15	14	14	14	13	15	16	15	15	15
MSE	88.00											

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	14	14	14	14	14	14	14	14	14	14	14	14
80.75												

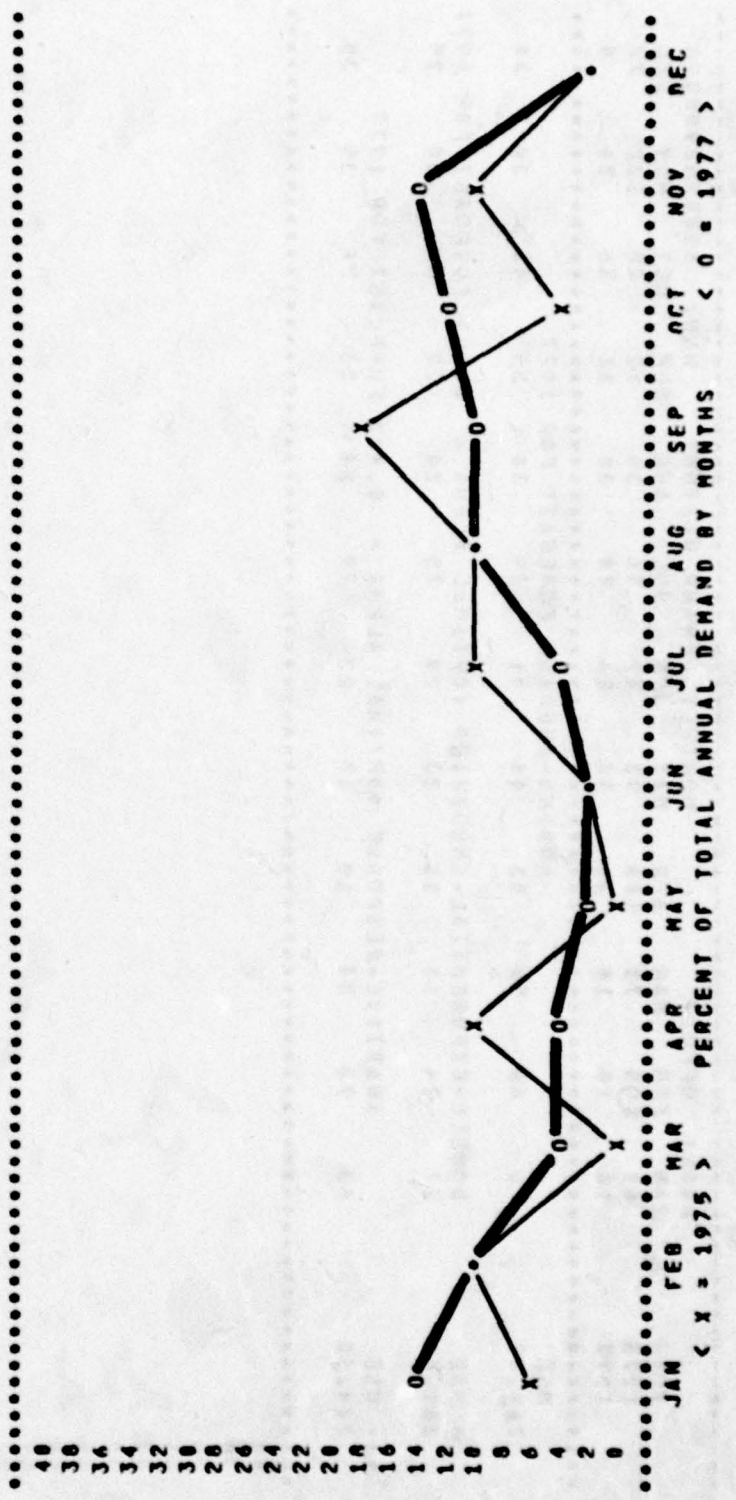
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	11	6	17	6	6	6	6	9	20	18	20	14
99.83												



BASE: OFFUTT MSN: 6505002998279

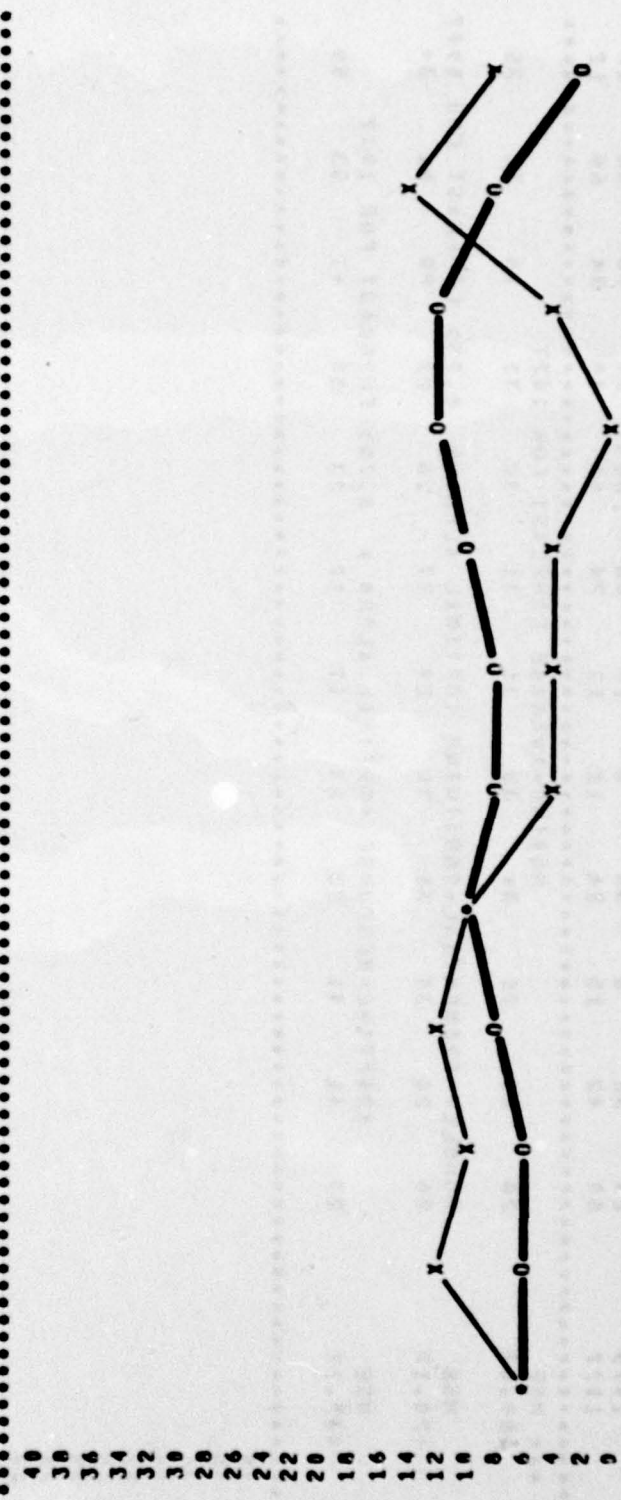
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	36	0	36	0	12	36	36	60	18	36	12
1977	60	42	10	24	12	12	24	40	40	54	60	12
MSE	MOVING-AVERAGE FORECAST FOR 1977											
309.67	26	29	29	31	30	31	31	30	31	30	33	35
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977											
420.17	26	20	30	31	30	29	27	26	27	29	31	34
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977											
435.17	23	41	41	23	23	17	12	23	30	47	53	59



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BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSN: 6505002908598
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  60  100  90  100  90  42  36  36  12  40  132  72
1977  18  10  18  24  30  24  24  30  36  36  24  6
.....
MSE  70  66  59  53  46  41  39  30  30  40  39  30
      MOVING-AVERAGE FORECAST FOR 1977
.....
MSE  77  24  18  18  23  29  25  24  29  35  36  25
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977
.....
MSE  63  72  34  10  17  23  29  24  23  20  35  35
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977
.....
40
38
36
34
32
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18
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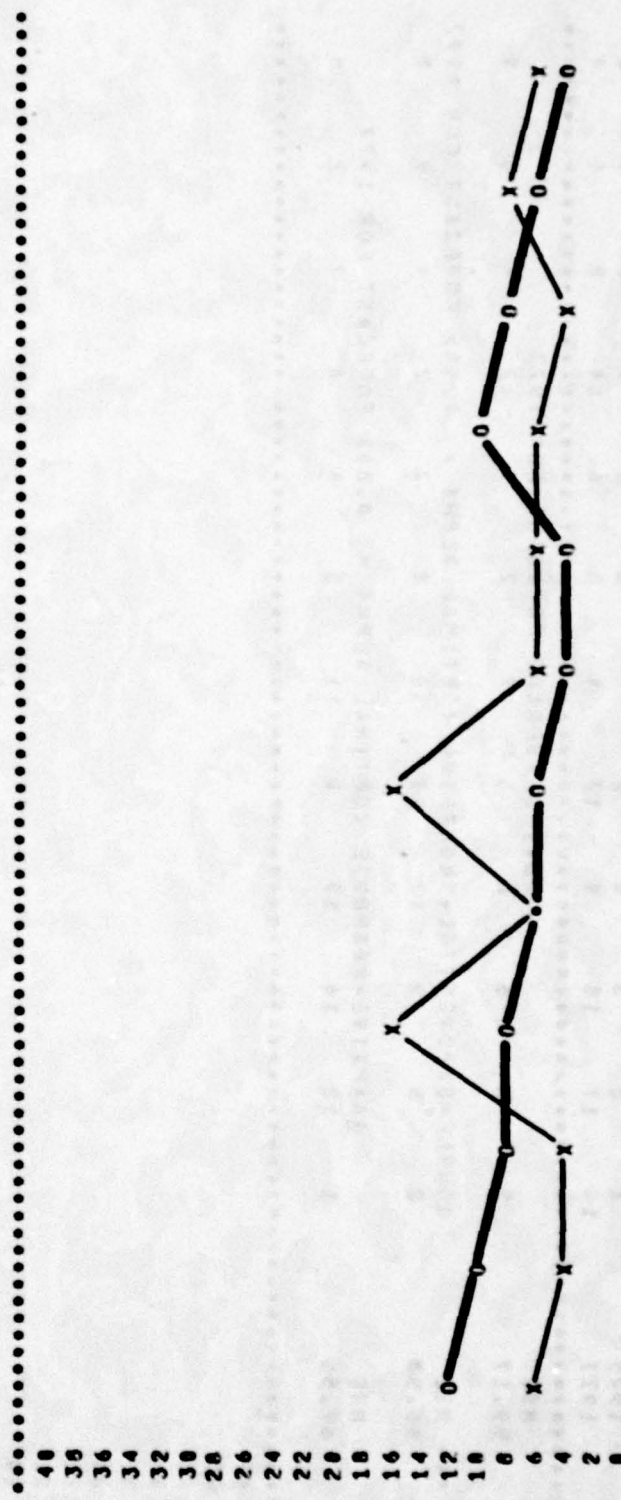


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.....
JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >
.....

```

BASE: OFFUTY		MONTHLY DEMAND HISTORY												MSM: 6505003750955
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	18	12	14	43	10	43	10	18	18	18	12	24	10	
1977	20	17	13	14	10	11	7	8	10	10	15	12	9	
MSE	41.42	21	22	22	22	19	19	16	15	14	14	15	14	
MSE	17.16	19	20	17	13	14	10	11	7	8	17	15	12	
MSE	13.50	17	19	19	18	15	14	10	10	9	9	16	15	



PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1975 > < X = 1977 >

BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505004341879

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	0	3	0	2	1	6	3	5	2	1	1
1977	14	17	18	0	13	1	8	6	14	8	6	4

MSE 59.17 2 3 5 6 6 7 7 7 8 8 9

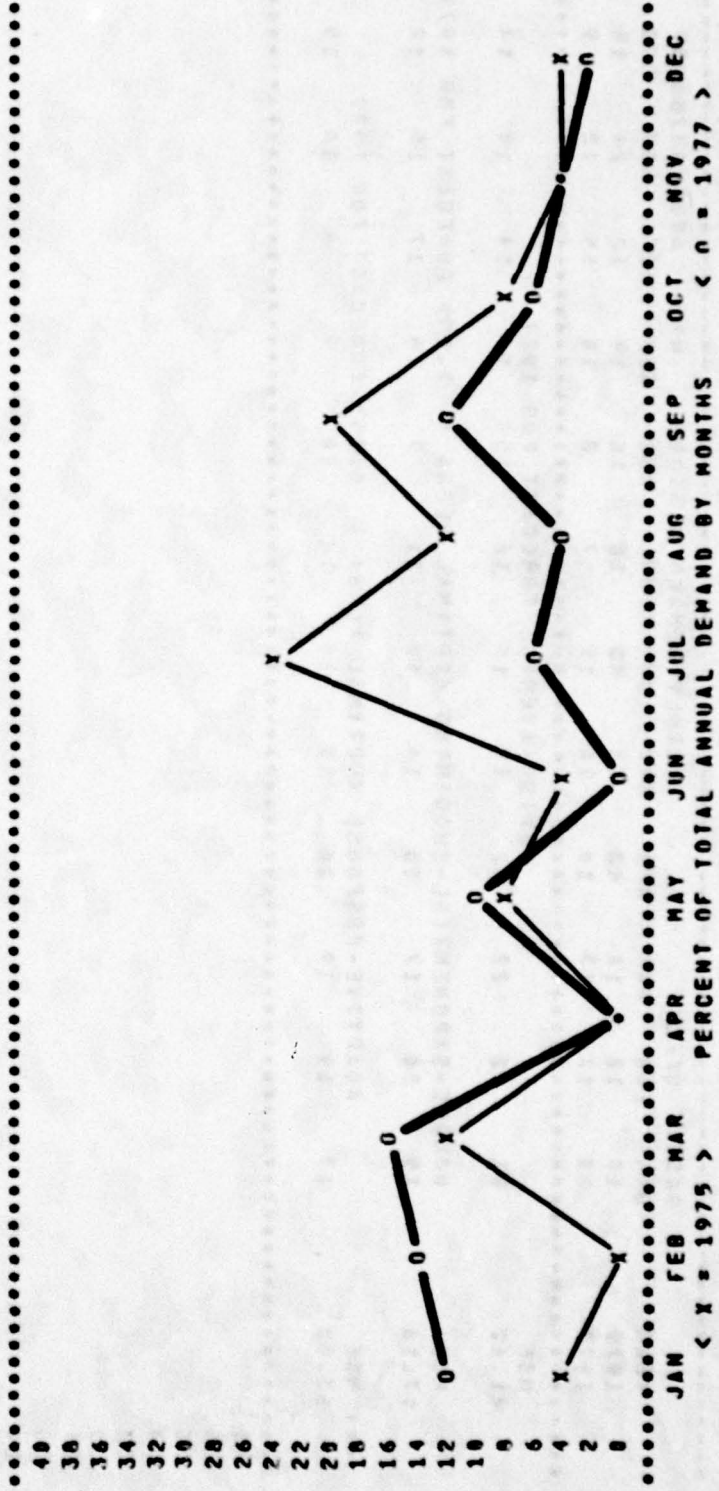
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.58> FORECAST FOR 1977

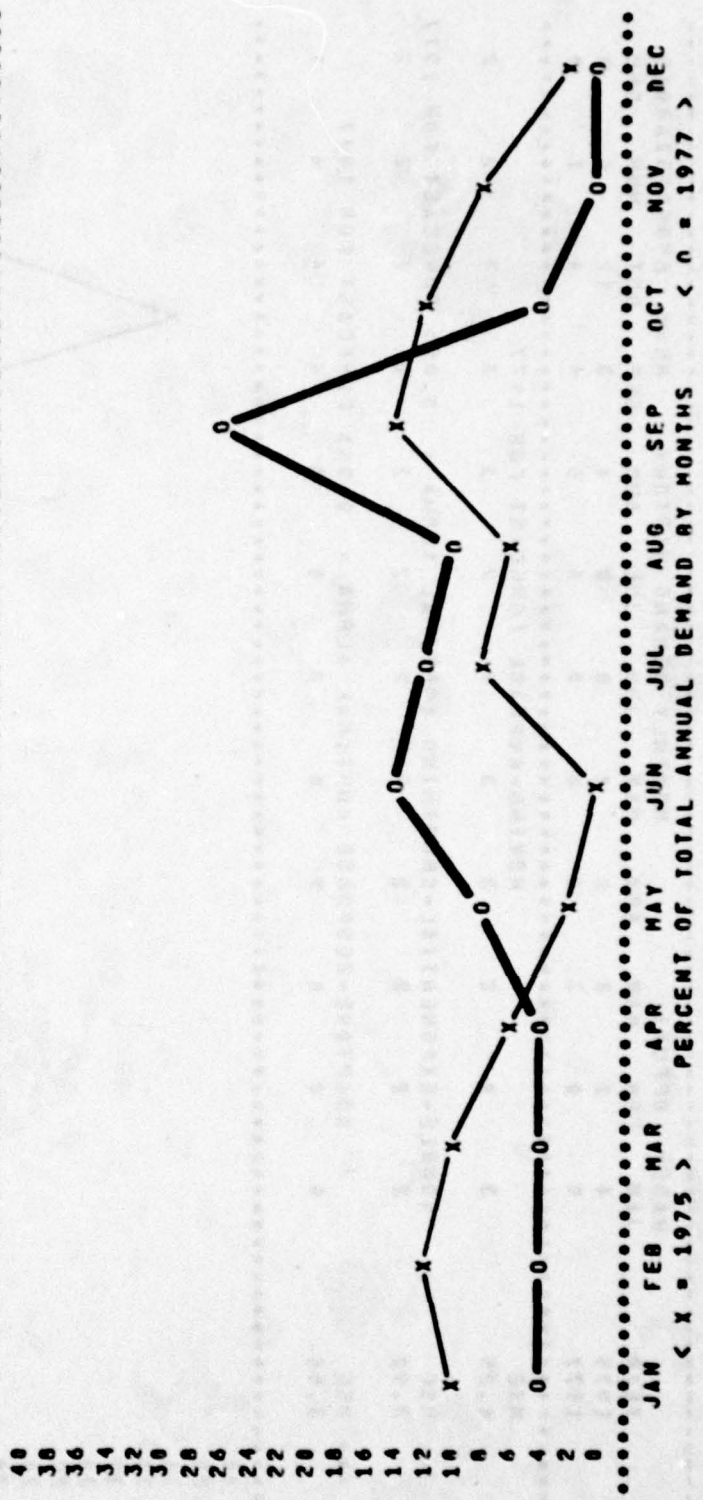
MSE 56.58 2 5 9 12 10 10 8 7 7 9 9 8

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

MSE 69.58 1 12 16 17 0 11 5 6 6 7 7 6



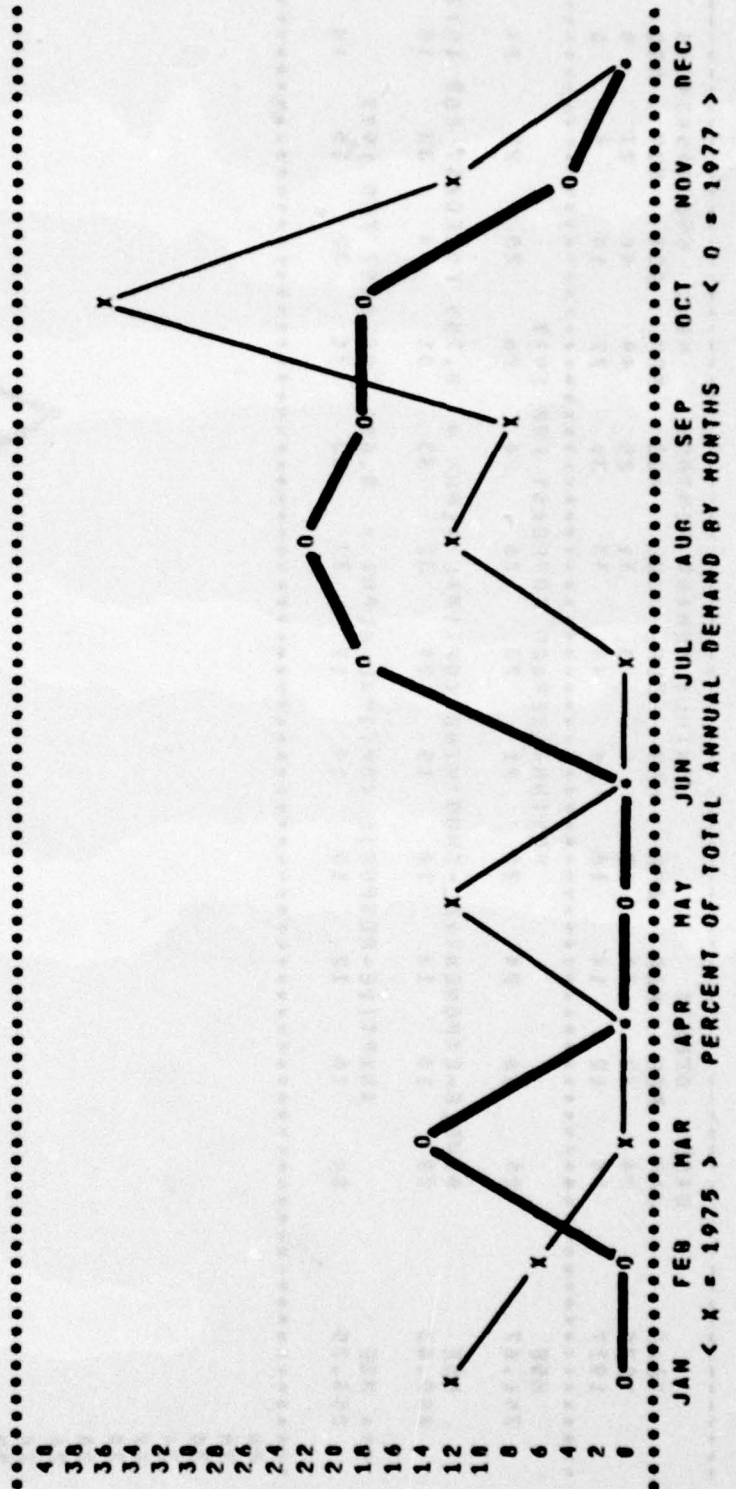
BASE1 OFFUTT		MONTHLY DEMAND HISTORY												MSM:
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975	34	43	37	22	9	3	31	25	49	46	27	9		
1977	14	12	14	16	24	48	33	38	72	14	4	8		
MSE	MOVING-AVERAGE FORECAST FOR 1977													
351.67	28	26	24	22	21	23	26	26	26	28	25	24		
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977													
489.63	28	16	13	14	15	28	32	33	31	54	33	15		
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.68> FORECAST FOR 1977													
258.75	24	16	12	13	14	17	37	33	31	32	15	14		



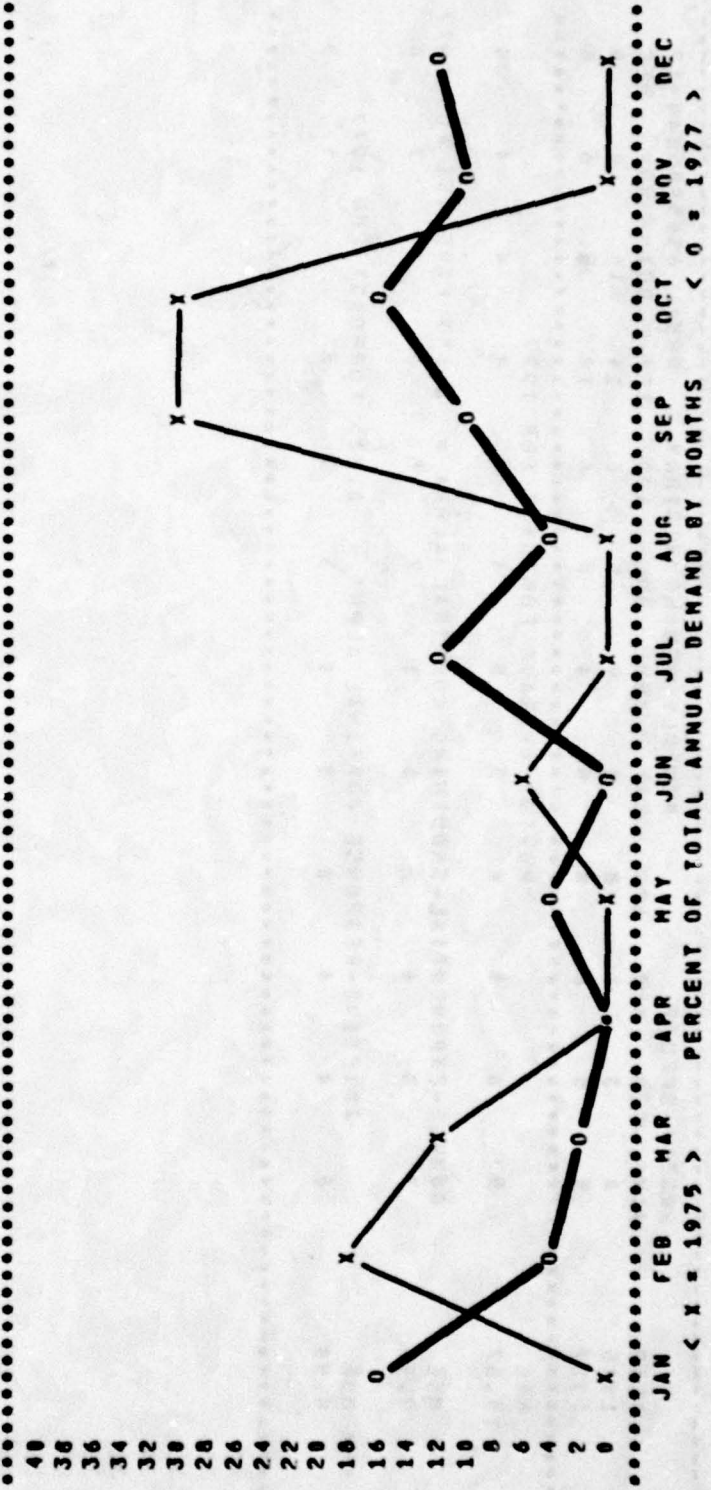
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BASE: OFFUTT          MONTHLY DEMAND HISTORY      MSN: 6505005768915
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  4    2    0    0    4    0    0    4    3   12   4    0
1977  0    0    3    0    0    0    4    5    4    4    1    0
MSE   3    2    2    3    3    2    2    3    3    3    2    2
      4.75
MOVING-AVERAGE FORECAST FOR 1977
.....
MSE   2    2    2    2    2    2    2    2    2    2    2    2
      3.92
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....
MSE   0    0    0    2    0    0    0    3    4    4    4    1
      3.50
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977
.....
-----

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BASE: OFFUTT		MONTHLY DEMAND HISTORY												NSM: 6505005790432
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DFC	
1975	0	3	2	0	0	1	0	0	5	5	0	0	0	
1977	6	2	1	0	2	0	5	2	4	6	4	5	5	
MSE	MOVING-AVERAGE FORECAST FOR 1977													
5.92	1	2	2	2	2	2	2	2	2	2	2	2	3	
*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977													
4.92	2	2	2	2	2	2	2	2	2	2	2	2	3	
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977													
6.75	0	0	0	1	1	0	0	0	3	2	2	2	4	



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 6505005R40412

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	3	1	0	6	9	5	6	14	10	0	0
1977	5	5	0	0	0	4	0	6	10	5	6	6

MSE 13.67

MOVING-AVERAGE FORECAST FOR 1977

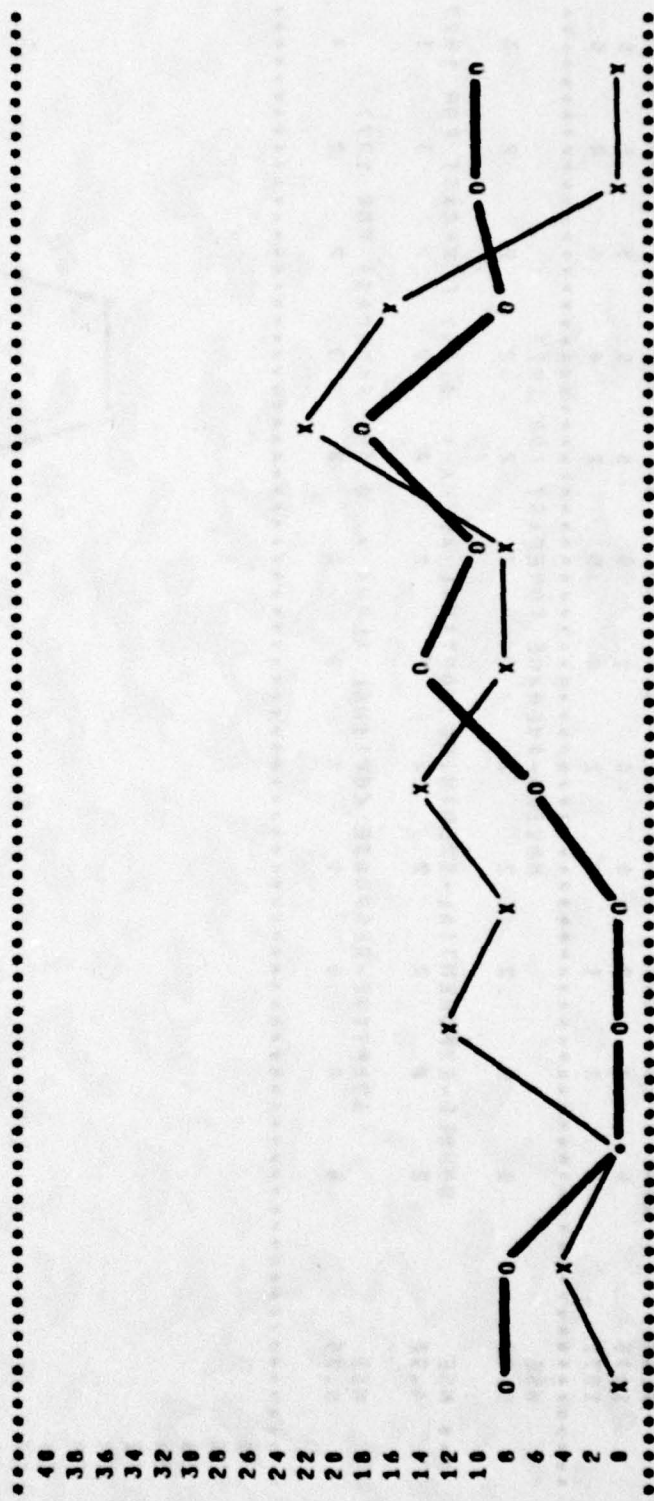
MONTH	4	5	6	7	8	9	10	11	12
FORECAST	4	4	4	4	4	4	4	4	4

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

MONTH	4	5	6	7	8	9	10	11	12
FORECAST	4	4	4	4	4	4	4	4	4

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

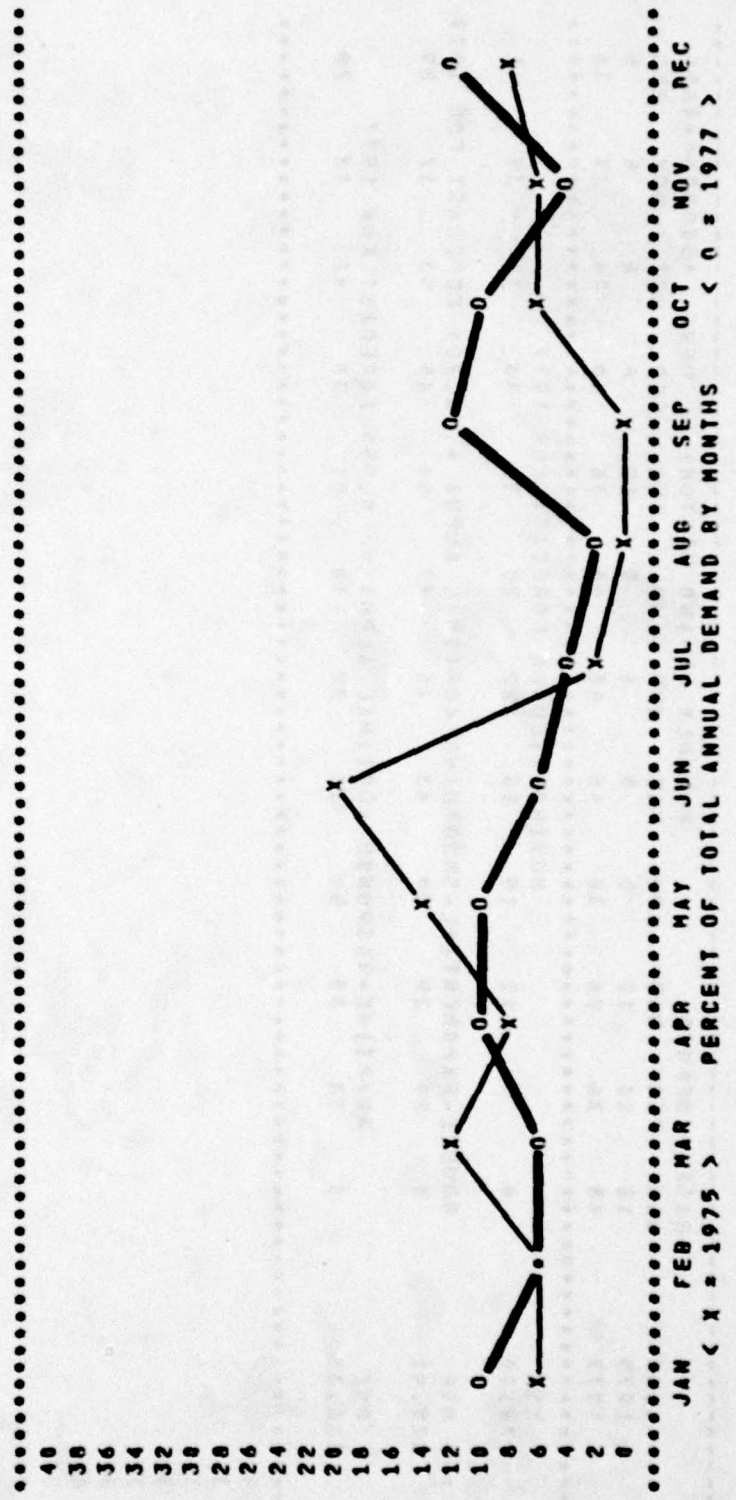
MONTH	4	5	6	7	8	9	10	11	12
FORECAST	4	4	4	4	4	4	4	4	4



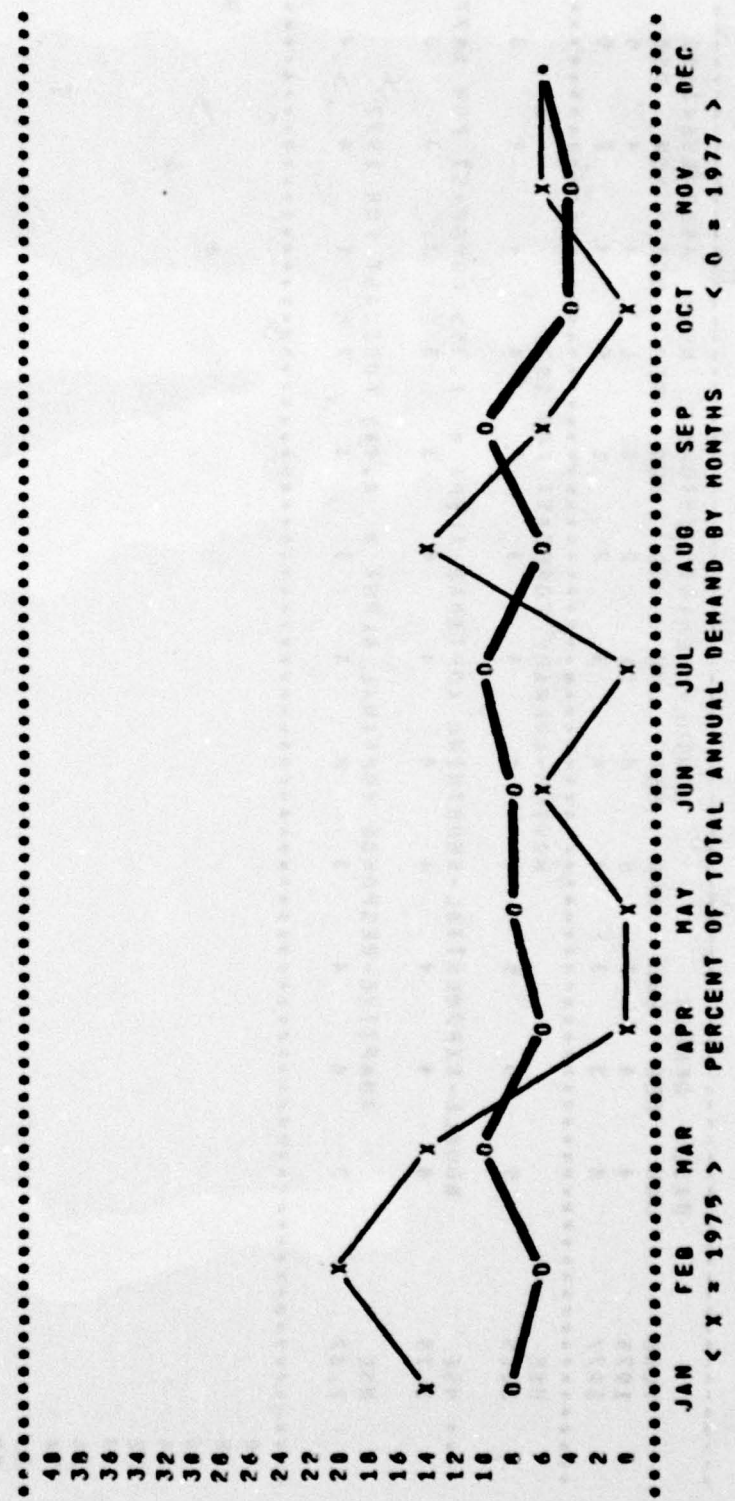
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BASE1 OFFUTT		MONTHLY DEMAND HISTORY MSN: 6505005043179											
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975		4	4	7	5	8	11	2	0	1	4	4	5
1977		4	3	3	4	4	3	2	1	5	4	2	5
MSE		MOVING-AVERAGE FORECAST FOR 1977											
2.25		5	5	5	4	4	4	3	3	3	4	4	3
...		DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977											
1.75		4	4	4	4	4	4	4	3	3	3	3	3
MSE		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.48> FORECAST FOR 1977											
2.67		3	4	4	3	2	3	3	3	2	1	4	4

.....



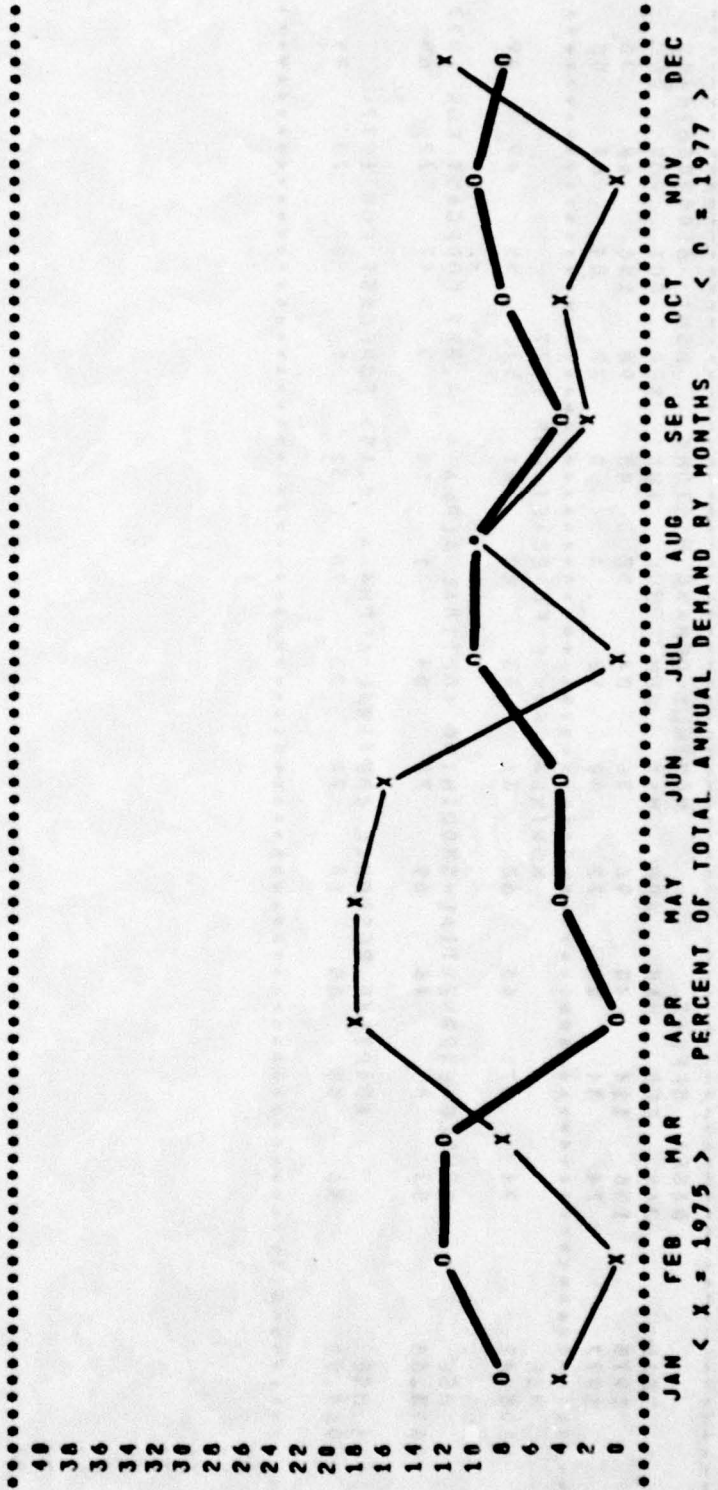
BASE1 OFFUTT												
MONTHLY DEMAND HISTORY												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	16	12	0	0	6	0	12	6	0	6	6
1977	48	36	60	36	48	48	60	36	60	24	24	36
MSE	6	9	11	15	18	22	26	31	33	37	39	41
MOVING-AVERAGE FORECAST FOR 1977												
.....												
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977												
MSE	5	29	35	49	43	45	47	54	45	53	37	29
.....												
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977												
MSE	6	33	35	59	36	38	40	51	38	40	38	28
.....												



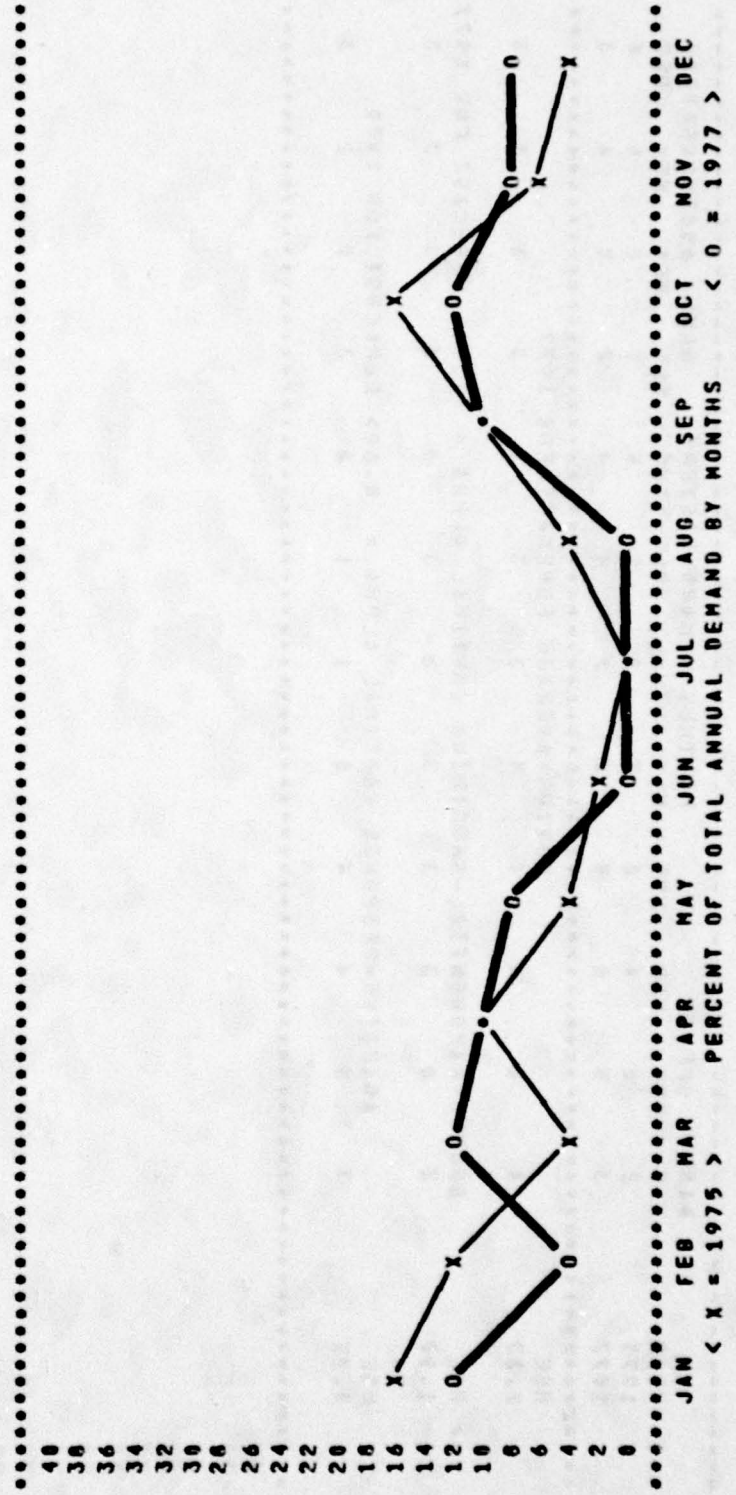
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.....
BASE1 OFFUTT MONTHLY DEMAND HISTORY MSN: 6505006007352
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1977 2 0 4 4 8 7 0 5 1 2 0 6
3 5 5 0 2 2 4 4 2 3 4 3
MSE .....
2.33 4 4 4 4 4 3 3 3 3 3 3
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
3 3 3 3 3 3 3 3 3 3 3 3
MSE .....
3.75 3 4 4 0 1 1 2 3 2 2 3
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977
3 3 4 4 0 1 1 2 3 2 2 3
.....

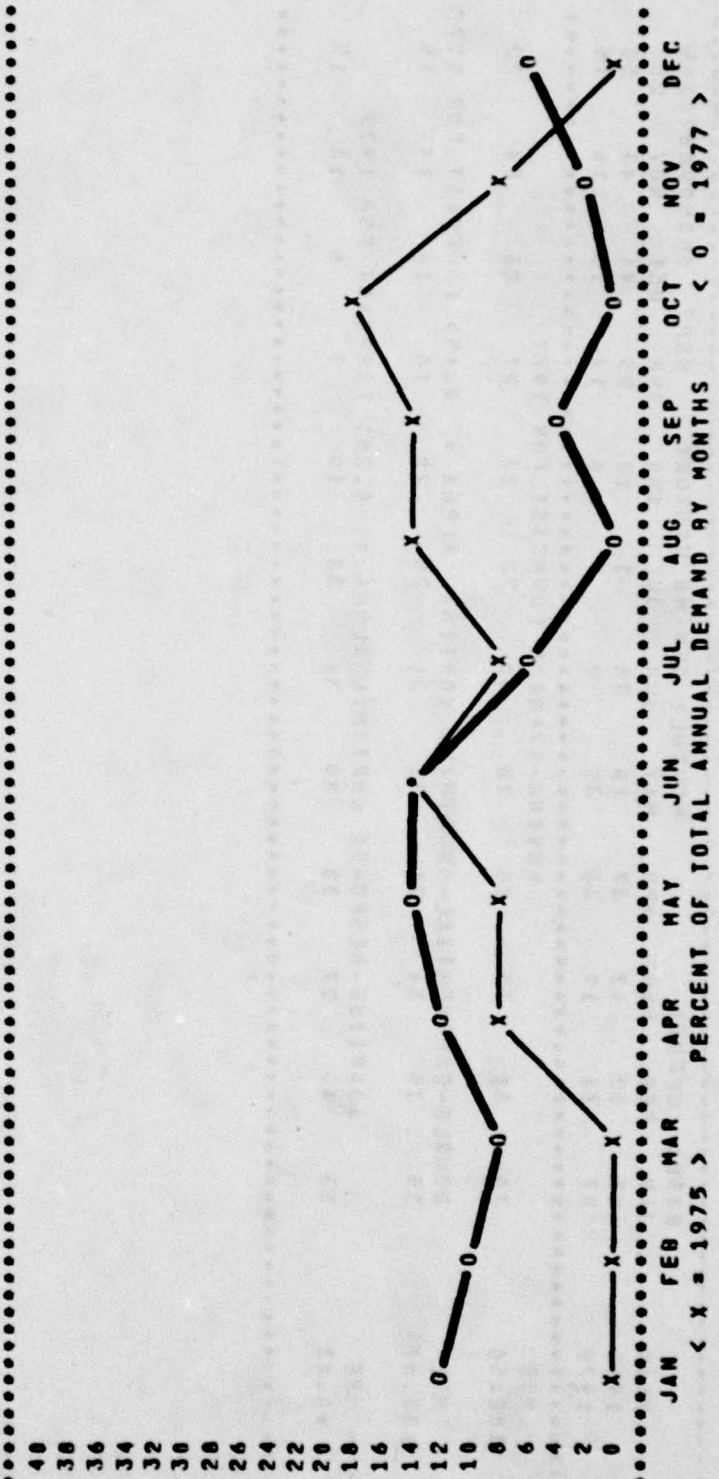
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BASE1 OFFUTT		MONTHLY DEMAND HISTORY												NSM: 6505006874482
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975		156	114	48	96	36	24	12	48	96	156	68	36	
1977		74	34	84	72	60	12	0	0	72	84	68	58	
MSE		74	67	60	63	61	63	62	61	57	55	49	49	
		MOVING-AVERAGE FORECAST FOR 1977												
MSE		DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977												
1893.66		53	65	46	69	72	64	31	10	3	47	72	65	
		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977												
908.92		58	53	65	60	74	73	70	32	1	0	70	81	

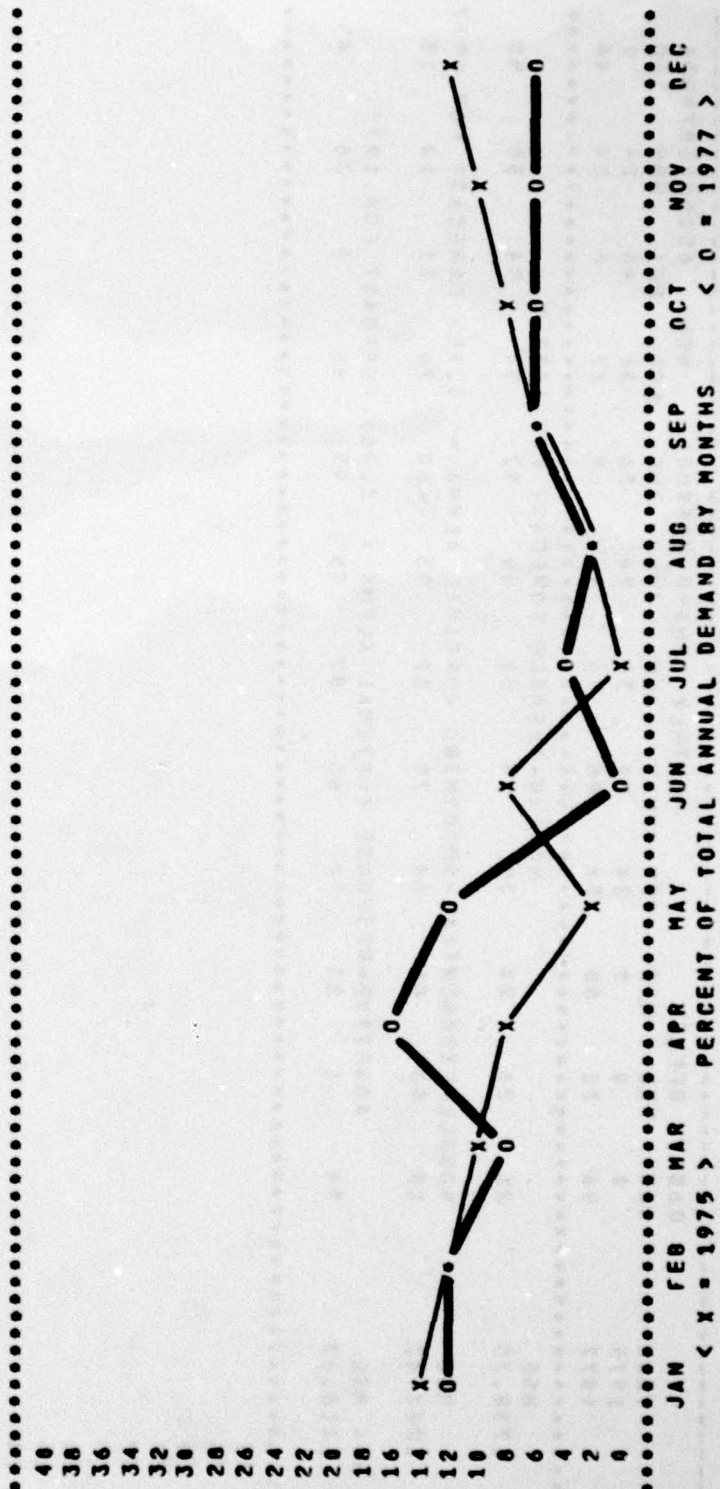


BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSN: 6505006674534
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975		0	0	0	24	24	36	24	36	36	48	24	0	
1977		66	72	68	84	96	96	48	0	37	0	24	48	
MSE		MOVING-AVERAGE FORECAST FOR 1977												
1738.75		21	28	34	39	44	50	55	57	54	54	50	50	
MSE		DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977												
1260.42		14	53	66	64	75	87	93	68	20	31	14	10	
MSE		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977												
1016.83		24	1	85	72	65	83	95	95	48	0	36	4	



BASE1 OFFUTT		MONTHLY DEMAND HISTORY												NSM: 6505006070205		
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
1975		62	52	42	37	10	30	1	10	25	41	43	50			
1977		27	31	19	30	31	2	9	6	14	17	16	15			
MSE		34	31	30	28	20	30	27	27	27	26	24	22			

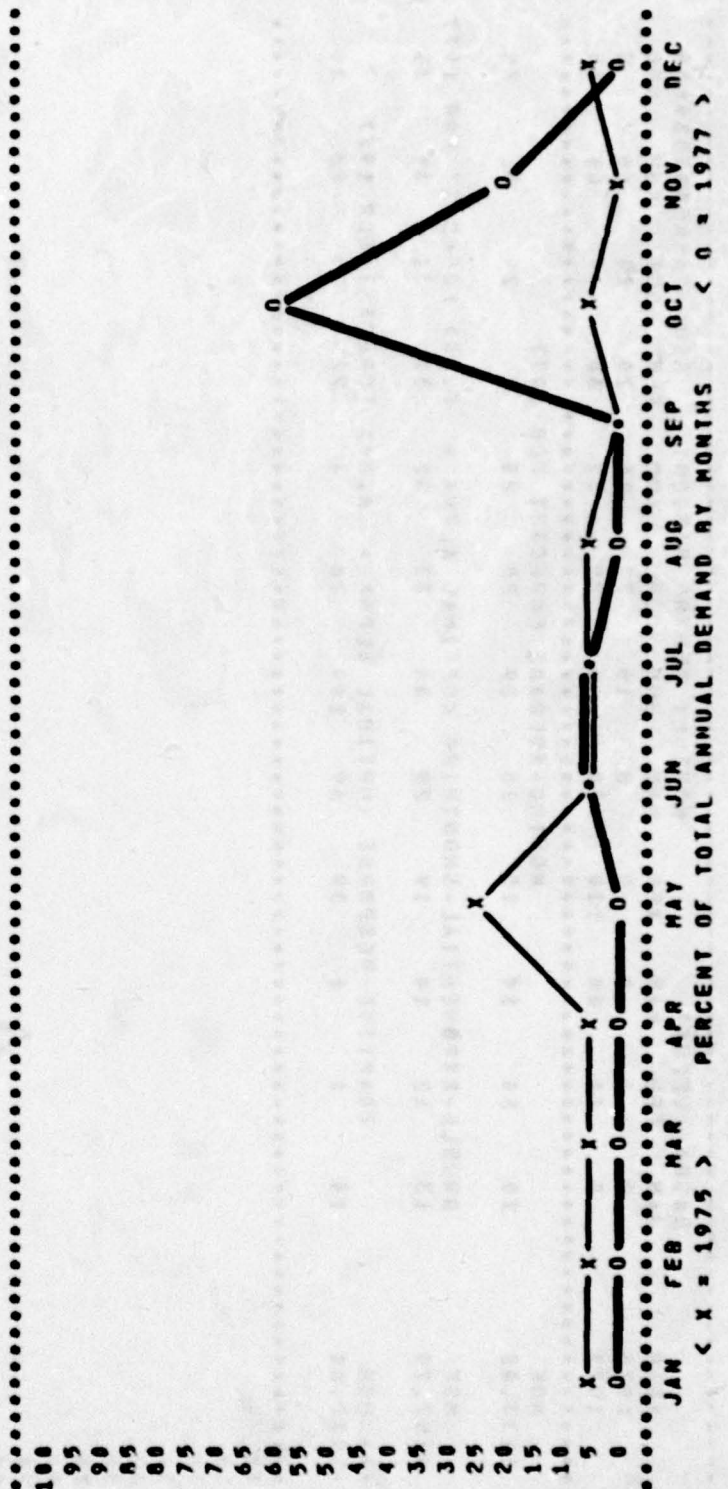
.....  
 MOVING-AVERAGE FORECAST FOR 1977  
 .....  
 MSE 102.50  
 .....  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977  
 MSE 130.67  
 .....  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977  
 MSE 96.00



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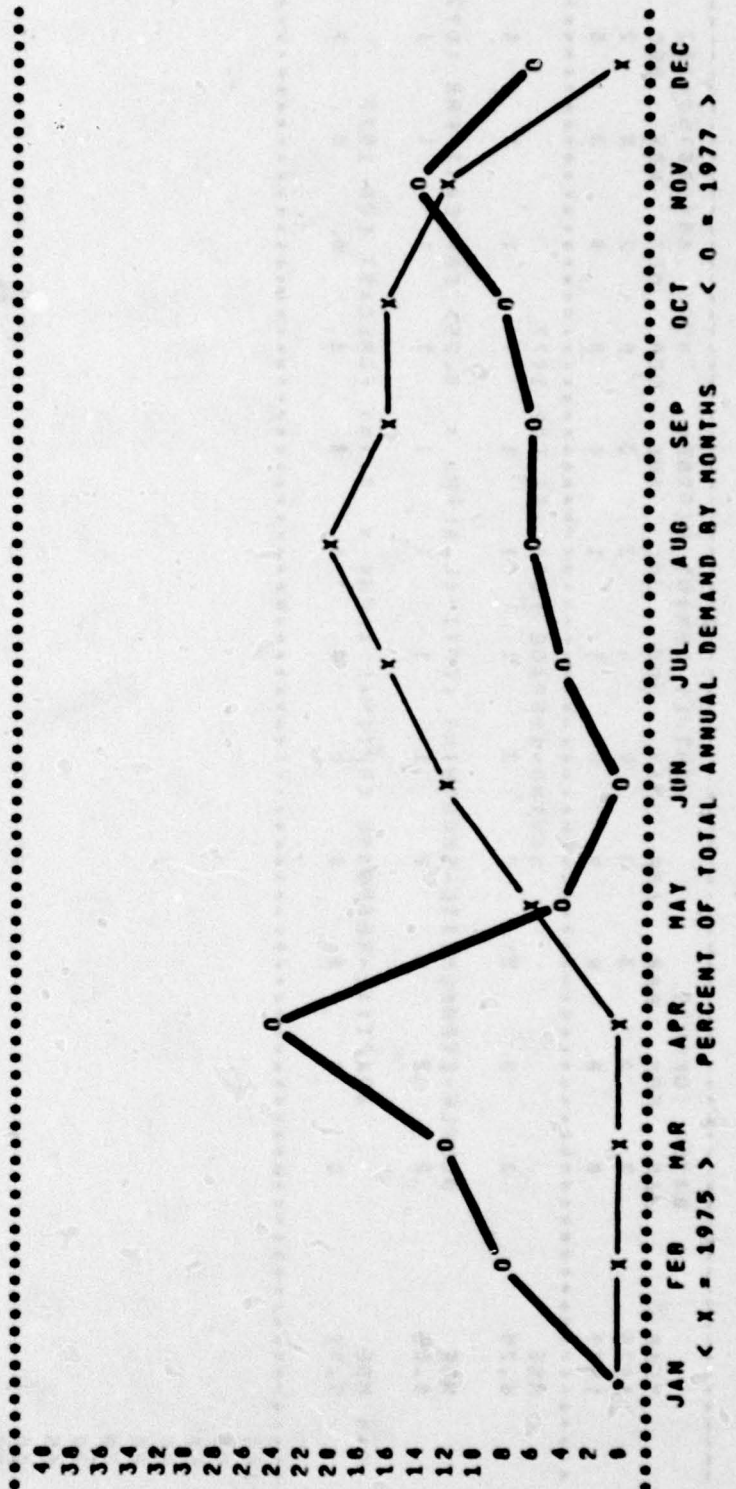
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BASE1 OFFUTT          MONTHLY DEMAND HISTORY  MSN: 6505007534773
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975   3    2    3    3    9    3    2    3    0    2    0    2
1977   0    0    0    0    0    1    1    0    0    0    3    0
MSE    6.75   3    2    2    2    2    1    1    1    1    1    1
MOVING-AVERAGE FORECAST FOR 1977
.....
MSE    6.00   2    2    2    2    1    1    1    1    1    1    1
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977
.....
MSE    5.92   0    0    0    0    0    0    0    0    0    0    0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
.....

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YEAR	MONTHLY DEMAND HISTORY												MSN: 6505007539609
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	0	0	0	2	0	15	20	25	20	20	15	0	
1977	0	40	60	110	20	0	25	30	30	40	65	35	
MSE	MOVING-AVERAGE FORECAST FOR 1977												
1133.00	10	10	14	19	28	29	28	28	28	29	31	35	

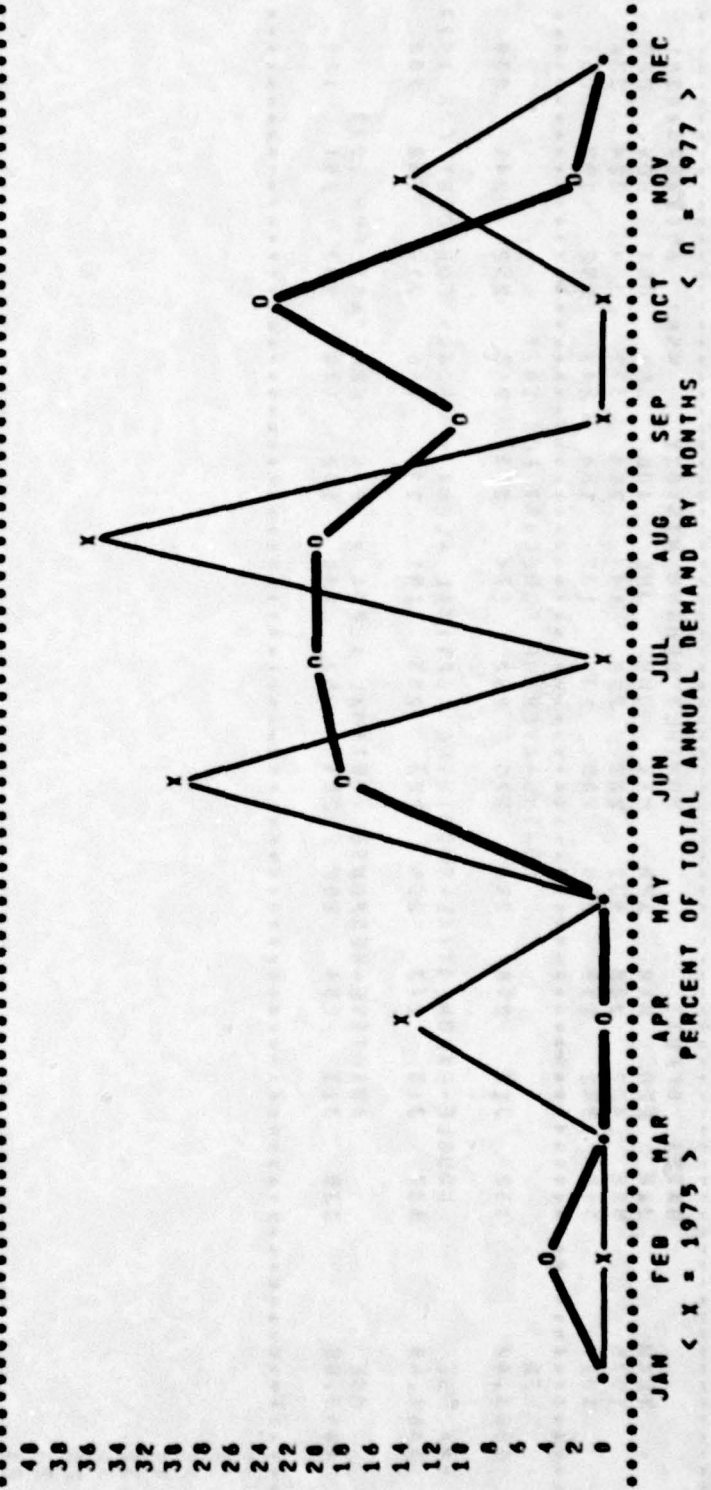
MSE 13 12 14 19 29 34 33 32 31 31 31 35  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977  
 MSE 14 0 0 39 59 109 20 4 22 25 20 39  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977



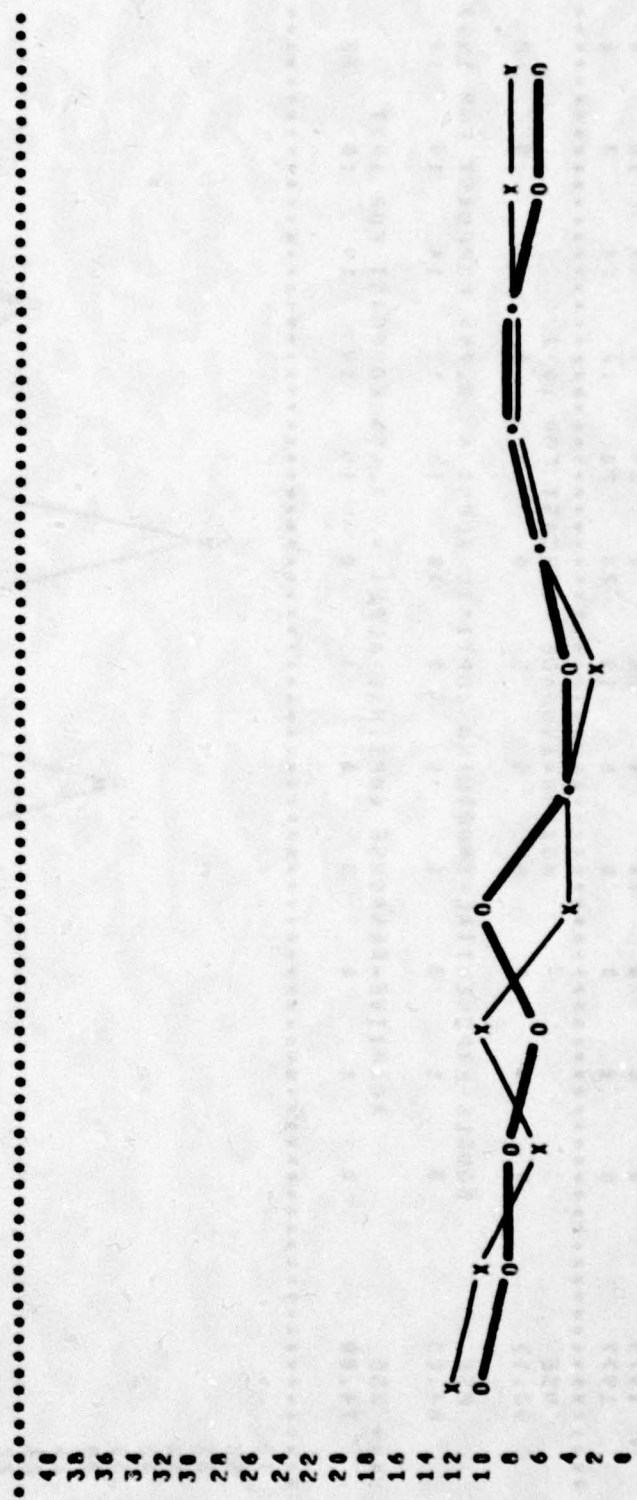
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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505007540076
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
      1977 0 0 0 10 0 20 0 24 1 0 10 0
          0 4 0 0 0 18 20 20 10 24 3 0
MSE 93.17 5 5 6 6 5 5 5 6 6 7 9 0
          MOVING-AVERAGE FORECAST FOR 1977
MSE 84.25 3 1 3 1 0 0 10 16 19 14 19 10
          DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977
MSE 74.00 0 0 0 3 0 0 0 15 19 19 10 23
          ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
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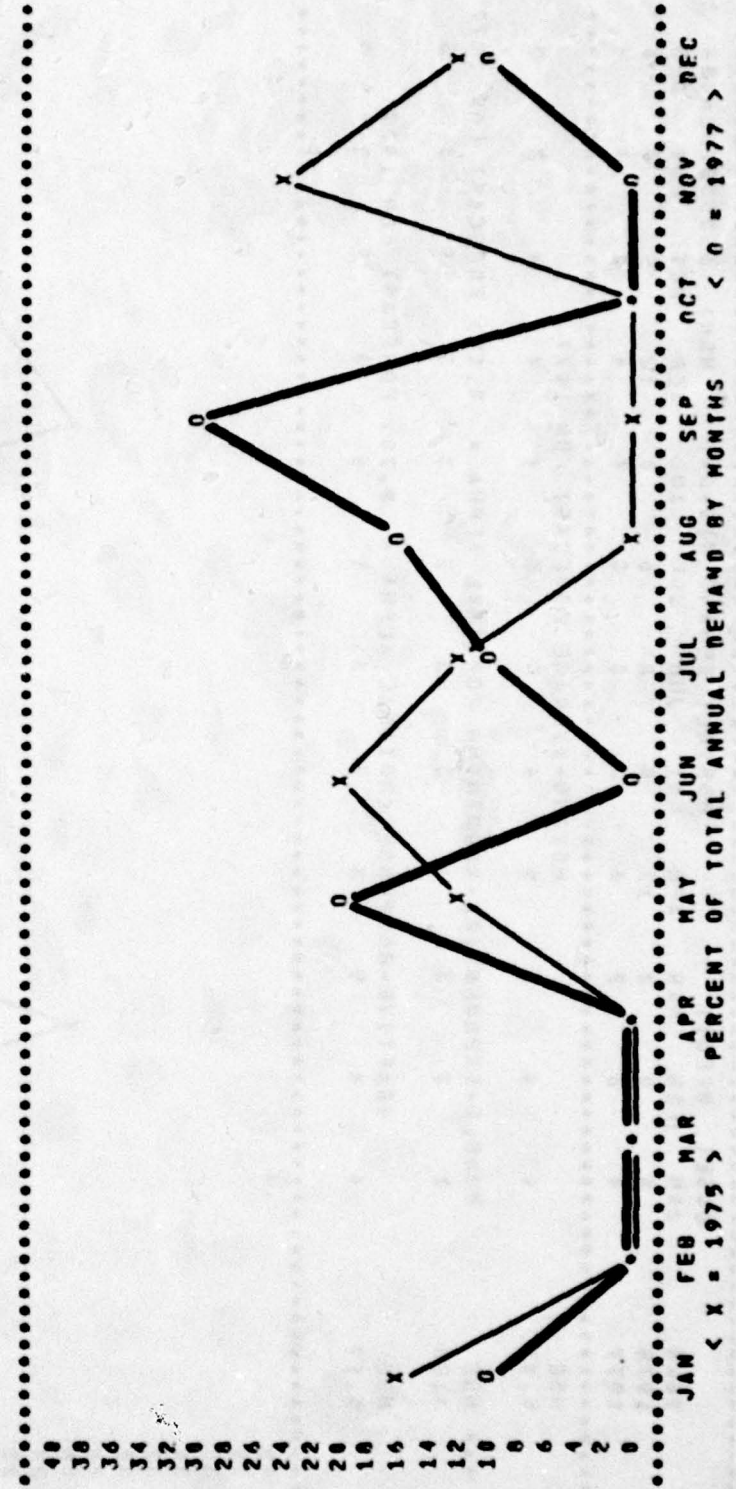
BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM: 6505007540381		
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SEP	OCT	NOV	DEC
1975	520	432	208	432	222	220	144	294	372	384	324	336	372	384	324	336
1977	300	252	252	204	200	132	132	180	248	252	180	204	248	252	180	204
MSE	MOVING-AVERAGE FORECAST FOR 1977															
5004.42	332	313	290	295	276	282	274	273	263	252	241	230	263	252	241	230
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977															
3606.65	337	313	273	258	223	263	181	146	166	214	240	200	166	214	240	200
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977															
4003.00	335	313	254	252	204	207	140	132	170	237	251	180	170	237	251	180



PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

BASE: OFFUTY		MONTHLY DEMAND HISTORY												MSN: 4505007643340
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975	48	0	0	0	36	60	36	0	0	0	72	36		
1977	12	0	0	0	24	0	12	20	36	0	0	12		
MSE	MOVING-AVERAGE FORECAST FOR 1977													
251.92	24	21	21	21	21	20	15	13	15	18	18	12		
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977													
184.92	16	17	17	17	17	17	17	17	17	17	17	17		
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977													
174.00	23	47	44	19	3	0	21	13	12	15	20	3		



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 65050070264A4

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	12	0	0	6	8	12	9	6	0
1977	4	6	2	6	3	0	0	4	4	2	4	4

MSE 5.92

MOVING-AVERAGE FORECAST FOR 1977

PERIOD	1	2	3	4	5
FORECAST	4	4	5	4	4

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

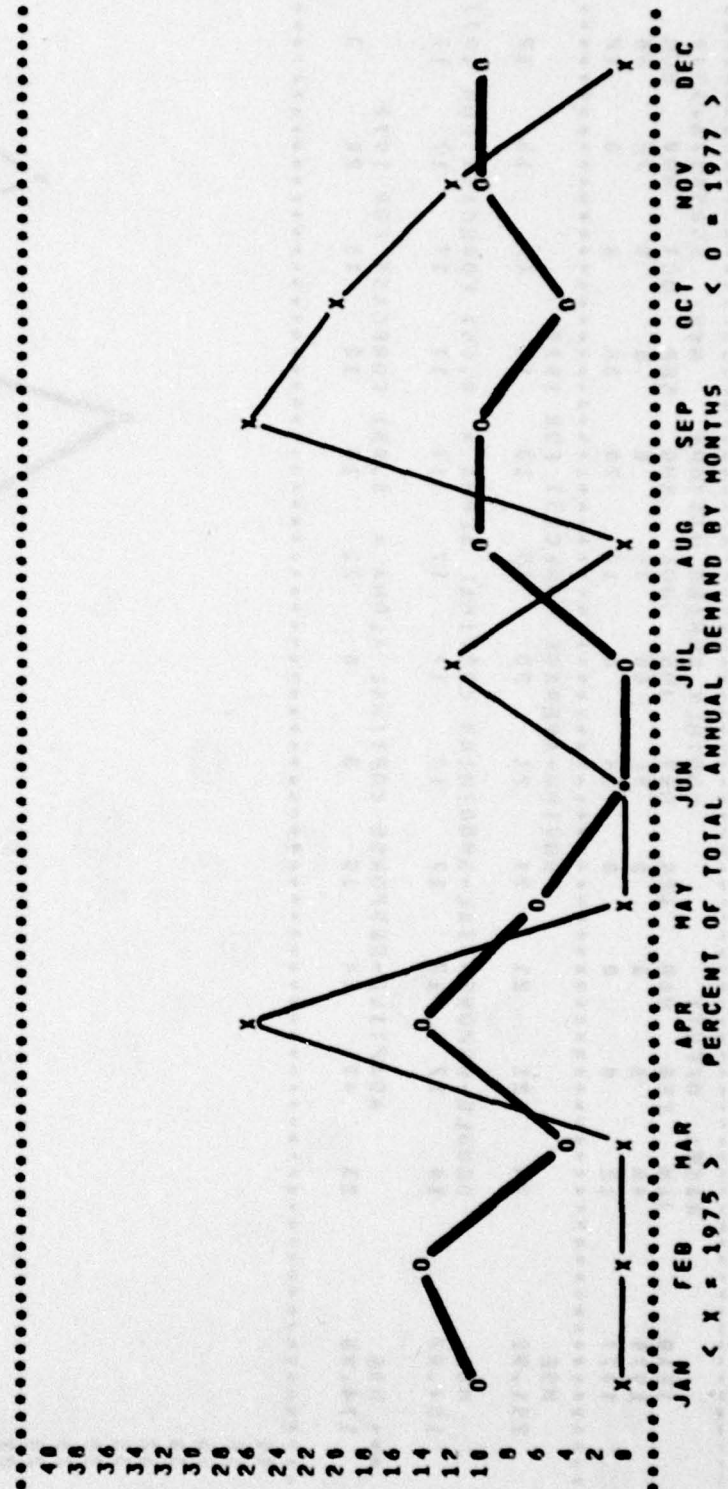
PERIOD	1	2	3	4	5
FORECAST	2	3	3	3	3

MSE 3.83

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977

PERIOD	1	2	3	4	5
FORECAST	4	4	5	3	3

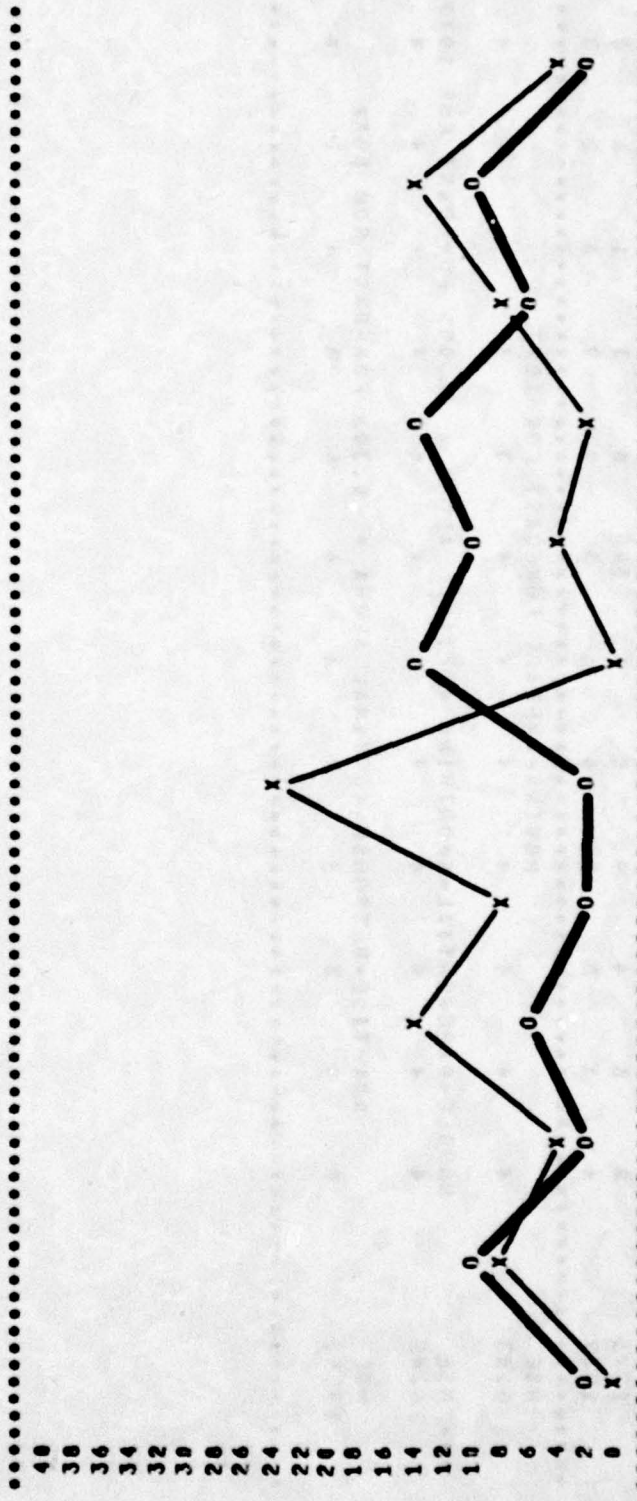
MSE 5.17



YEAR	MONTHLY DEMAND HISTORY												HSM: 650500702651A
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	0	4	2	6	4	10	0	2	1	4	6	2	
1977	1	3	1	2	1	1	4	3	4	2	3	1	
MSE	MOVING-AVERAGE FORECAST FOR 1977												
2.42	3	4	3	3	3	3	2	2	2	3	3	2	

\*\*\* MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977

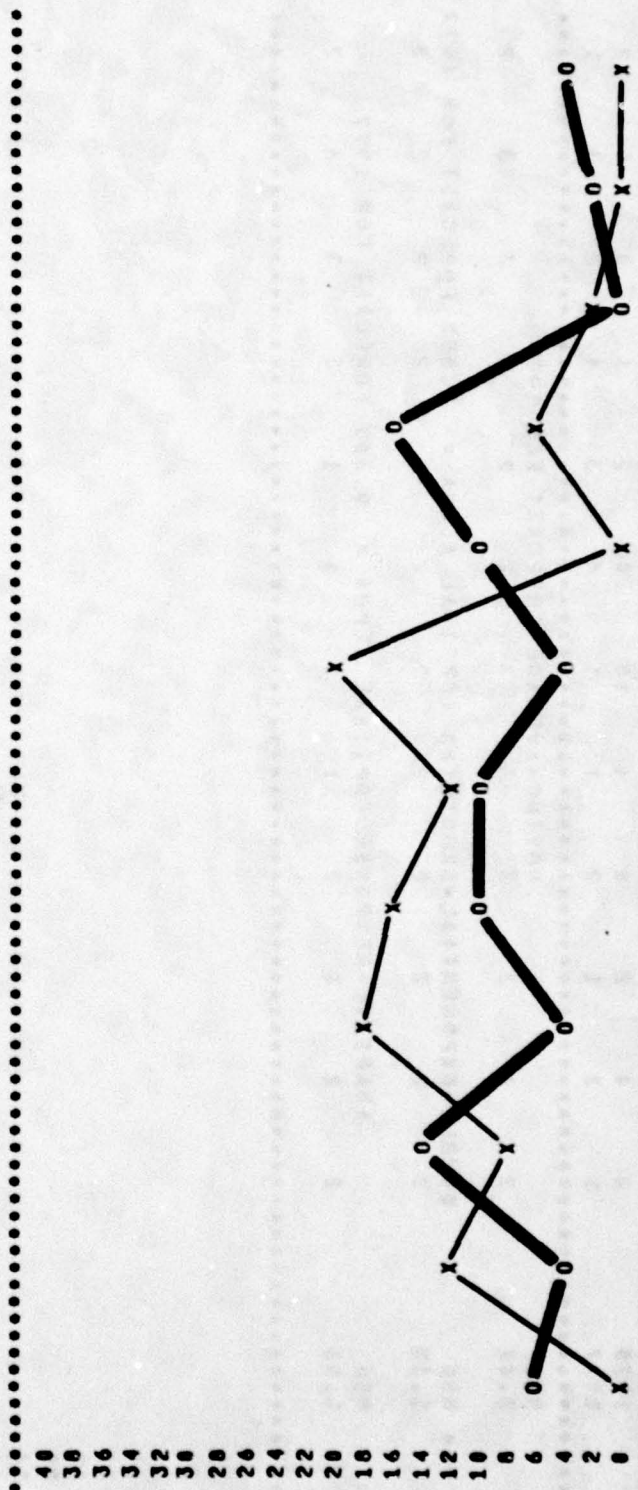


< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

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.....
BASE1 OFFUTT MONTHLY DEMAND HISTORY MSN: 6505000090241
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1977 4 3 8 3 6 6 3 6 9 0 2 3
MSE 6.83 4 4 4 4 4 4 4 3 4 4 4 4
MOVING-AVERAGE FORECAST FOR 1977
.....
... MSE 6.42 4 4 4 4 4 4 4 4 4 4 4 4
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
MSE 13.50 0 0 3 3 7 3 4 5 3 4 4 7 0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977
.....

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.....
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >
.....

```

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	224	324	216	155	204	71	72	116	138	168	228	72
1977	188	72	54	56	48	38	42	36	81	48	58	88

MSI OFFUTT MSN: 6505000694177

MONTHLY DEMAND HISTORY

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	100	105	78	50	56	50	40	42	37	73	53	57
1977	166	156	135	122	113	100	98	95	88	84	74	59

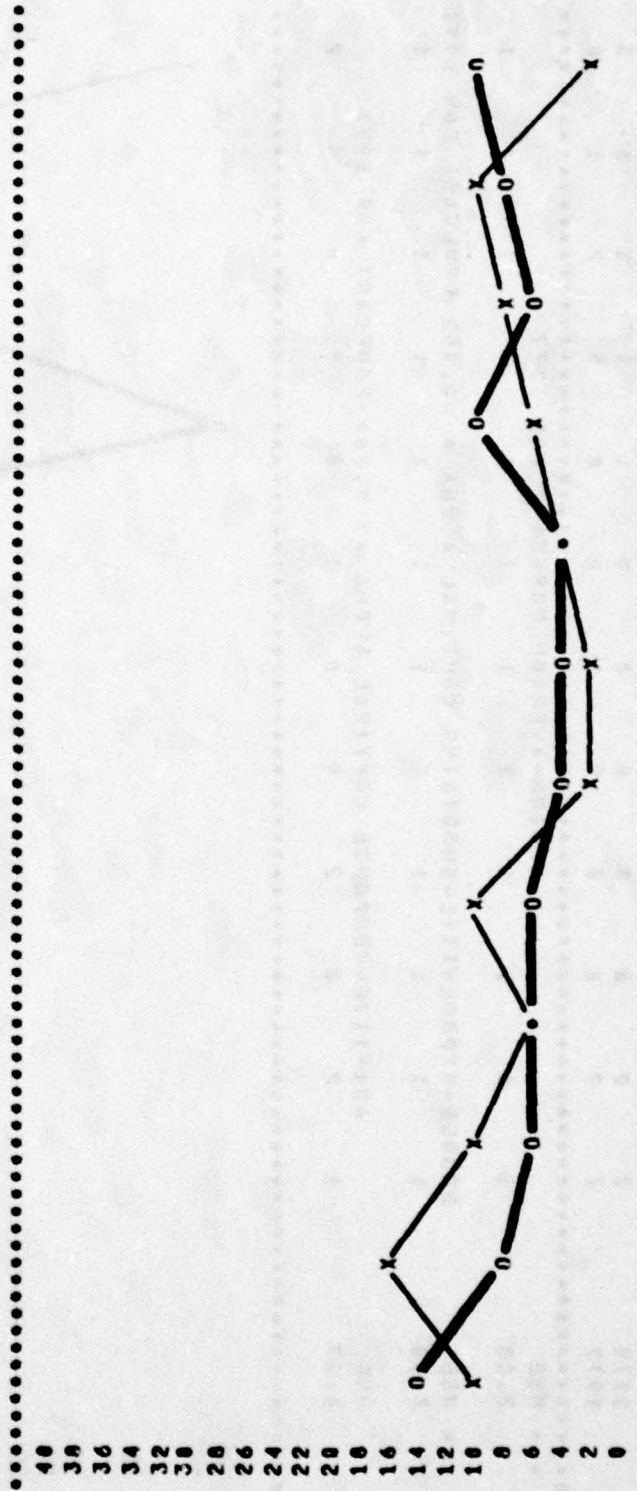
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	100	105	78	50	56	50	40	42	37	73	53	57
1977	166	156	135	122	113	100	98	95	88	84	74	59

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977

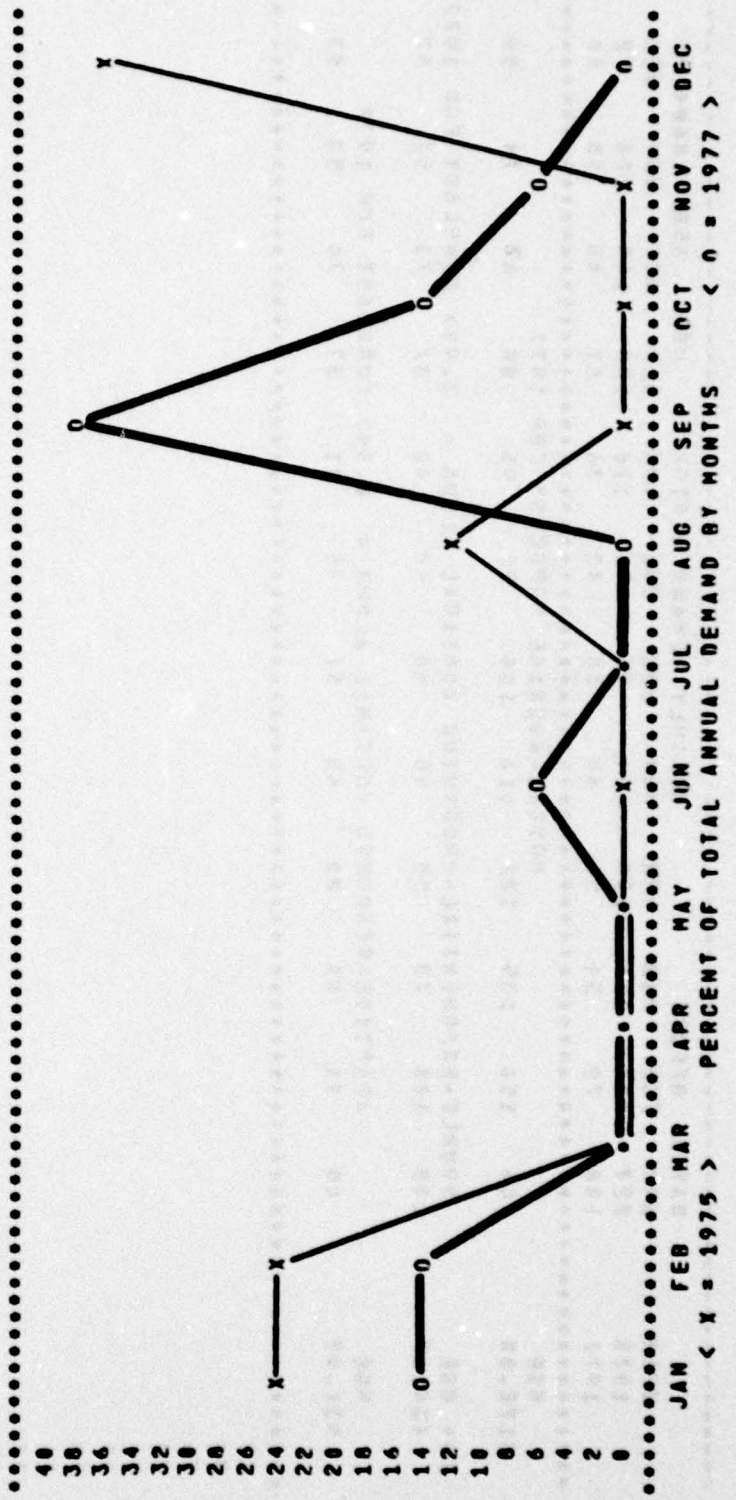
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	100	105	78	50	56	50	40	42	37	73	53	57
1977	166	156	135	122	113	100	98	95	88	84	74	59



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BASE1 OFFUTT MONTHLY DEMAND HISTORY NSM: 65050007103A7
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 2 2 0 0 0 0 1 0 0 0 0 3
1977 2 2 0 0 0 1 0 0 5 2 1 0
*** MSE
2.00 1 1 1 1 1 1 1 1 1 1 1
*** MSE
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
1 1 1 1 1 1 1 1 1 1 1 1
*** MSE
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977
2.67 1 2 2 2 0 0 0 0 0 0 4 2
-----

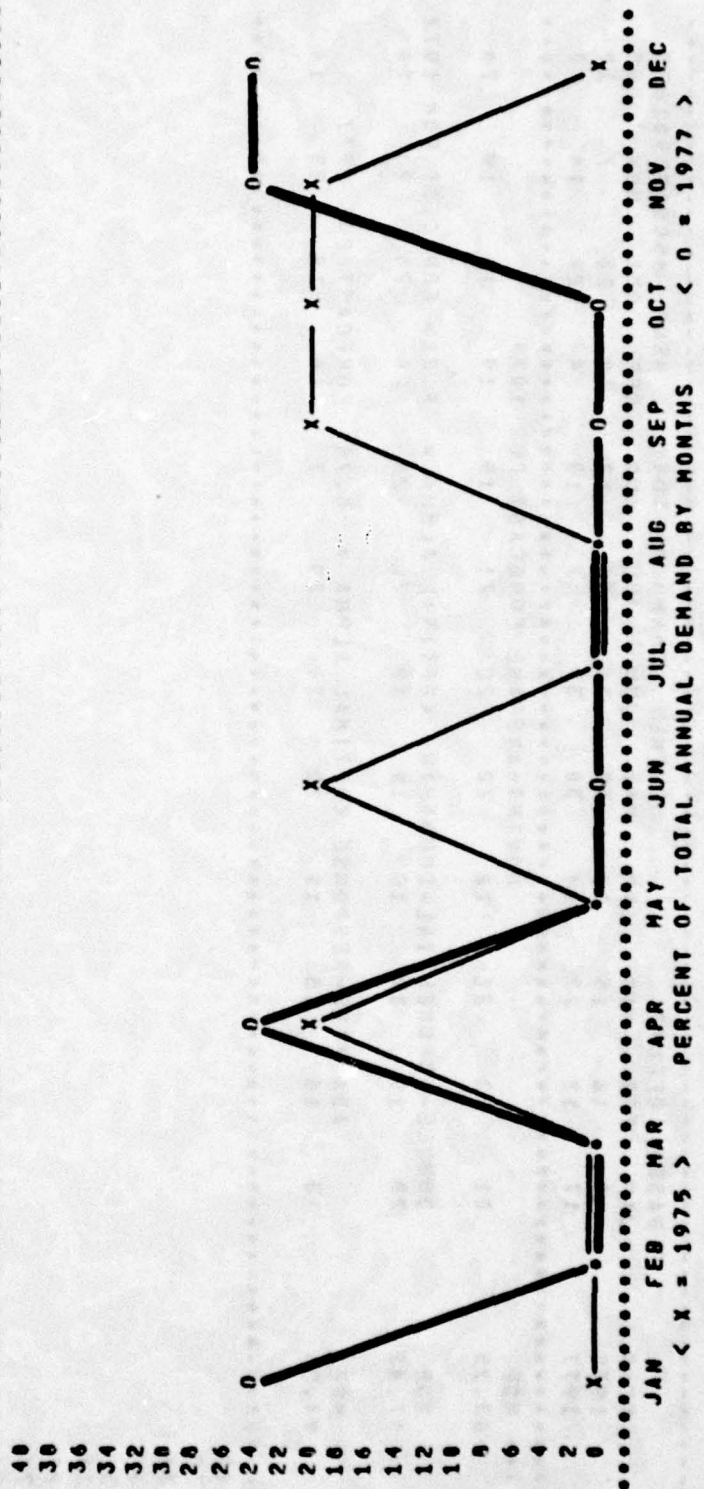
```



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BASE: OFFUTT MONTHLY DEMAND HISTORY NSM: 6505000767239
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  0    0    0    1    0    1    0    0    1    1    1    0
1977  1    0    0    1    0    0    0    0    0    0    1    1
MSE   0    1    1    1    1    1    0    0    0    0    0    0
      0.58
MSE   0    0    0    0    0    0    0    0    0    0    0    0
      0.33
MSE   0    0    0    0    0    0    0    0    0    0    0    0
      0.25
-----
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
0    0    0    0    0    0    0    0    0    0    0    0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
0    0    0    0    0    0    0    0    0    0    0    1
-----

```



BASE: OFFUTT MSN: 6505000901633

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	16	15	27	30	36	36	12	30	20	7	12
1977	17	12	22	24	30	30	7	18	24	29	14	7

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	21	22	21	22	22	22	21	19	19	19	19	20

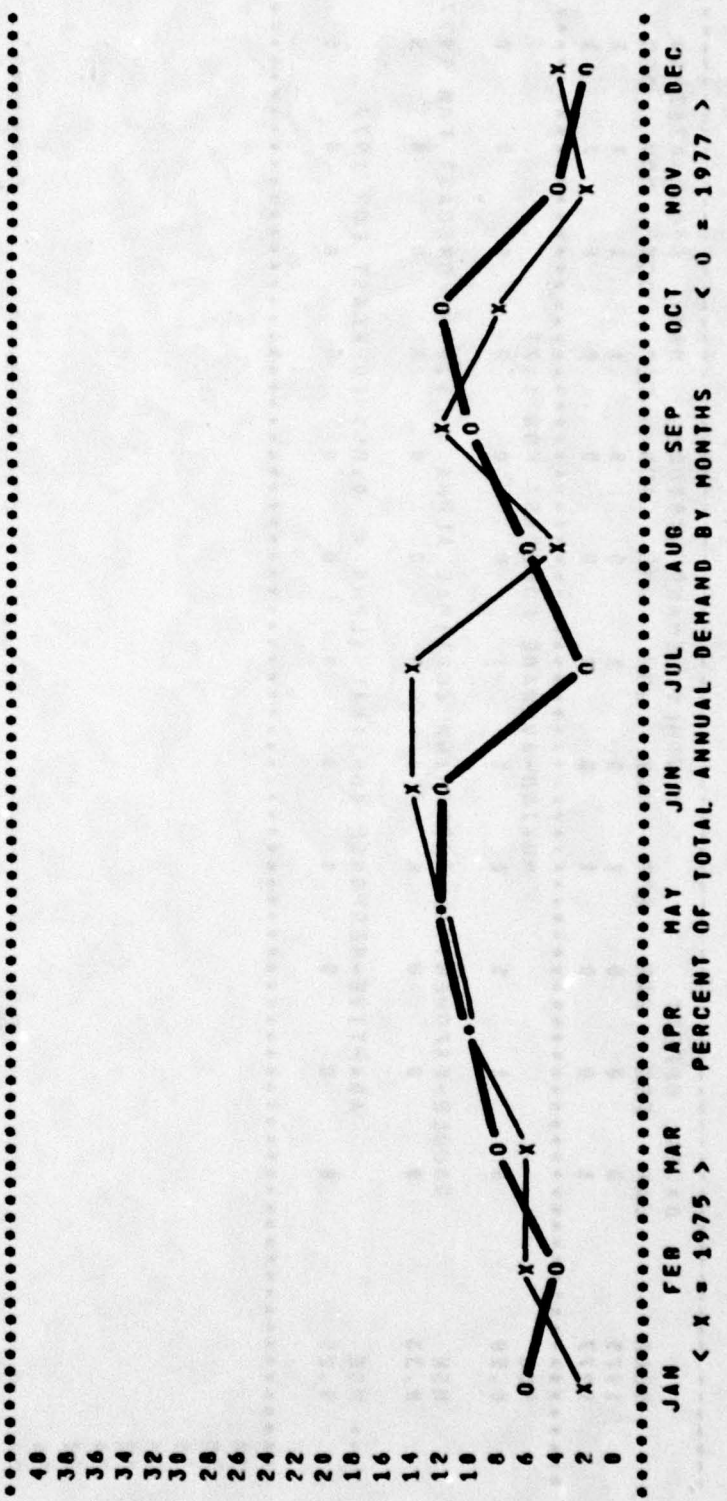
MSE 63.75

MSE 67.42

MSE 94.25

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977



BASE: OFFUTT MSN: 6505000901726

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	3	0	0	0	0	0	8	3	5	4	2
1977	2	3	0	0	0	0	3	4	3	5	0	0

MSE

MSE	3	3	3	3	3	2	3	2	2	2	2	2
-----	---	---	---	---	---	---	---	---	---	---	---	---

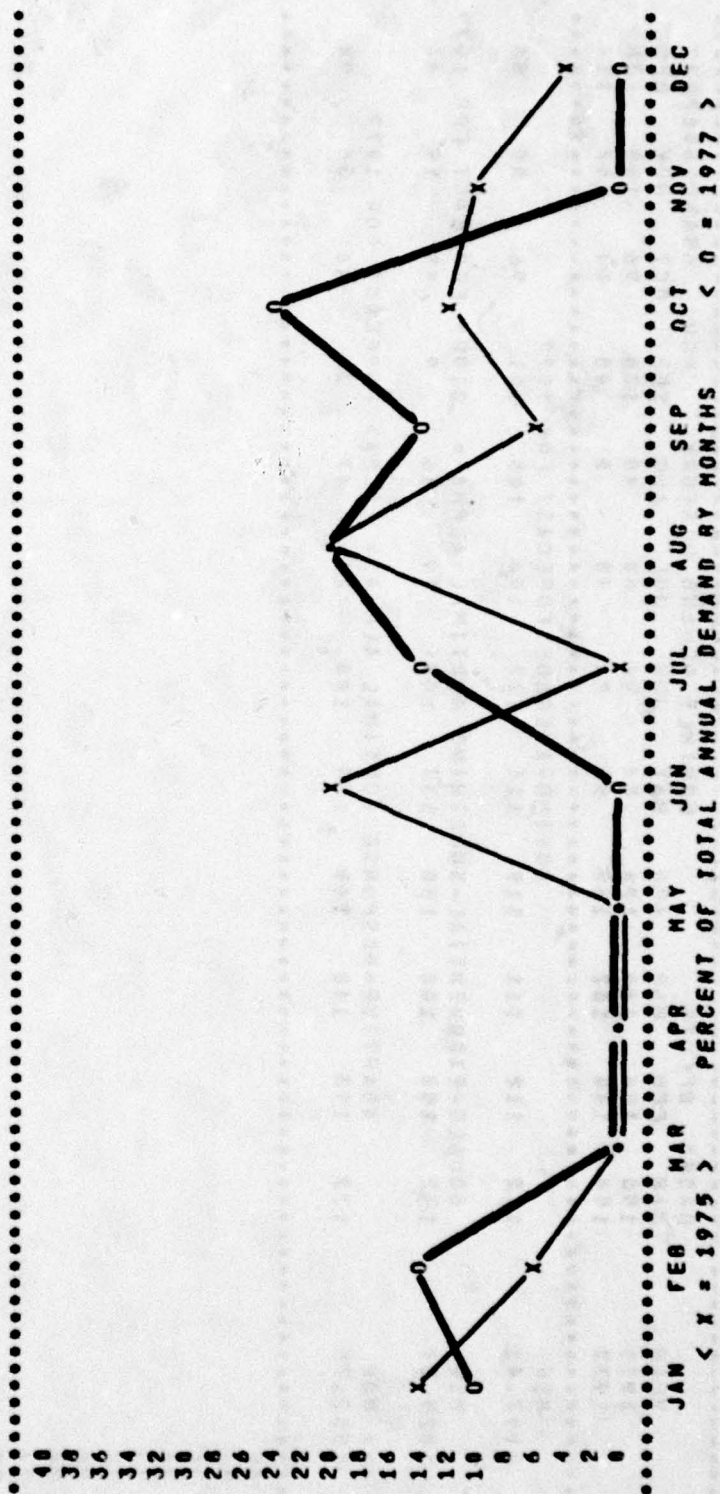
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

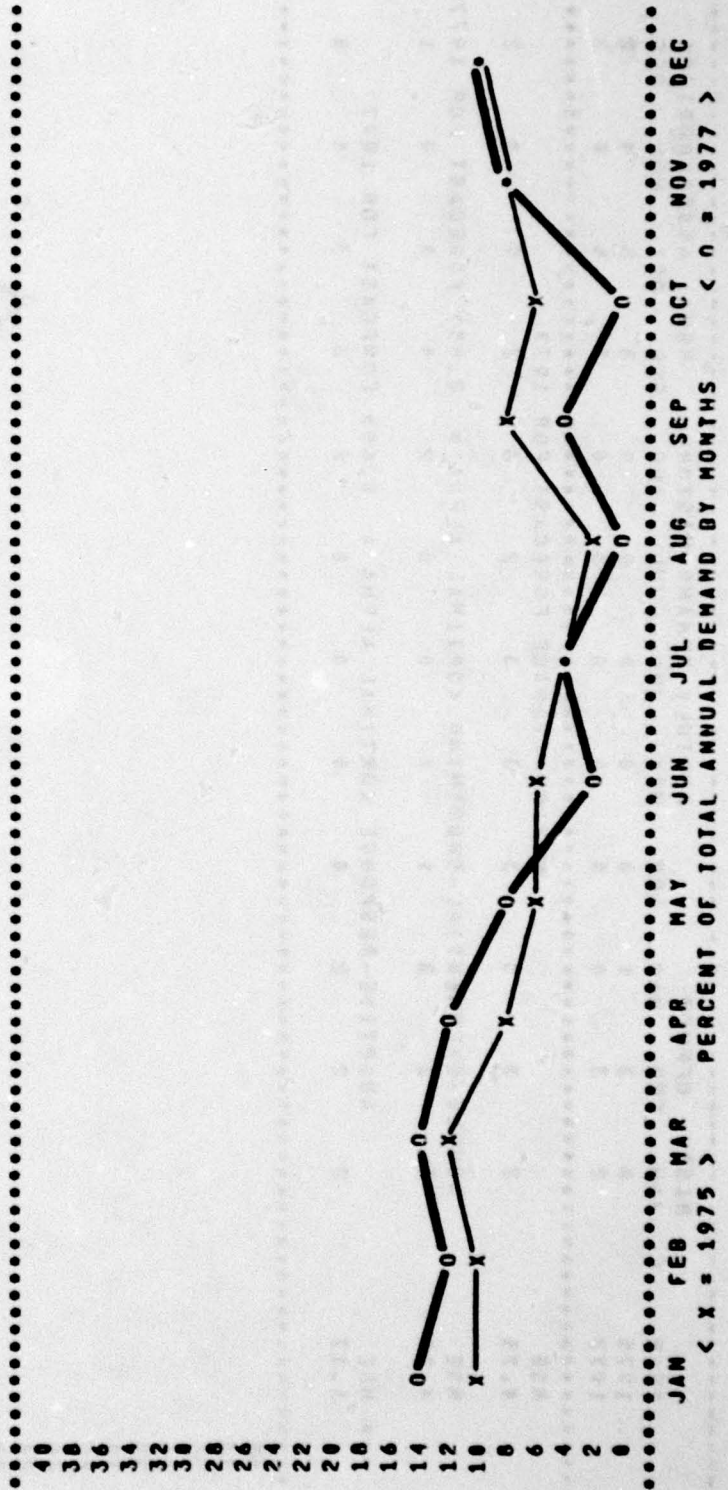
MSE	3	2	3	1	0	0	0	2	4	3	4	1
-----	---	---	---	---	---	---	---	---	---	---	---	---

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

MSE	3.17	2	2	0	0	0	0	2	3	3	4	0
-----	------	---	---	---	---	---	---	---	---	---	---	---



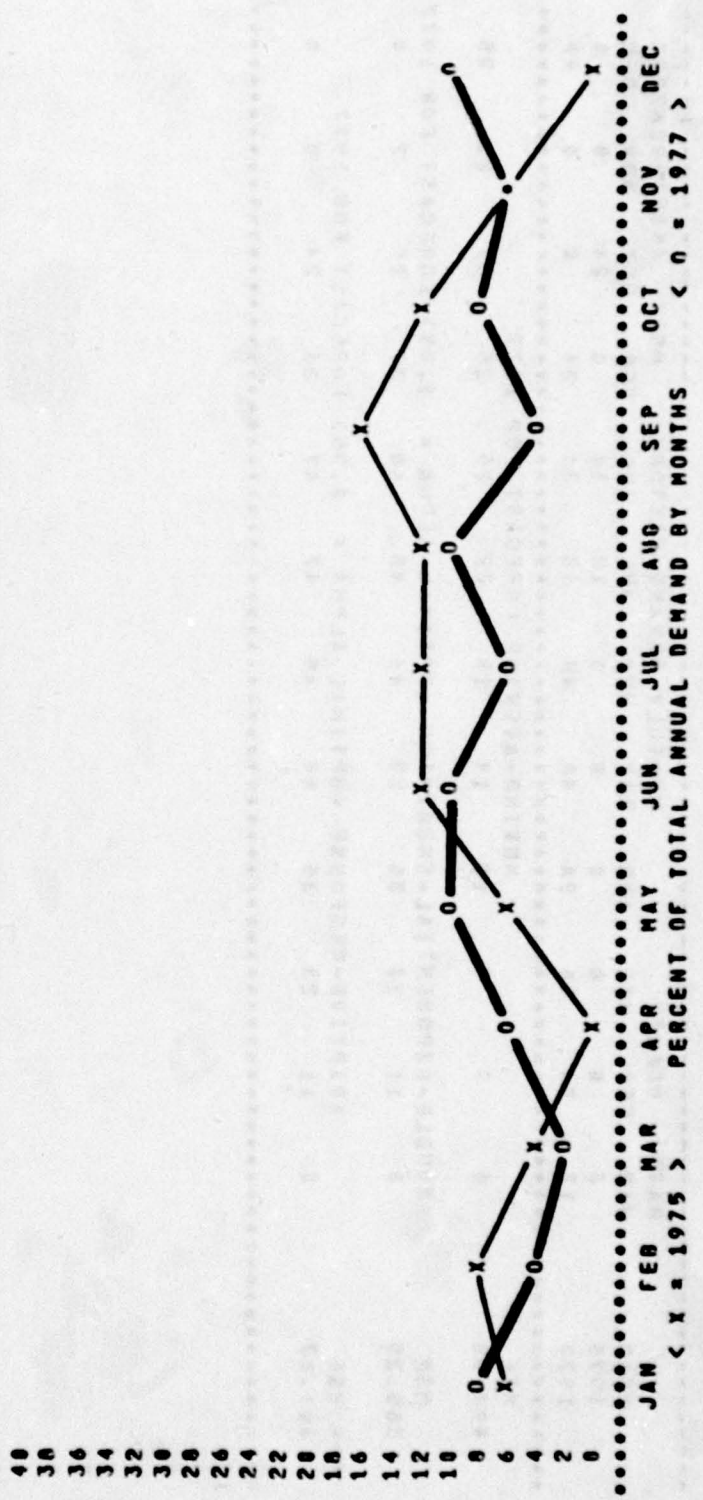
-----												
BASE: OFFUTT												
MONTHLY DEMAND HISTORY MSN: 4505000902027												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	156	156	168	126	84	96	60	48	188	96	188	138
1977	154	148	162	132	96	24	48	0	48	14	182	114
.....												
MSE	MOVING-AVERAGE FORECAST FOR 1977											
3197.42	112	112	111	110	111	112	106	105	101	96	89	88
.....												
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.98> FORECAST FOR 1977											
1825.39	132	150	142	158	137	104	39	46	0	48	19	86
.....												
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977											
1567.75	127	153	140	149	134	188	26	47	35	46	36	94
.....												



```

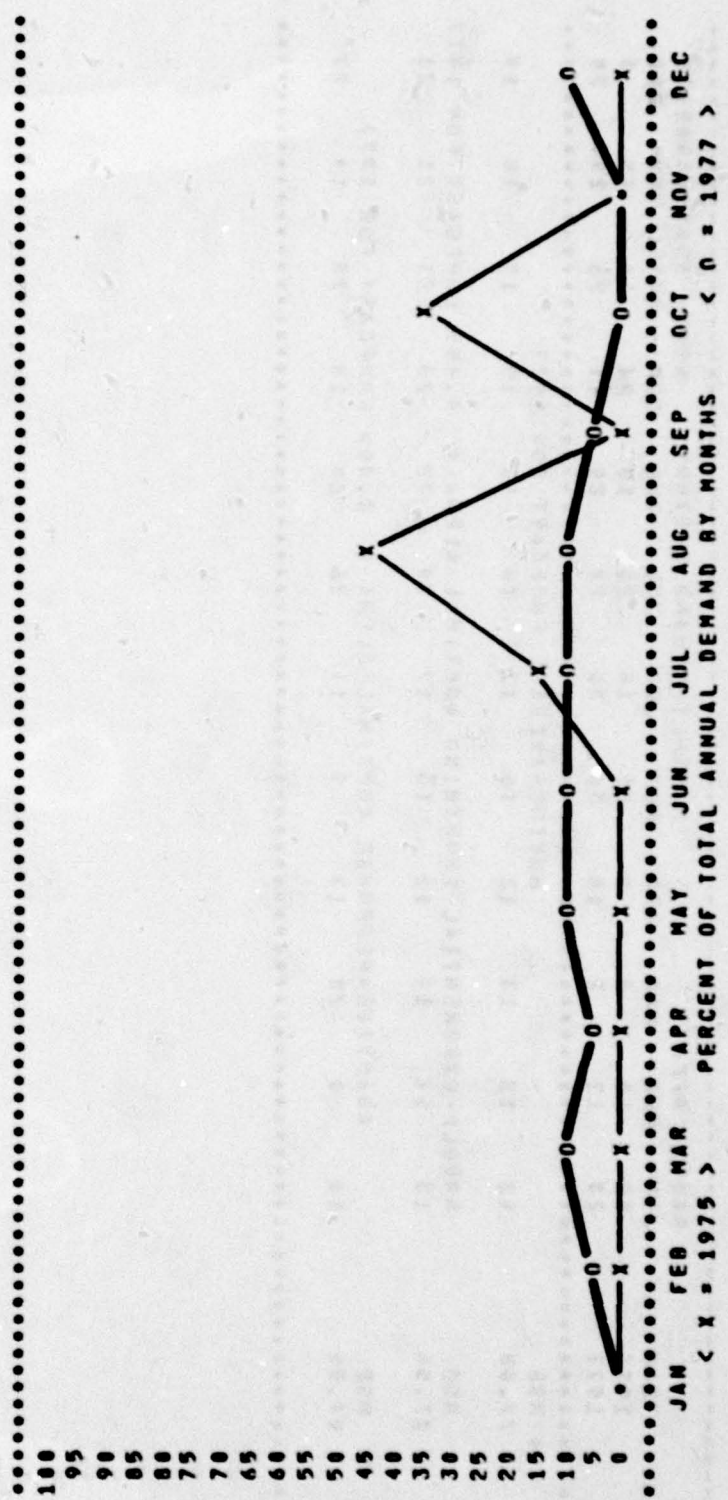
.....
BASE: OFFUTT          MONTHLY DEMAND HISTORY  MSN: 6505000902172
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  10  12  6   8  10  18  20  18  24  18  10  0
1977  23  12  7  18  30  30  20  29  11  24  20  30
.....
MSE  12  13  13  13  15  17  18  18  10  17  10  19
.....
MSE  13  14  14  12  13  17  20  22  23  21  21  21
.....
MSE  10  0  22  13  9  17  28  29  20  28  14  22
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
13  14  14  12  13  17  20  22  23  21  21  21
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977
10  0  22  13  9  17  28  29  20  28  14  22
.....

```

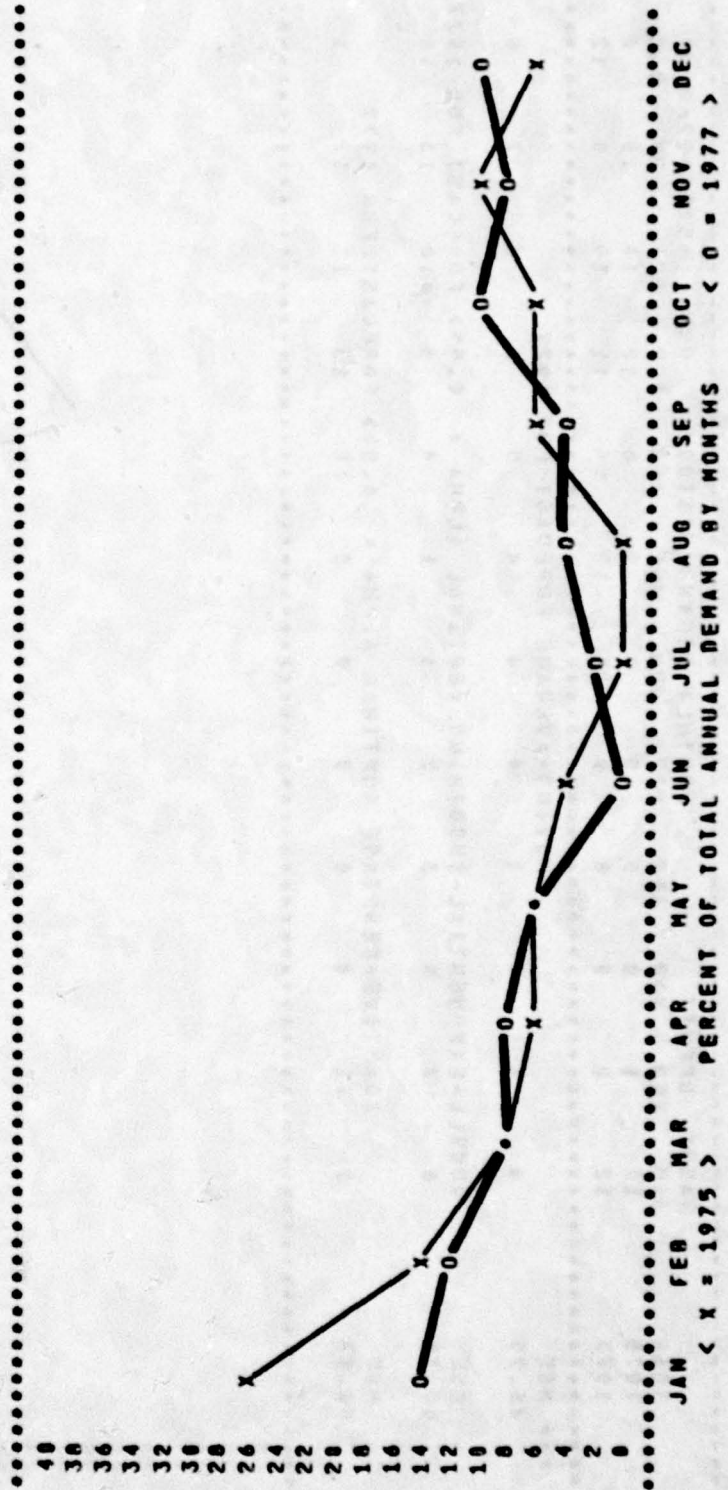


BASE: OFFUTT MSN: 4505009242097

		MONTHLY DEMAND HISTORY											
		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
YEAR													
1975		0	0	0	0	0	0	12	30	0	24	0	0
1977		12	24	36	24	48	48	48	36	24	0	0	48
MSE		MOVING-AVERAGE FORECAST FOR 1977											
494.50		6	7	9	12	14	18	22	25	25	27	25	25
MSE		DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
365.35		0	11	23	35	25	46	48	48	37	25	2	0
MSE		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977											
361.17		0	11	23	35	24	45	47	47	36	24	0	0



BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM:
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	DFC	
1975	1632	835	576	482	384	386	0	0	368	378	672	488		
1977	414	364	228	222	174	51	96	185	156	288	258	276		
MSE	MOVING-AVERAGE FORECAST FOR 1977													
16253.25	496	395	355	326	311	294	273	281	289	272	265	238		
*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977													
5549.42	432	415	369	242	224	179	63	93	104	151	275	253		
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.98> FORECAST FOR 1977													
6888.33	488	412	388	233	222	174	51	95	180	148	287	258		



BASE: OFFUTT MSN: 4505009269202

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	10	0	0	0	0	0	0	0	12	10	10	0
1977	12	0	0	0	0	1	12	14	11	19	0	12

MOVING-AVERAGE FORECAST FOR 1977

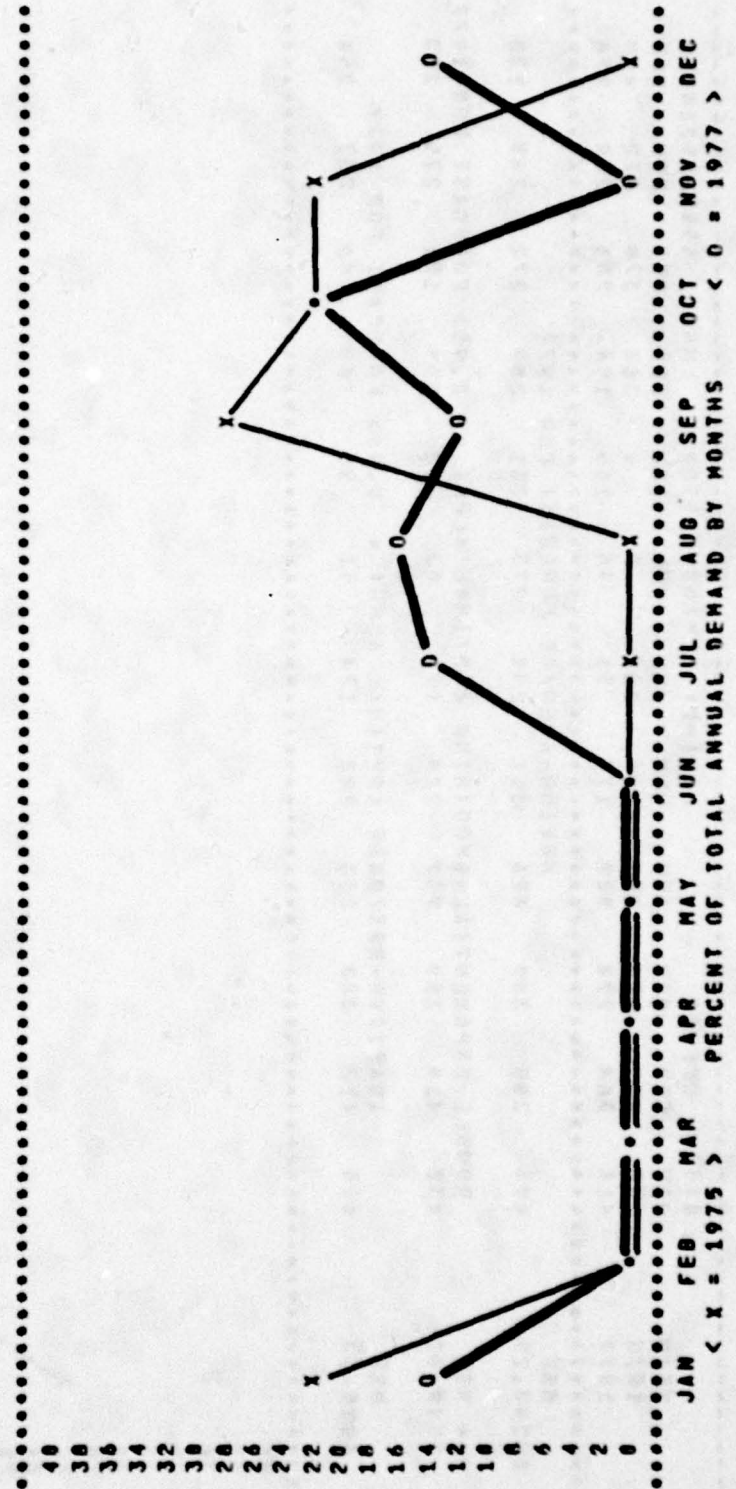
	4	4	4	4	4	5	6	6	7	6	
MSE	46.75										

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977

	6	7	5	3	2	1	1	4	0	10	13	10
MSE	50.78											

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

	5	11	4	0	0	0	10	13	11	12	1
MSE	56.67										



```

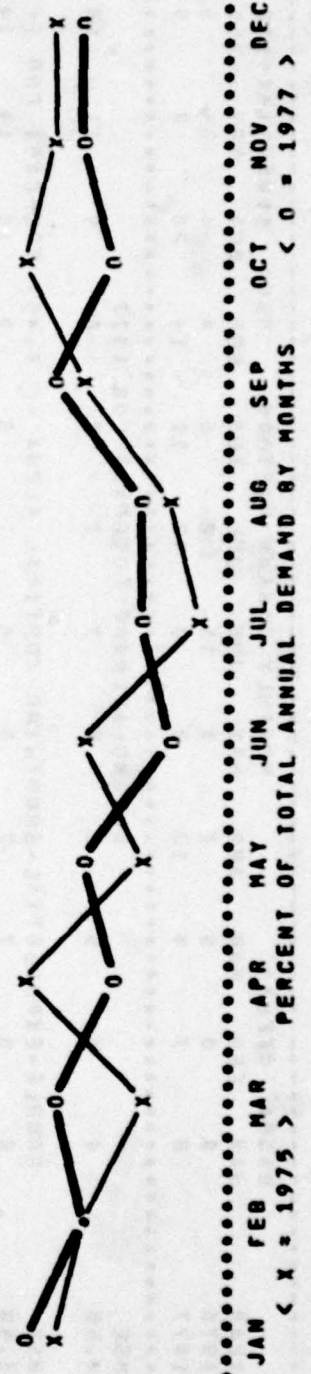
.....
BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505009354095
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 1056 968 484 1268 588 864 192 336 1888 1448 1856 1248
1977 796 579 675 439 538 243 384 339 755 488 624 566
.....
MSE MOVING-AVERAGE FORECAST FOR 1977
74927.42 874 852 828 836 768 764 712 728 728 707 627 591
.....
MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977
51751.78 1211 913 665 667 582 519 328 362 346 641 531 596
.....
MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977
48210.75 1148 939 651 674 546 538 251 383 366 504 481 552
.....

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```

.....
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
.....

```



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.....
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >
.....

```

BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 650500944130

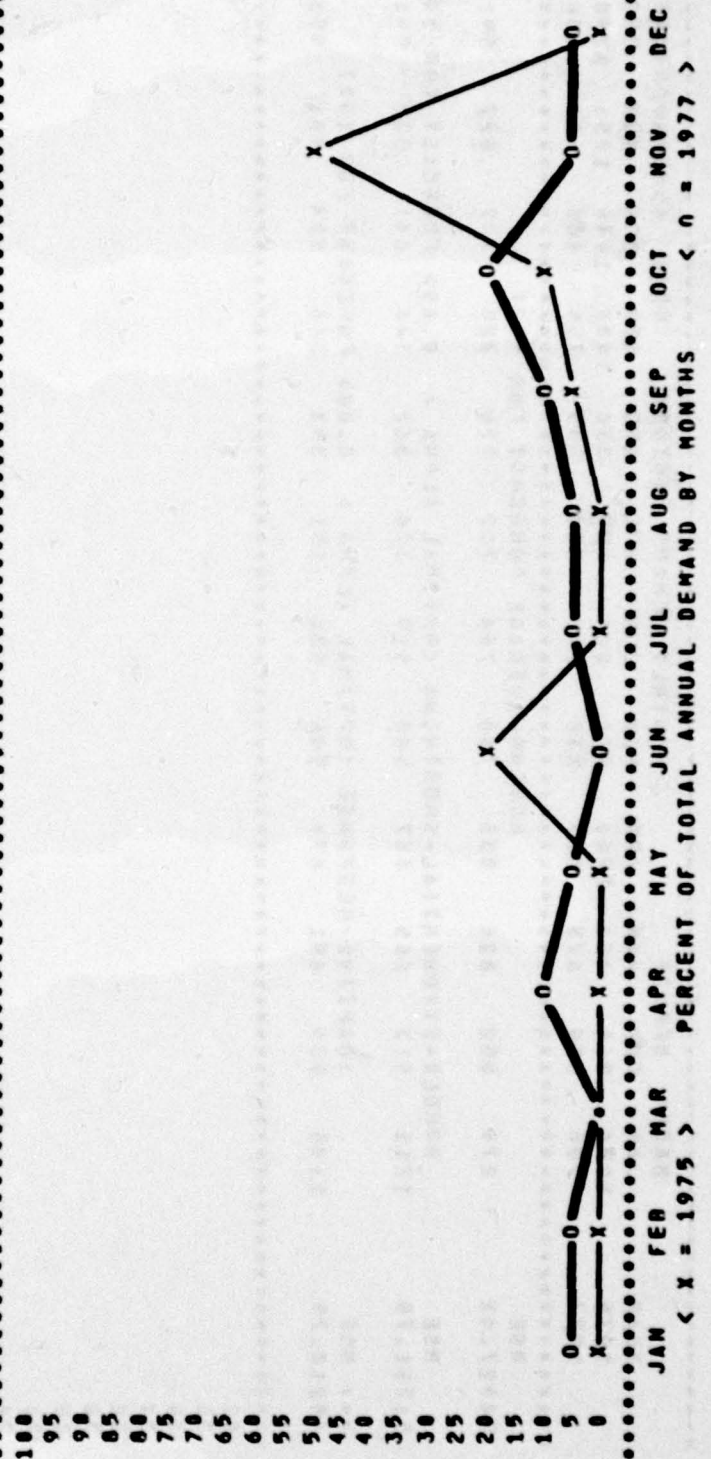
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	11	2	0	4	6	24	0
1977	0	7	4	13	0	3	12	10	14	20	7	9

MSE 44.58 MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

MSE 59.00 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

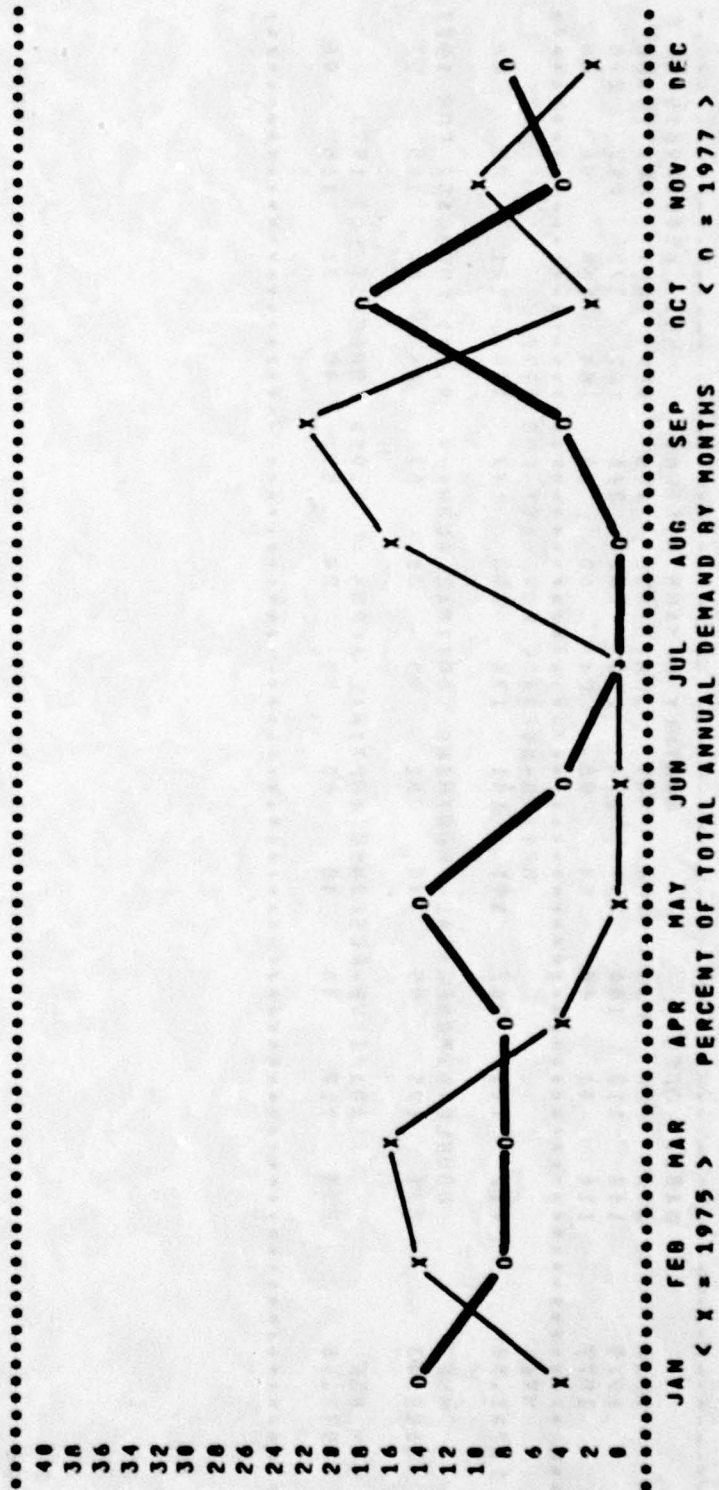
.....



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.....
BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: %505009464700
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 100 250 300 100 0 0 300 400 50 200 50
1977 150 100 100 100 150 50 0 0 50 200 50 100
MSE 146 150 130 121 121 133 130 130 113 83 96 83
.....
... MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
4304.17 149 141 129 119 111 119 104 74 48 42 88
.....
MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977
4334.58 128 135 132 116 104 142 94 30 3 46 74 53
.....

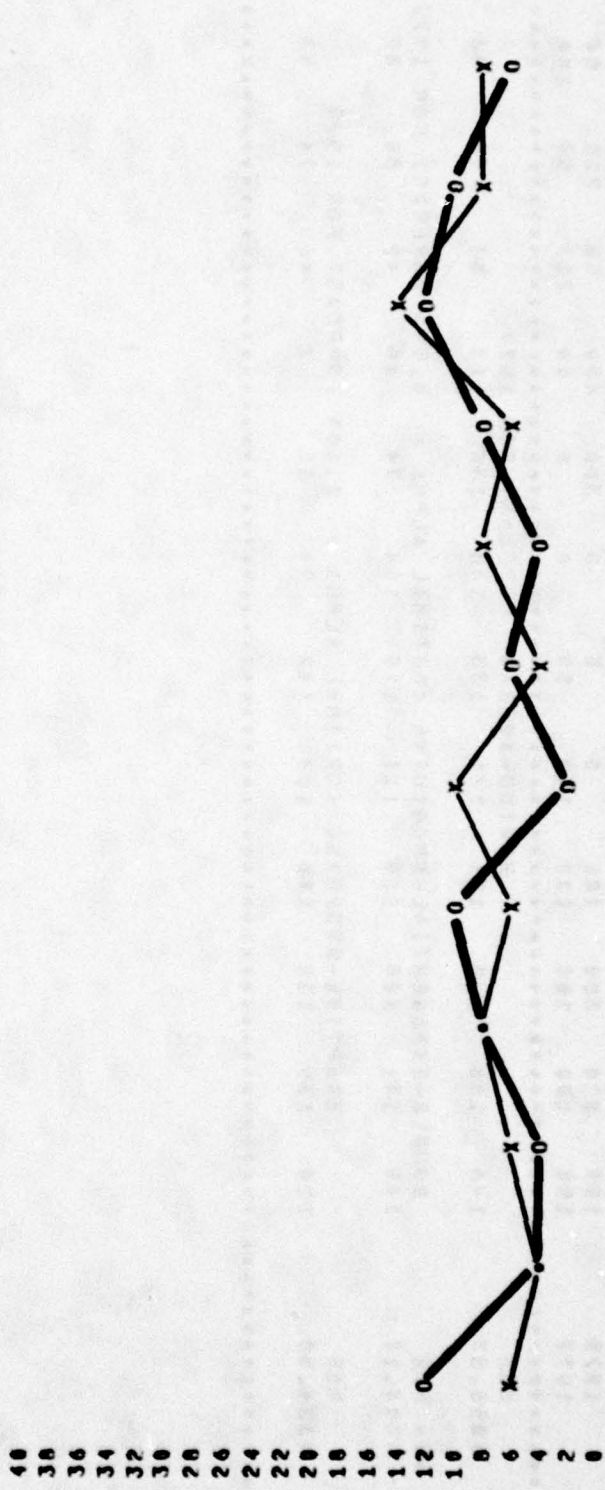
```



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.....
BASE: OFFUTT MONTHLY DEMAND HISTORY NSM: 6905009615504
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 160 110 100 204 174 283 132 240 192 372 252 220
1977 114 48 48 84 96 24 68 42 84 108 96 60
.....
MSE 10201.50 212 207 202 191 191 174 153 147 130 121 99 86
.....
MSE 2610.03 231 125 55 49 81 95 31 57 44 80 105 97
.....
MSE 2579.50 233 117 48 48 83 95 24 59 45 76 106 96
.....
.....

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.....
PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < N = 1977 >
.....

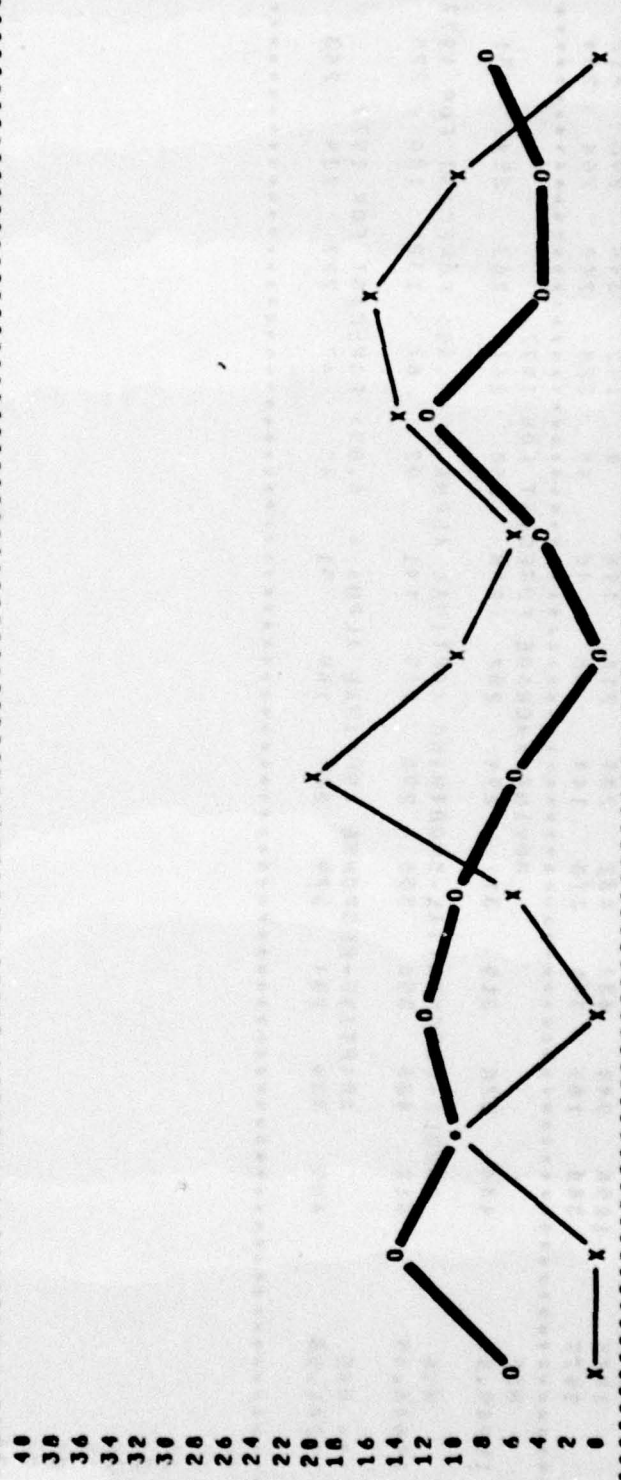
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APPENDIX E  
COMPUTER PRODUCTS, SEASONAL (WHITEMAN)

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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSM: 6505000636197
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 0 0 14 0 9 24 13 0 10 19 12 0
1977 6 12 9 10 0 5 0 4 11 4 4 7
MSE 20.42 10 10 11 11 12 12 10 9 9 A 7 6
.....
*** MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
11.75 5 6 6 6 6 6 6 6 6 6 6 6
MSE 12.92 7 6 5 11 9 9 0 6 0 3 6 4
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977
.....

```



BASE: WHITEMAN MSN: 6505000640765

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1056	948	432	432	204	216	148	0	192	396	296	016
1977	304	105	391	216	144	48	48	48	228	240	264	264

MOVING-AVERAGE FORECAST FOR 1977

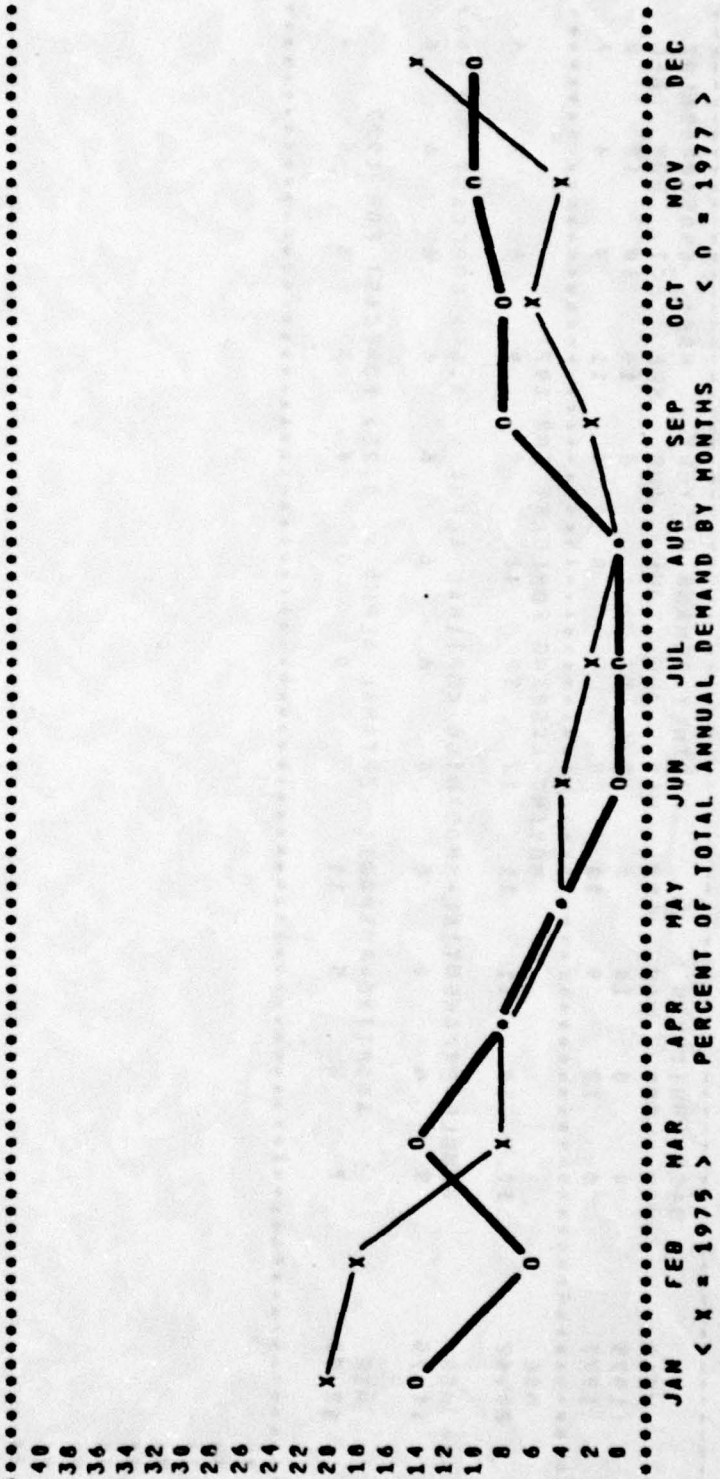
MSE	10969.50	434	378	315	312	294	282	268	260	264	267	254	251
-----	----------	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

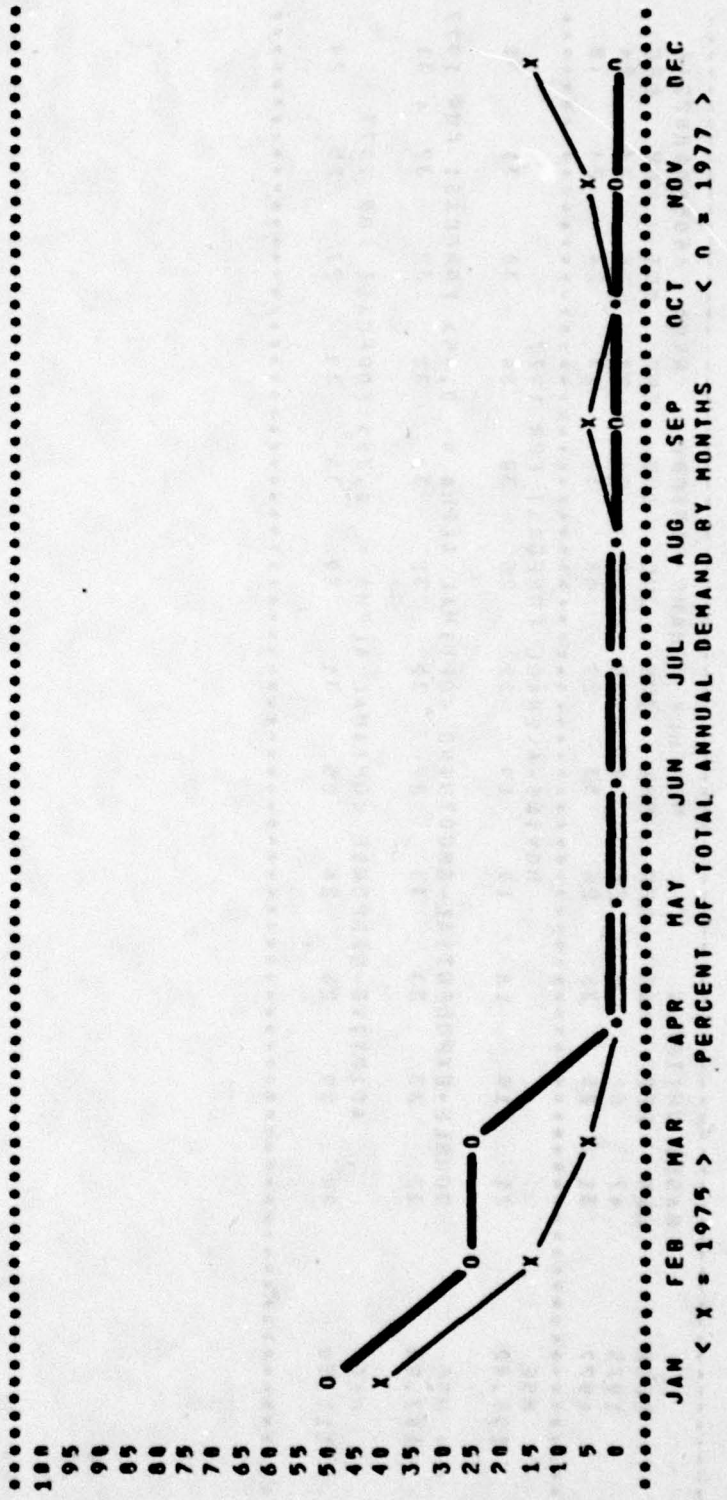
MSE	19046.35	512	406	356	355	296	225	141	92	67	132	106	275
-----	----------	-----	-----	-----	-----	-----	-----	-----	----	----	-----	-----	-----

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

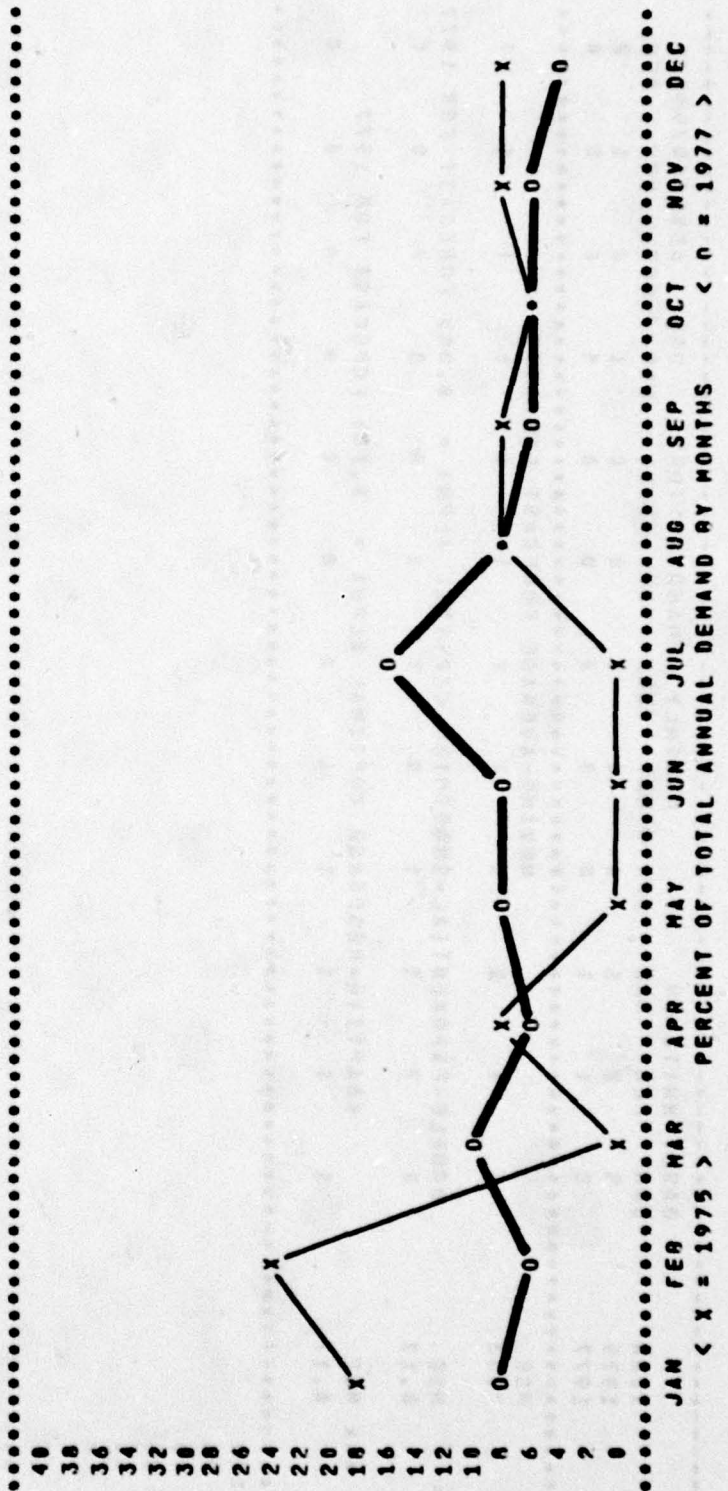
MSE	12241.50	409	304	284	379	207	169	51	40	47	227	239	263
-----	----------	-----	-----	-----	-----	-----	-----	----	----	----	-----	-----	-----



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505000796269  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 1975 5 2 1 0 0 0 0 0 1 0 1 2  
 1977 2 1 1 0 0 0 0 0 0 0 0 0  
 MSE 0.03 1 1 1 1 1 1 1 1 1 1 1  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977  
 2 1 1 0 0 0 0 0 0 0 0 0  
 MSE 0.17 1 1 1 1 1 1 1 1 1 1 1  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977  
 1 1 1 1 1 1 1 1 1 1 1 1



BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505000002246  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 1975 47 61 8 24 0 0 24 24 10 24 24  
 1977 31 25 36 26 33 29 60 30 24 24 24 18  
 MSE 195.42 21 19 16 19 19 22 25 30 30 31 31  
 .....  
 MOVING-AVERAGE FORECAST FOR 1977  
 .....  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 MSE 107.00 33 33 33 33 32 32 32 32 32 32 31  
 .....  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977  
 MSE 111.50 22 29 25 26 25 31 29 33 30 27 25 24  
 .....



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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505001161038

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	9	12	0	6	9	3	10	3	3	3	0
1977	2	1	1	0	0	0	0	0	0	0	0	0

MSE 11.00

MOVING-AVERAGE FORECAST FOR 1977

	4	4	4	3	2	2	1	1
MSE	6	6	5	4	4	3	2	1

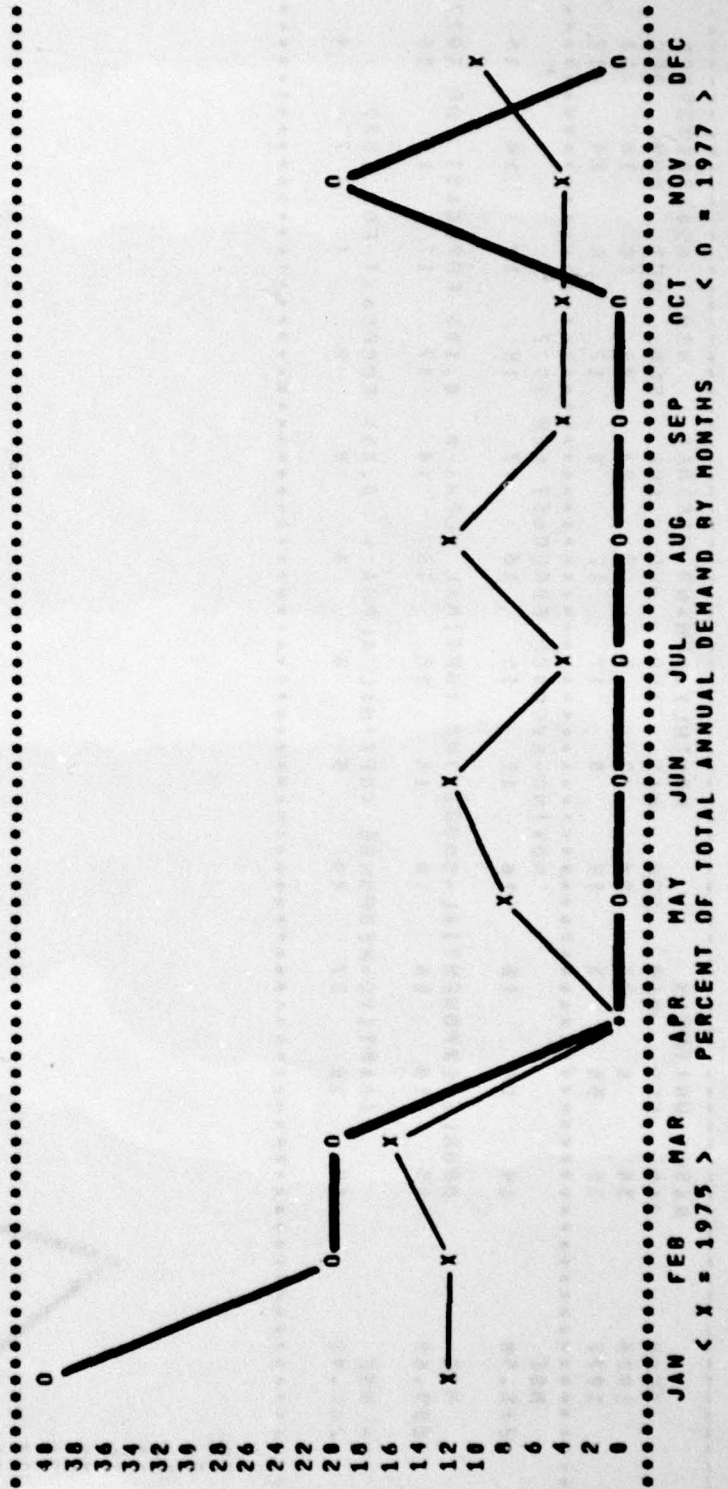
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

	3	2	1	0	0	0	0	0
MSE	5	4	3	2	1	0	0	0

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

	3	2	1	1	0	0	0	0
MSE	3	2	1	1	0	0	0	0

-----



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505001335A00

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	36	0	24	24	0	0	0	24	24	10	10	10
1977	36	55	3	12	0	12	12	0	12	0	24	12

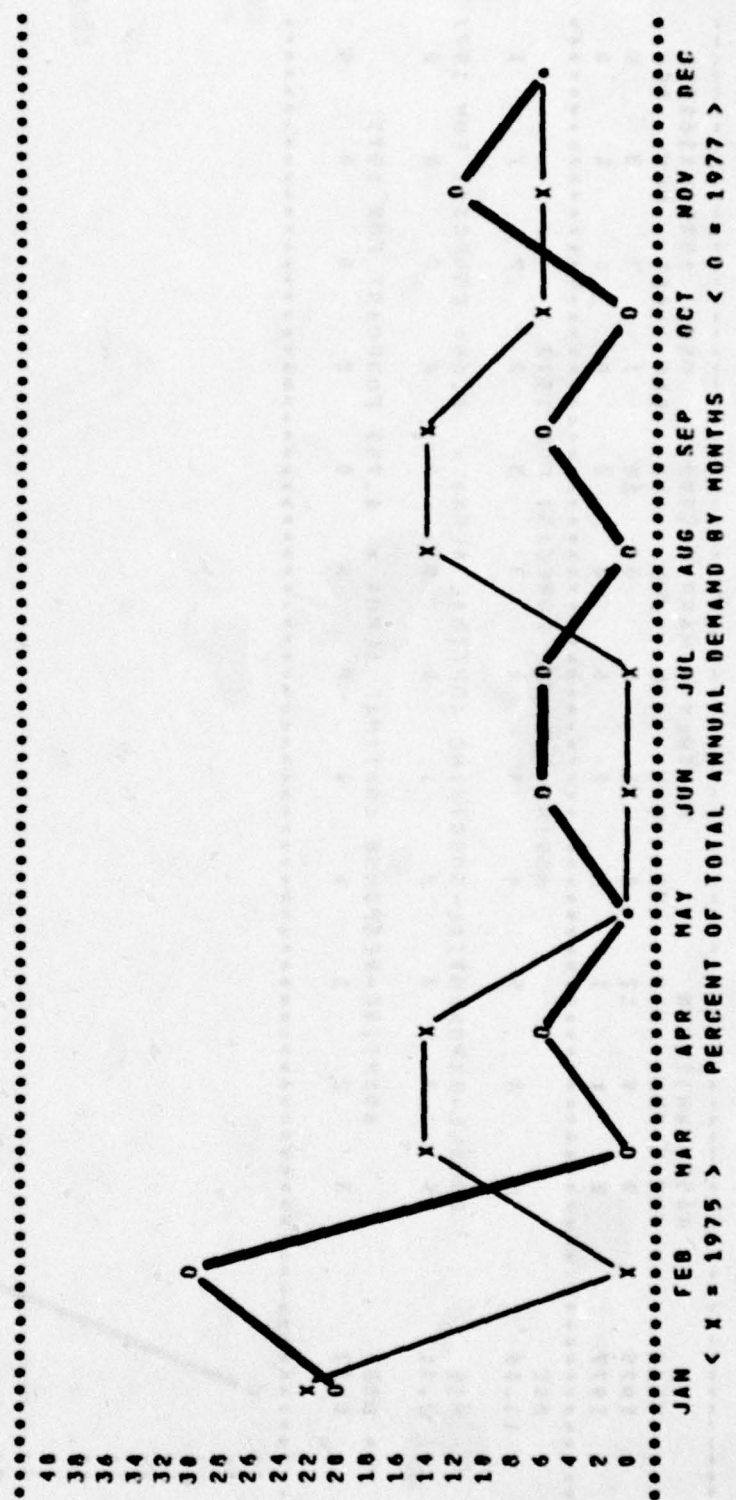
MSE 271.56 14 14 18 16 15 15 17 15 14 14 15

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE	18	18	18	18	18	18	18	18	17	17	16	16
-----	----	----	----	----	----	----	----	----	----	----	----	----

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	12	10	27	49	5	8	6	6	6	4	7	4
-----	----	----	----	----	---	---	---	---	---	---	---	---



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505001596625

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	10	10	0	0	0	0	0	17	0	0	9	0
1977	6	6	0	12	9	11	14	15	10	11	10	6

MSE 14.50

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	7	6	5	5	6	7	8	9	9	10	10	10

MSE 7.02

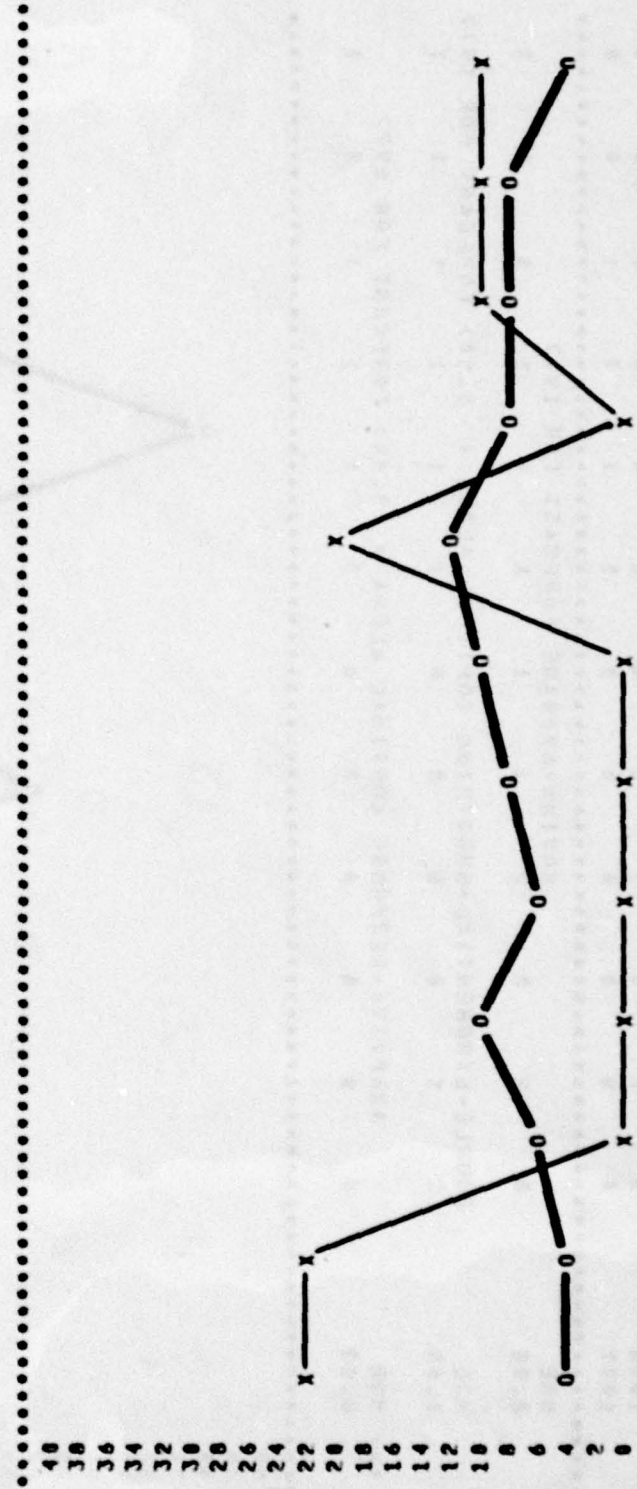
DOUBLE-EXPONENTIAL-SMOOTHING OPTIMAL ALPHA = 0.90 > FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	8	6	6	8	11	9	11	13	15	11	11	10

MSE 7.25

ADAPTIVE-RESPONSE OPTIMAL ALPHA = 0.90 > FORECAST FOR 1977

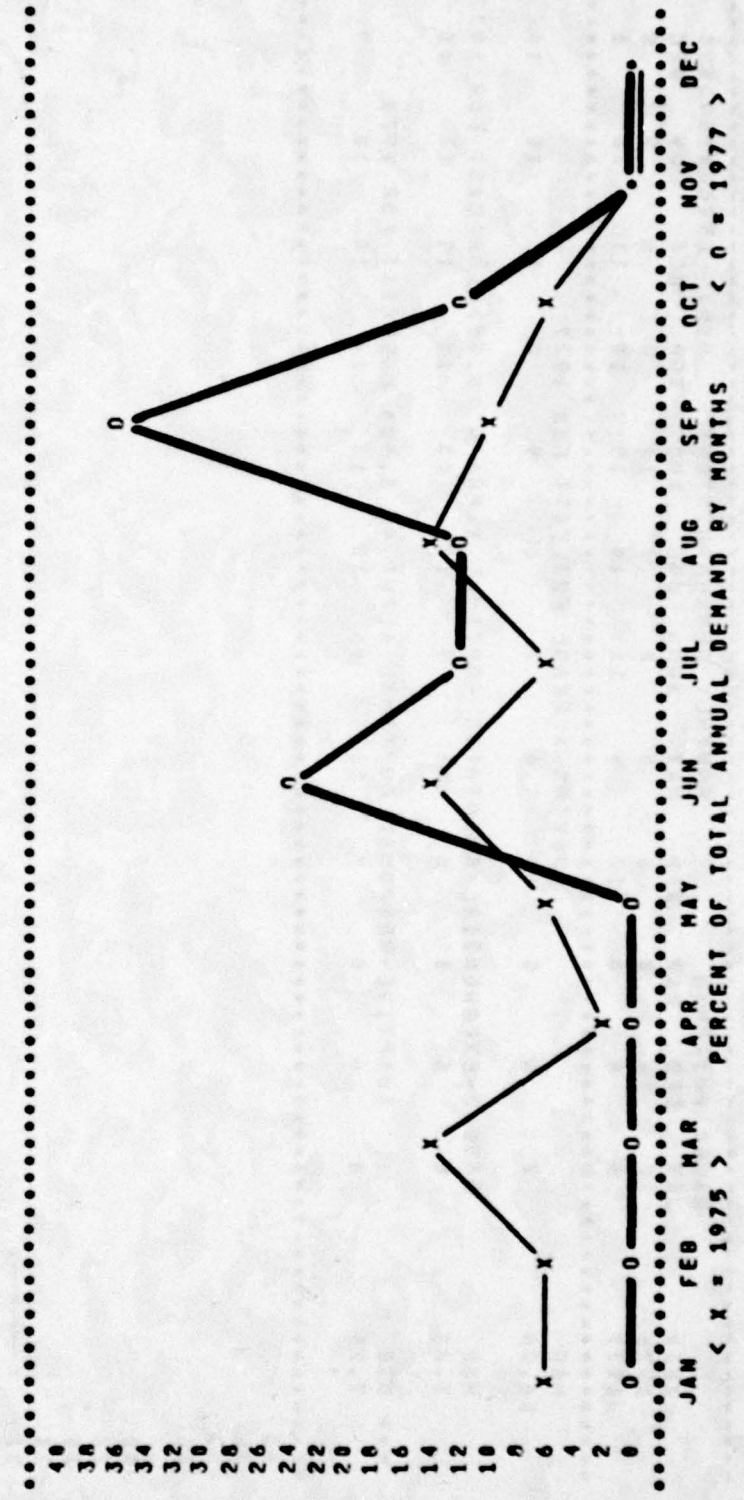
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	8	6	6	7	11	9	10	13	14	10	10	9



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BASE: WHITEMAN MONTHLY DEMAND HISTORY NSN: 6505001590475
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
      1977 0 0 0 0 0 2 1 1 3 1 0 0
MSE 2.00 2 2 2 2 1 1 1 1 1 1 1
MOVING-AVERAGE FORECAST FOR 1977
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
MSE 1.00 1 1 0 0 0 0 1 1 1 1 1
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977
MSE 0.03 0 0 0 0 0 0 0 1 1 1 2
.....

```



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSM: 6505002998279

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	0	4	0	14	24	12	6	16	20	8
1977	5	0	0	4	6	7	6	5	6	8	18	12

MSE 37.42 10 10 9 9 9 10 9 0 7 7 6 6

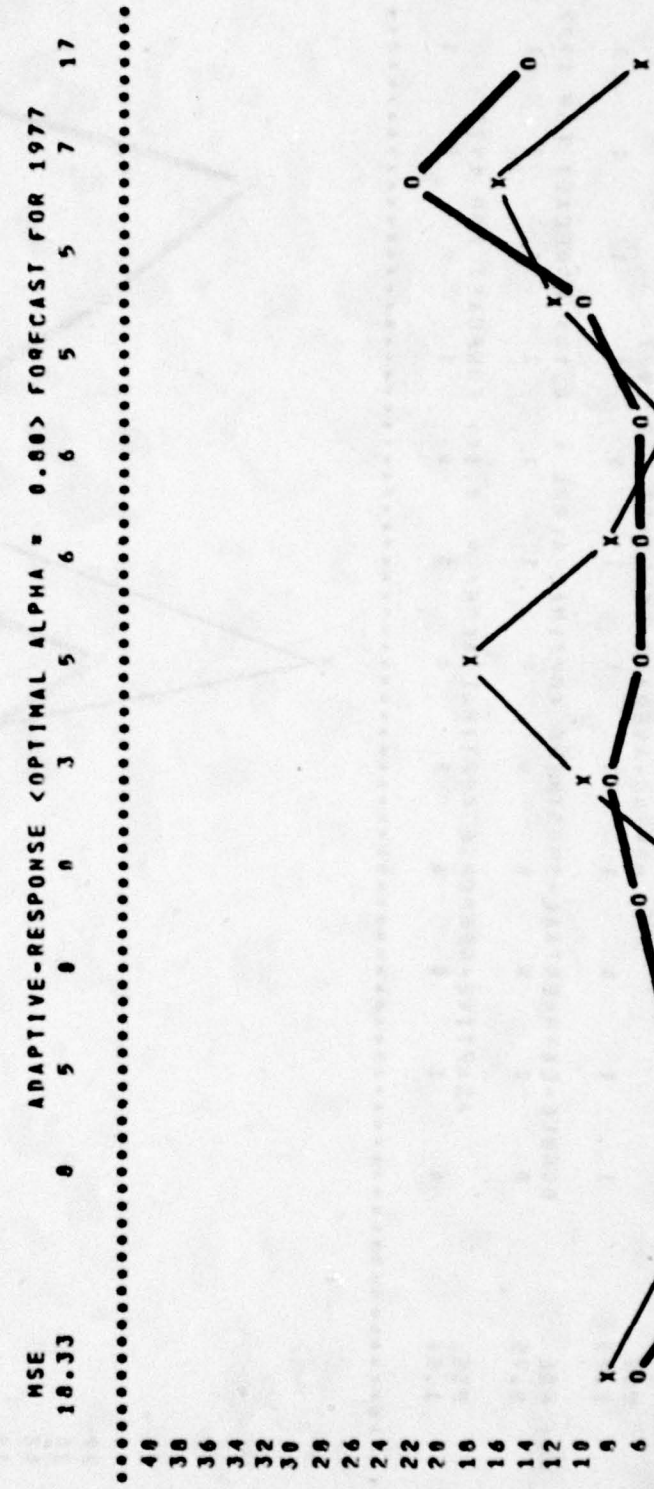
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE 17.88 9 5 1 0 4 6 7 6 5 6 8 17

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

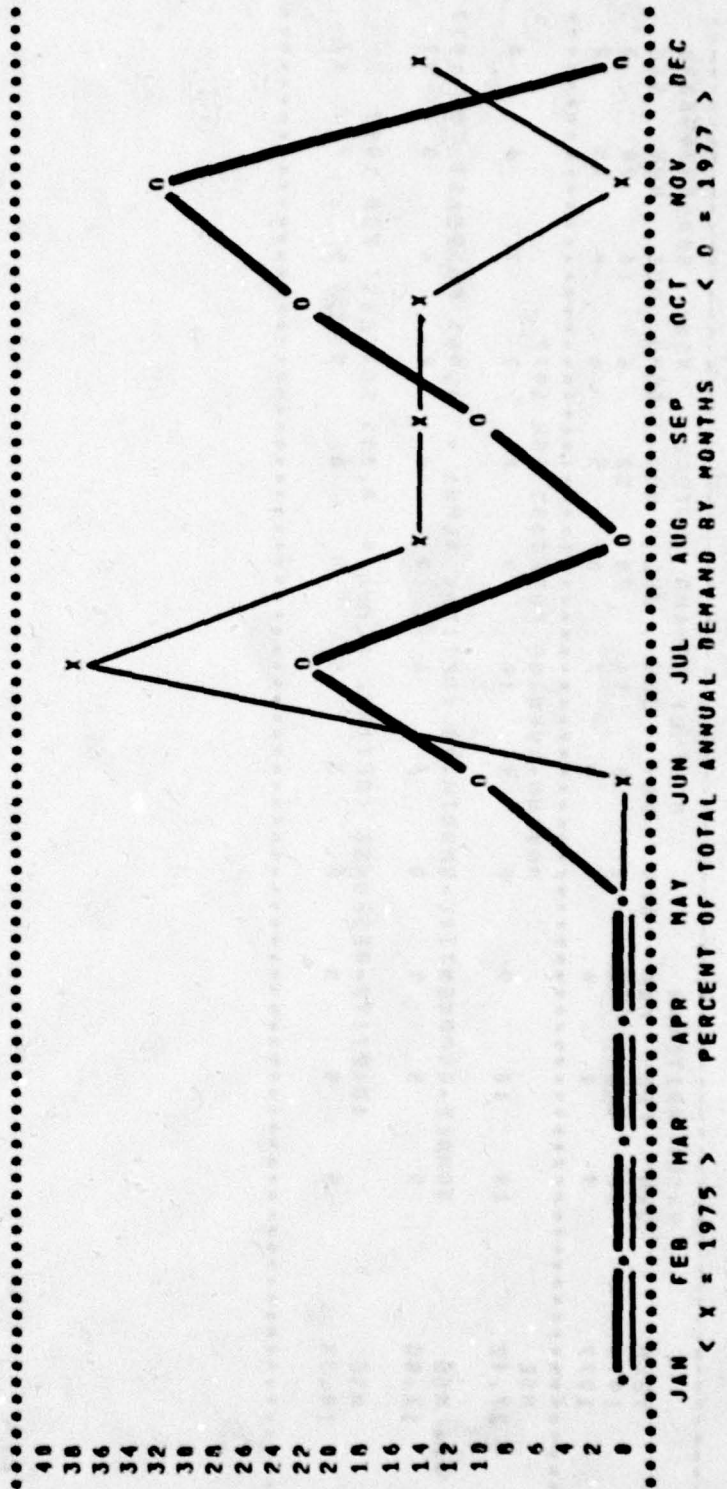
MSE 18.33 0 5 0 0 3 5 6 6 5 5 7 17



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BASE: WHITEMAN          MONTHLY DEMAND HISTORY      MSN: 6505002990J54
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  0    0    0    0    0    5    2    2    2    0    2
1977  0    0    0    0    1    2    0    1    2    3    0
MSE   1.00  1    1    1    1    1    1    1    1    1    1    1
      MOVING-AVERAGE FORECAST FOR 1977
.....
MSE   0.75  DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
      0    0    0    0    0    1    1    1    1    1    1    1
MSE   1.50  ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
      0    1    0    0    0    0    0    0    1    0    0    1
-----

```



BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSM: 6505005596859

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	22	34	0	0	4	26	16	12	10	22	12	6
1977	16	17	18	21	14	5	10	13	2	11	13	7

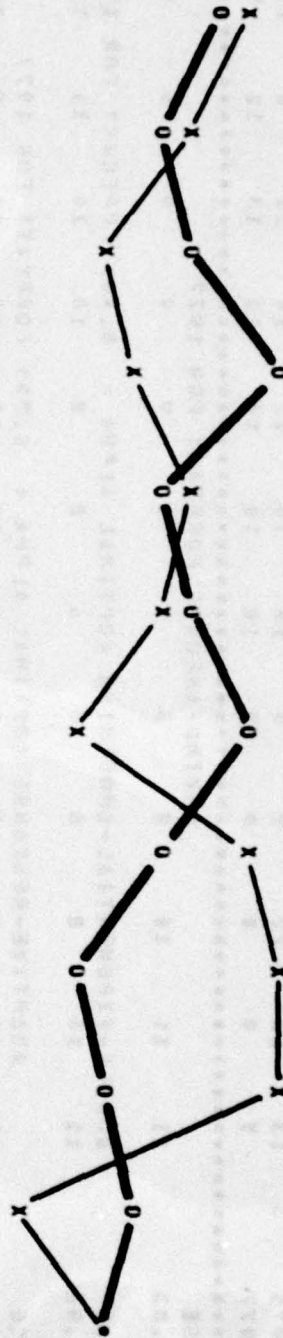
MSE 39.33 14 14 13 14 16 17 15 14 15 13 12 12

MSE 28.92 14 14 15 16 17 17 14 13 12 10 10 10

MSE 25.92 12 7 17 17 20 14 6 9 10 2 9

.....

- 40
- 38
- 36
- 34
- 32
- 30
- 28
- 26
- 24
- 22
- 20
- 18
- 16
- 14
- 12
- 10
- 8
- 6
- 4
- 2
- 0



.....  
 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 < X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505005760042

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	13	13	22	2	5	10	10	17	10	11	8	15
1977	5	0	0	0	20	10	10	14	10	13	10	5

MSE 43.83

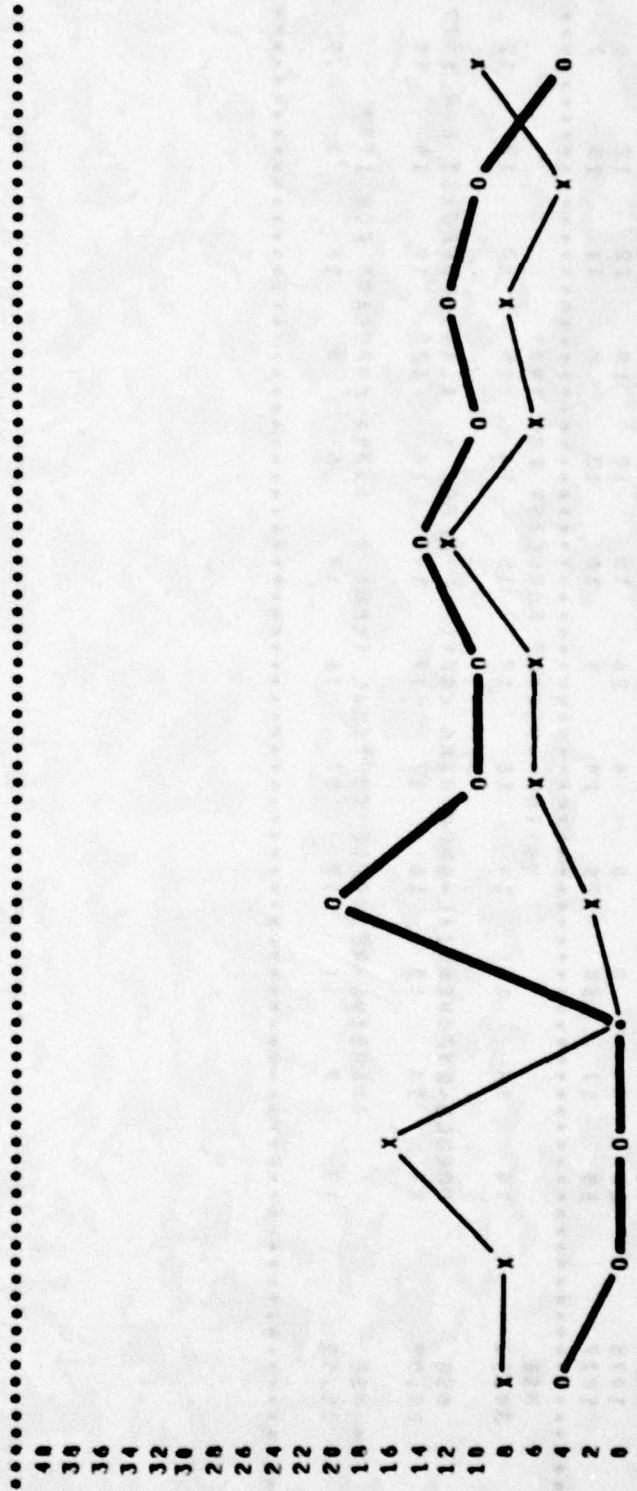
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977

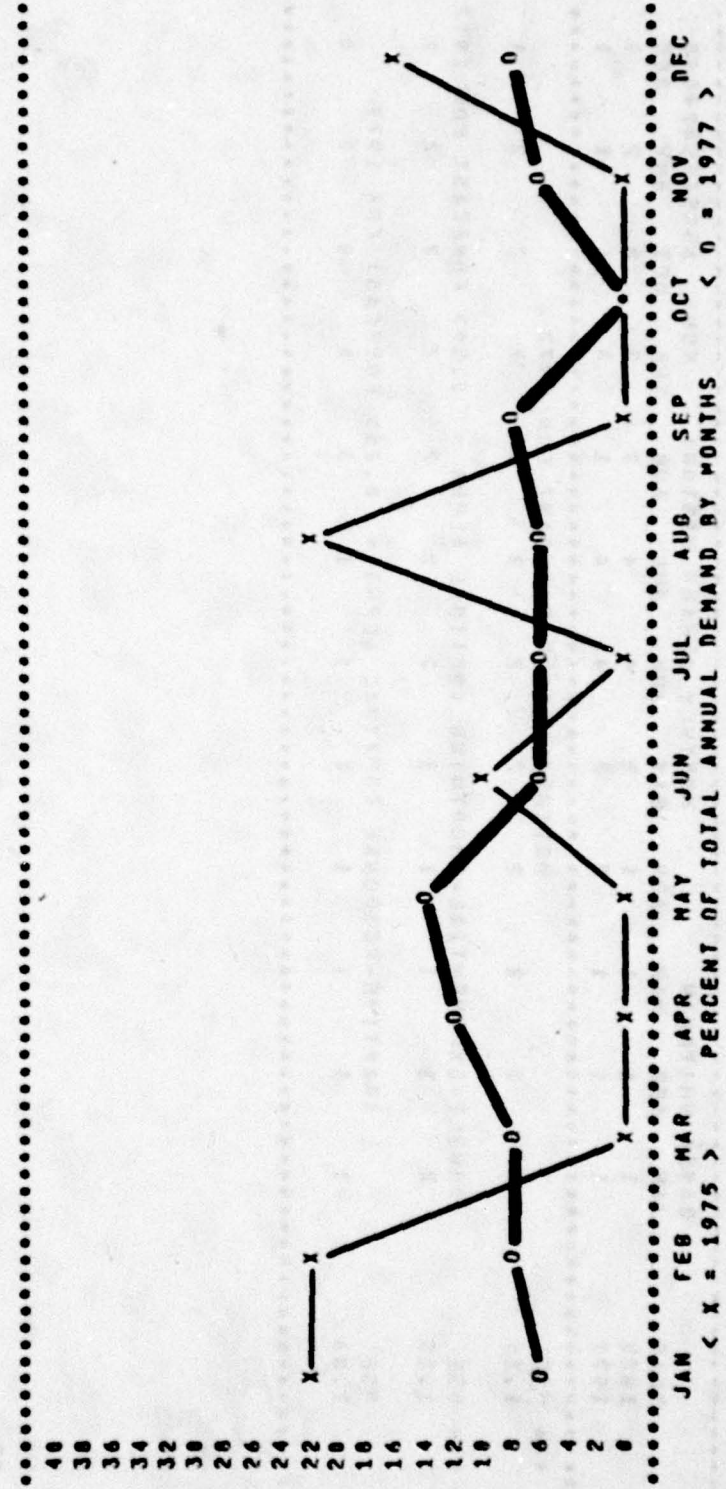
MSE 46.92

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

MSE 42.67



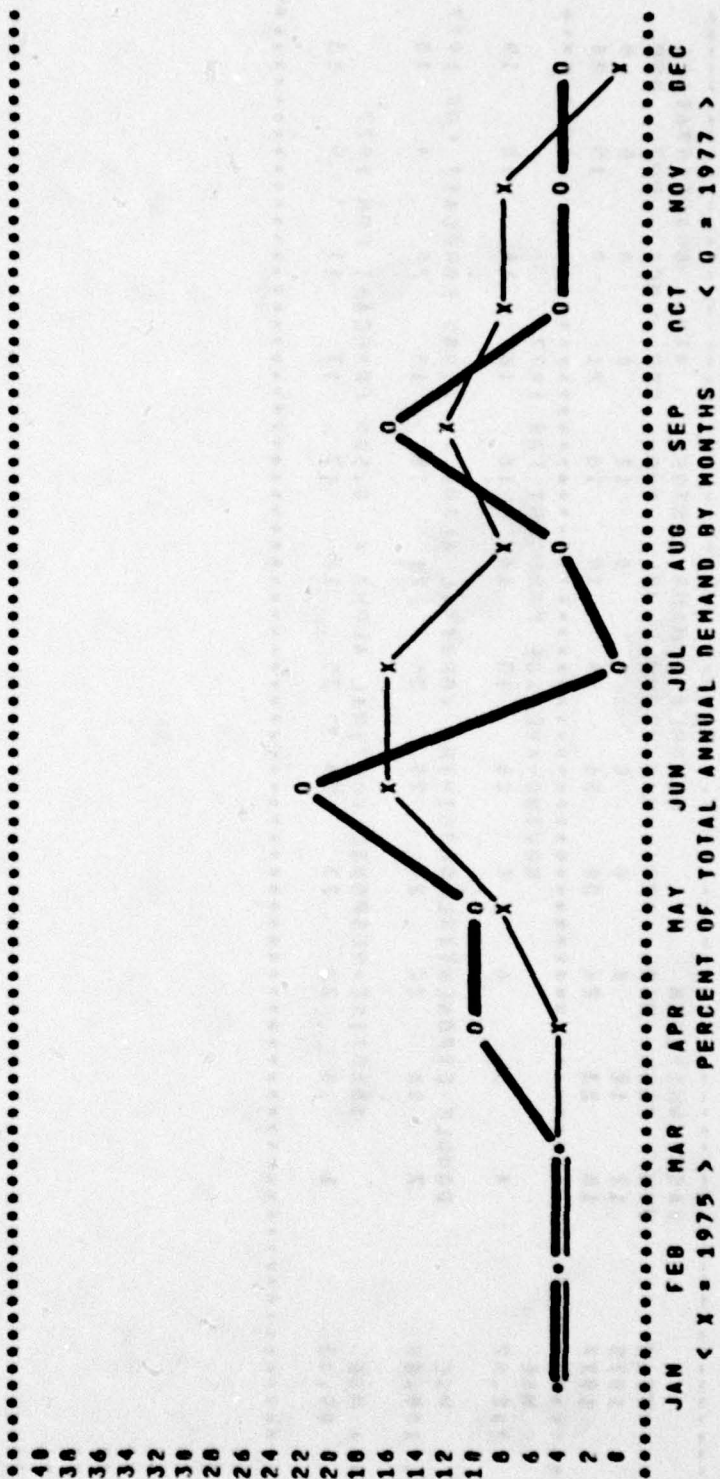
BASE1 WHITEMAN		MONTHLY DEMAND HISTORY												MSN: 6505005769120		
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC				
1975	12	12	0	0	0	6	0	12	0	0	0	9				
1977	10	23	24	30	36	10	10	10	21	0	15	24				
MSE	MOVING-AVERAGE FORECAST FOR 1977															
202.67	4	5	6	8	10	13	14	16	16	18	10	19				
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977															
100.69	7	16	22	24	29	35	21	10	14	20	4	13				
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977															
99.33	1	16	22	23	29	35	10	17	17	17	9	13				



```

BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505005024060
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975   1    1    1    1    2    4    4    2    3    2    0
1977   1    1    1    2    2    4    0    1    3    1    1    1
.....
... MSE 1.25 2 2 2 2 2 2 2 2 2 2 1
MOVING-AVERAGE FORECAST FOR 1977
.....
... MSE 1.25 2 1 1 1 2 2 2 2 2 2 1
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
.....
... MSE 1.83 1 1 1 1 1 1 1 3 0 0 0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....

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BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: 650500619A737

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	0	3	2	2	2	3	2	2	0	1	1
1977	3	3	1	2	1	2	2	1	2	1	2	2

MOVING-AVERAGE FORECAST FOR 1977

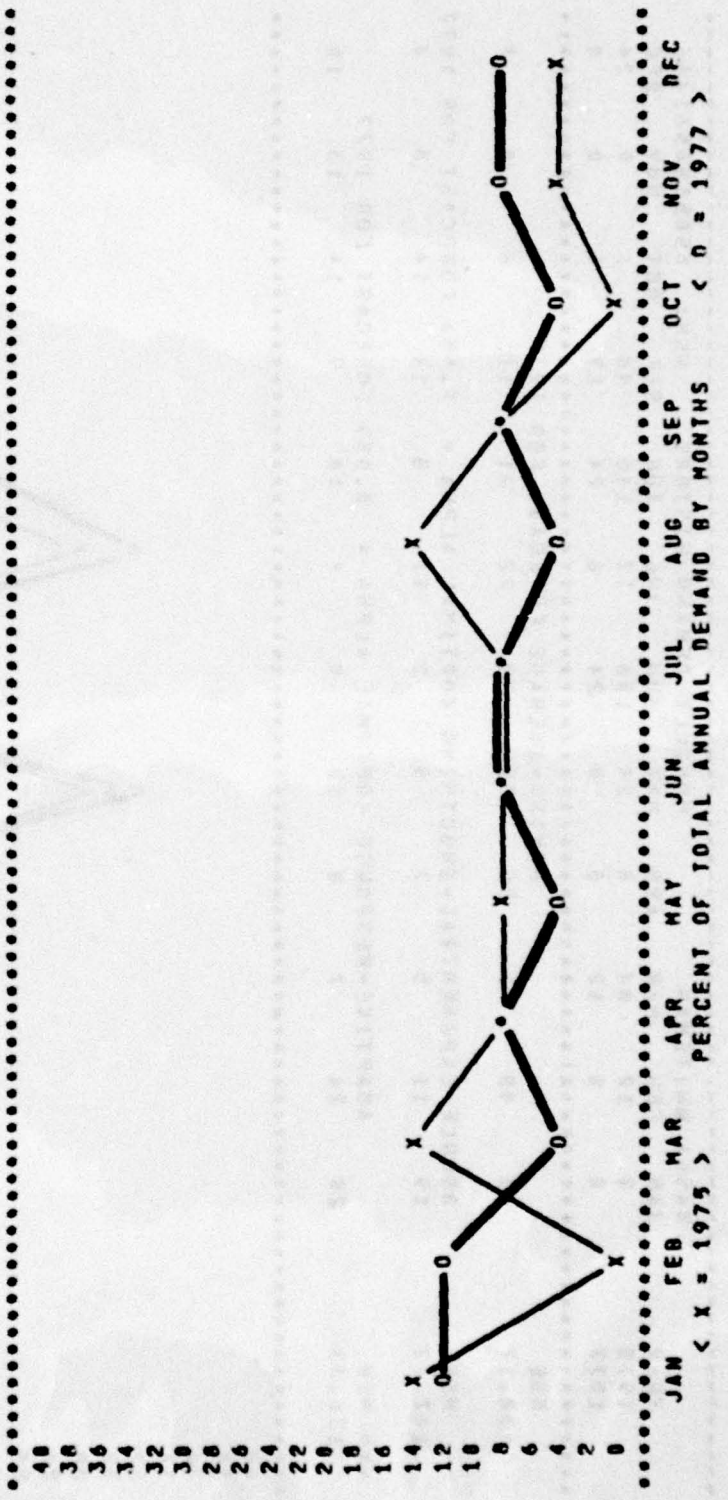
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	2	2	2	2	2	2	2	2	2	2	2

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

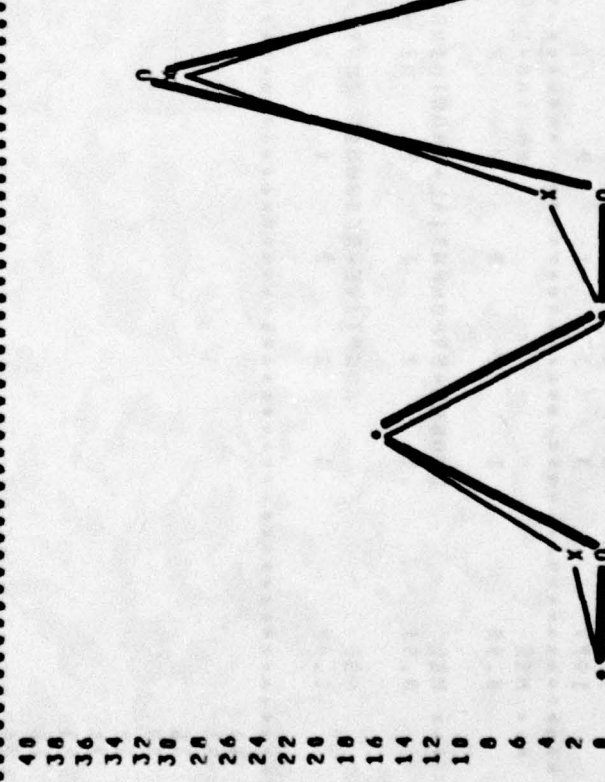
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	2	2	2	2	2	2	2	2	2	2	2

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

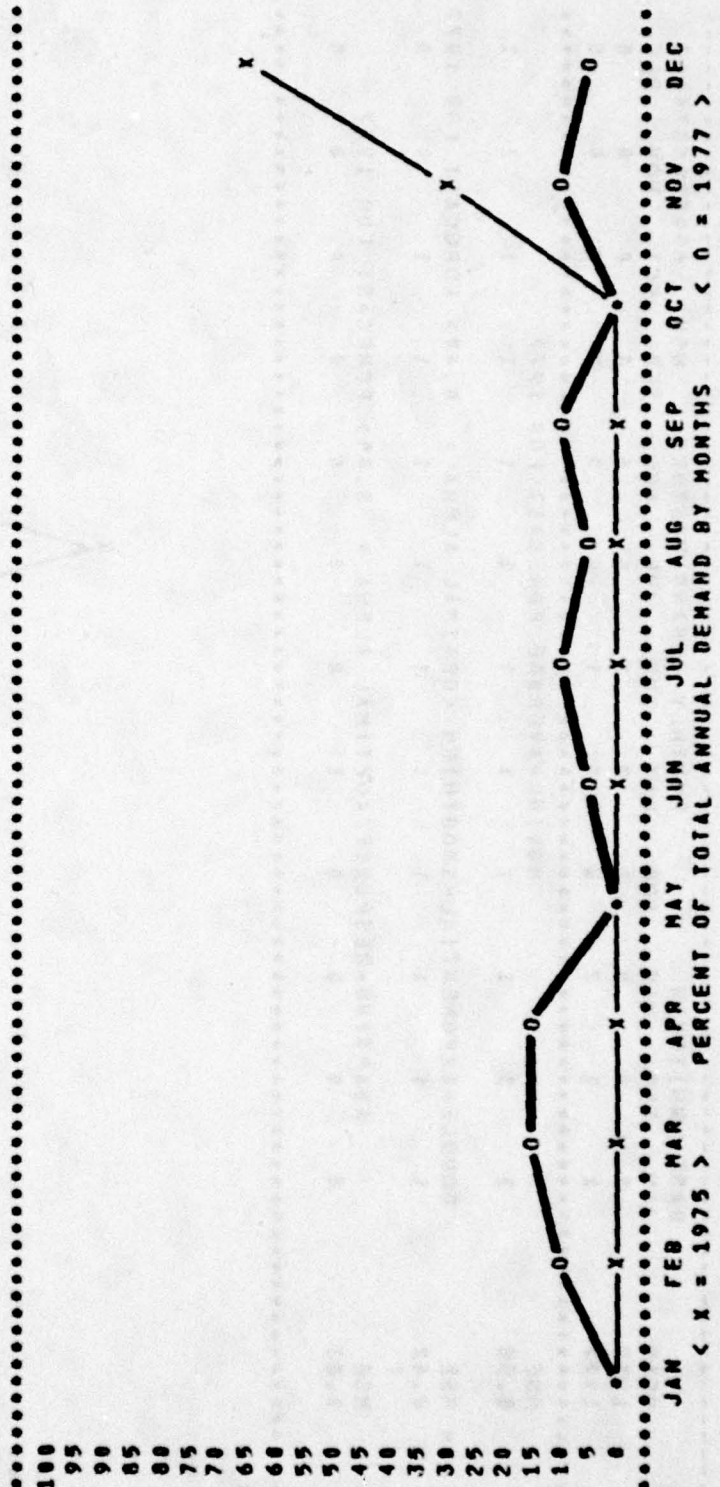
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	2	2	1	1	1	1	1	1	1	1	1



-----												
BASE: WHITEMAN												
MONTHLY DEMAND HISTORY MSN: 6505006561466												
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	12	04	0	24	156	12	148	48	0	0	24
1977	0	0	12	0	0	24	0	24	12	0	0	0
.....												
MOVING-AVERAGE FORECAST FOR 1977												
MSE	42	42	41	35	35	33	22	21	11	0	0	0
.....												
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977												
MSE	19	11	5	7	5	2	11	8	14	14	8	4
.....												
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977												
MSE	20	24	7	0	10	9	4	18	9	14	13	10
.....												



RASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505006674049  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 1975 0 0 0 0 0 0 0 0 0 0 3 6  
 1977 0 2 3 3 0 1 2 1 2 0 2 1  
 MSE 1.42 1 1 1 1 1 1 1 2 2 2 2  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977  
 1.17 0 1 1 1 1 1 1 1 1 1 1  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977  
 5.00 6 0 1 2 2 0 0 1 1 1 0



BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: 4505006874053

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	2	0	6	0	0	0	0
1977	1	1	2	0	1	1	0	0	1	0	0	0

MSE 0.58

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	1	1	1	1	1	1	1	1	1	1	1

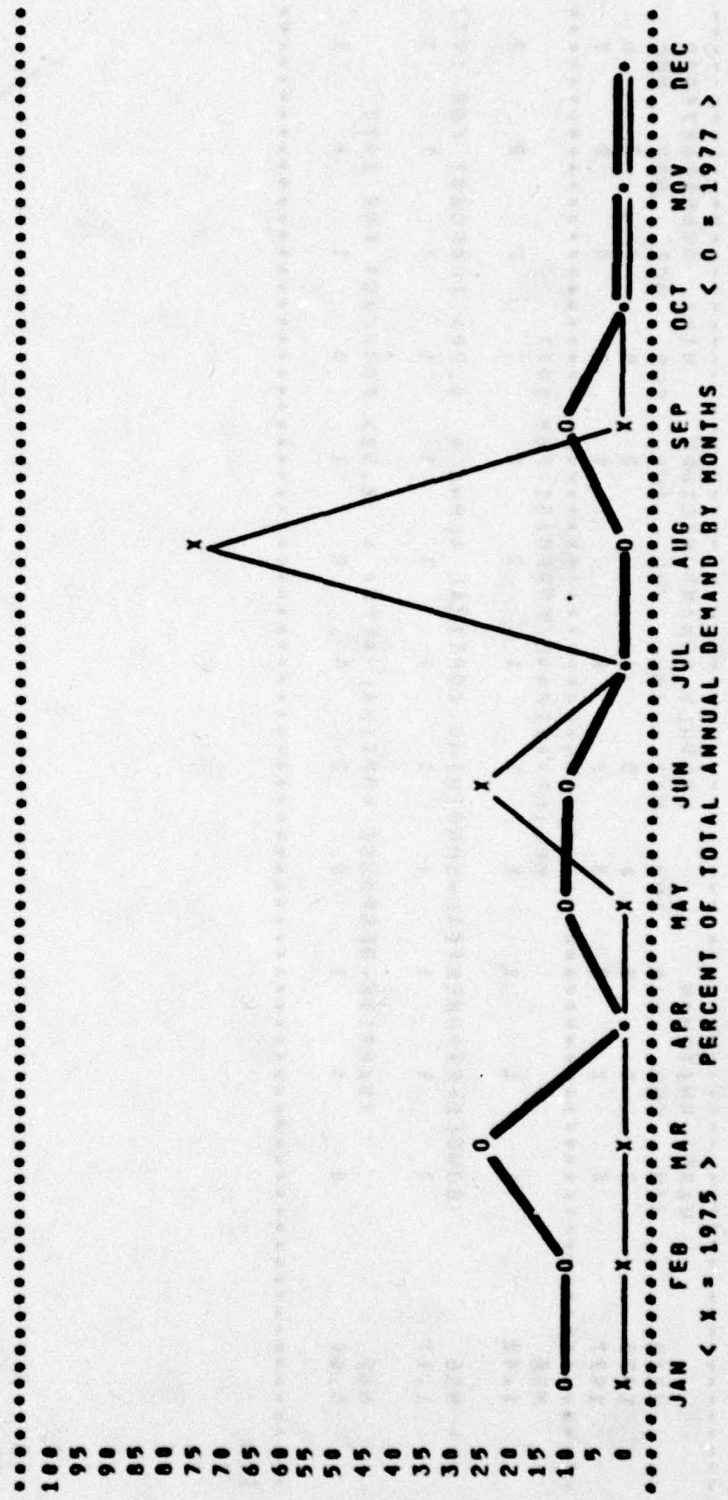
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	1	1	1	1	1	1	1	1	1	1	1	1

MSE 0.42

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

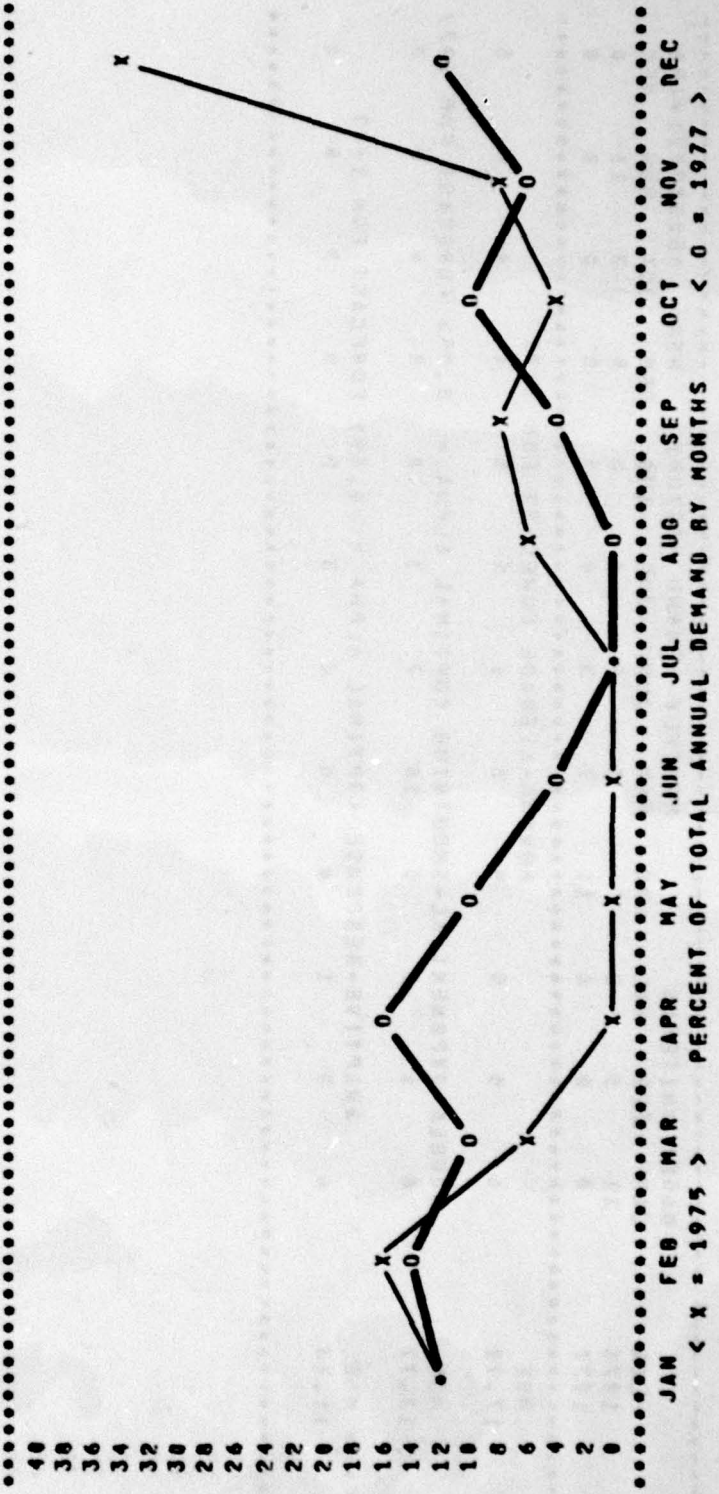
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	1	0	0	0	0	0	0	0



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BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505006070205
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
      1977 6 7 5 0 0 0 0 5 6 4 4 6 25
MSE 12.50 6 6 5 5 6 6 7 7 6 6 6 6
      MOVING-AVERAGE FORECAST FOR 1977
MSE 11.00 7 8 0 0 0 7 7 5 4 4 3 3
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977
MSE 7.50 7 19 6 6 5 5 4 2 0 0 1 3
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

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BASE1 WHITEMAN MONTHLY DEMAND HISTORY NSN: 4505007219121

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	11	5	2	4	3	9	4	0	5	3	11	6
1977	0	0	6	11	7	3	0	0	0	0	0	0

MSE 17.92 6 5 5 5 6 6 6 5 4 4 4 3

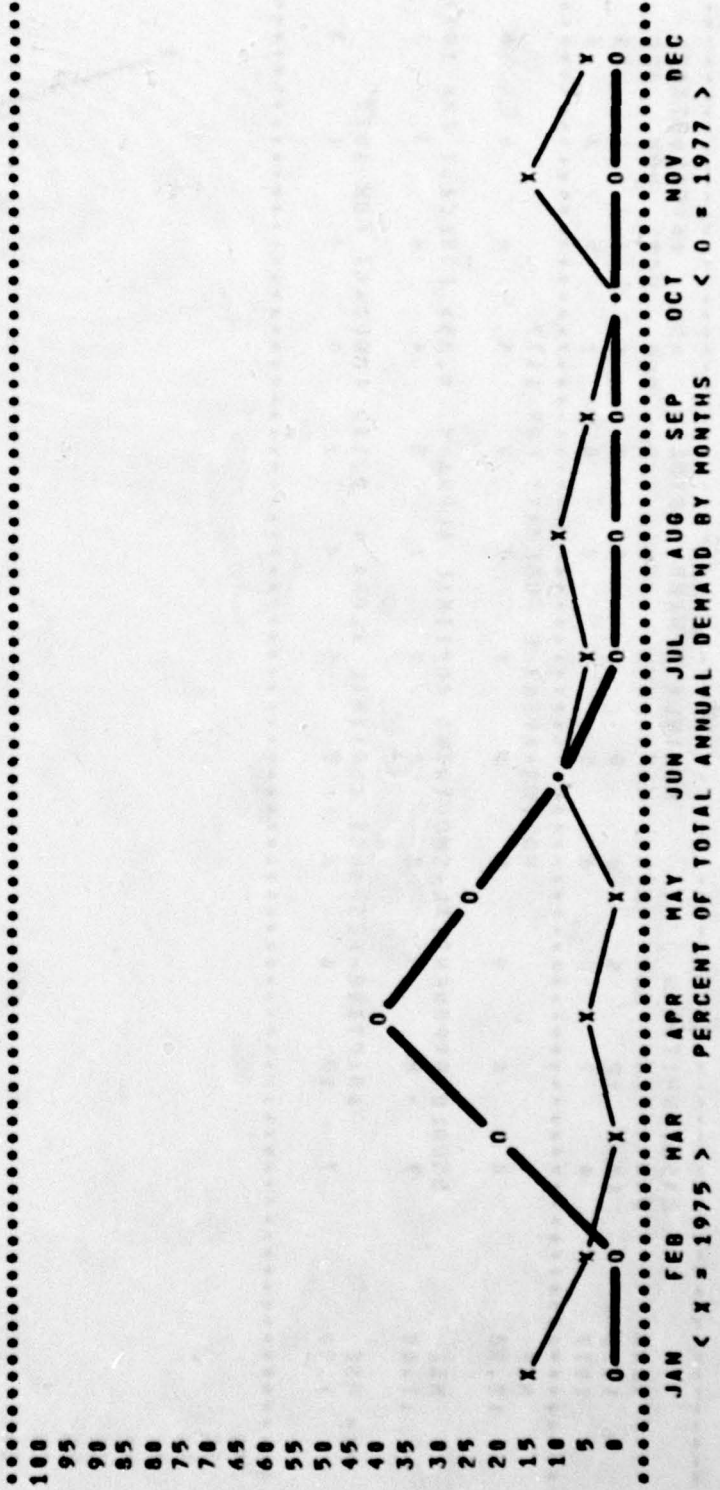
MSE 12.77 6 1 0 5 10 7 3 0 0 0 0 0

MSE 11.83 6 3 1 4 6 6 3 2 0 0 0 0

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977

MOVING-AVERAGE FORECAST FOR 1977



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSM: 65050076J6R21

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	1	2	1	0	0	0	0	0
1977	1	2	2	2	0	0	0	0	1	0	2	0

MOVING-AVERAGE FORECAST FOR 1977

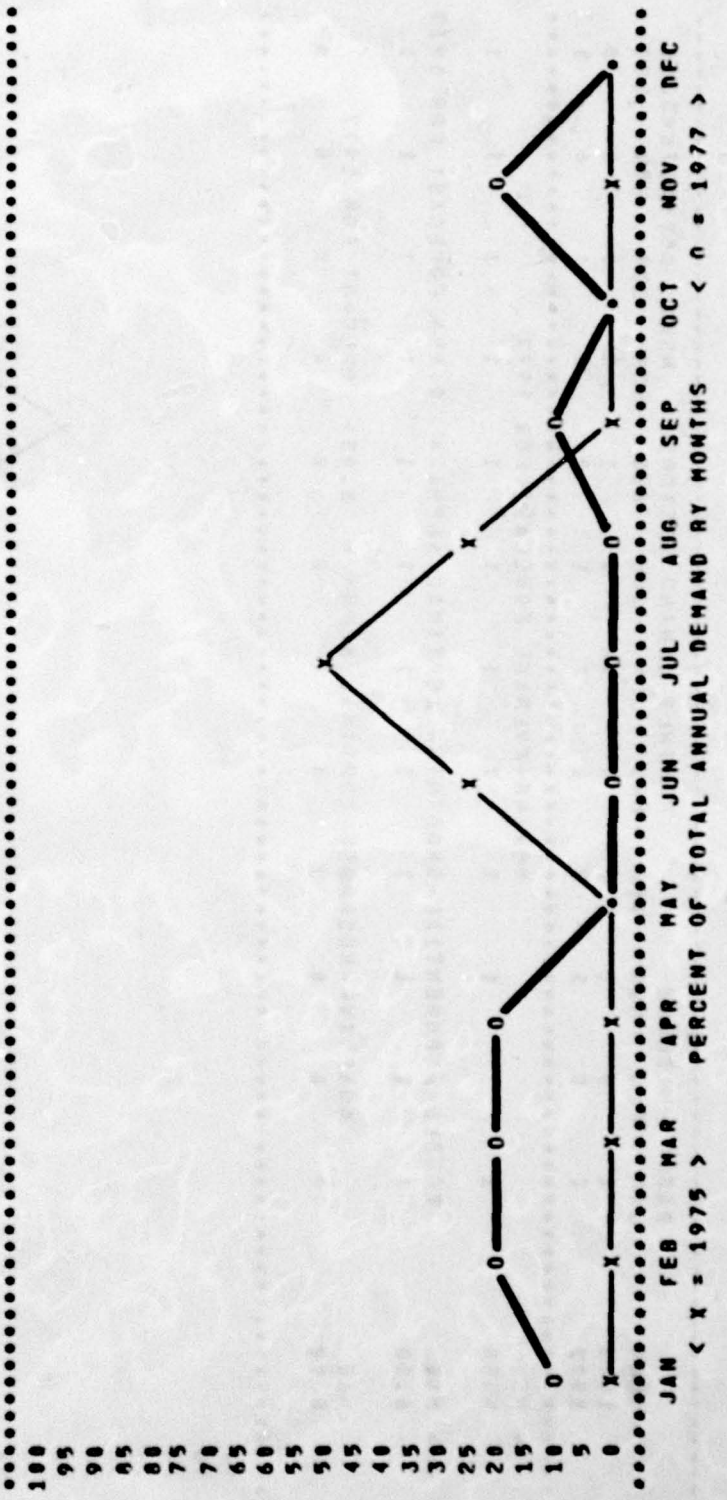
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.17	0	0	1	1	1	1	1	1	1	1	1	1

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.17	0	0	1	1	1	1	1	1	1	1	1	1

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

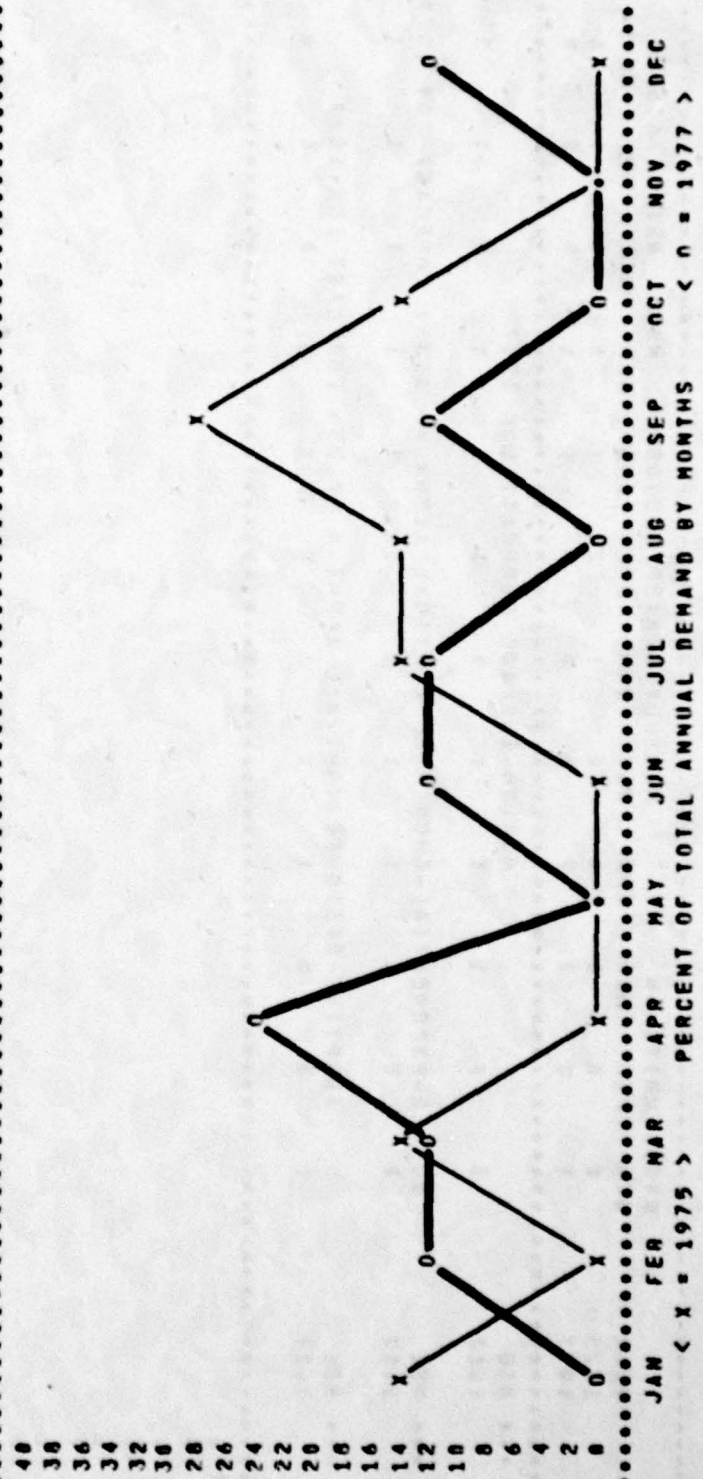
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.17	0	0	0	1	1	1	0	0	0	0	0	0



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.....
BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: A985007643366
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 1 0 1 0 0 0 1 1 2 1 0 0
1977 0 1 1 2 0 1 1 0 1 0 0 1
.....
MSE 0.50 MOVING-AVERAGE FORECAST FOR 1977
1 1 1 1 1 1 1 1 1 1 1 1
.....
MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977
1 1 1 1 1 1 1 1 1 1 1 1
.....
MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
0 0 0 0 0 1 0 0 0 0 0 0
.....

```



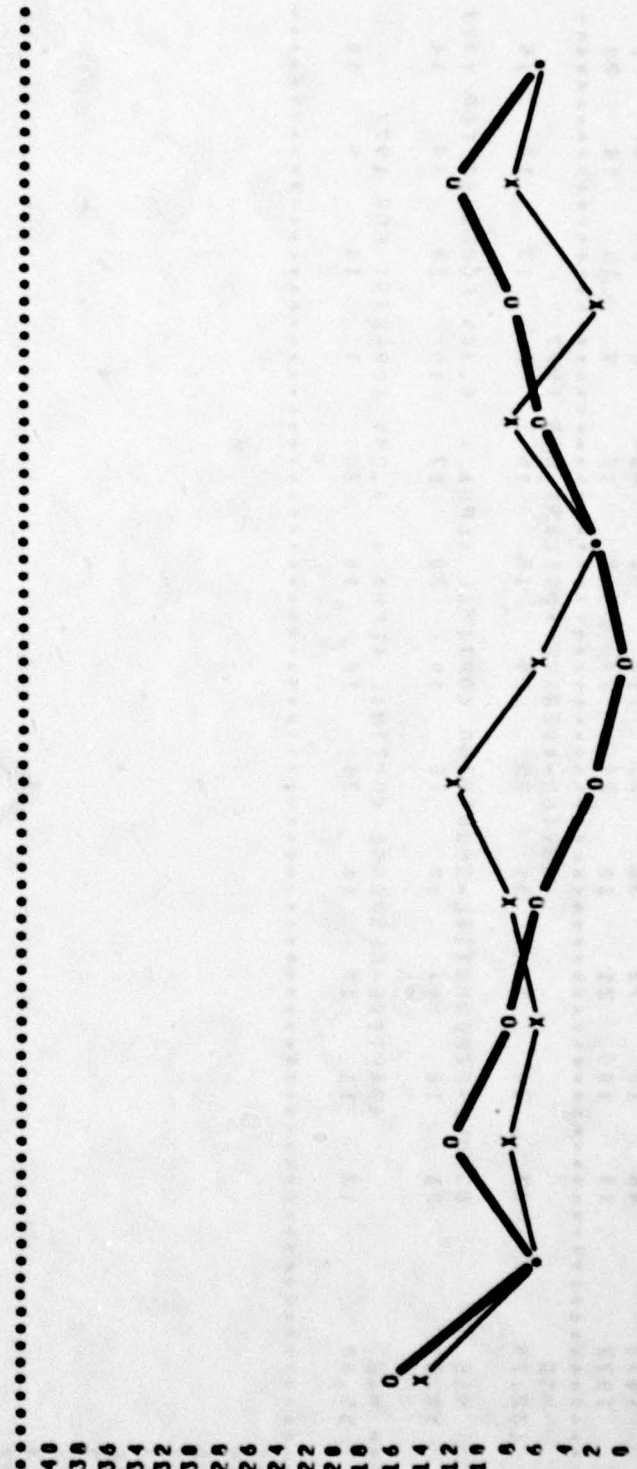
BASE: WHITEMAN MONTHLY DEMAND HISTORY MSM: 6505007826761

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	150	66	96	77	79	120	77	23	84	24	96	72
1977	200	84	156	116	96	36	12	48	96	100	156	96

MSE 3070.50 00 05 07 92 95 96 89 84 86 87 87 94 99

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 2768.17 101 101 101 101 101 101 101 100 100 99 99 99

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977  
 3140.25 07 74 129 04 122 116 114 41 12 47 06 107



PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1975 >  
 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

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BASE: WHITEMAN		MONTHLY DEMAND HISTORY												MSM: 6505000901299
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	48	12	72	36	72	112	32	48	0	0	0	0	12	
1977	14	19	21	18	24	24	0	12	9	18	14	24		
MSE		37	34	35	31	29	25	18	15	12	13	14	15	
		132.75												

MOVING-AVERAGE FORECAST FOR 1977

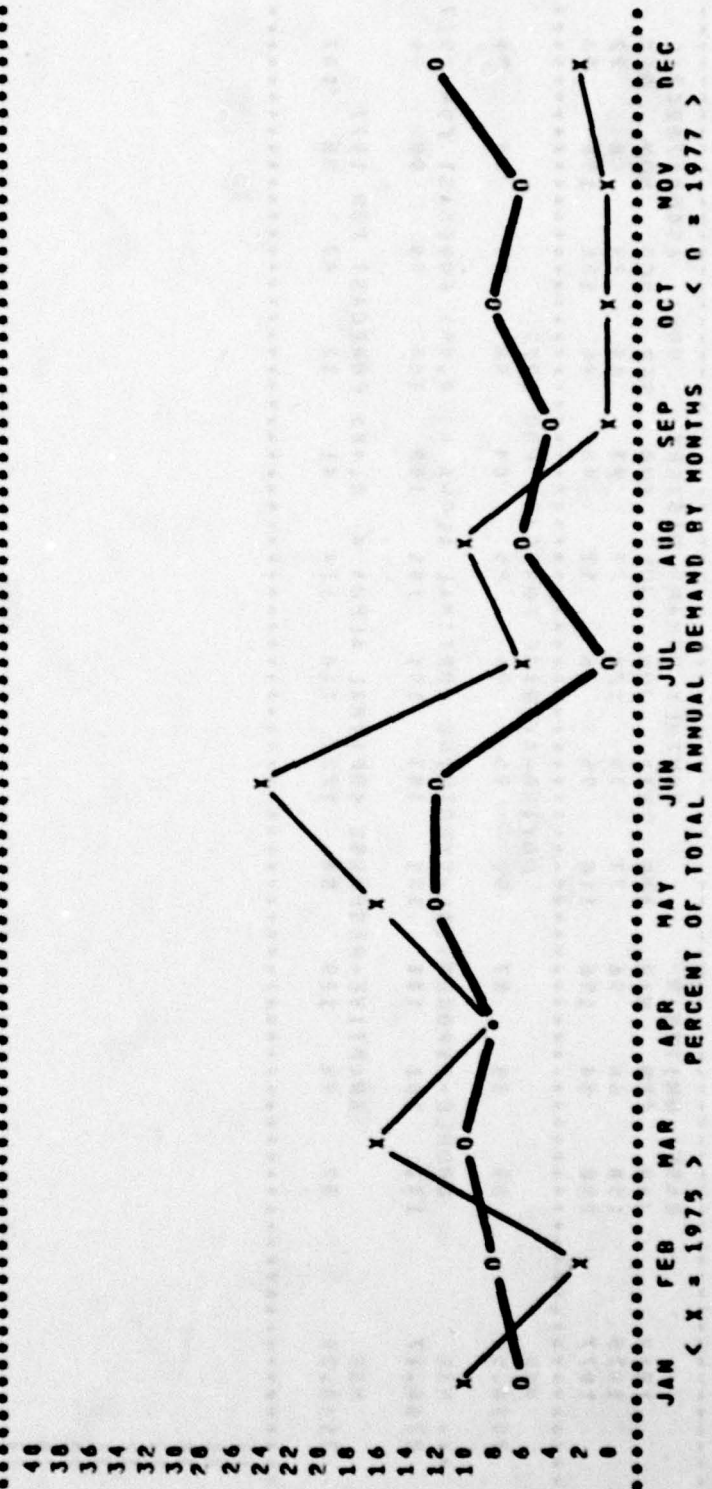
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.48> FORECAST FOR 1977

MSE	21	18	17	17	17	19	20	17	15	14	14	14
-----	----	----	----	----	----	----	----	----	----	----	----	----

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

MSE	12	11	12	16	20	18	18	23	0	10	9	18
-----	----	----	----	----	----	----	----	----	---	----	---	----

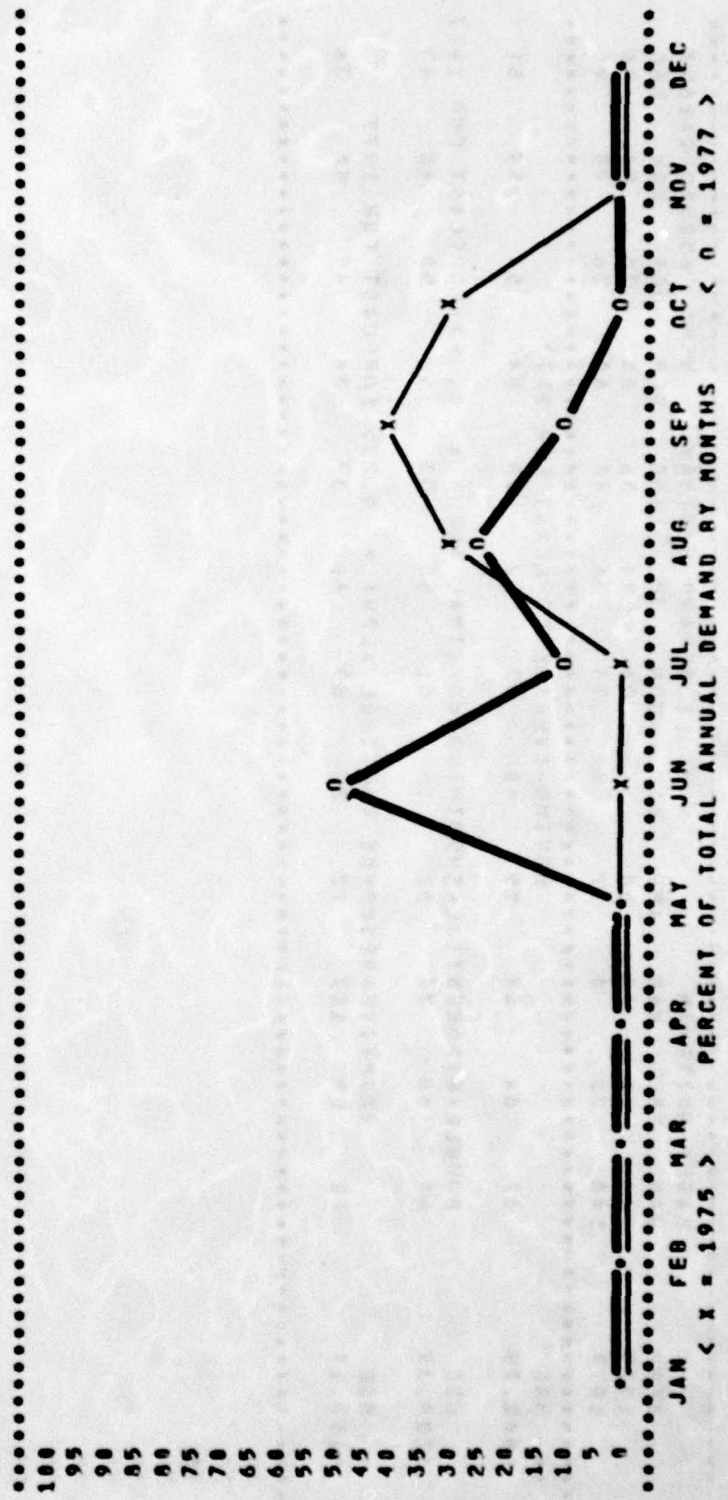
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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 65050009A1573
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 0 0 0 0 0 0 0 6 0 6 0 0
1977 0 0 0 0 0 10 2 5 2 0 0 0
... MSE MOVING-AVERAGE FORECAST FOR 1977
... MSE 0.50 2 2 2 2 2 2 3 3 2 2 2
... MSE 0.92 1 1 1 1 1 1 1 1 1 1 1
... MSE 9.67 1 0 0 0 0 0 0 9 2 2 1
-----
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
-----

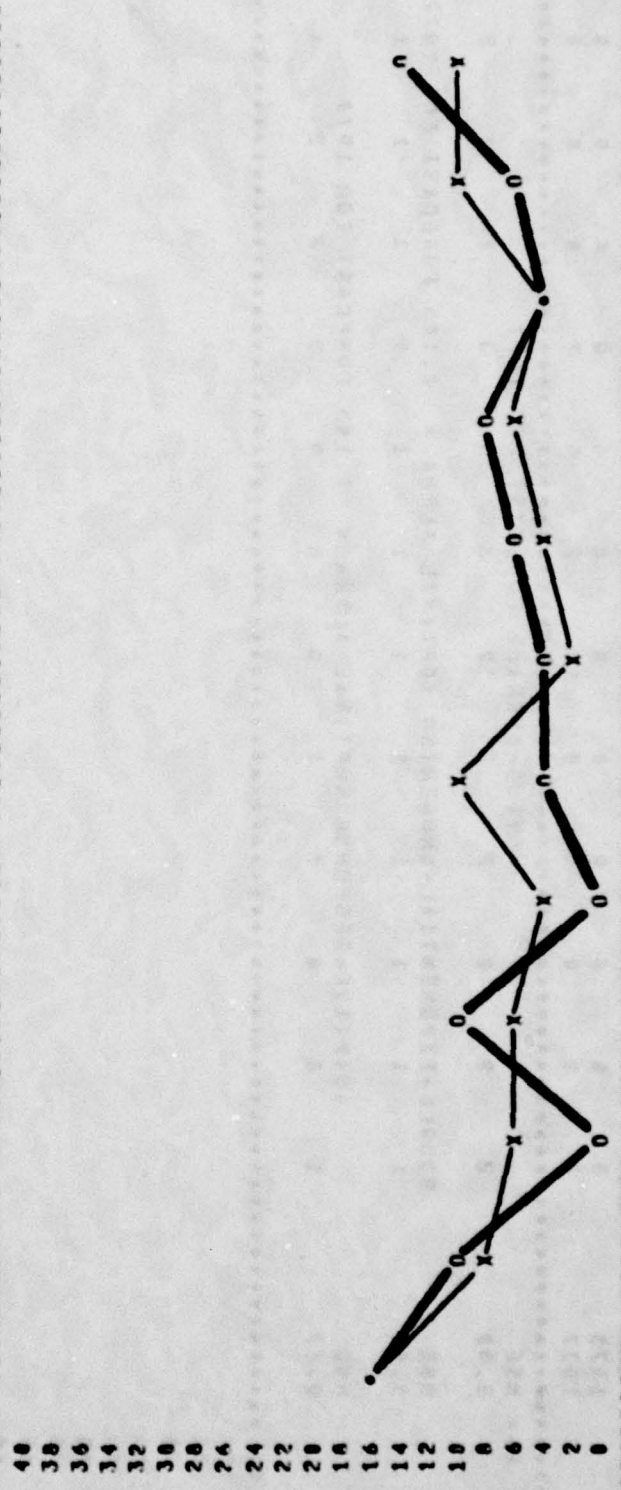
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RASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 4505000901657
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  144  72  60  68  36  96  24  36  68  36  84  96
1977  183  72  8  72  8  36  36  48  68  36  48  96
.....
MSE  1062.75  67  64  64  59  60  57  52  53  54  54  54  51
.....
MSE  1220.33  64  68  70  67  65  61  56  53  50  58  48  48
.....
MSE  1153.17  72  89  107  72  25  69  41  37  36  45  56  36
.....

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.....
JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >
.....

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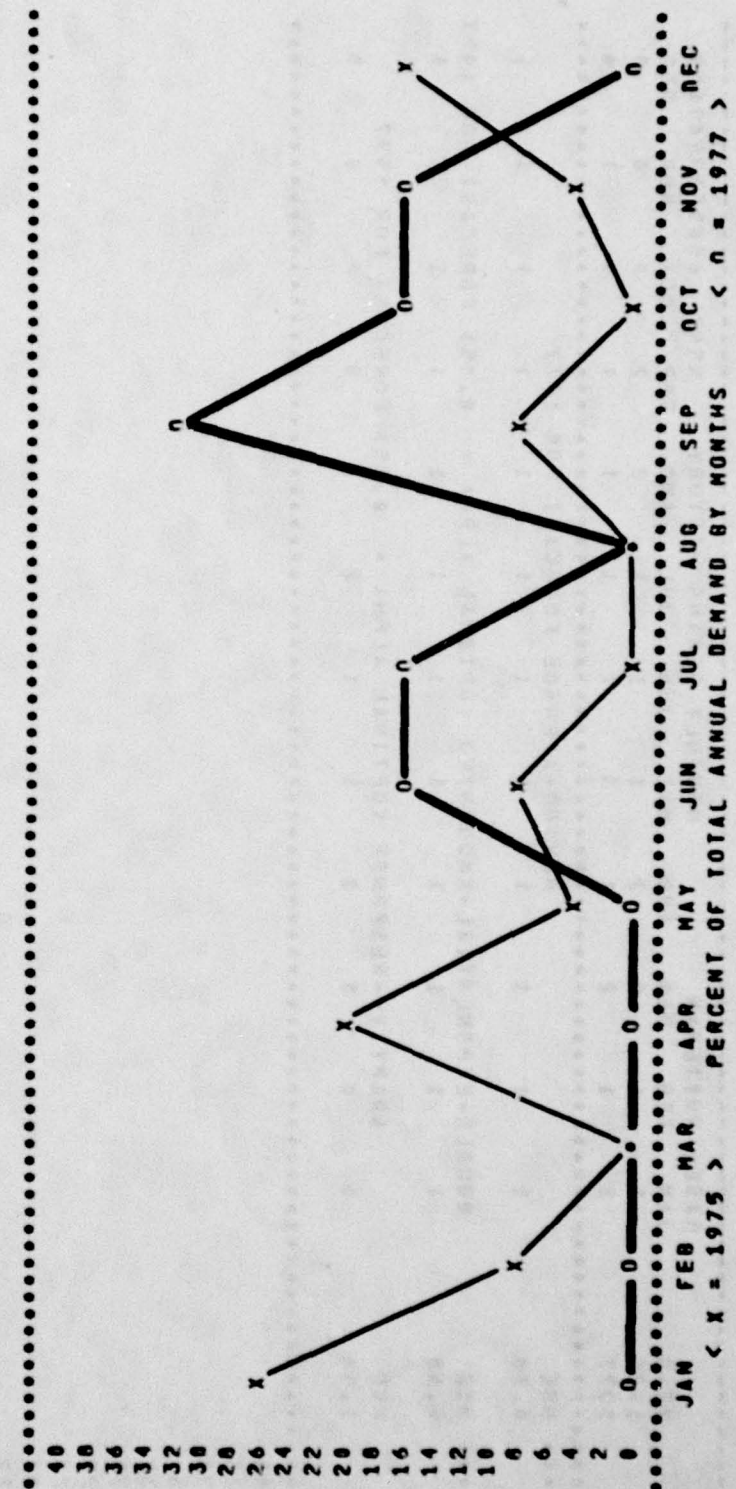
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-----
BASE: WHITEMAN          MONTHLY DEMAND HISTORY  MSN: 6505000901040
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975   6   2   0   5   1   2   0   0   2   0   1   4
1977   0   0   0   0   0   1   1   0   2   1   1   0
MSE    2   1   1   1   1   1   1   1   1   1   1   1
MOVING-AVERAGE FORECAST FOR 1977
.....

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977
MSE    1   1   1   1   1   1   1   1   1   1   1   1
.....

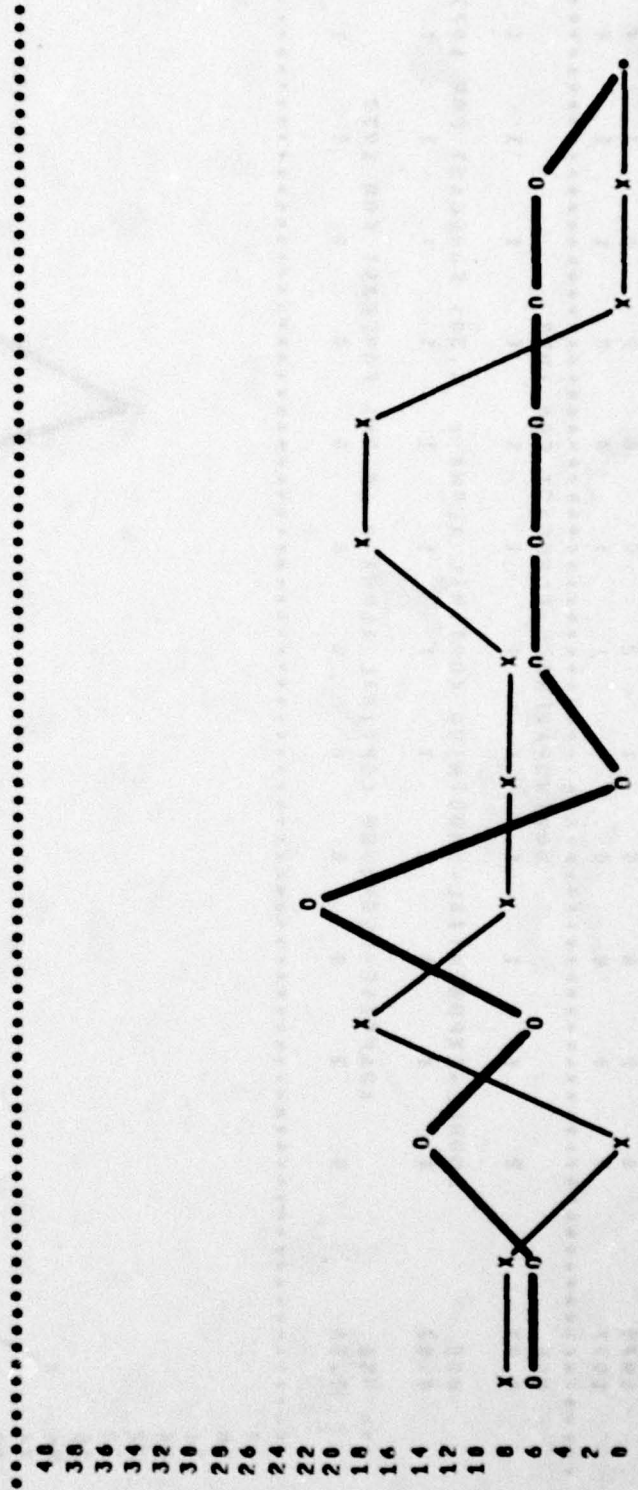
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977
MSE    0   3   0   0   0   0   0   0   0   0   0   1
.....

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RASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505009040119  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SFP OCT NOV DEC  
 1975 1 1 0 2 1 1 1 2 2 0 0 0  
 1977 1 1 2 1 3 0 1 1 1 1 1 0  
 \*\*\* MSE  
 0.50 1 1 1 1 1 1 1 1 1 1 1

MOVING-AVERAGE FORECAST FOR 1977  
 \*\*\*\*\*  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977  
 1 1 1 1 1 1 1 1 1 1 1 1  
 MSE 0 0 0 1 1 2 0 0 0 0 0 0  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 1 1 1 1 1 1 1 1 1 1 1 1



BASE: WHITEMAN		MONTHLY DEMAND HISTORY												NSM: 6505009262241			
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SEP	OCT	NOV	DEC	
1975	24	18	20	12	8	48	18	66	128	36	66	48					
1977	36	30	36	42	18	18	24	24	36	18	36	36					
MSE	40	41	42	43	46	47	45	45	42	35	33	31					

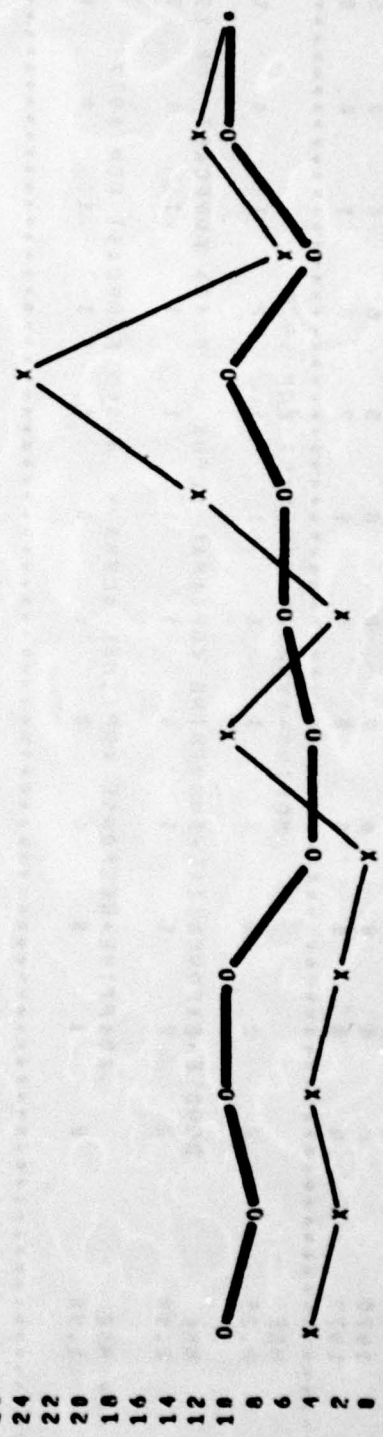
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE	26	28	29	29	30	31	31	31	31	31	32	32	32	32	32	32
-----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

MSE	49	45	40	37	36	40	28	19	23	23	24	18				
-----	----	----	----	----	----	----	----	----	----	----	----	----	--	--	--	--



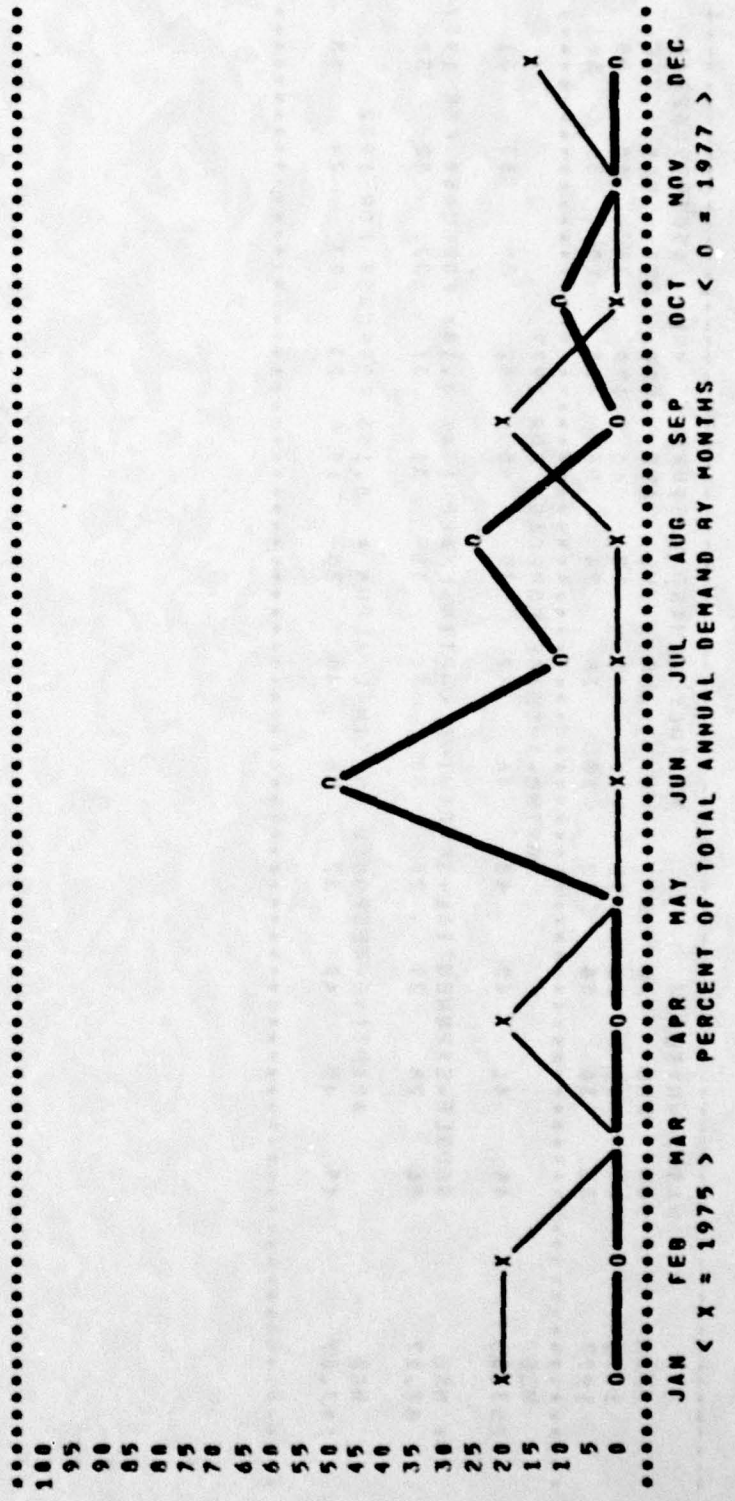
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >

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BASE: WHITEMAN
MONTHLY DEMAND HISTORY MSN: 6505009269089
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
      1977 0 0 0 0 0 0 0 0 0 0 0 0
MSE 2.25 2 2 1 1 1 1 1 1 2 1 1 1 1
MOVING-AVERAGE FORECAST FOR 1977
MSE 2.00 2 2 1 1 1 1 1 1 1 1 1 1
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977
MSE 1.50 0 1 0 0 0 0 0 0 1 1 1 1 0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

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BASE: WHITEMAN MONTHLY DEMAND HISTORY NSM: 6505009269197

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	0	12	6	2	0	0	6
1977	10	5	50	0	0	10	0	0	5	0	3	0

MSE

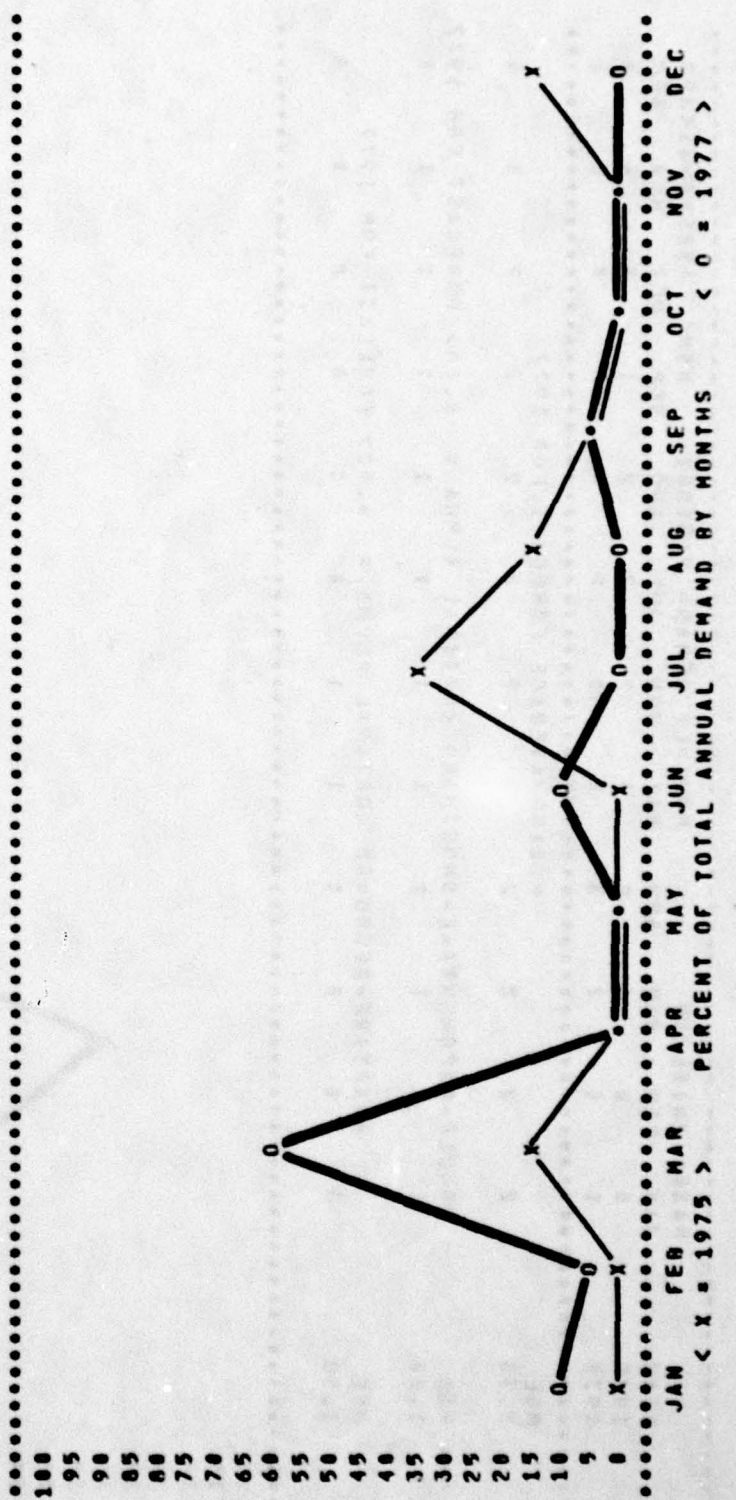
MOVING-AVERAGE FORECAST FOR 1977	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
210.75	3	4	4	0	0	0	0	7	7	7	7	7

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
202.42	2	2	3	3	4	4	4	4	5	5	5	5

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

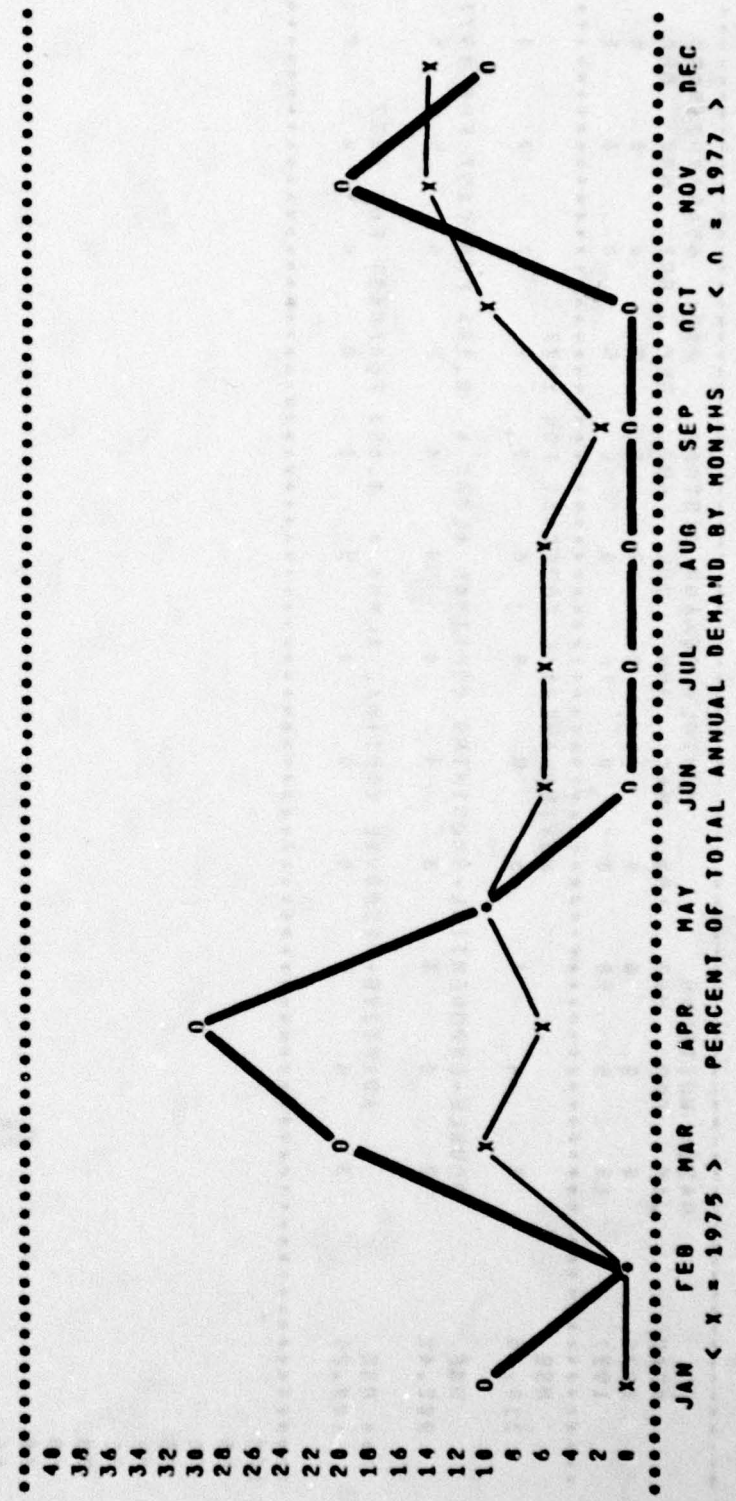
MSE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
109.25	3	0	5	5	0	0	5	0	0	0	0	2



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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505009314329
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1977 0 0 3 2 3 2 2 2 1 3 4 4
1 0 2 3 1 0 0 0 0 0 2 1
.....
MSE 2.33 2 2 2 2 2 2 2 2 2 1 1
.....
MOVING-AVERAGE FORECAST FOR 1977
.....
*** MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
1.00 1 1 1 1 1 1 1 1 1 1 1
.....
MSE 1.50 3 1 0 1 1 1 0 0 0 0 0
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
.....
.....

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AD-A076 922

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL--ETC F/G 15/5  
AN EVALUATION OF SEASONALITY IN THE UNITED STATES AIR FORCE MED--ETC(U)  
SEP 79 V R GILLOTH , J F OHL, W A WELLS  
AFIT-LSSR-13-79B

UNCLASSIFIED

NL

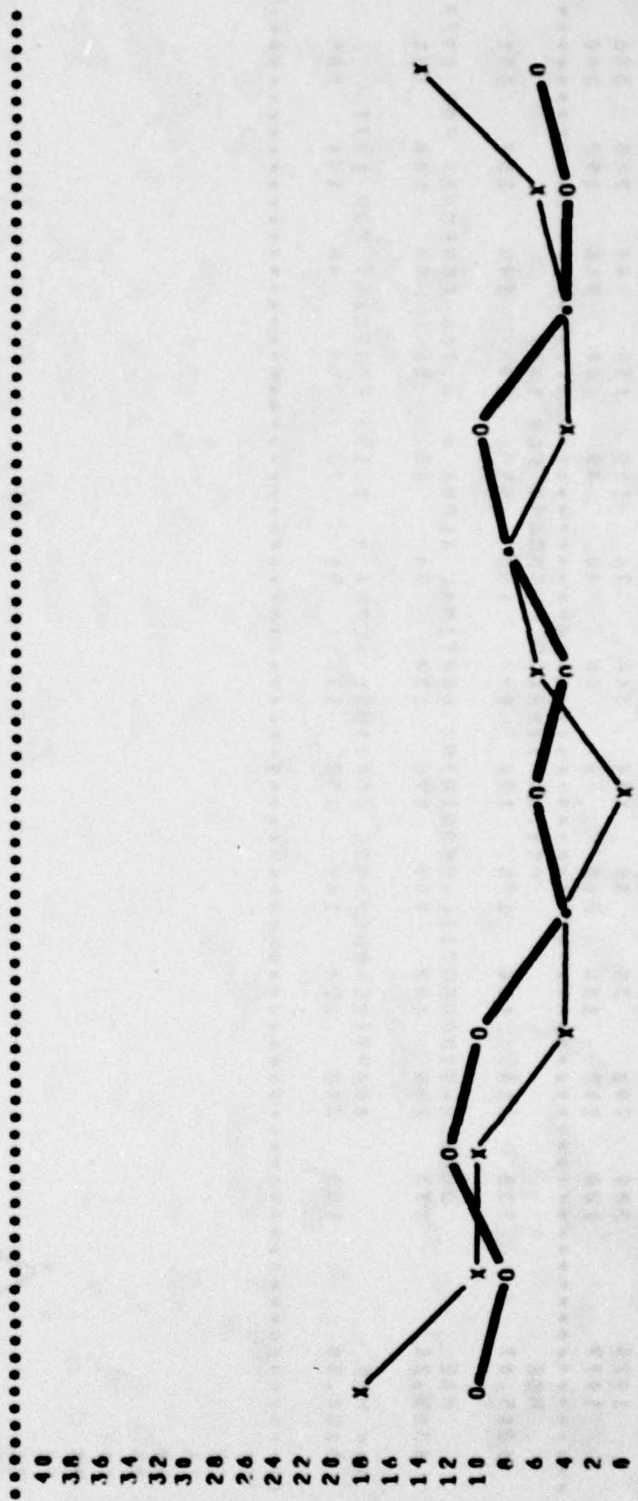
3 OF 3  
AD-  
A076922



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BASE: WHITEMAN          MONTHLY DEMAND HISTORY   MSN: 6505009057301
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  24  14  13  6   7   8  12  5   7   8  18
1977  9   8  12  9   5   6   5   7   9   5   5   6
MSE   10  9   8   8   9   8   9   9   8   9   8   8
      7.42
MSE   10  10  10  10  10  9   8   7   7   7   7   6
      5.42
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
MSE   8   13  9   8   8   8   5   5   5   5   8   5
      4.33
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977
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JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  PFC
< X = 1975 >  PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS  < O = 1977 >
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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 4505009984391

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	20	12	16	26	27	77	12	0	0	0	6
1977	19	20	14	47	6	14	16	11	14	13	20	20

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	18	19	19	19	21	20	19	14	13	15	16	17

MSE 100.00

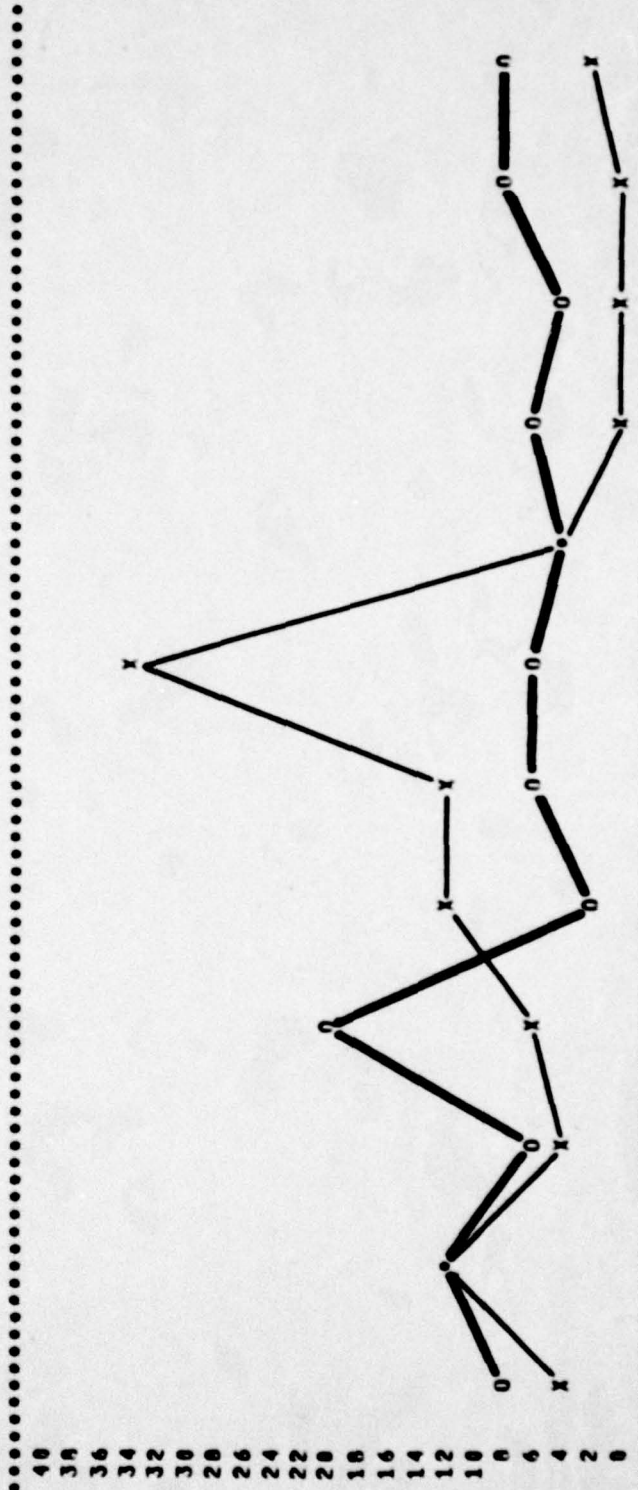
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	18	18	18	18	18	18	18	18	18	18	18	18

MSE 153.00

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	5	16	27	14	31	10	12	12	11	11	12



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

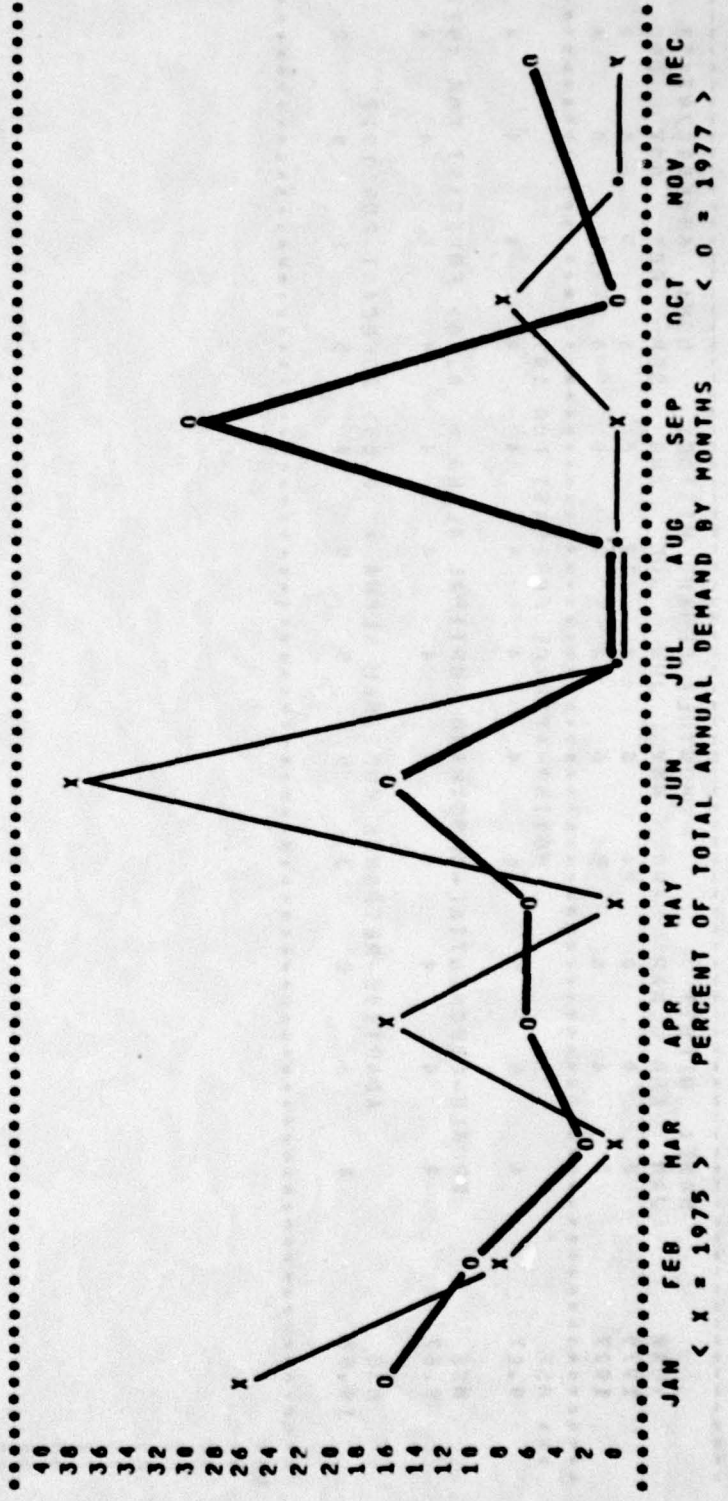
APPENDIX F

COMPUTER PRODUCTS, NONSEASONAL (OFFUTT)

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BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSN: 4505000716547
YEAR 1975      JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
      6         2         0         4         0         9         0         0         0         2         0         0
      5         3         1         2         2         5         0         0         9         0         0         2
MSE   2         2         2         2         2         2         2         2         2         2         2         2
      7.00
MOVING-AVERAGE FORECAST FOR 1977
.....
MSE   3         3         3         3         3         3         3         2         2         2         2         2
      7.00
DOURLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....
MSE   0         0         3         3         1         1         1         4         0         0         0         7
      11.50
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977
.....

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BASE: OFFUTT MONTHLY DEMAND HISTORY HSN: 6505000797453

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	24	0	0	12	0	6	9	0	0
1977	3	6	6	5	6	0	9	0	0	7	0	6

MOVING-AVERAGE FORECAST FOR 1977

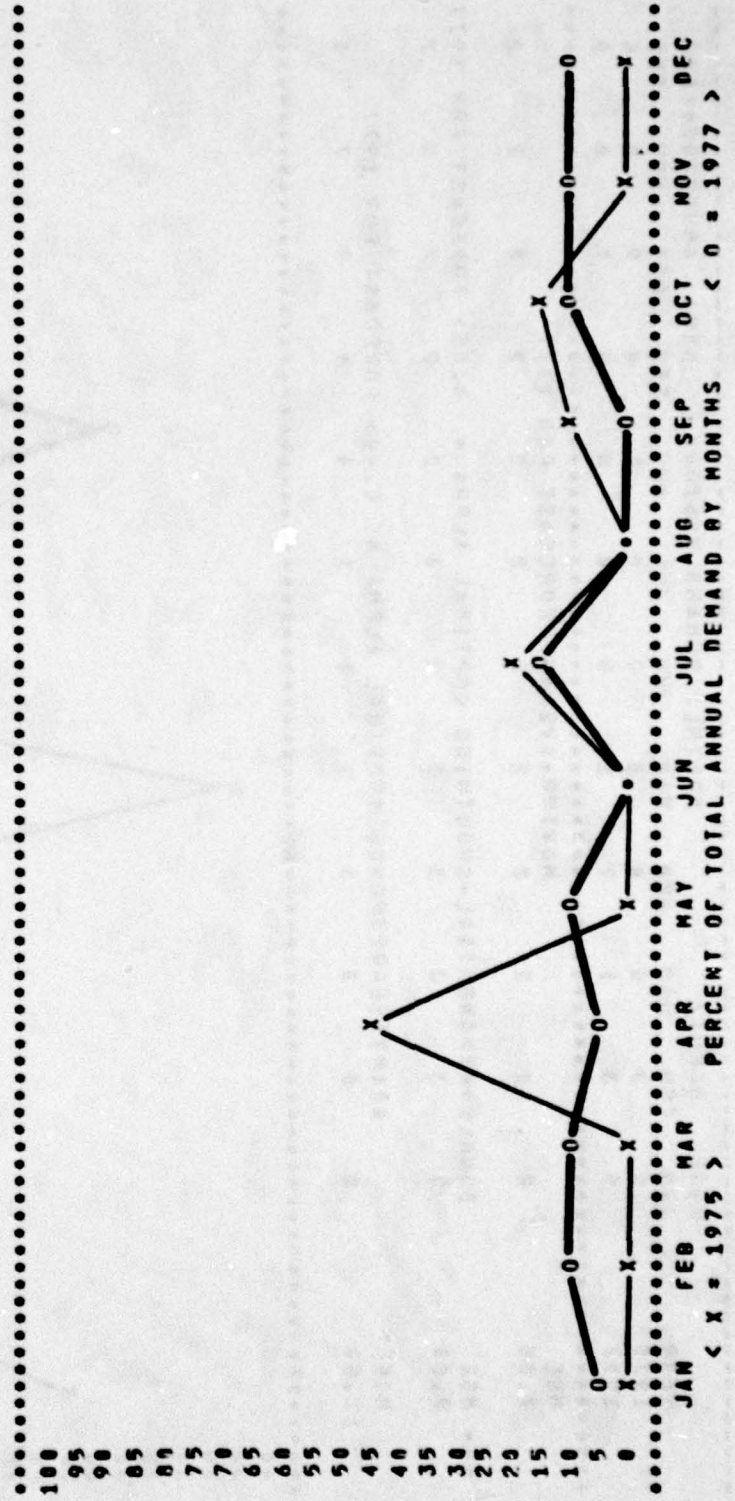
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	4	5	5	6	4	4	4	4	4	4	4	4

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	4	4	4	4	4	4	4	4	4	4	4	4

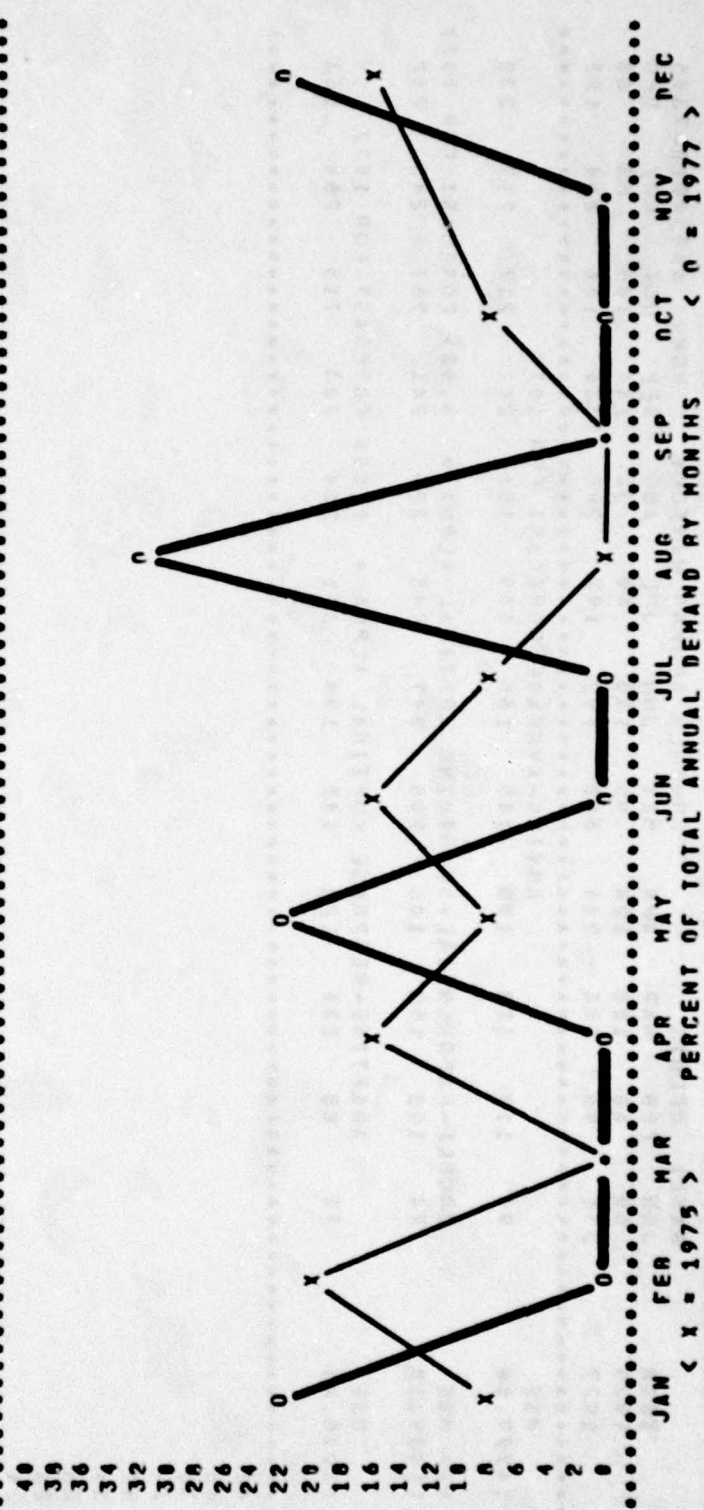
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	0	0	3	5	5	5	0	5	1	0	2



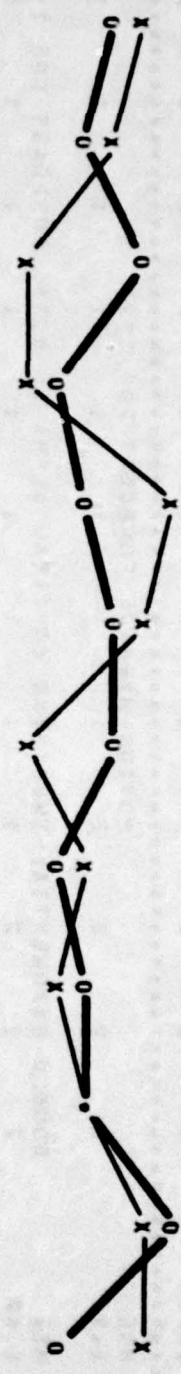
BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505000093424

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	5	0	4	2	4	2	0	0	2	0	4
1977	2	0	0	0	2	0	0	3	0	0	0	2
MSE	MOVING-AVERAGE FORECAST FOR 1977											
1.92	2	2	2	2	1	1	1	1	1	1	1	1
...	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977											
MSE	2	2	2	1	1	1	1	1	1	1	1	1
1.67	...											
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977											
1.83	2	0	1	0	0	0	0	0	0	2	0	0



BASE: OFFUTT		MONTHLY DEMAND HISTORY												NSM: 65050010A7395
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975	68	68	100	120	96	149	60	36	144	145	84	60		
1977	336	96	200	240	342	192	192	200	336	144	264	192		
MSE	MOVING-AVERAGE FORECAST FOR 1977													
14779.00	94	117	120	135	145	165	169	180	201	217	217	232	232	
*** MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977													
11439.17	94	152	152	186	200	247	243	229	241	267	243	242	242	
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977													
13946.00	75	88	236	122	145	194	301	204	203	215	204	163	163	

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 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 < X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < 0 = 1977 >  
 .....

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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001153205

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	16	8	6	8	11	2	8	8	0	12	6
1977	8	1	8	8	6	2	5	8	2	4	6	1

MSE 10.42

MOVING-AVERAGE FORECAST FOR 1977

	3	4	5	6	
MSE	6	5	4	4	3

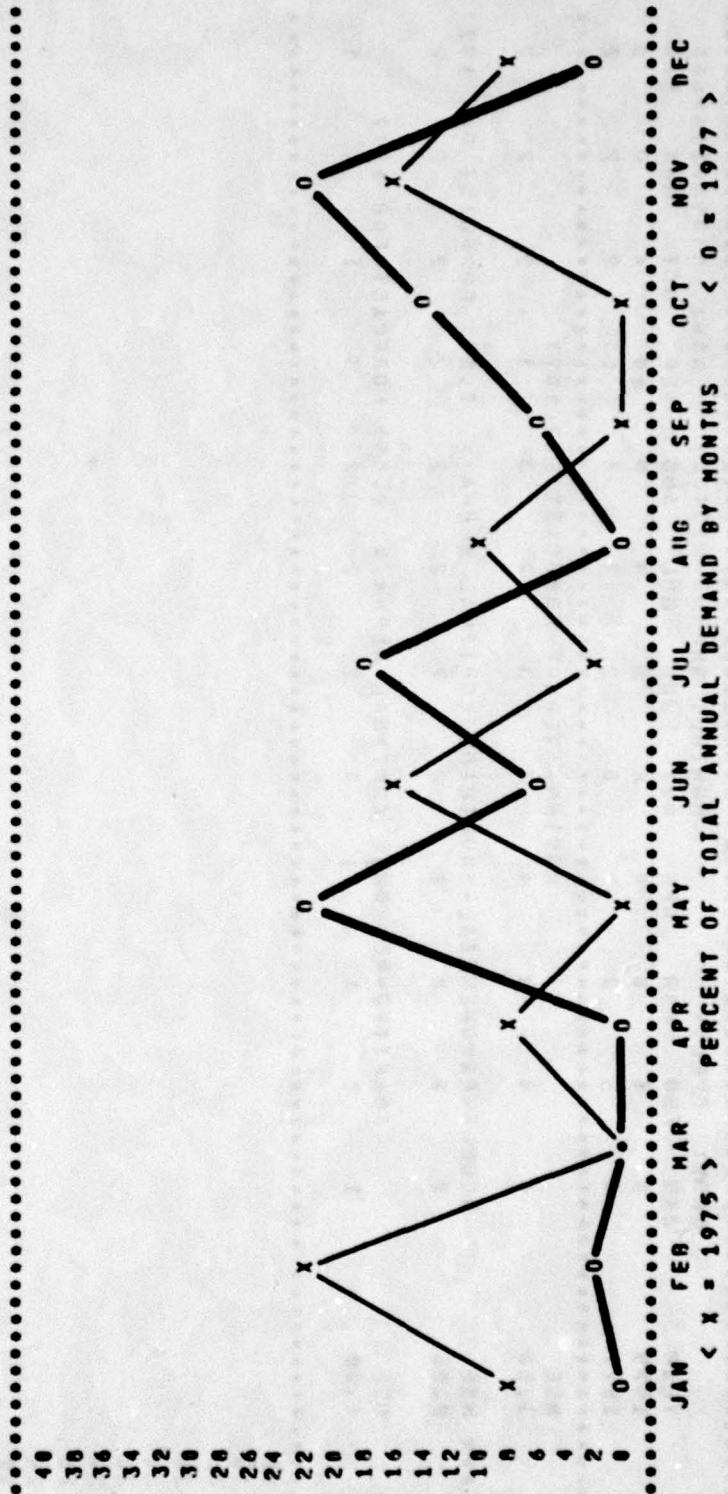
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

	3	4	5	
MSE	5	4	4	3

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

	1	2	3	4
MSE	4	5	8	0

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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001169668

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	0	4	6	8	4	0	10	4	0	0
1977	3	1	2	6	6	2	2	4	1	2	2	2

MSE 3.50

MOVING-AVERAGE FORECAST FOR 1977

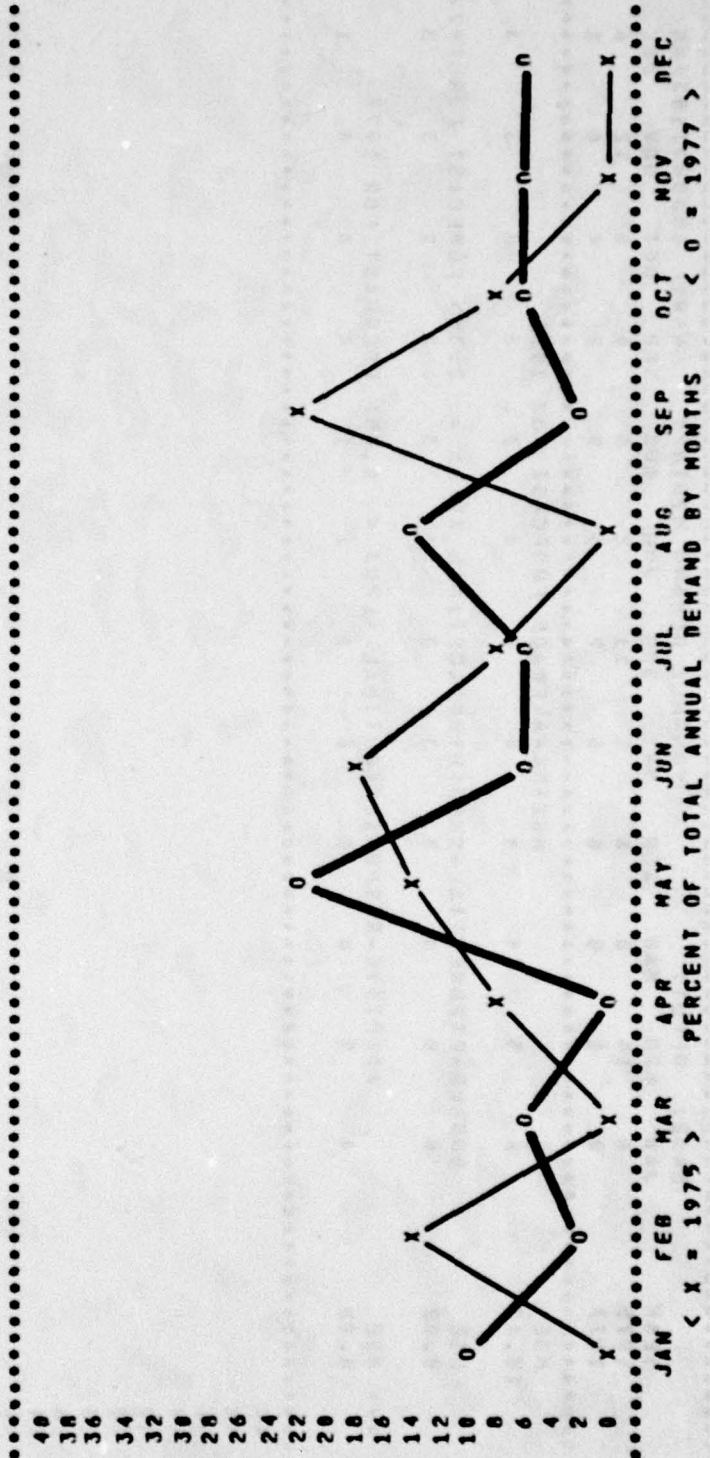
MSE	4	3	4	3	3	3	2	2	2
3.50	4	3	4	3	3	3	2	2	2

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	2	2	2	2	2	2	2	2	2
2.25	2	2	2	2	2	2	2	2	2

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.55> FORECAST FOR 1977

MSE	1	2	1	1	0	2	2	3	1	1
4.50	1	2	1	1	0	2	2	3	1	1



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BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 6505001199321

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	9	0	0	3	3	4	3	0	0	1	7	2
1977	21	17	13	15	32	16	8	16	23	14	19	17

MSE 115.00

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	3	4	6	7	8	10	11	12	12	14	15	16

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

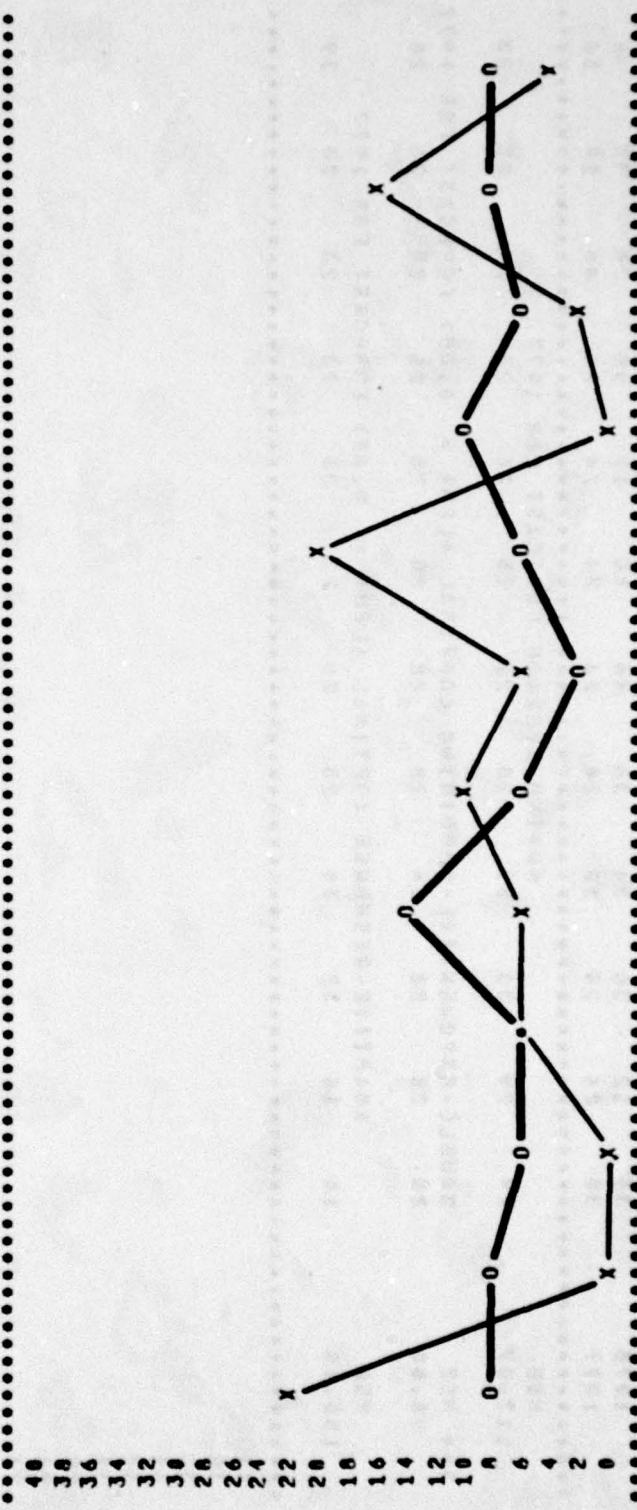
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	3	11	14	14	15	22	20	15	15	18	17	18

MSE 79.00

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	1	19	17	15	15	24	16	13	15	16	14	14

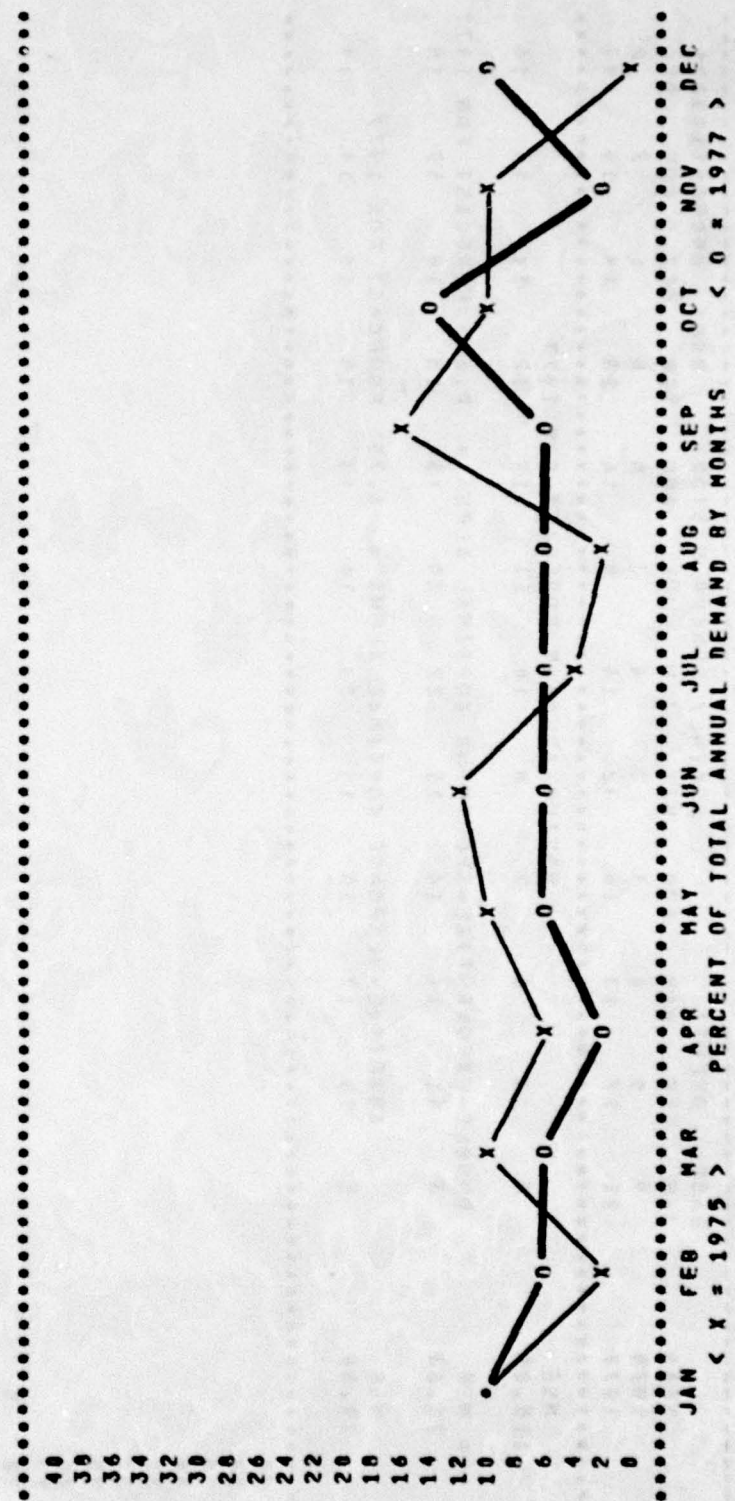
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BASE: OFFUTT
MONTHLY DEMAND HISTORY
YEAR 1975 1977
JAN 36 36
FEB 12 24
MAR 36 24
APR 24 12
MAY 36 24
JUN 44 24
JUL 16 24
AUG 12 24
SEP 58 24
OCT 36 48
NOV 36 12
DEC 0 36
MSE 112.67
MOVING-AVERAGE FORECAST FOR 1977
29 29 30 29 28 27 25 26 27 24 25 23
-----
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
MSE 96.00
28 28 28 28 28 28 28 28 28 28 28 28
-----
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
MSE 155.00
16 16 32 30 28 20 23 23 23 23 23 39
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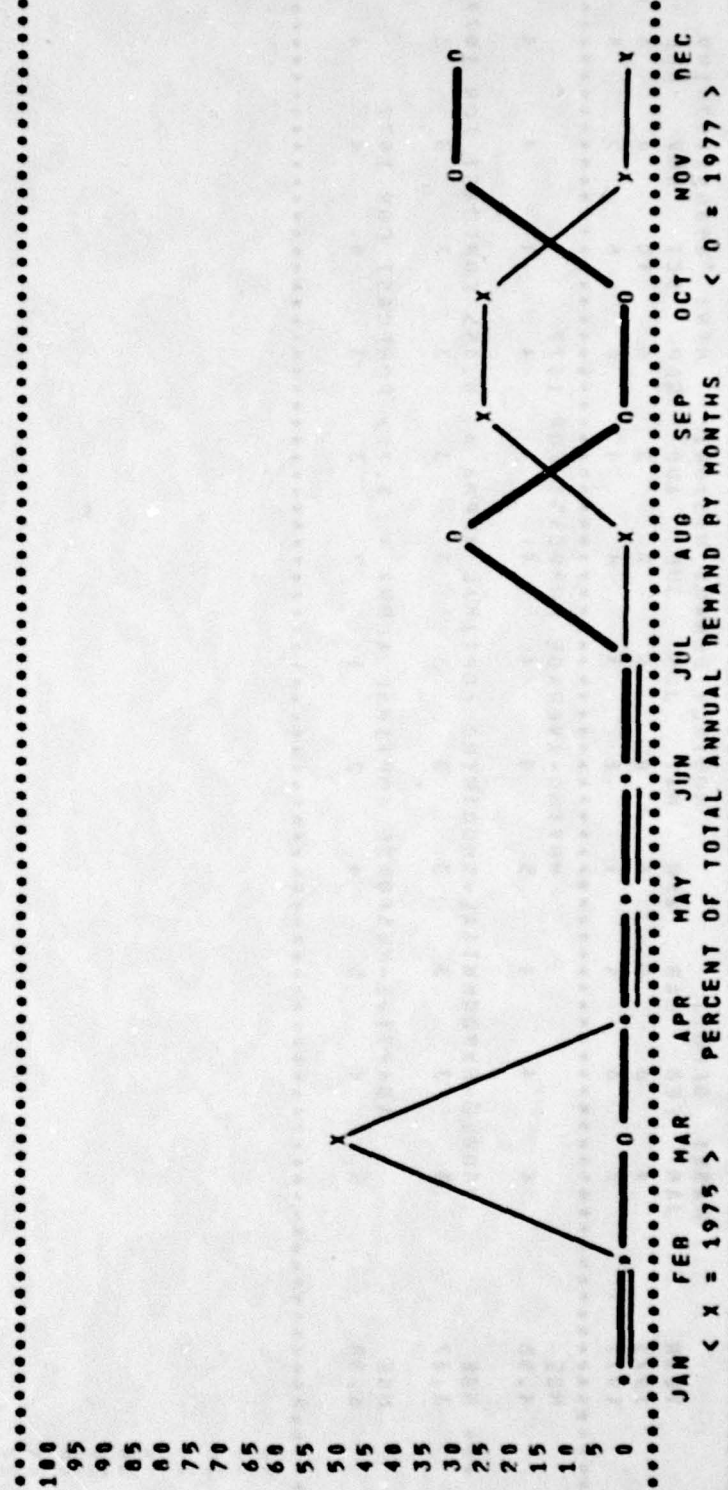
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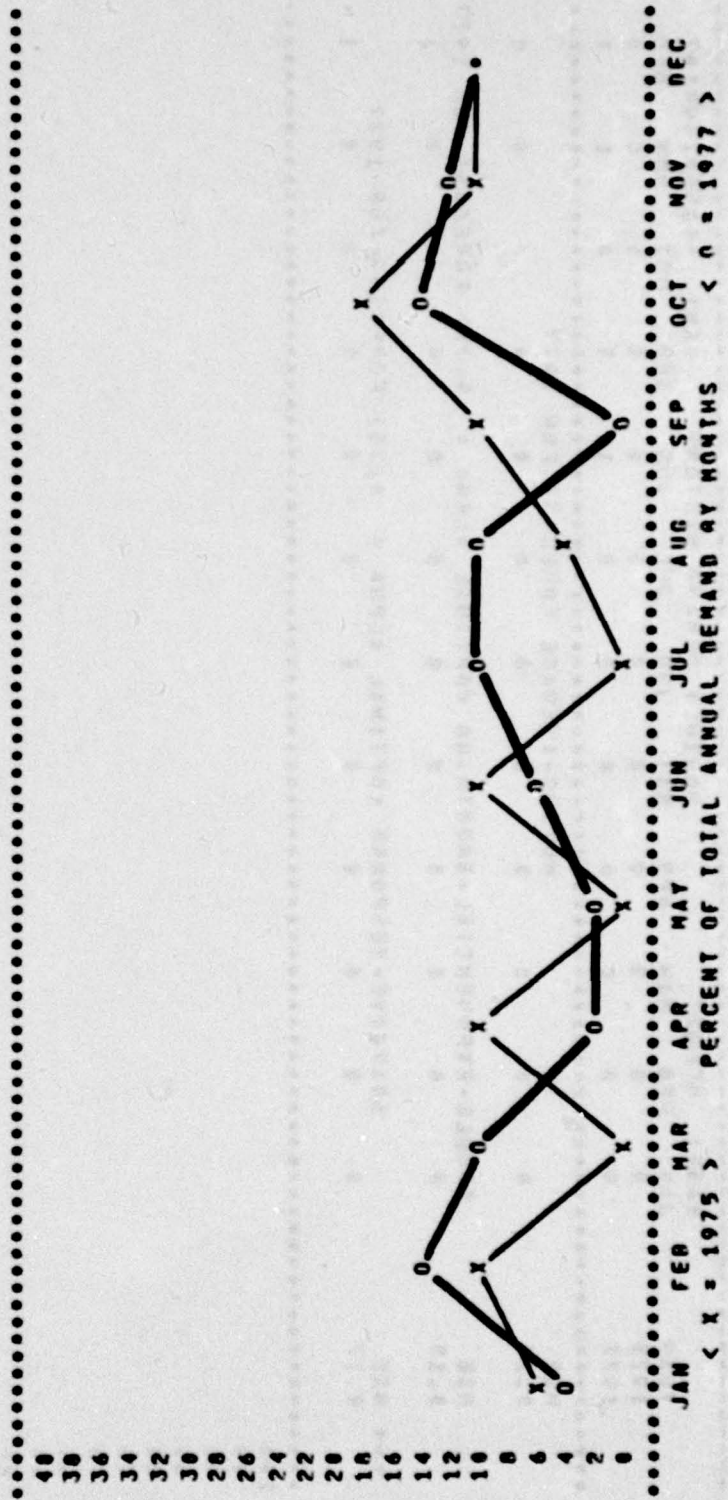
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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001490107
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
      1977 0 0 2 0 0 0 0 0 0 1 1 0 0 0
MSE 0.25 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      MOVING-AVERAGE FORECAST FOR 1977
MSE 0.18 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977
MSE 0.17 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

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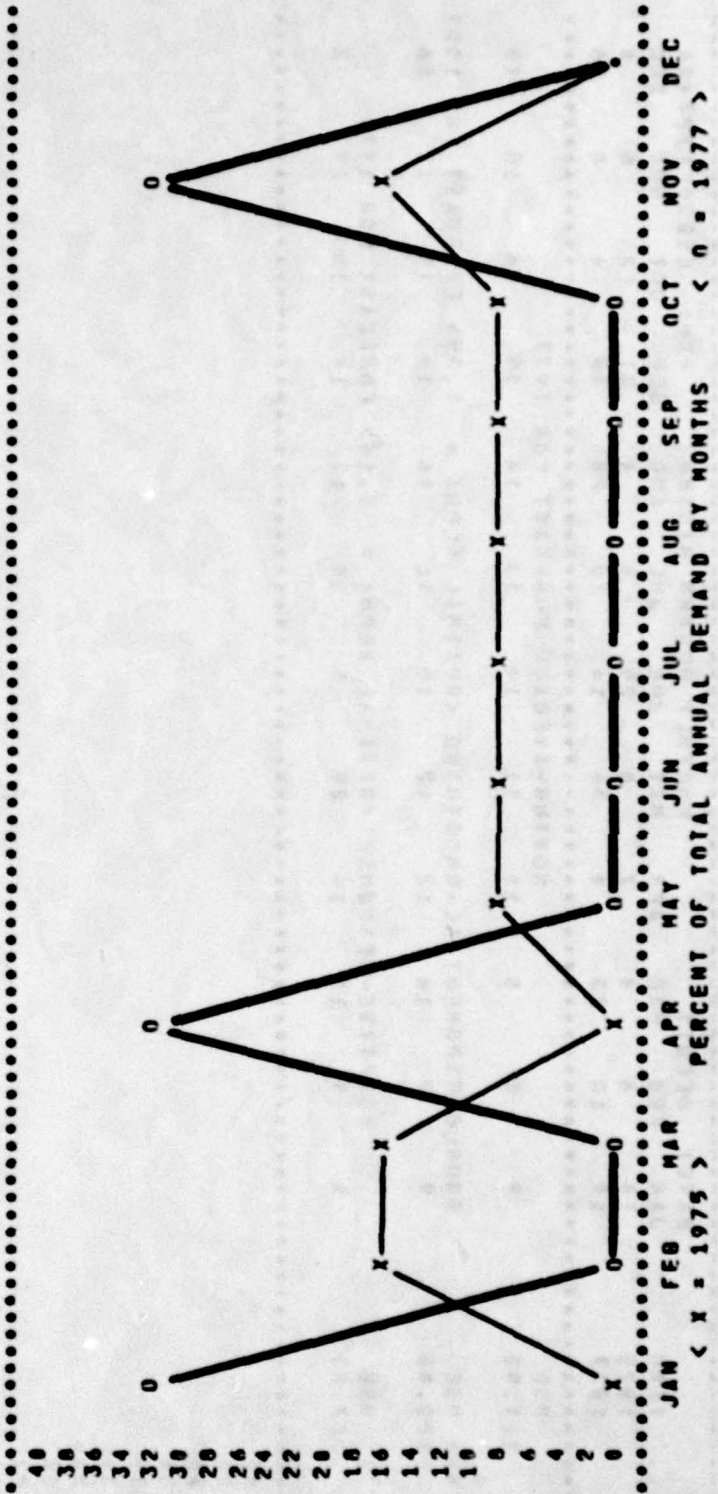
BASE: OFFUTT		MONTHLY DEMAND HISTORY MSN: 650500153A199											
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	4	6	8	6	8	6	8	3	6	18	6	6	
1977	2	6	4	1	1	3	4	4	8	6	5	4	
MSE	MOVING-AVERAGE FORECAST FOR 1977												
4.50	4	4	4	5	4	4	4	4	4	4	4	4	4
...	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977												
3.67	3	3	3	3	3	3	3	3	3	3	3	3	3
...	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.70> FORECAST FOR 1977												
6.50	5	4	5	4	2	1	2	3	3	3	4	4	4



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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 4505001594893
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC DFC
1977 1 0 0 1 0 0 0 0 0 0 0 1 0
MSE 0.67 1 1 1 1 1 1 1 1 1 1 1 0 0
MOVING-AVERAGE FORECAST FOR 1977
MSE 0.33 1 1 1 1 1 1 1 1 1 1 1 0 0
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
MSE 0.25 0 0 0 0 0 0 0 0 0 0 0 0 0
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

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BASE1 OFFUTT MONTHLY DEMAND HISTORY MSN: 6505001723420

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	18	6	4	7	0	25	0	4	21	12	6	0
1977	14	18	23	4	36	16	10	20	30	4	8	16

MSE 121.92

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	9	0	9	11	11	14	13	14	15	16	15	15

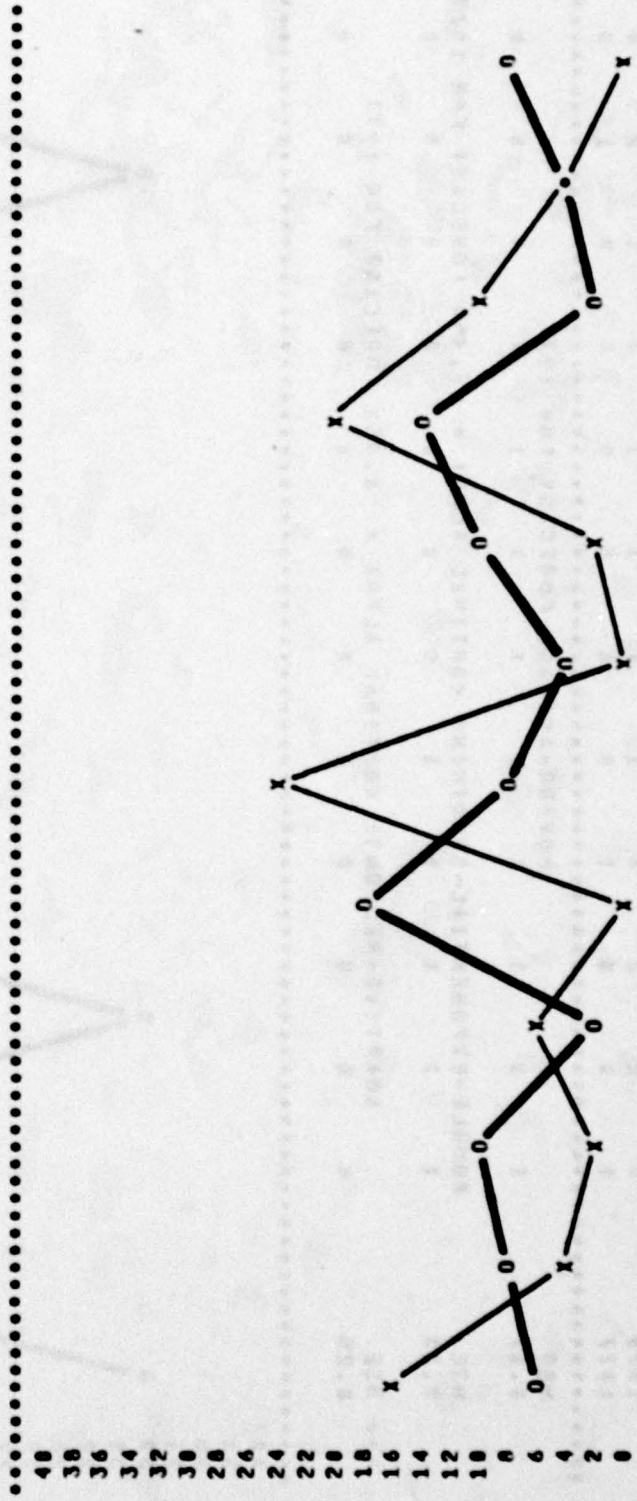
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	9	9	10	12	12	15	16	16	16	16	17	16

MSE 167.83

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	5	5	11	14	20	5	20	17	14	15	20	6



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 < X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505002001641

YEAR	JAN	FEB	MAR	APP	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	12	0	0	0	0	0	0
1977	8	10	7	4	0	5	0	4	12	0	6	7

MSE 19.03 2 2 3 4 4 5 4 4 5 6 5 5 5

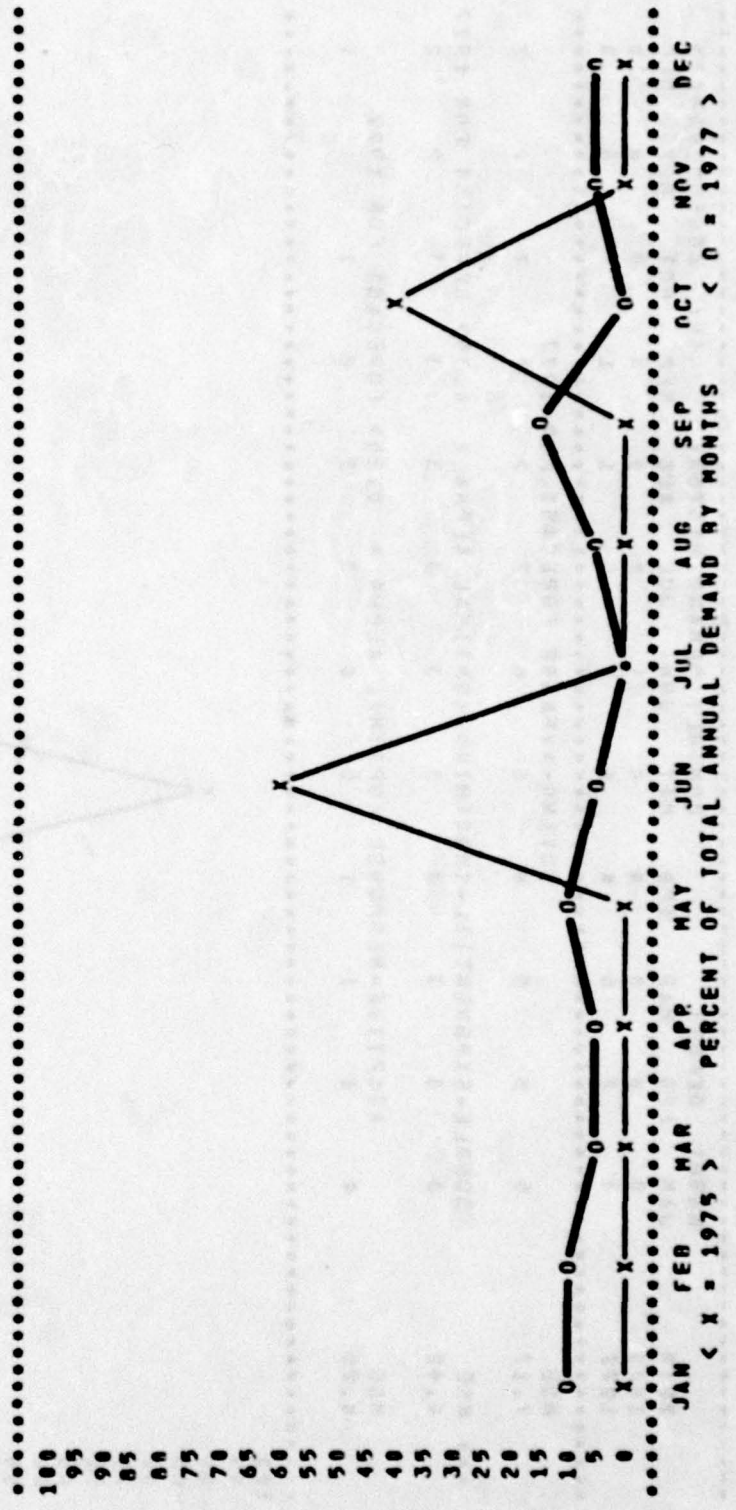
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

MSE 10.33 2 3 4 5 5 6 5 5 5 5 5 5

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE 20.00 0 0 0 0 7 5 5 5 2 3 3 0



BASE1 OFFUTT MONTHLY DEMAND HISTORY MSNI 6505002904433

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	4	51	0	0	0	0	0	0
1977	3	2	6	0	6	2	5	1	1	1	0	0

MSE 7.17

MOVING-AVERAGE FORECAST FOR 1977

MONTH	FORECAST
JAN	5
FEB	5
MAR	5
APR	6
MAY	6
JUN	6
JUL	2
AUG	2
SEP	2
OCT	2
NOV	2
DEC	2

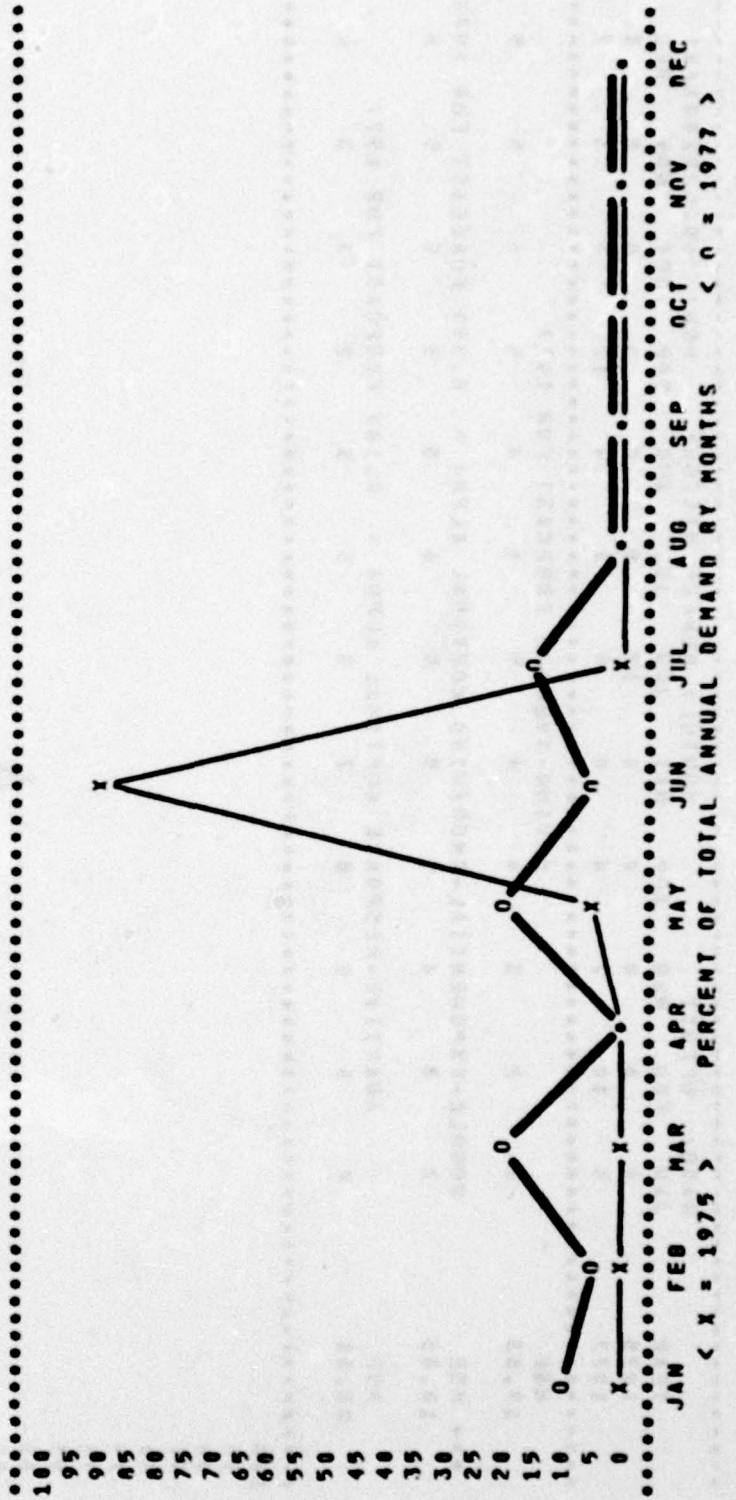
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977

MONTH	FORECAST
JAN	3
FEB	3
MAR	3
APR	3
MAY	3
JUN	3
JUL	3
AUG	3
SEP	3
OCT	3
NOV	2
DEC	2

MSE 4.42

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

MONTH	FORECAST
JAN	0
FEB	0
MAR	1
APR	1
MAY	5
JUN	0
JUL	3
AUG	3
SEP	2
OCT	2
NOV	1
DEC	1



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YEAR	MONTHLY DEMAND HISTORY												MSM: 4505004007294
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975	6	2	4	4	2	6	4	0	2	0	7	0	
1977	3	2	2	3	2	2	3	1	4	1	3	2	
MSE	MOVING-AVERAGE FORECAST FOR 1977												
1.67	4	4	4	3	3	3	3	3	3	3	3	2	

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\*\*\* MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977

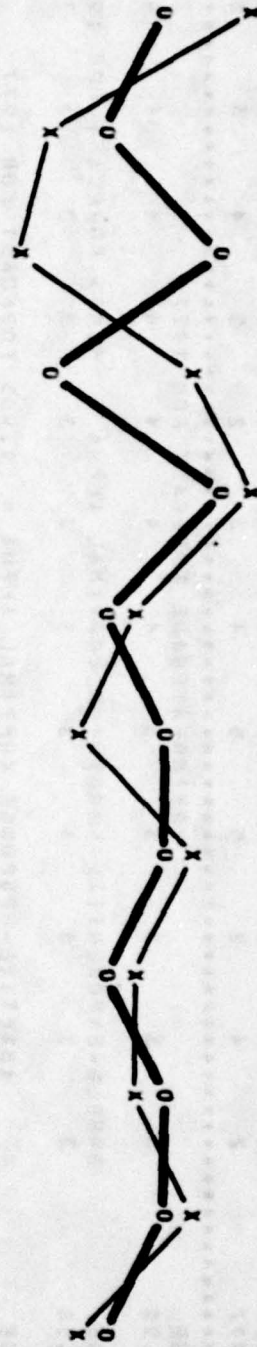
1.25	4	3	3	3	3	2	2	2	2	3	2	2
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MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977

2.25	0	2	2	2	2	2	2	2	1	2	1	1
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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

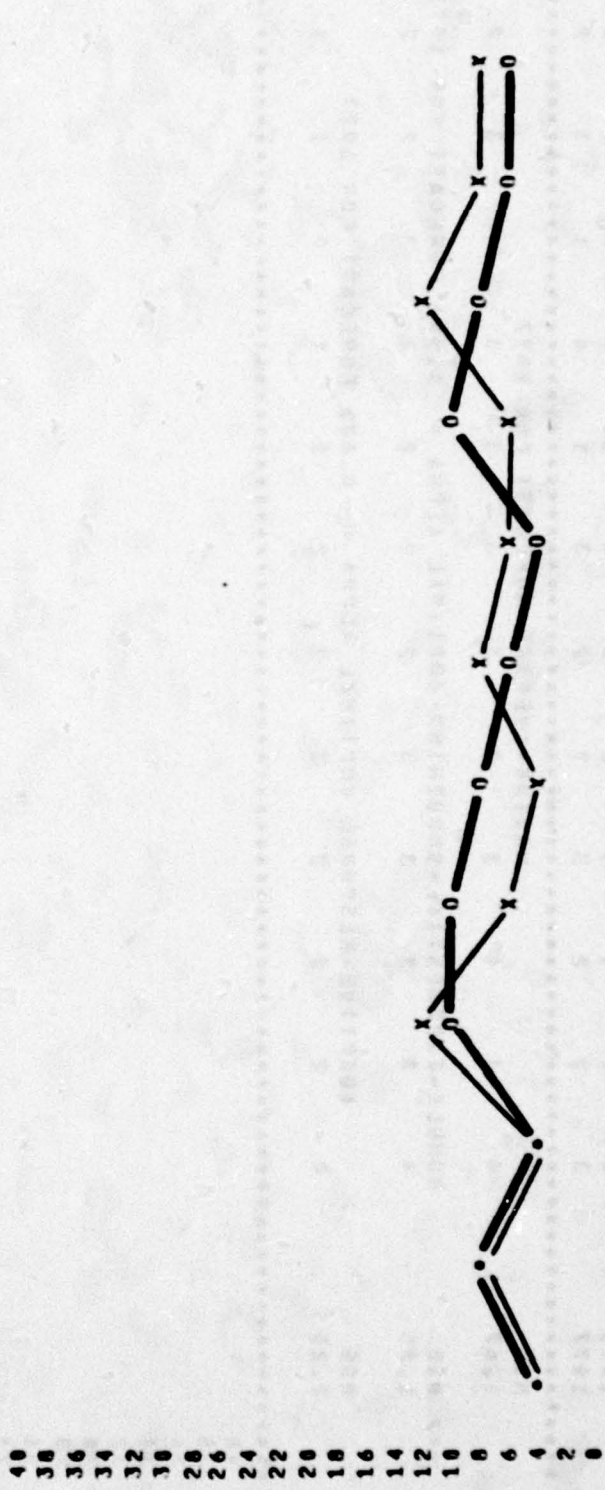
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < O = 1977 >

.....

```

BASE1 OFFUTY          MONTHLY DEMAND HISTORY      MSN: 6505005500464
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  2    4    2    5    3    2    4    3    3    5    4    4
1977  2    4    2    5    5    4    3    2    5    4    3    3
MSE   3    3    3    3    3    4    4    4    4    4    4    4
      1.50
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
MSE   3    3    3    3    3    3    3    3    3    3    3    3
      1.50
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977
MSE   4    2    3    2    4    4    4    3    2    4    4    3
      2.50
.....

```

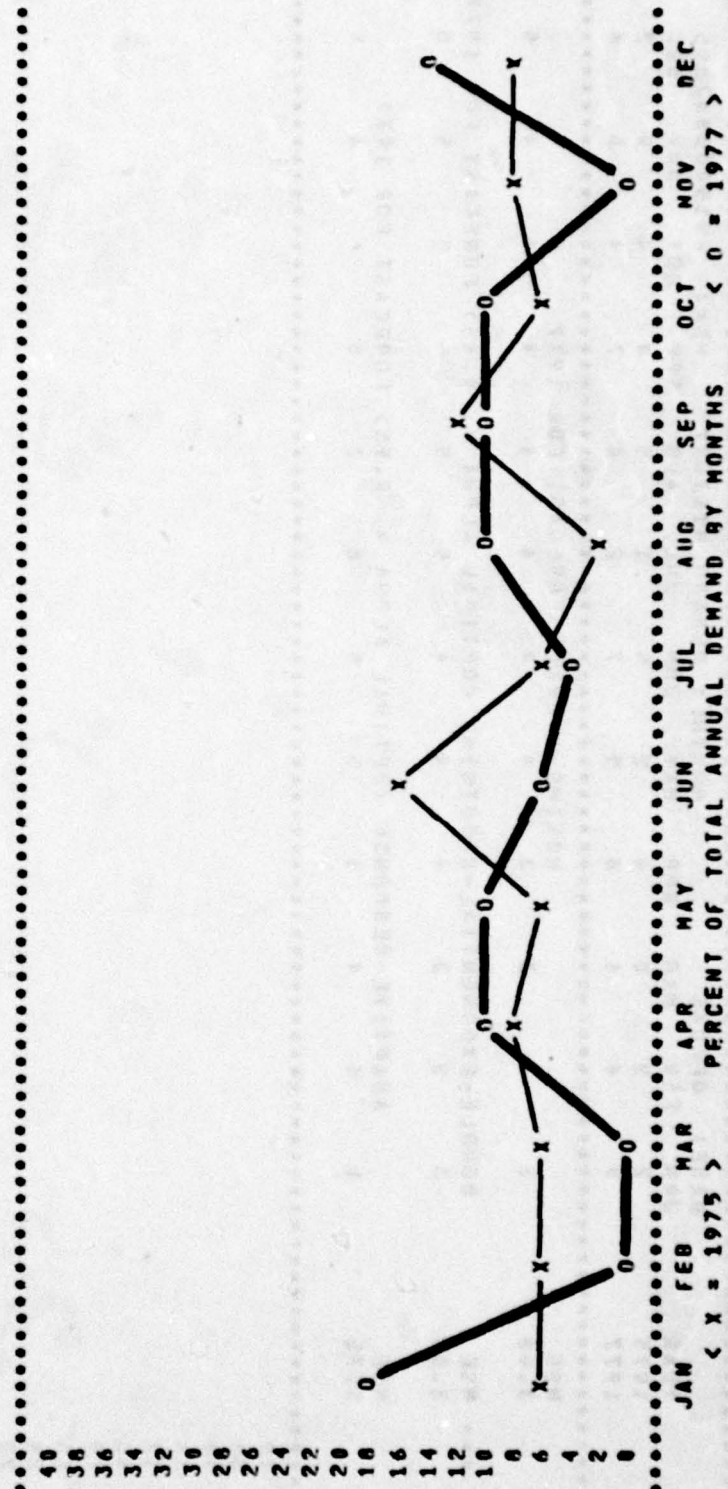


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.....
JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
< X = 1975 >    PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS    < O = 1977 >
.....

```

BASE: OFFUTT MONTHLY DEMAND HISTORY NSM: 6505005024679  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 1975 12 12 12 10 12 30 12 6 26 12 16 10  
 1977 11 0 0 6 6 4 3 7 6 7 0 9  
 MSE 59.50 16 15 14 13 12 12 10 9 7 7 6  
 DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.80> FORECAST FOR 1977  
 17 13 5 1 4 5 5 4 6 6 7 2  
 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977  
 16 14 11 6 0 5 5 4 3 5 5 6



-----

BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505005842A95

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	2	2	0	4	2	5	1	5	4	4	0	2
1977	5	4	4	6	5	7	2	6	7	4	6	4

MSE 3.92

MOVING-AVERAGE FORECAST FOR 1977

	3	4	5	6	7	8	9	10	11	12		
FORECAST	3	3	3	3	4	4	4	4	4	4	4	5

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

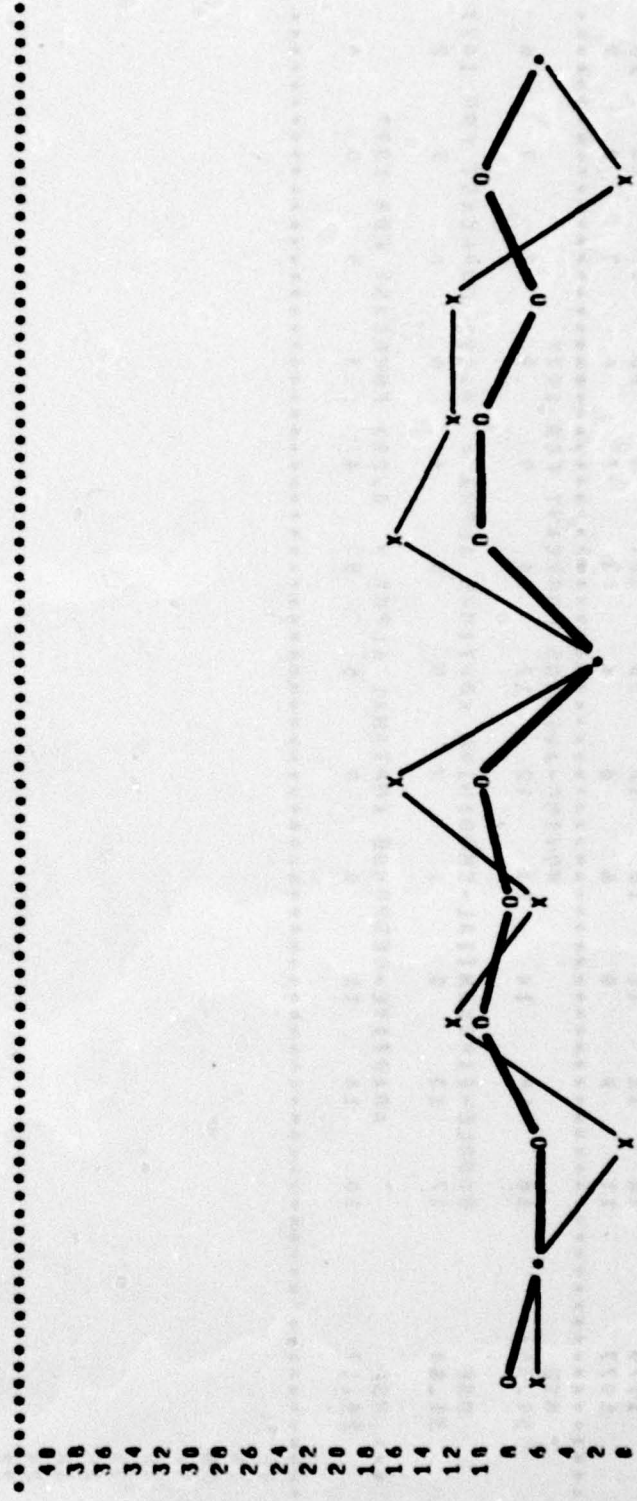
	3	4	5	6	7	8	9	10	11	12	
FORECAST	3	3	3	4	4	4	5	5	5	5	5

MSE 3.08

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

	1	4	5	6	7	8	9	10	11	12
FORECAST	1	4	4	5	6	2	5	4	4	5

-----



.....

BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSN: 6505006167A36

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	4	2	0	2	1	3	0	1	2	1	4	0
1977	1	4	1	3	2	4	2	2	5	2	1	3

MSE

2.50      2      1      2      2      2      2      2      2      2      2      2      2      3      2

.....

MOVING-AVERAGE FORECAST FOR 1977

.....

.....

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

2      2      2      2      2      2      2      2      2      2      2      2      2      2      2

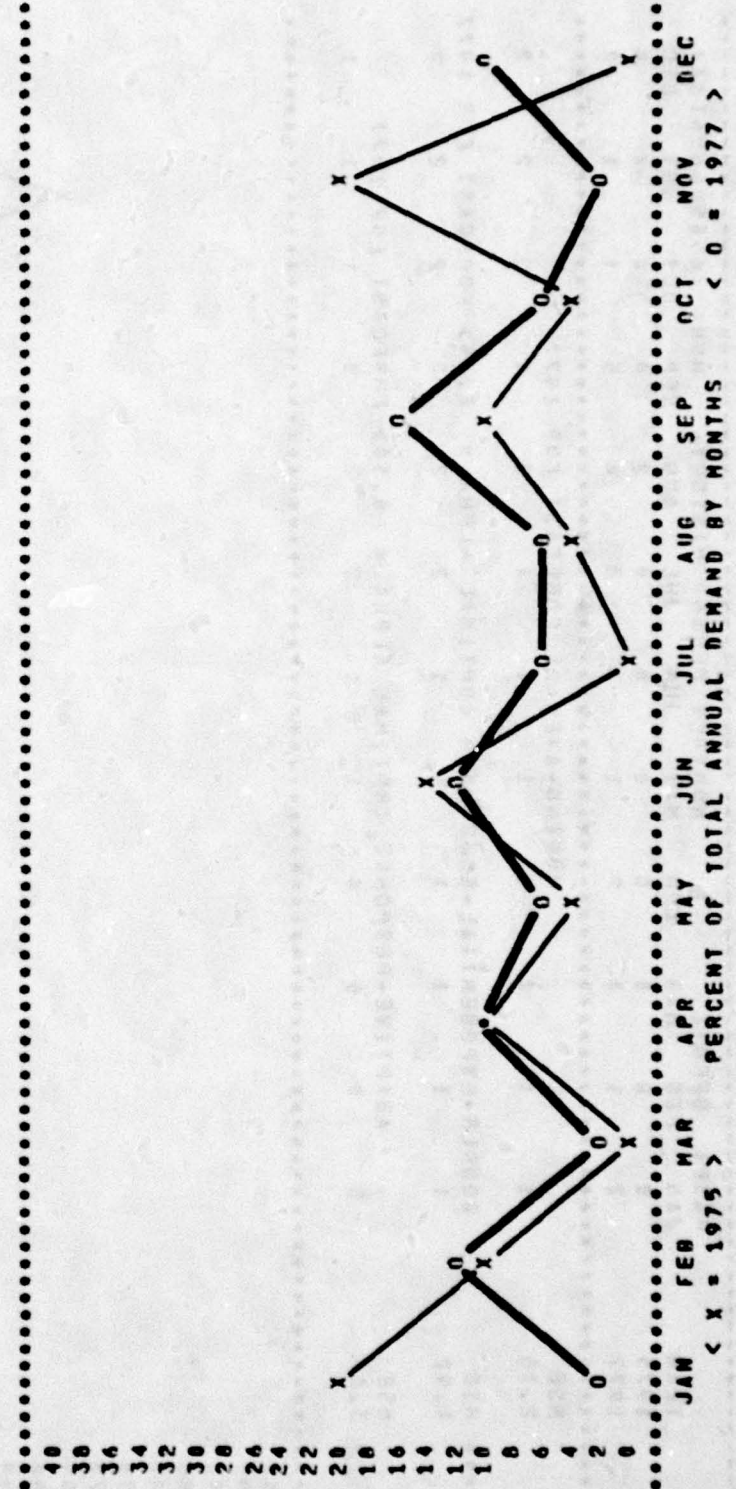
MSE

3.33      0      1      1      2      2      3      2      2      2      2      2      2      2      1

.....

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.75> FORECAST FOR 1977

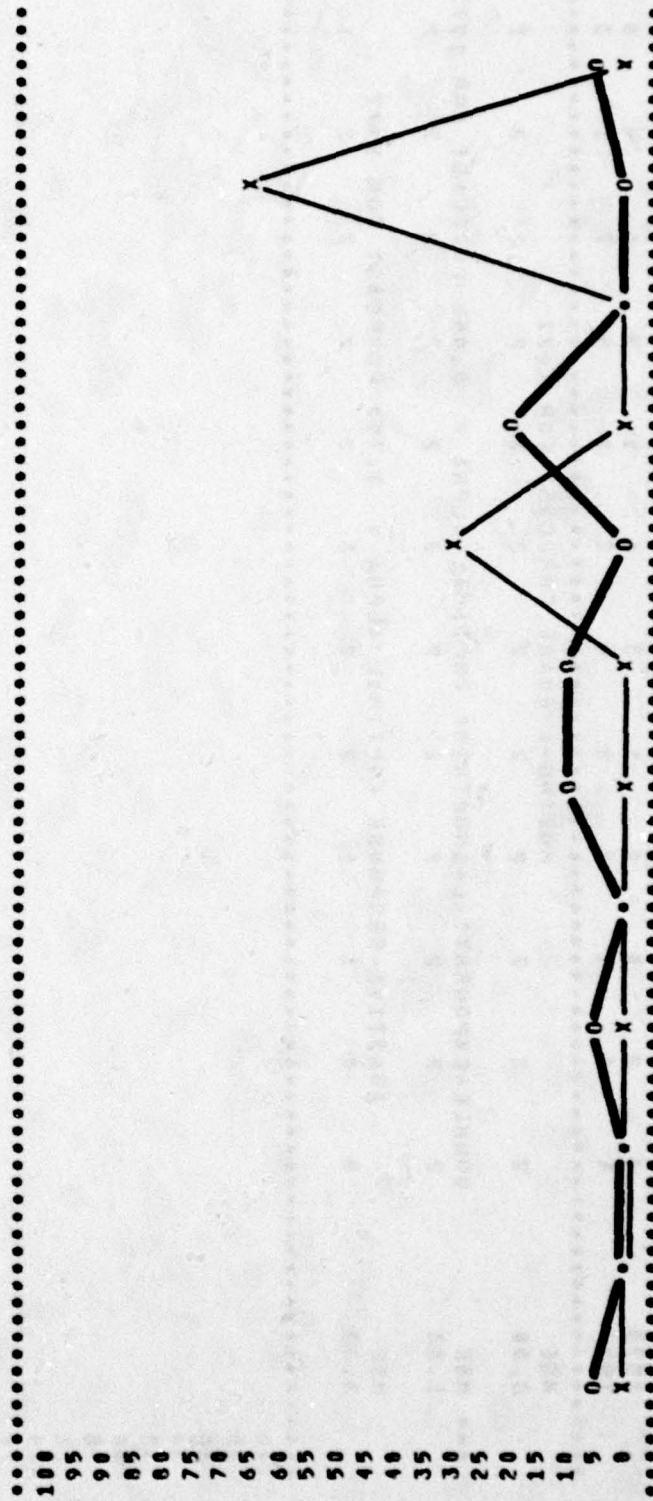
.....



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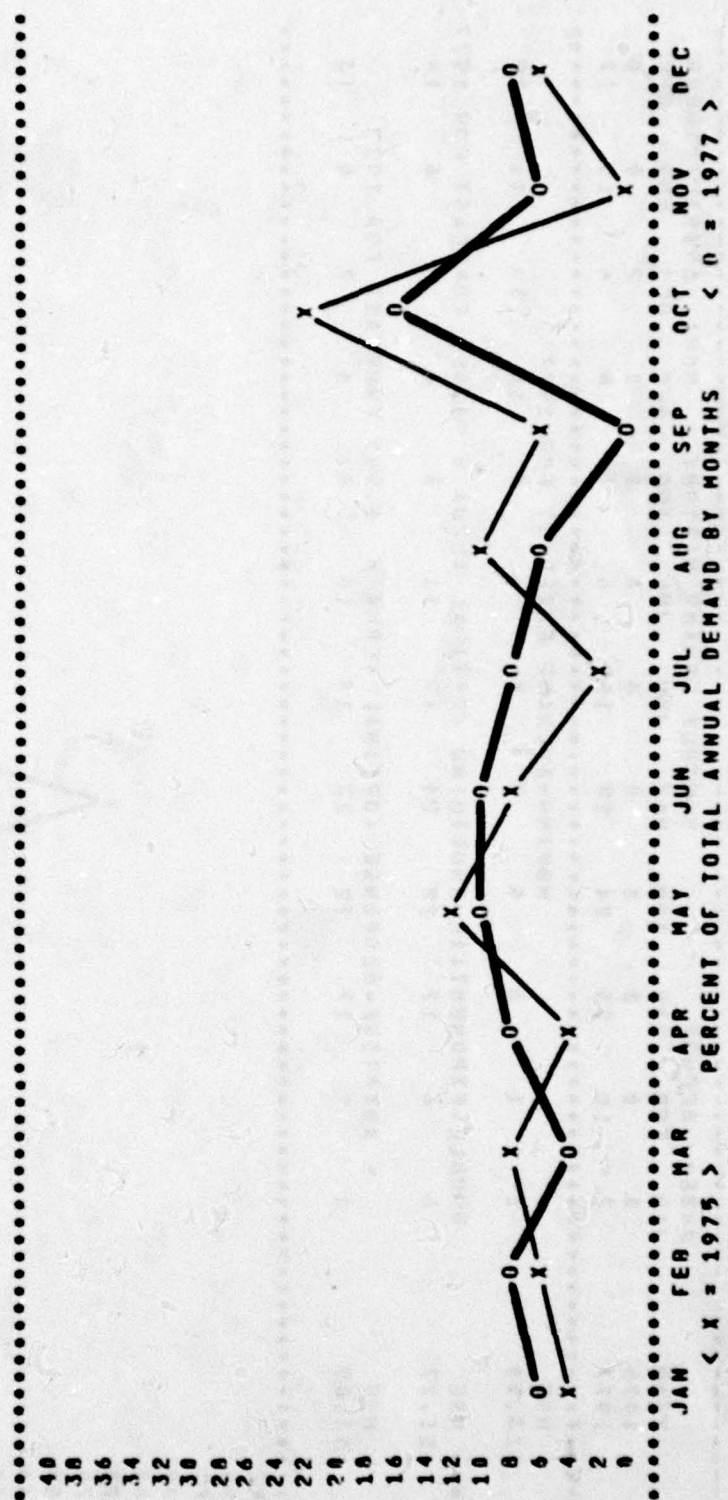
.....
YEAR 1975 1977
RASE1 OFFUTT
MONTHLY DEMAND HISTORY MSN: 6505006561344
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0 0 0 0 0 0 0 0 0 0 0 0
2 1 0 2 1 3 3 0 5 1 1 2
.....
MSE 2.75
MOVING-AVERAGE FORECAST FOR 1977
1 1 1 1 1 1 1 2 1 2 2 2
.....
DORLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977
1 1 1 1 1 1 2 2 2 2 2 2
.....
MSE 3.67
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
0 0 0 1 1 1 2 2 0 1 1 1
.....

```



BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM: 6505006640857		
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
1975		4	6	7	4	12	8	3	10	6	20	0	6			
1977		4	6	3	6	7	7	5	4	0	11	4	5			
MSE		MOVING-AVERAGE FORECAST FOR 1977														
0.50		7	7	7	7	7	7	7	7	6	6	5	5			

.....  
 \*\*\* MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 7.17 6 6 6 6 6 6 6 6 6 6 6 6 6  
 MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977  
 10.03 3 0 1 4 3 4 6 6 5 4 1 10  
 .....



BASE: OFFUTT MONTHLY DEMAND HISTORY MSM: 6505007218099

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	6	0	0	0	2	0	0
1977	7	10	23	24	10	10	0	6	0	6	15	27

MSE

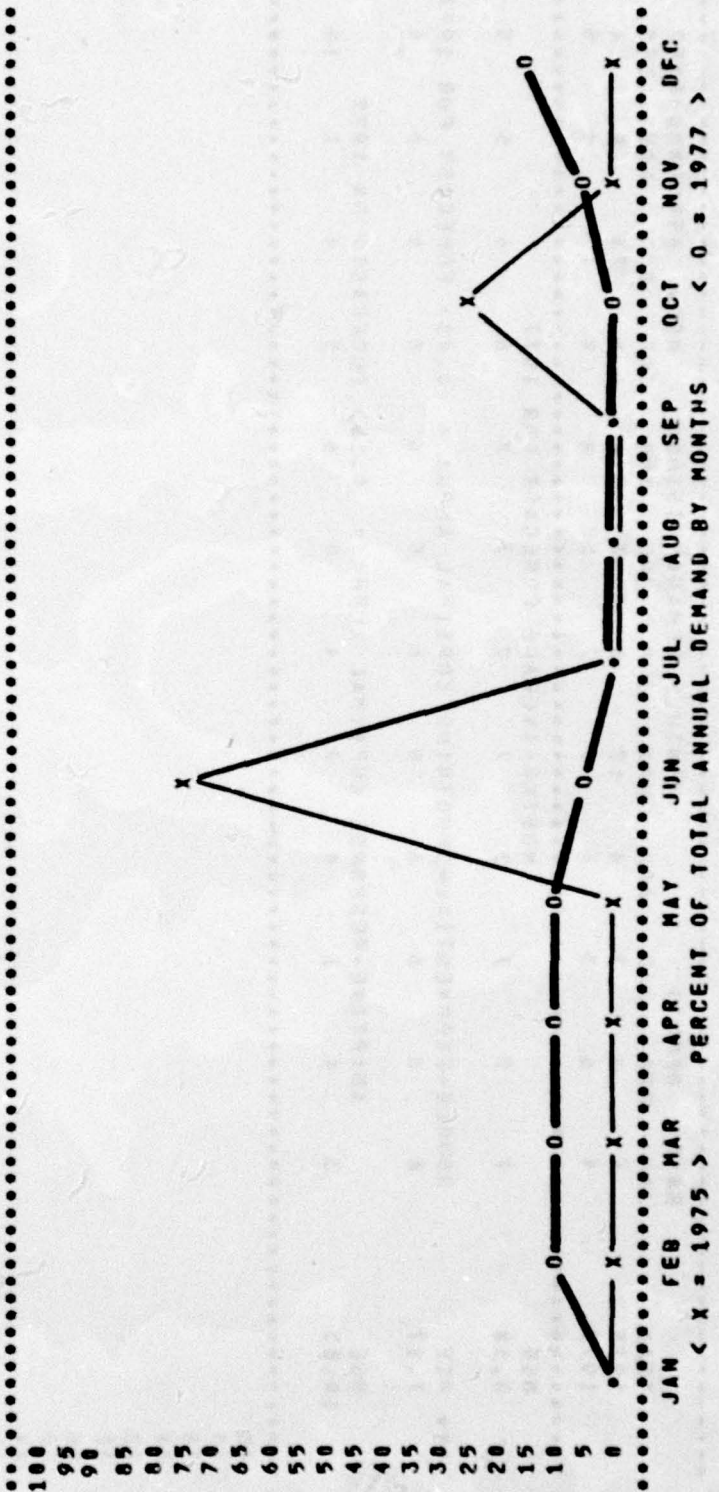
MOVING-AVERAGE FORECAST FOR 1977	8	9	10	11	12
123.50	1	1	3	5	7

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE	6	17	22	24	19	11	0	6	0	6	6	14
51.77	0	6	17	22	24	19	11	0	6	0	6	14

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.95> FORECAST FOR 1977

MSE	5	17	22	23	10	10	0	6	7	6	13
53.00	0	5	17	22	23	10	10	0	6	7	13



BASE: OFFUTT      MONTHLY DEMAND HISTORY      NSM: 6505007542547

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	26	24	12	24	24	24	12	18	0	36	10	0
1977	12	12	19	15	19	0	10	4	0	18	4	19

MSE

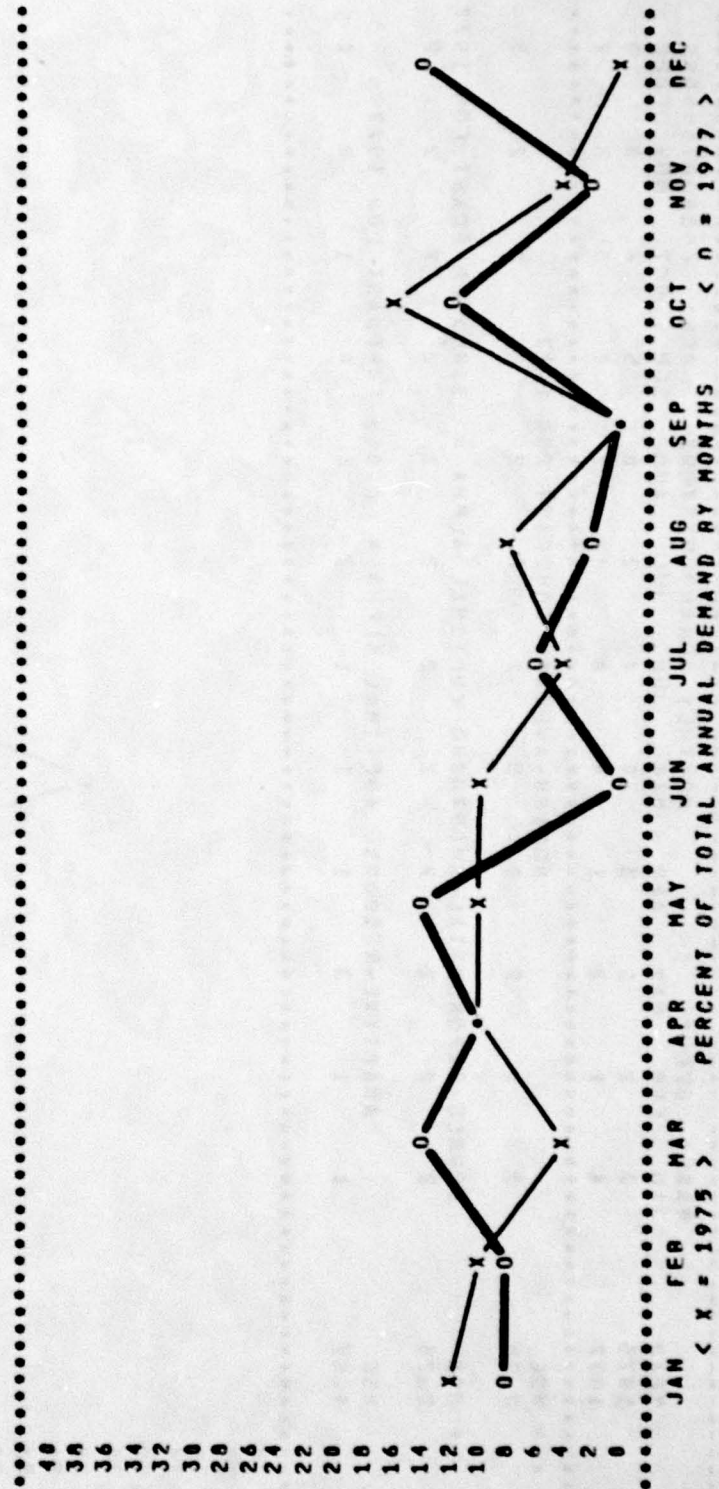
MSE	10	16	15	16	15	15	13	13	11	11	10	9
58.03												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

MSE	14	12	12	13	14	15	12	11	9	7	8	8
58.25												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE	12	10	11	11	13	14	17	1	7	6	4	13
58.67												



.....

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	2	1	3	0	7	2	0	5	0	0	2
1977	4	1	2	1	4	0	4	2	0	3	0	2

.....

BASE: OFFUTT      MONTHLY DEMAND HISTORY      MSN: 6505007650589

.....

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	2	1	3	0	7	2	0	5	0	0	2
1977	4	1	2	1	4	0	4	2	0	3	0	2

.....

MSE      2      2      2      2      2      2      2      2      2      2      2      2      2

.....

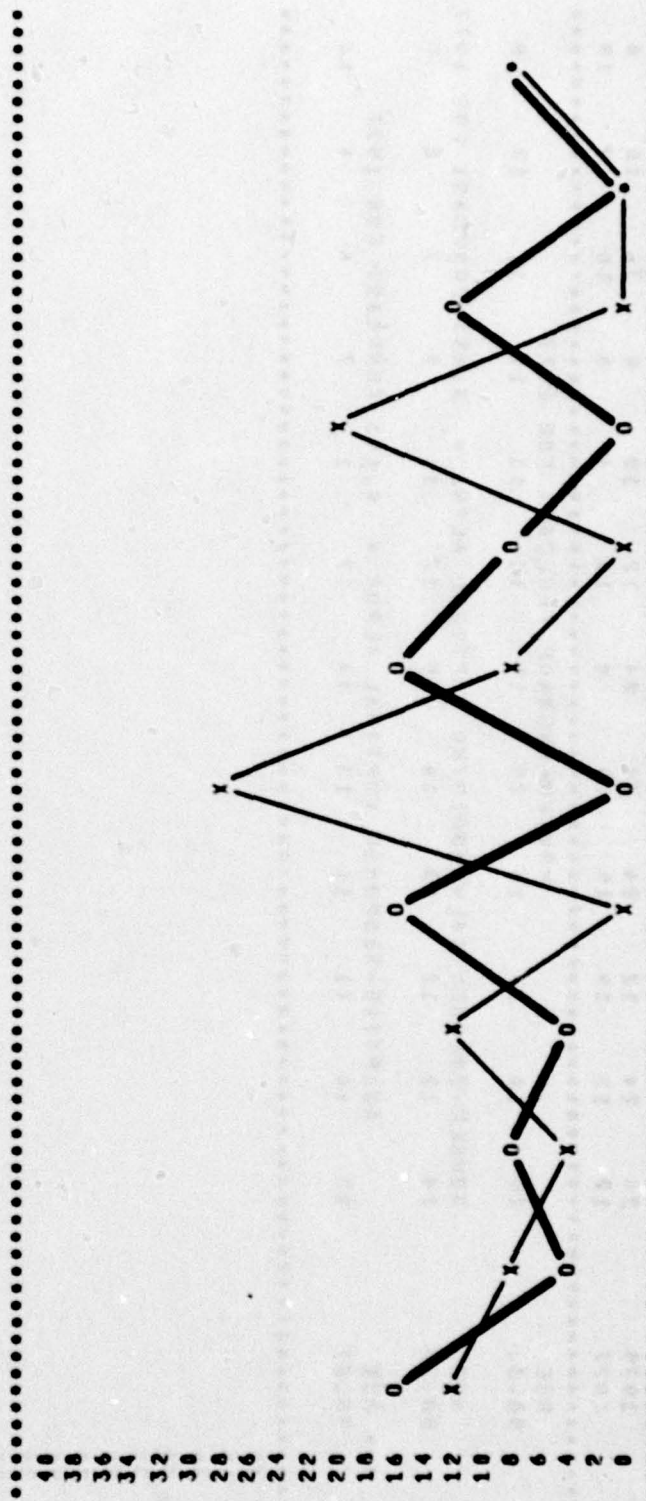
.....

MSE      2.25      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

.....

MSE      4.67      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.85> FORECAST FOR 1977

.....



BASE: OFFUTT MONTHLY DEMAND HISTORY NSM: 6505008542242

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	6	8	6	4	20	4	0	4	8	18	6
1977	0	0	4	2	5	0	9	9	0	4	0	6

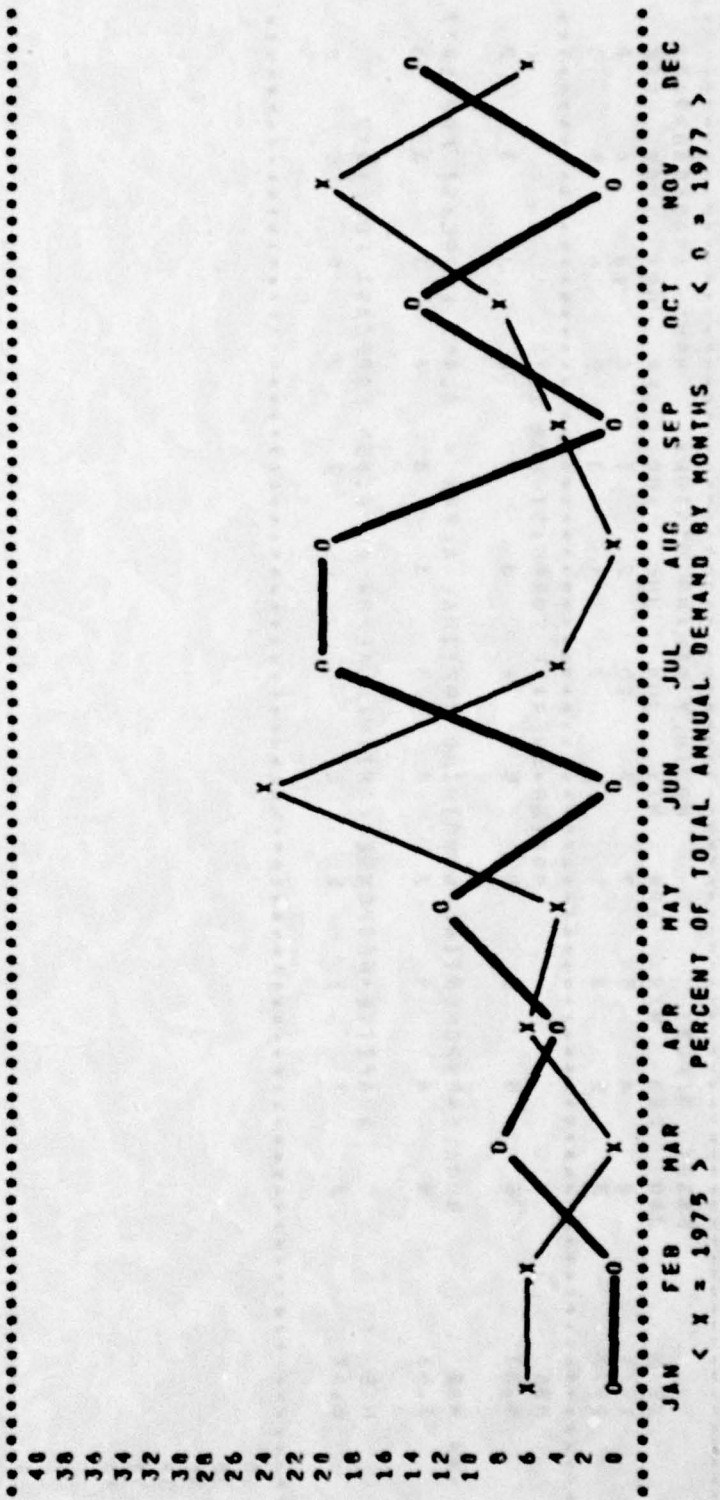
MSE 20.25 7 6 6 6 6 6 4 5 5 5 5 3

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	7	6	4	4	4	4	4	4	4	4	4	4
-----	---	---	---	---	---	---	---	---	---	---	---	---

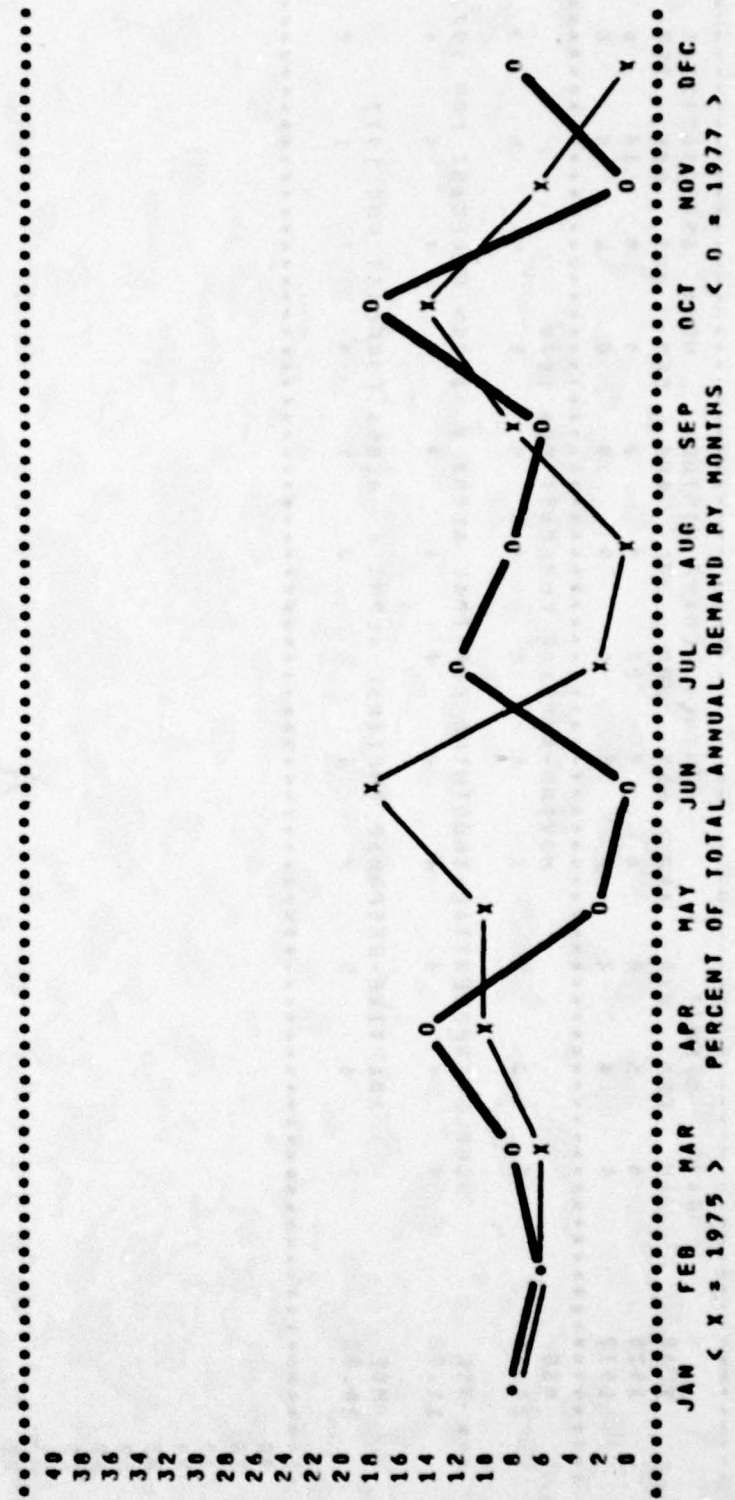
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	7	6	5	2	3	2	3	1	4	7	1	2
-----	---	---	---	---	---	---	---	---	---	---	---	---



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505008899033

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	4	5	7	7	12	2	0	6	10	4	0
1977	3	2	3	5	1	0	4	3	2	6	0	3
MSE	MOVING-AVERAGE FORECAST FOR 1977											
5.03	5	5	5	5	5	4	3	3	3	3	3	2
MSE	DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.40> FORECAST FOR 1977											
3.03	5	4	4	3	3	3	3	3	3	3	3	3
MSE	ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977											
6.67	3	3	2	2	2	1	0	2	2	2	5	0



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 650500000153A

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	4	0	2	4	0	0	0	3	1	1	0
1977	1	2	2	1	2	0	1	1	2	2	1	0

MSE 0.67

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	2	1	2	1	1	1	1	1	1	1	1

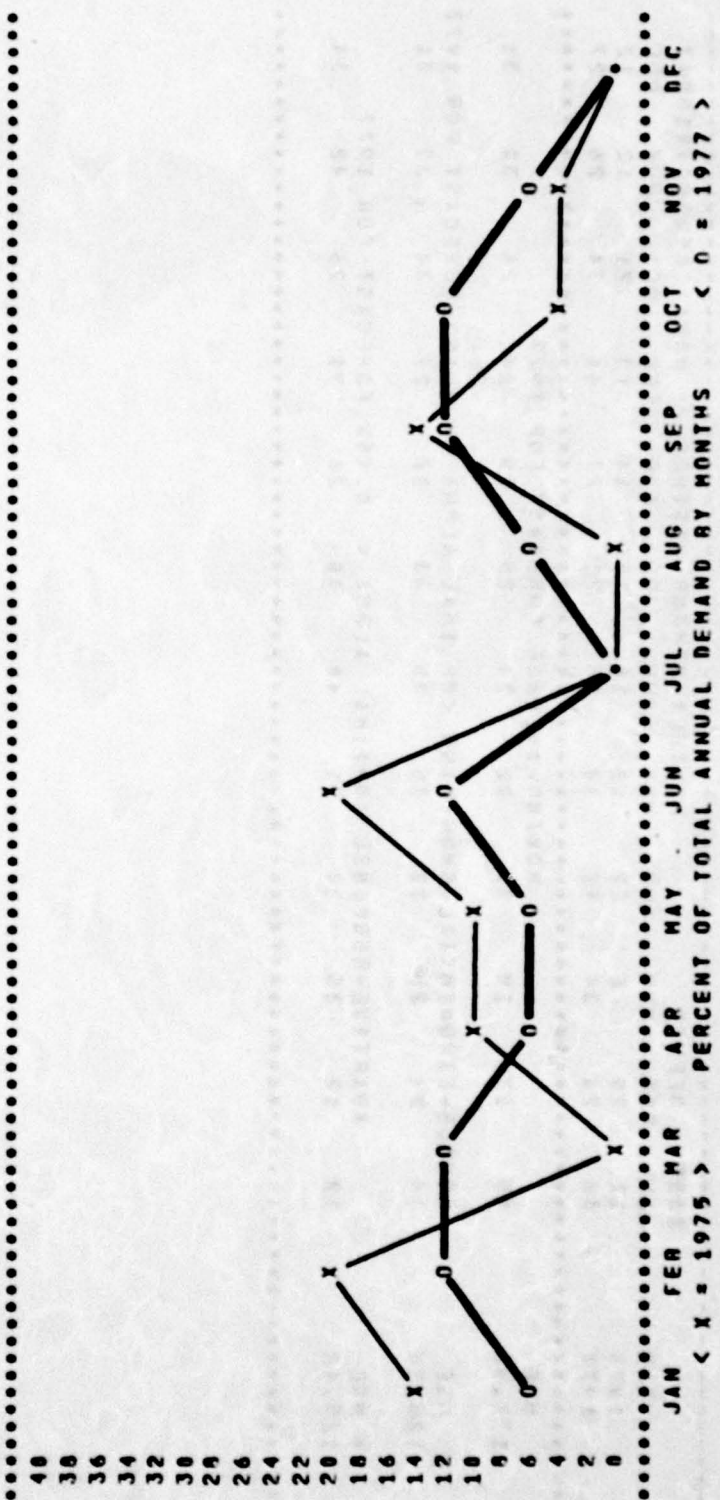
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	2	2	2	1	1	1	1	1	1	1	1

MSE 1.25

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	0	1	1	1	1	1	0	0	1	1	1



BASE: OFFUTT MSN: 6505009010043

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	11	20	6	22	12	18	18	14	13	21	12	12
1977	30	24	34	42	40	26	21	27	44	34	26	27

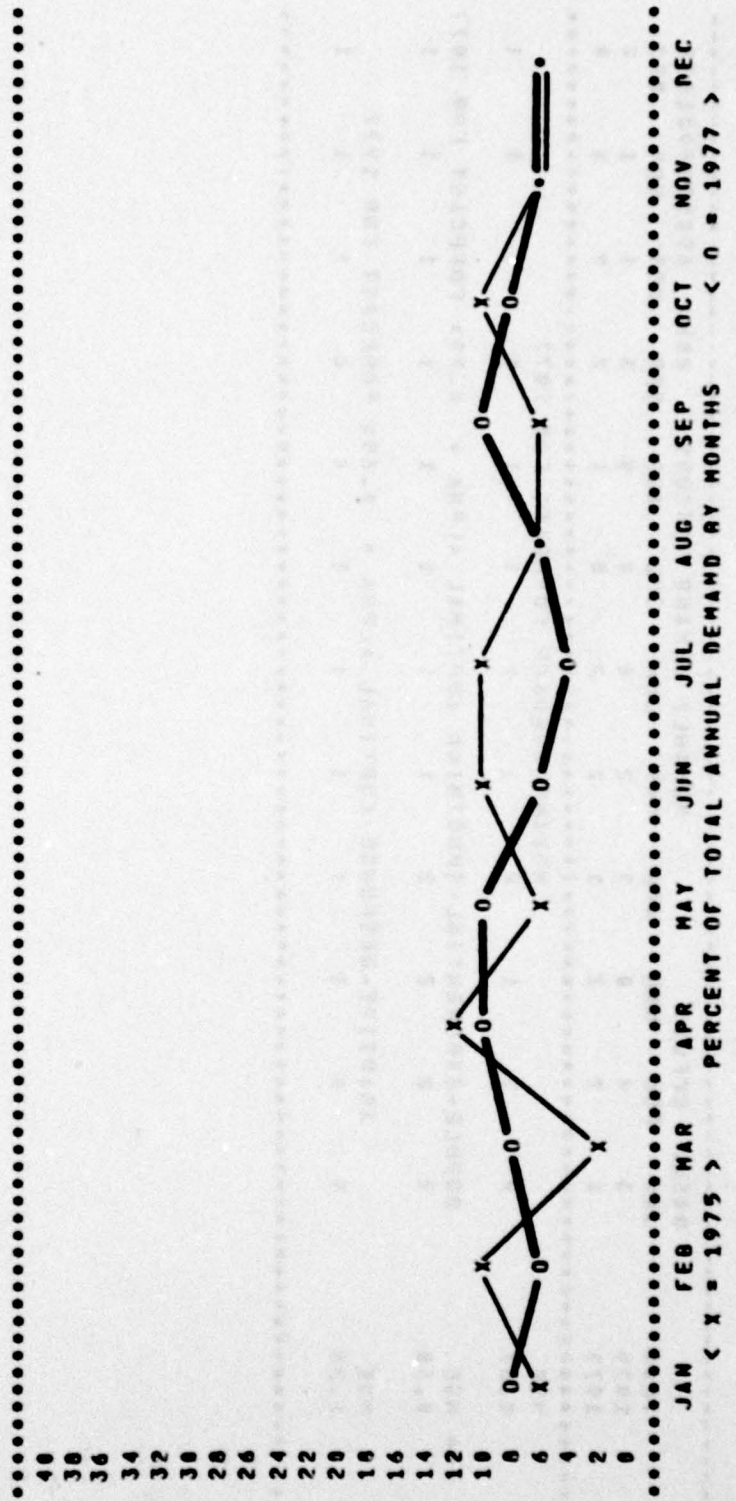
MSE 171.50 15 17 18 20 22 24 25 25 26 28 30 31

MSE 128.26 14 24 25 29 35 38 33 27 27 34 35 31

MSE 125.42 12 12 35 24 31 40 40 26 21 26 42 34

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.65> FORECAST FOR 1977

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977



BASE: OFFUTT MSN: 6505009262241

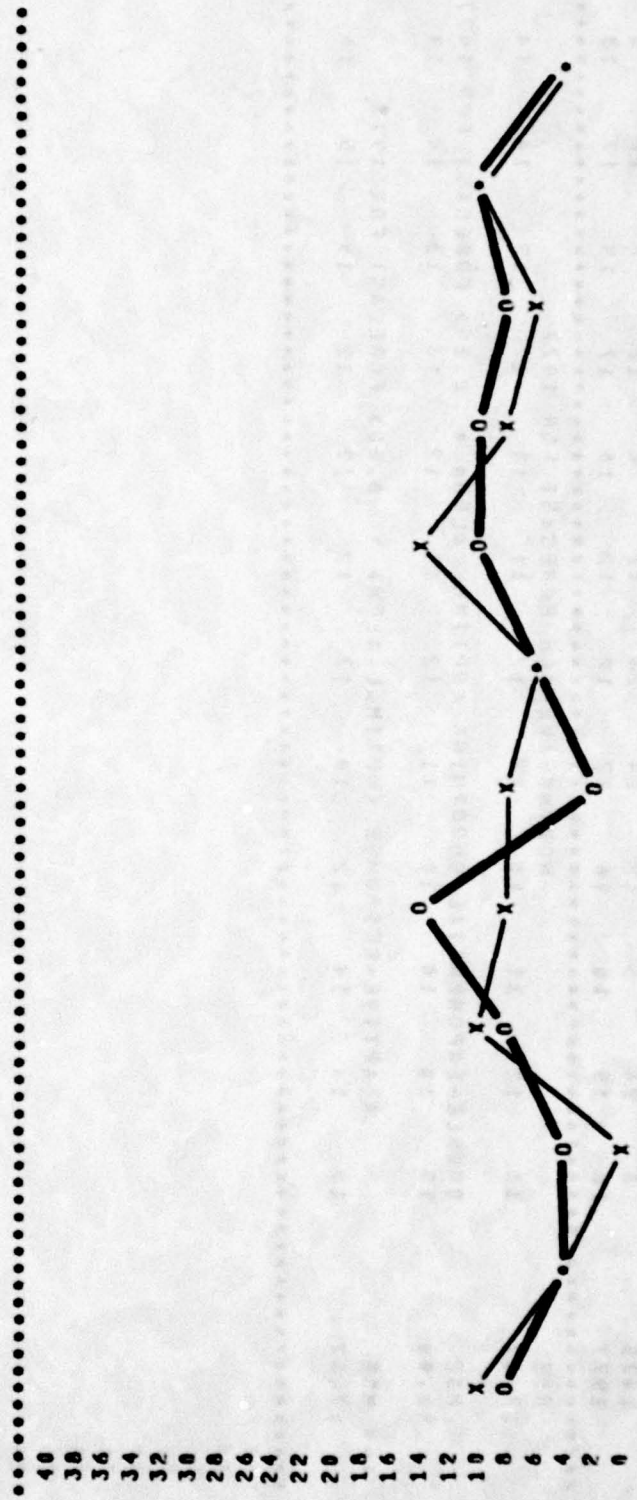
YEAR	MONTHLY DEMAND HISTORY											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	72	36	8	66	68	60	48	97	68	44	72	36
1977	36	24	26	42	64	12	30	45	44	36	46	26
MSE	MOVING-AVERAGE FORECAST FOR 1977											
342.17	55	52	51	53	51	51	47	46	41	40	39	37

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

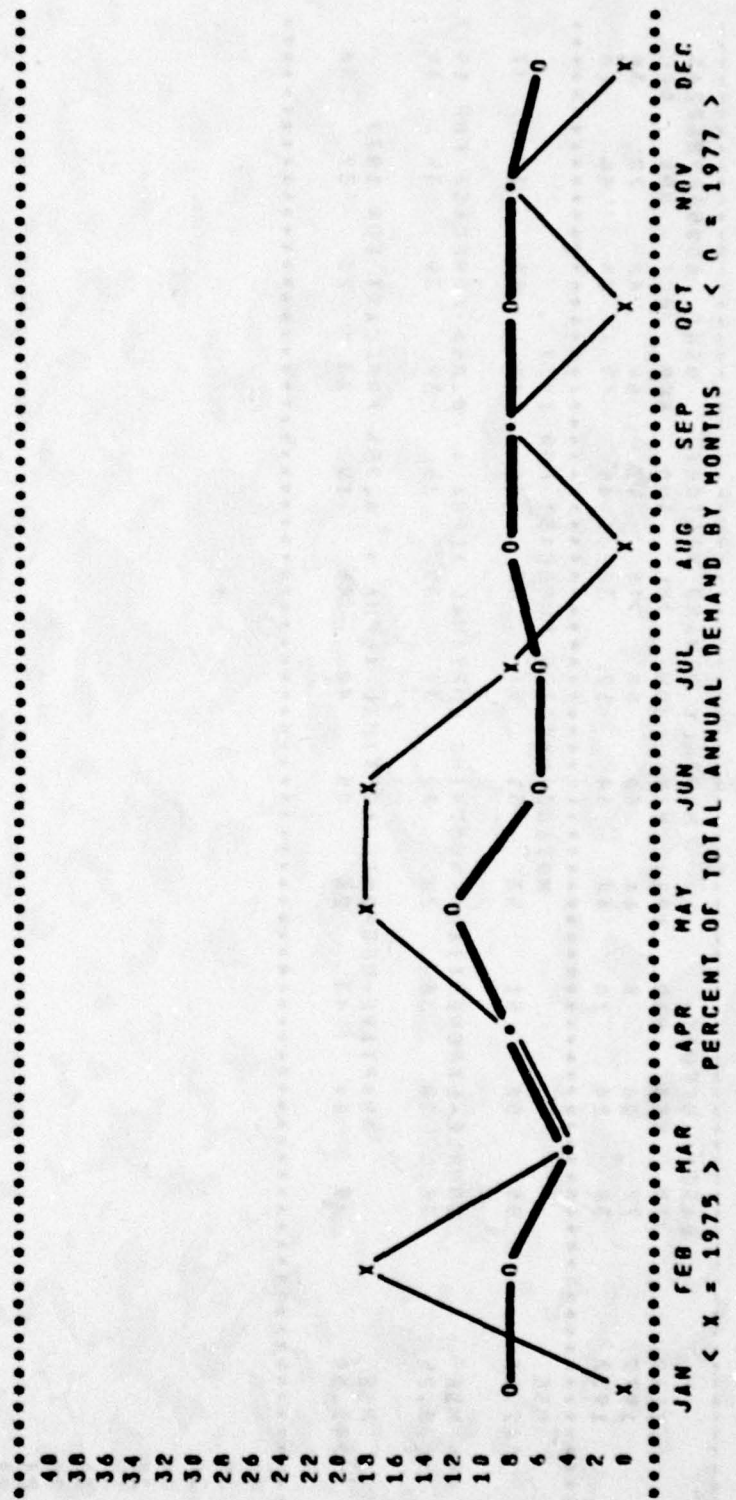
MSE	38	38	38	38	39	39	39	39	39	39	39	39
-----	----	----	----	----	----	----	----	----	----	----	----	----

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	49	64	43	26	25	40	48	19	23	23	37	36
-----	----	----	----	----	----	----	----	----	----	----	----	----



BASE: OFFUTT		MONTHLY DEMAND HISTORY												MSM: 6505009269089
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
1975		0	24	6	12	24	24	12	0	12	0	12	0	
1977		16	15	10	16	22	12	12	16	17	15	17	13	
MSE		MOVING-AVERAGE FORECAST FOR 1977												
19.17		11	12	11	11	12	12	11	11	12	12	14	14	
MSE		DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977												
22.00		10	10	10	10	11	12	12	12	13	13	14	14	
MSE		ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.60> FORECAST FOR 1977												
17.67		10	14	14	12	14	17	12	12	12	15	15	16	



BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505009355059

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	3	7	14	4	6	9	9	3	8	2	8
1977	8	7	7	6	7	14	9	16	8	16	4	6

MSE 25.92

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	6	6	6	6	6	6	6	7	7	7	8	8

MSE 25.75

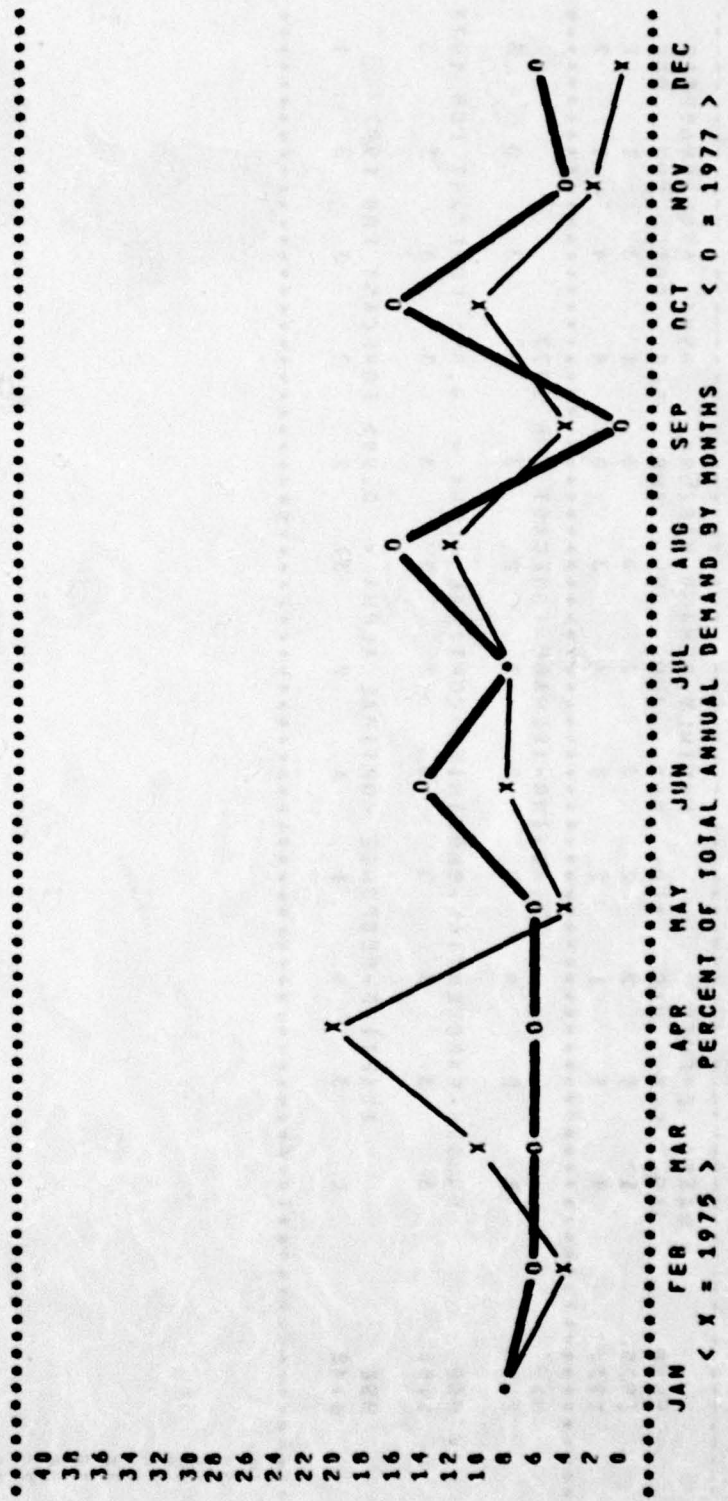
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	6	6	6	6	6	6	6	7	8	8	8	8

MSE 38.58

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977

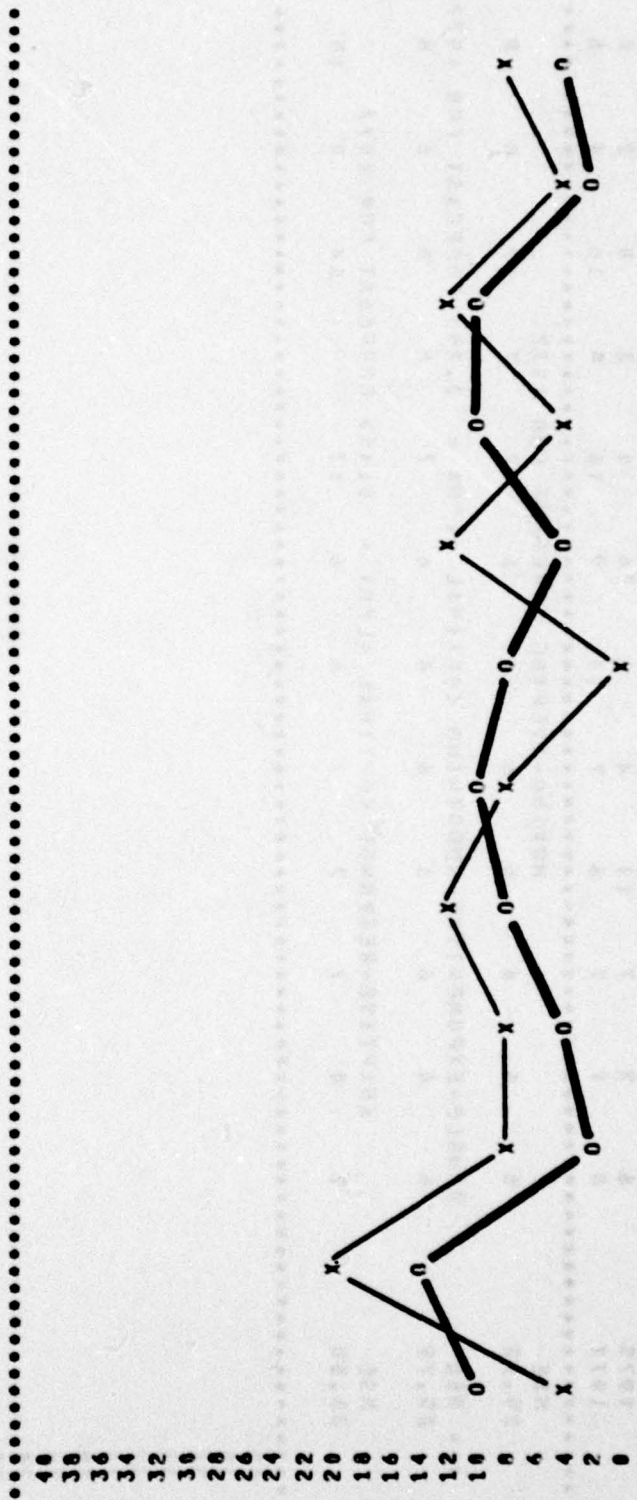
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	1	0	7	7	7	6	6	13	9	14	0	15



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BASE: OFFUTT MONTHLY DEMAND HISTORY MSN: 6505009652512
YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1975 1 5 2 2 3 2 0 3 1 3 1 2
1977 4 5 1 2 3 4 3 2 4 4 1 2
MSE 2 2 2 2 2 2 2 3 3 3 3 3
2.33
... MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
1.58 3 3 3 3 3 3 3 3 3 3 3
MSE 3.42 1 3 4 1 1 2 3 2 2 3 3 1
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.90> FORECAST FOR 1977
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JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
< X = 1975 > PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS < N = 1977 >
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APPENDIX G  
COMPUTER PRODUCTS, NONSEASONAL (WHITEMAN)

BASE: WHITEMAN MONTHLY DEMAND HISTORY HSN: 6505000835616

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	4	3	9	4	4	4	7	6	9	4	8
1977	9	7	5	12	6	5	5	7	6	5	7	5

MSE 5.25 MOVING-AVERAGE FORECAST FOR 1977

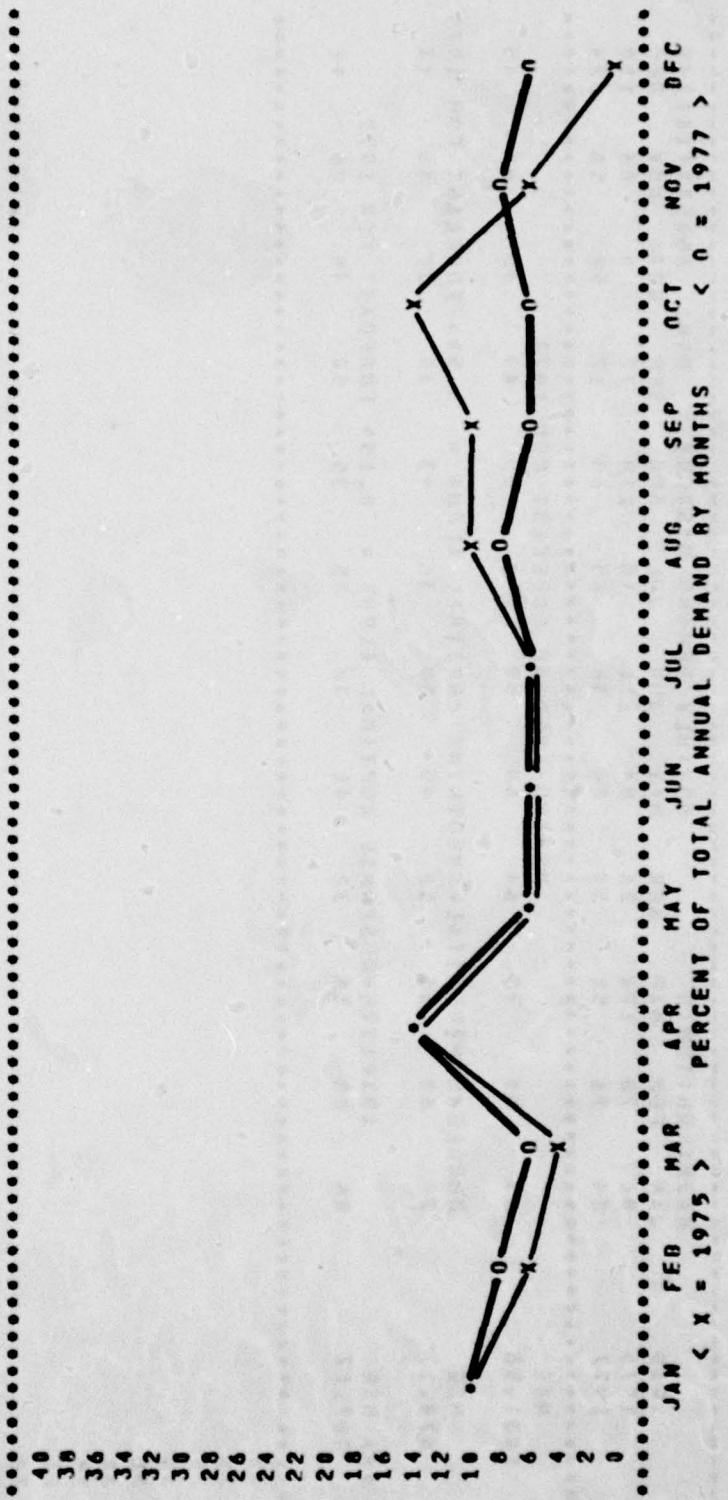
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	5	5	6	6	6	6	6	6	6	6	6	6

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.30> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	5	5	5	6	6	6	6	6	6	6	6	6

MSE 0.00 ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977

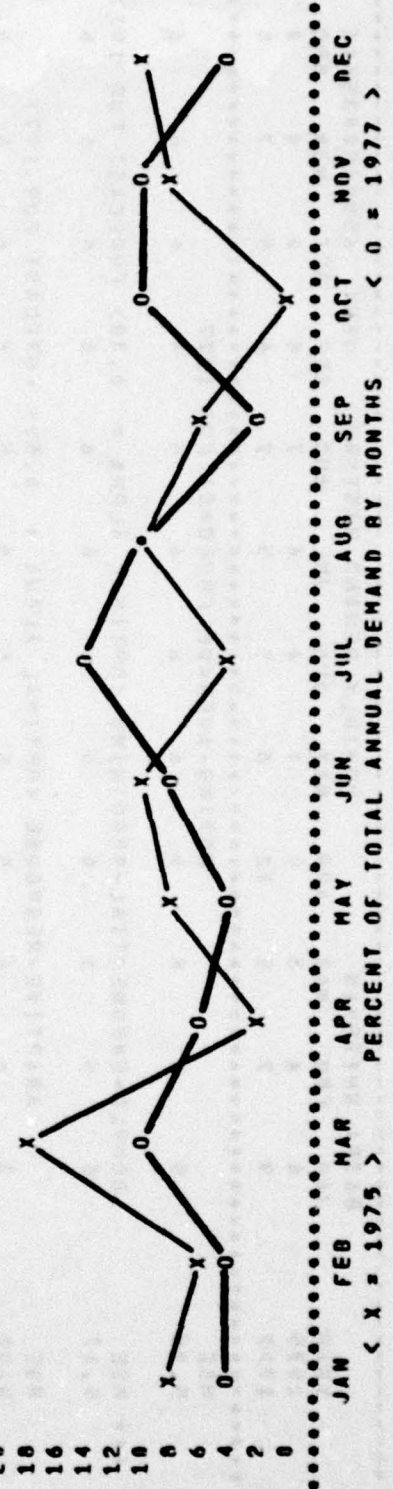
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	3	6	6	5	5	5	5	5	6	6	5	5



BASE1 WHITEMAN		MONTHLY DEMAND HISTORY												MSM: 6505001161740	
YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1975		82	78	190	26	84	110	48	118	77	0	84	116		
1977		24	26	50	34	74	36	65	48	12	52	50	24		
MSE		MOVING-AVERAGE FORECAST FOR 1977													
1031.50		85	88	75	64	64	59	53	55	49	43	48	45		

MSE 367.17      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977  
 78    68    55    50    45    39    36    43    46    38    40    43

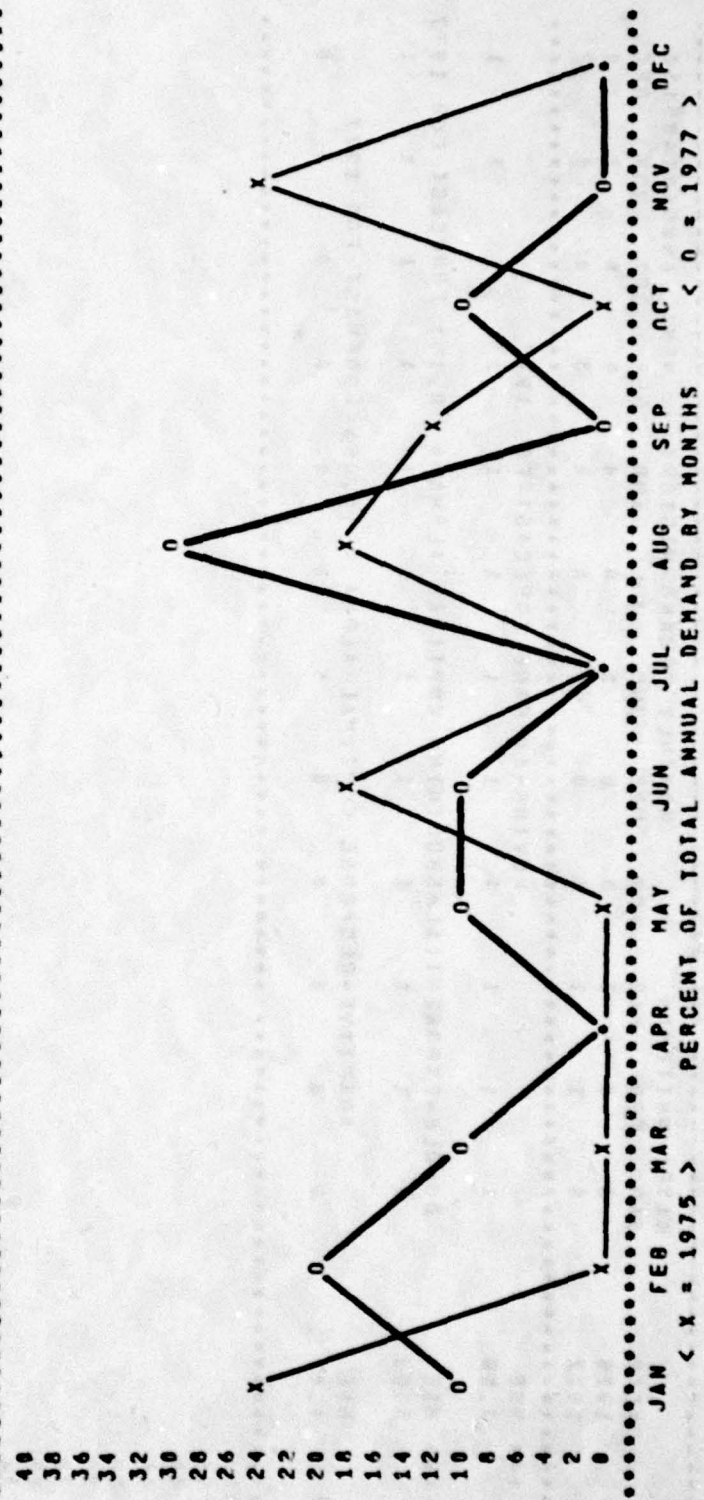
MSE 367.17      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977  
 56    88    36    32    41    38    35    35    50    44    26    47



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BASE: WHITEMAN          MONTHLY DEMAND HISTORY      NSM: 6505001316420
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  0    0    0    0    0    6    0    6    4    0    0    0
1977  1    2    1    0    1    1    0    3    0    1    0    0
.....
MSE   3    2    2    2    2    2    2    2    2    1    2    1
2.00
.....
MSE   3    2    2    2    1    1    1    1    1    1    1    1
1.42
.....
MSE   1    0    0    1    1    0    0    0    0    2    0    0
1.17
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.50> FORECAST FOR 1977
3    2    2    2    1    1    1    1    1    1    1    1
.....
ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
1    0    0    1    1    0    0    0    0    2    0    0
.....

```



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505001405150

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	6	0	0	0	0	0	0	4	0	0	2	0
1977	0	1	1	6	0	0	0	0	3	0	0	2

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	1	1	1	1	1	1	1	1	1	1	1	1

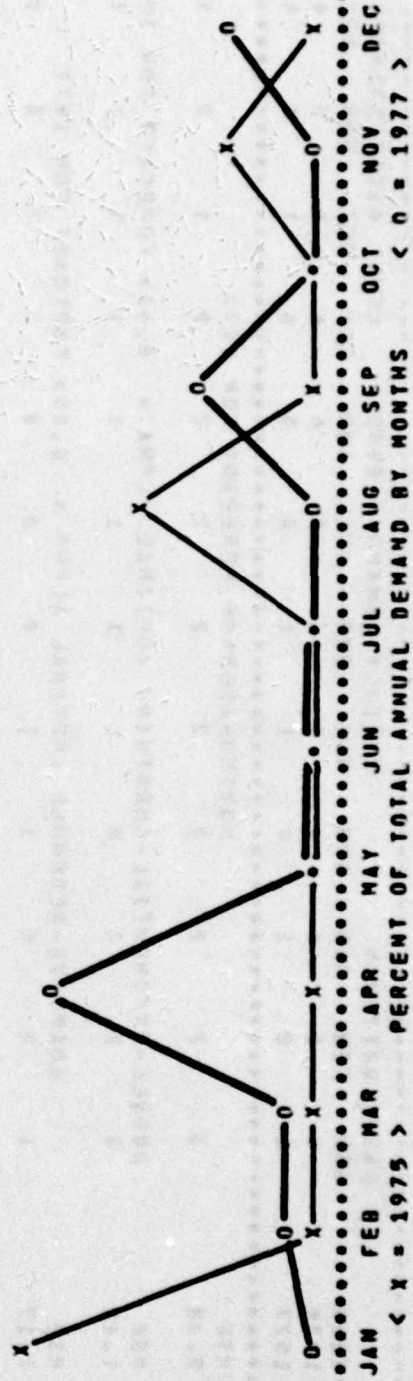
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	1	1	1	1	1	1	1	1	1	1	1	1

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	0	0	0	0	5	0	0	0	0	0	0

100  
95  
90  
85  
80  
75  
70  
65  
60  
55  
50  
45  
40  
35  
30  
25  
20  
15  
10  
5  
0

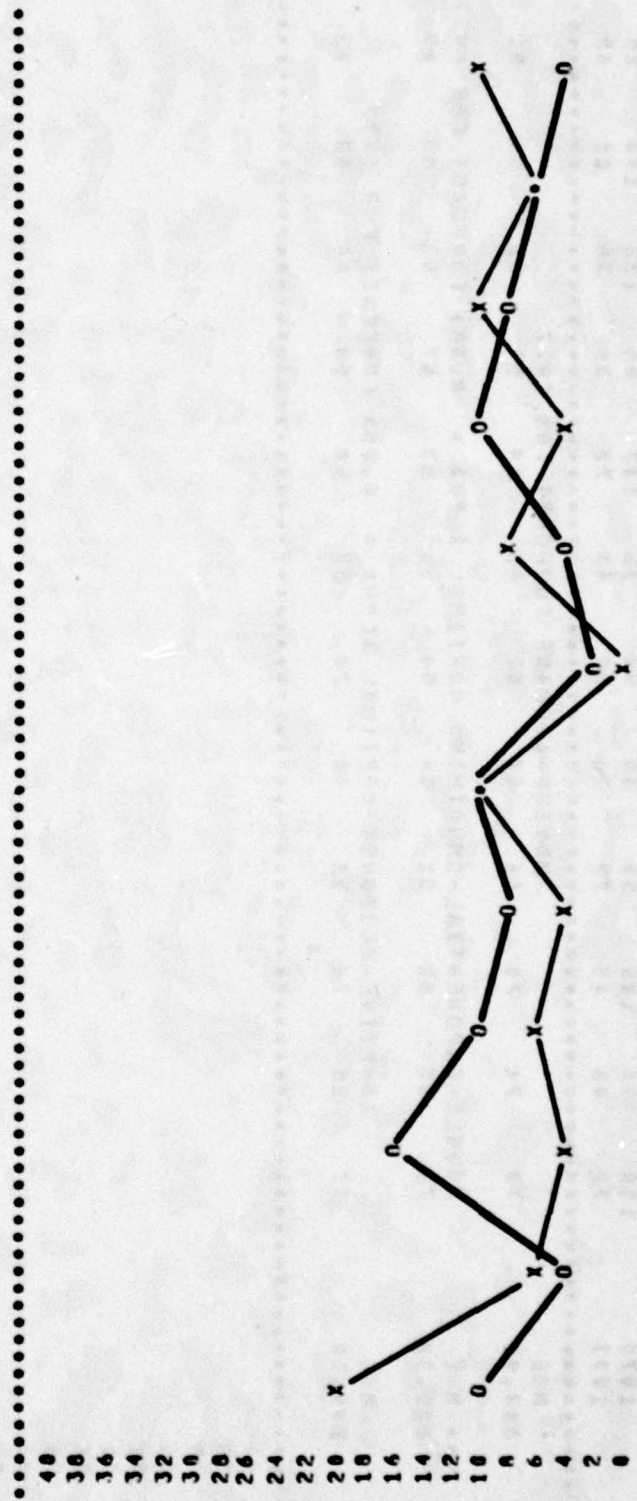




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 RASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505001530750  
 YEAR JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC  
 1975 21 6 5 7 4 11 1 9 4 11 7 11  
 1977 6 3 10 6 5 6 2 3 7 5 4 3  
 MSE 7.50 8 7 7 7 7 7 7 6 6 6 6  
 MOVING-AVERAGE FORECAST FOR 1977  
 .....

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977  
 MSE 6.08 8 8 7 7 7 7 6 5 5 5 5

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977  
 MSE 5.83 5 10 6 5 7 6 5 5 4 3 6 5



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSM: 6505001601500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	6	0	0	0	0	3	2	0	2	0	0
1977	1	2	0	0	4	2	1	2	1	2	1	0

MOVING-AVERAGE FORECAST FOR 1977

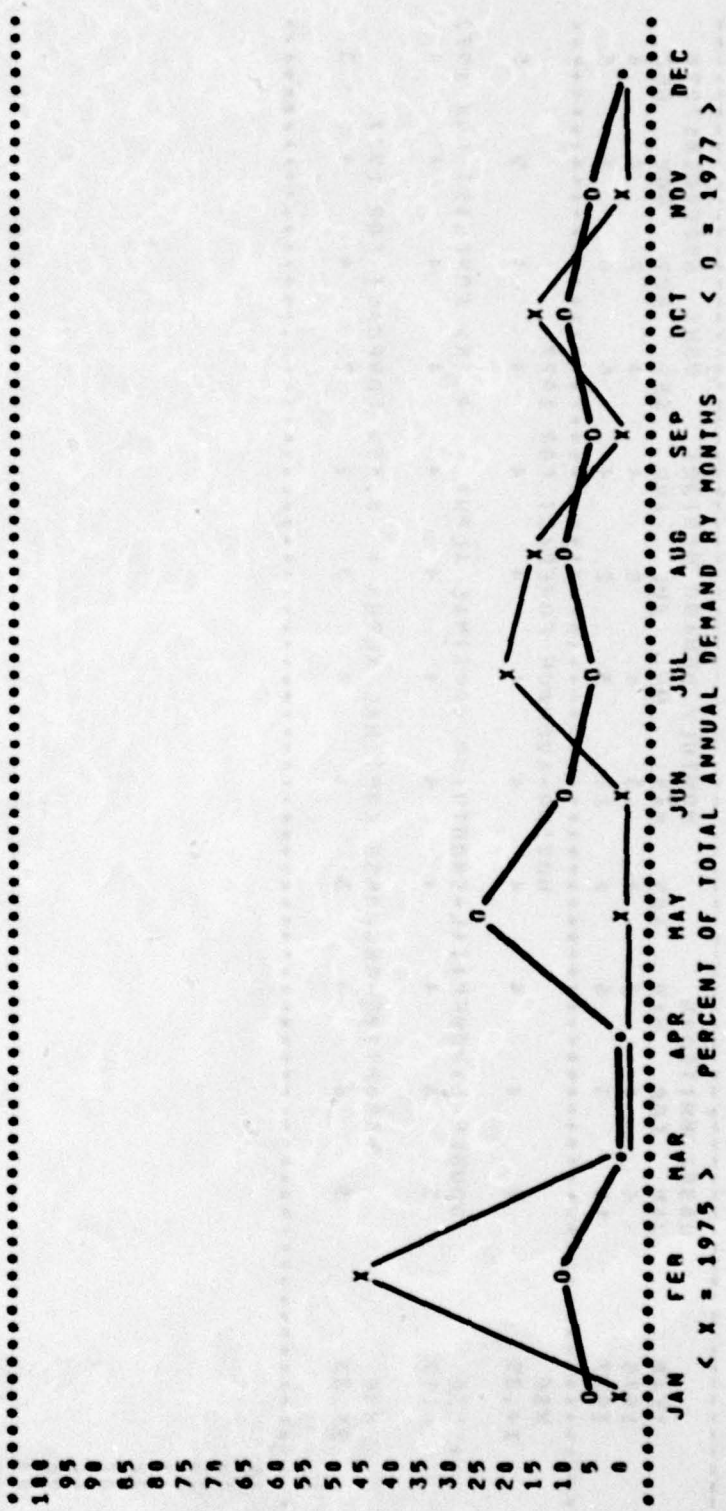
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.33	1	1	1	1	1	1	1	1	1	1	1	1

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.33	1	1	1	1	1	1	1	1	1	1	1	1

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

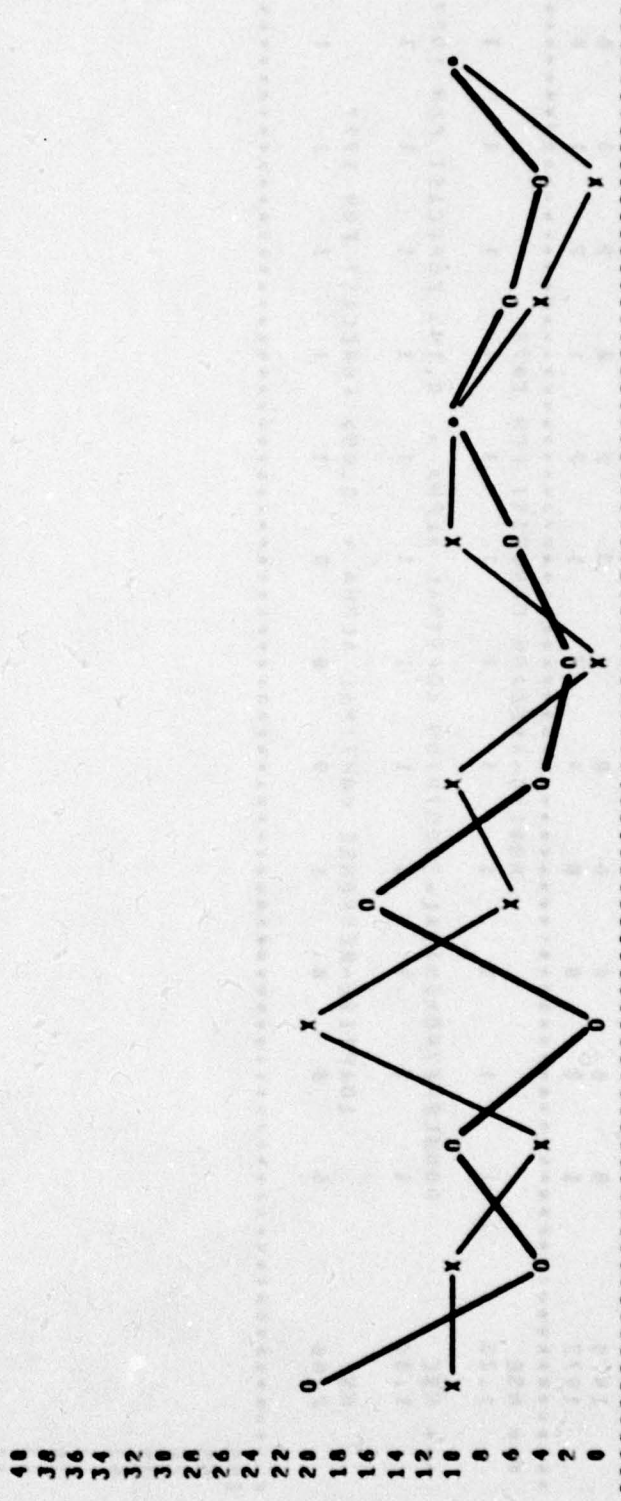
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2.00	0	0	0	1	0	0	0	1	1	1	1	1



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BASE: WHITEMAN          MONTHLY DEMAND HISTORY  MSN: 6505001017296
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  4    4    2    8    3    4    0    4    4    2    0    4
1977  13   3    6    8    18   3    2    4    6    4    3    6
.....
MSE   3    4    4    4    4    4    4    4    4    4    4    5
14.25
.....
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977
3    3    4    4    4    4    4    4    4    4    4    4
14.17
.....
MSE   3    8    3    3    1    4    3    2    2    4    4    3
21.33
.....

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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505002065349

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	27	0	0	12	0	10	10	0	22	0	6
1977	14	4	4	10	6	9	10	10	10	0	0	0

MSE 21.92

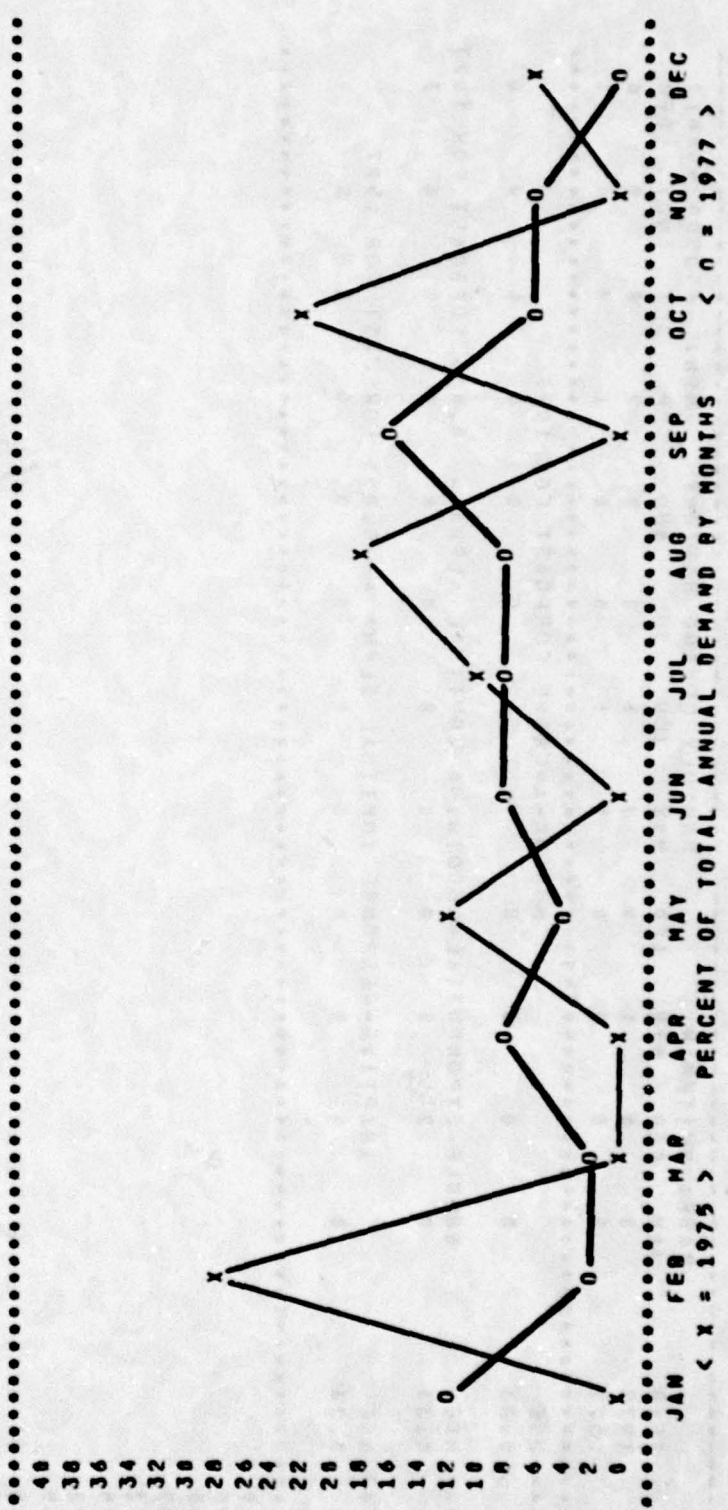
MOVING-AVERAGE FORECAST FOR 1977

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

MSE 20.75

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE 29.00



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505002990617

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	1	0	0	0	0	0	2	0	0	0
1977	0	0	0	0	1	1	0	0	1	0	0	1

MOVING-AVERAGE FORECAST FOR 1977

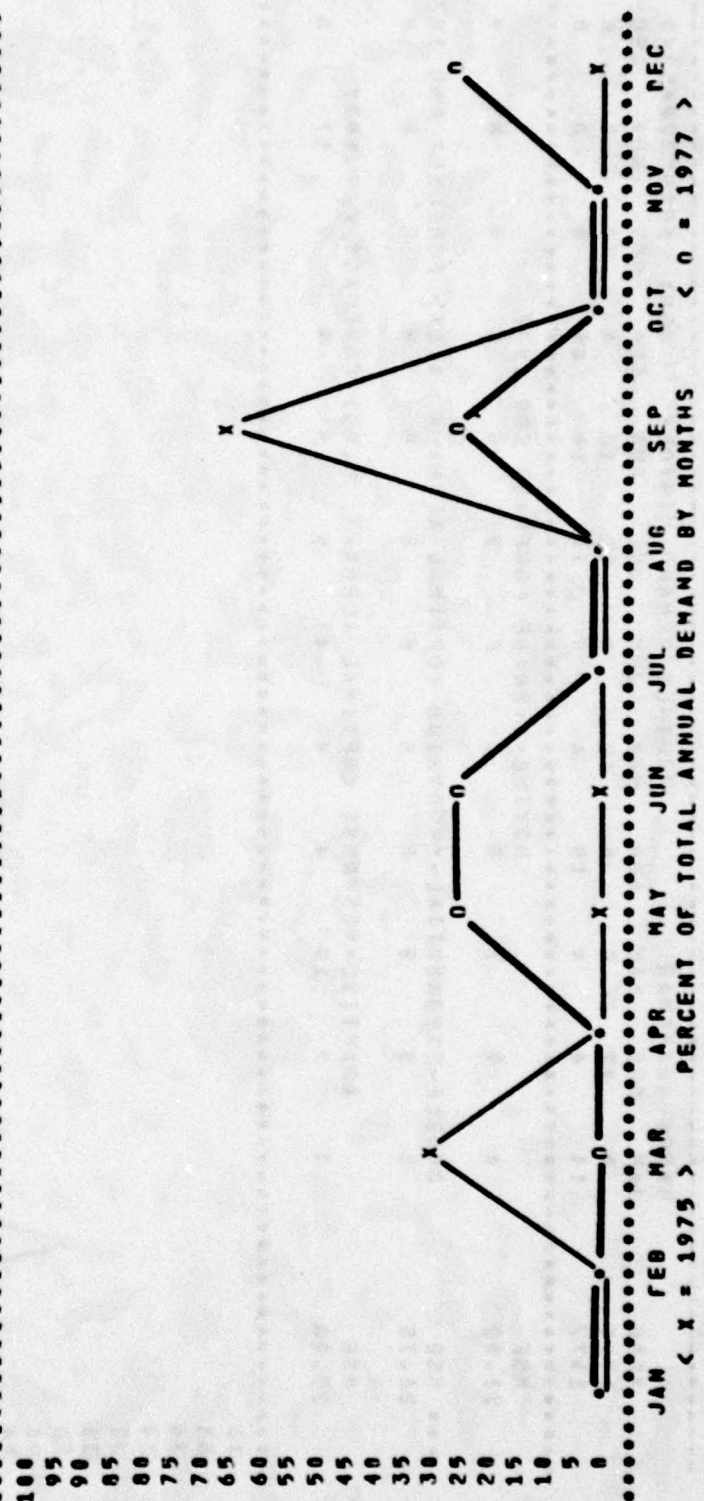
MSE	0	0	0	0	0	0	0	0	0	0	0	0
0.33												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	0	0	0	0	0	0	0	0	0	0	0	0
0.33												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

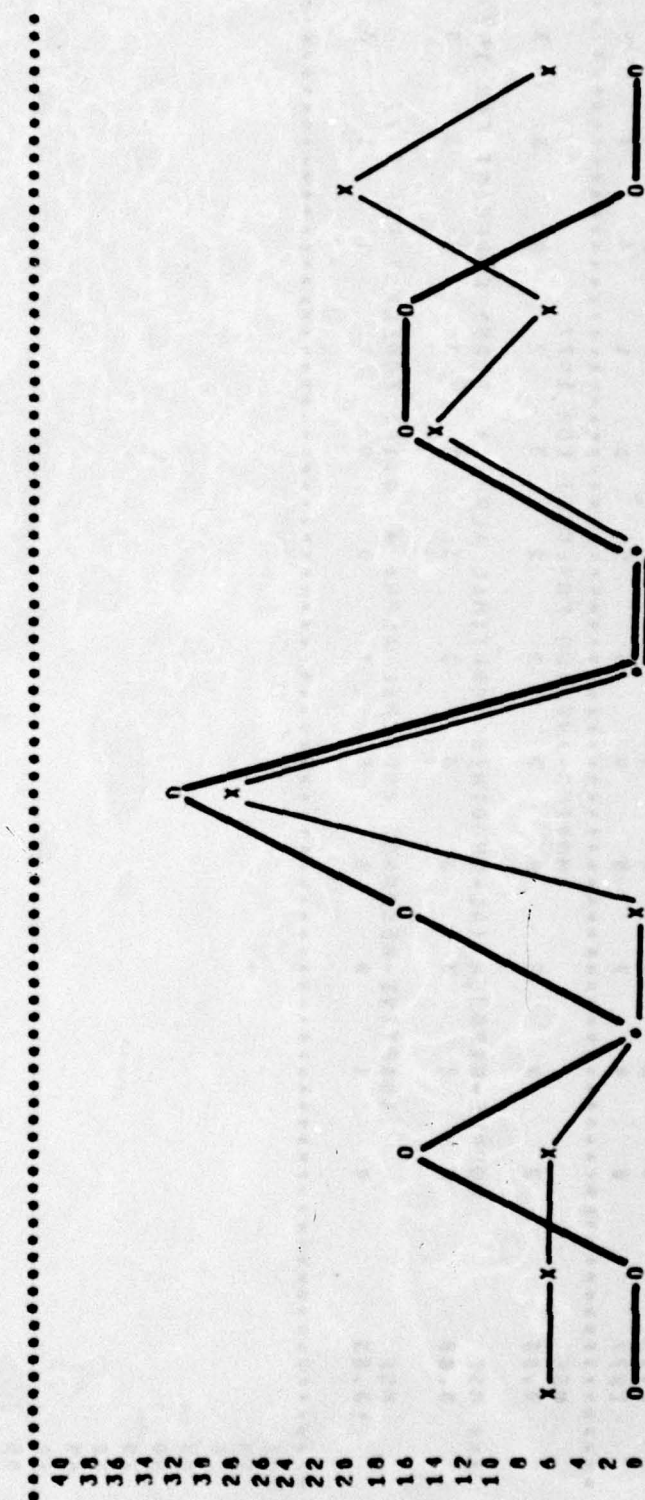
MSE	0	0	0	0	0	0	0	0	0	0	0	0
0.33												



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BASE: WHITEMAN          MONTHLY DEMAND HISTORY  MSN: 6505005306470
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  1    1    1    0    0    4    0    0    2    1    3    1
1977  0    0    1    0    1    2    0    0    1    1    0    0
.....
... MSE 1    1    1    1    1    1    1    1    1    1    1    1
      0.67
.....
... MSE 1    1    1    2    1    1    1    1    1    1    1    1
      0.67
.....
... MSE 1    1    0    0    0    0    0    1    0    0    0    0
      0.83
.....

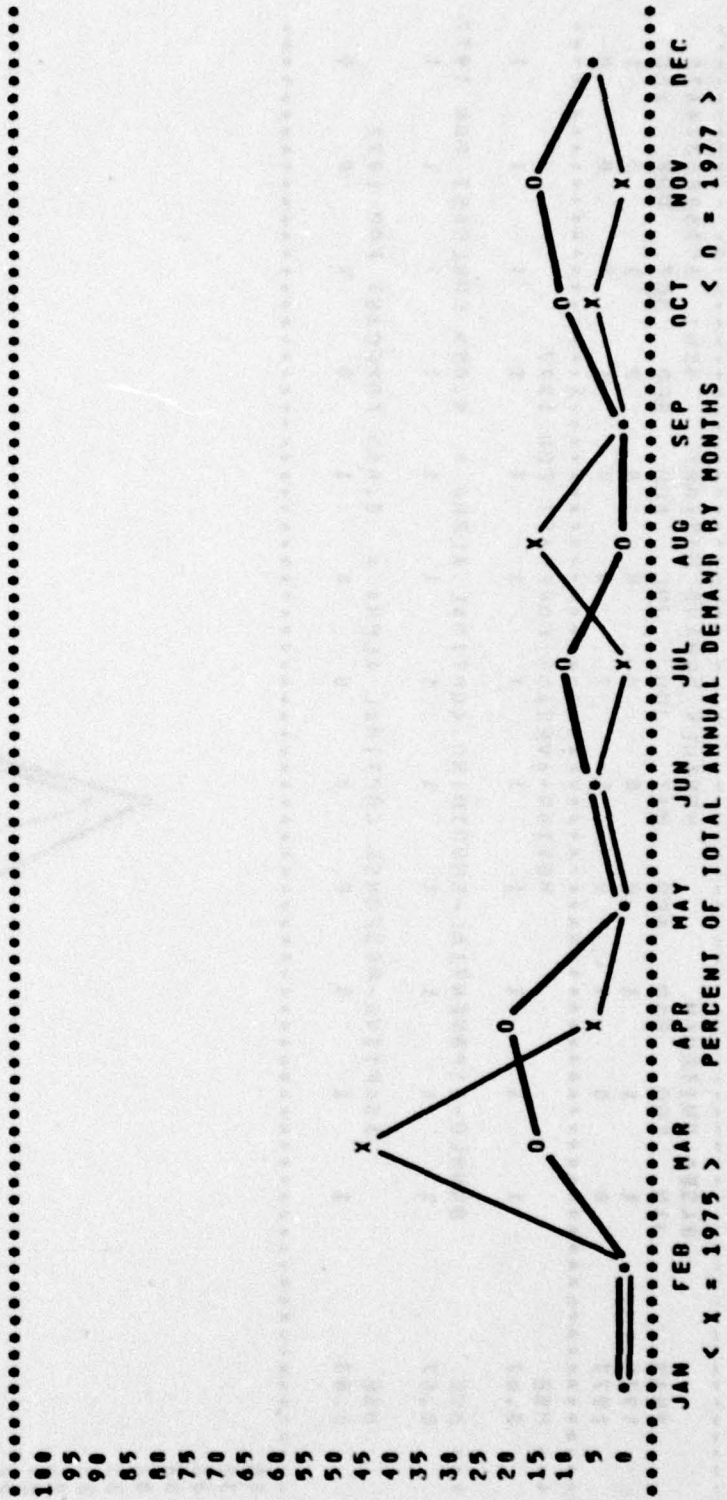
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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505005R25370
YEAR 1975 JAN FEB MAR APR MAY JUN JUL AUG SFP OCT NOV DEC
1977 0 0 10 2 0 2 0 4 9 2 0 2
0 0 7 8 0 3 5 1 1 4 7 3
MSE 2 2 2 2 2 2 2 2 2 2 2 2 3 3
9.00
... MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
0.00 3 3 3 3 3 3 3 3 3 3 3 3
MSE 13.03 0 1 0 0 0 7 0 0 1 1 1 1 3

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BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505005043470

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	40	20	0	20	0	30	0	10	0	0	20	20
1977	15	1	6	20	0	10	5	5	0	20	5	5

MOVING-AVERAGE FORECAST FOR 1977

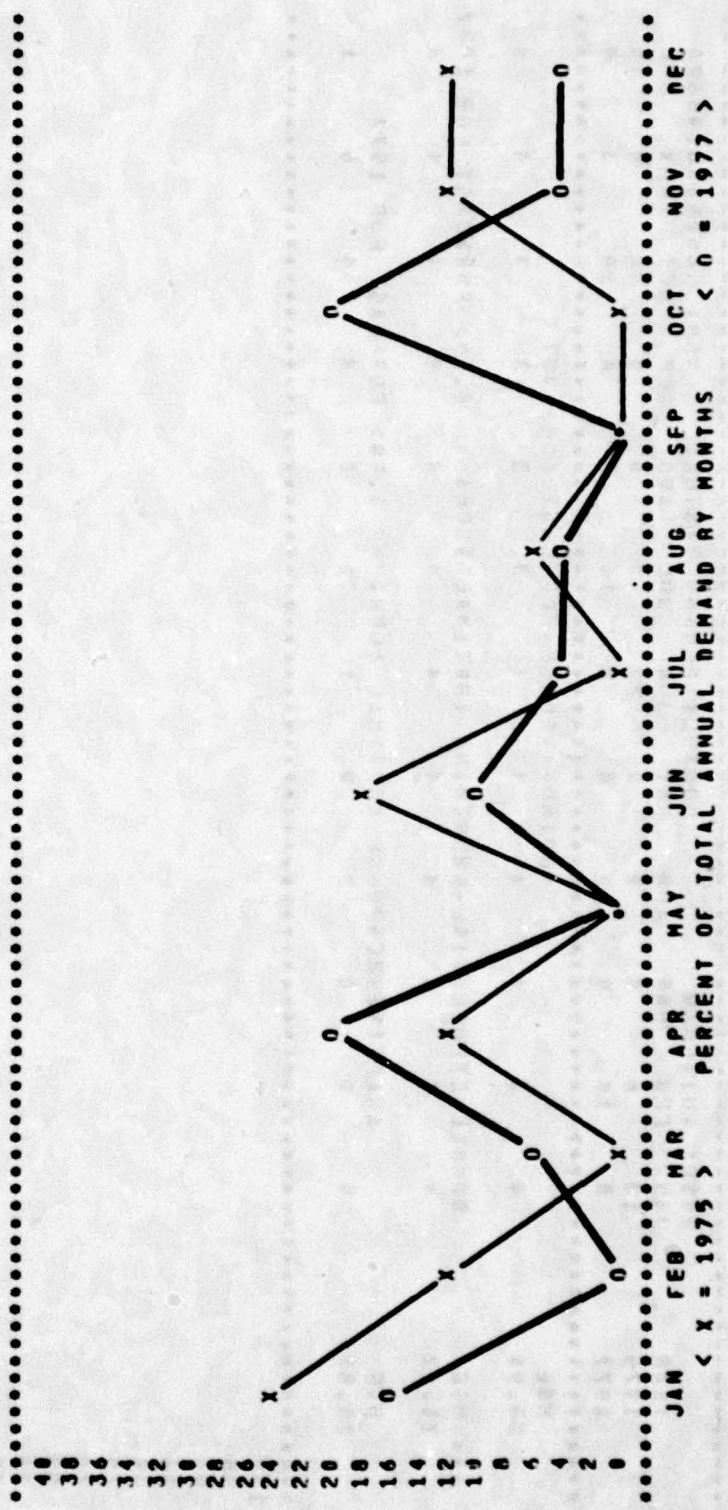
MSE	13	11	10	10	10	10	9	9	9	10	10	9
49.50												

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

MSE	12	11	11	11	11	10	10	9	9	8	8	8
54.25												

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE	14	18	16	14	8	10	12	10	6	5	0	10
66.50												



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSM: 6505006198620

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	12	6	0	0	0	22	0	0	0	0	0	10
1977	0	10	0	10	0	0	10	0	0	10	3	0

MSE 23.50

MOVING-AVERAGE FORECAST FOR 1977

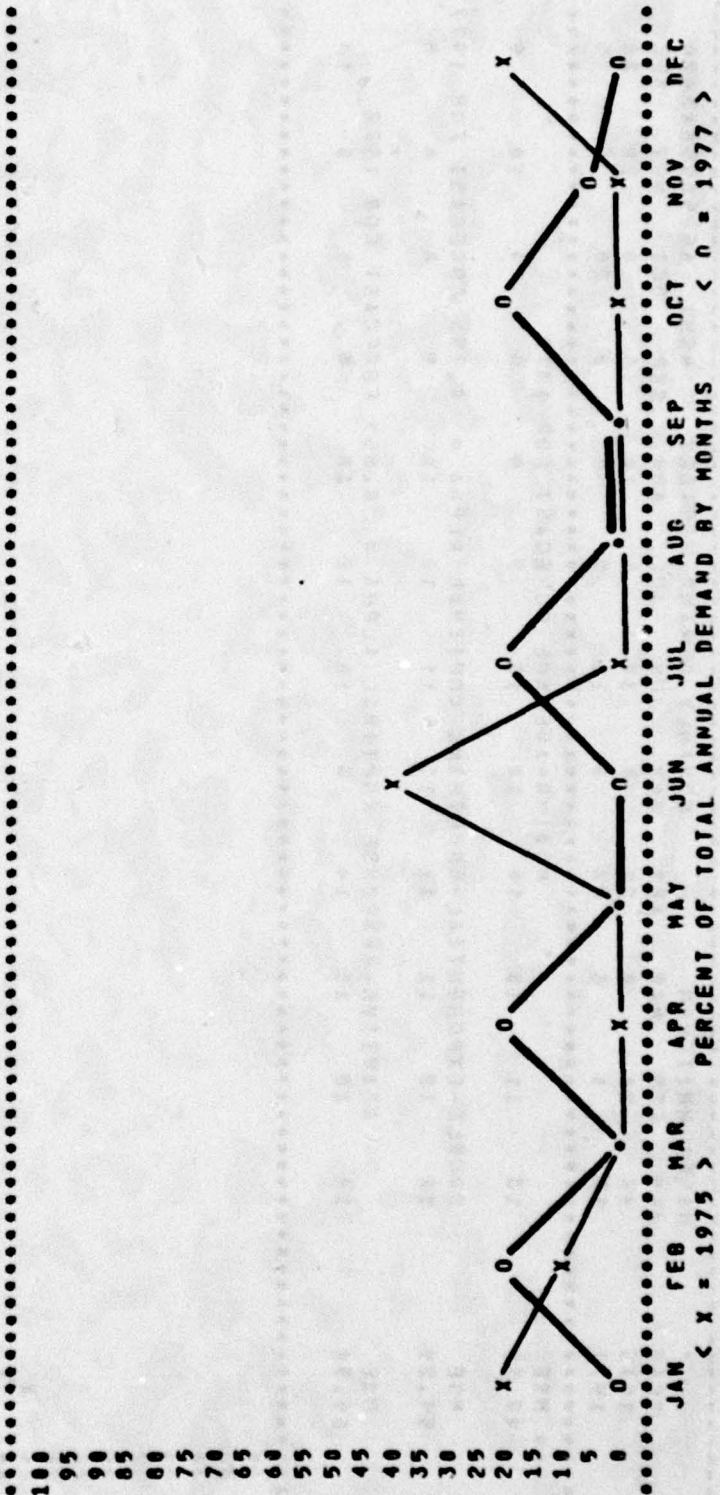
	4	3	4	4	4	3	3	3	4	4
MSE	21.42	4	4	4	4	4	4	4	4	4

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

	4	4	4	4	4	4	4	4	4	4
MSE	25.03	5	5	0	2	0	1	0	0	4

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.20> FORECAST FOR 1977

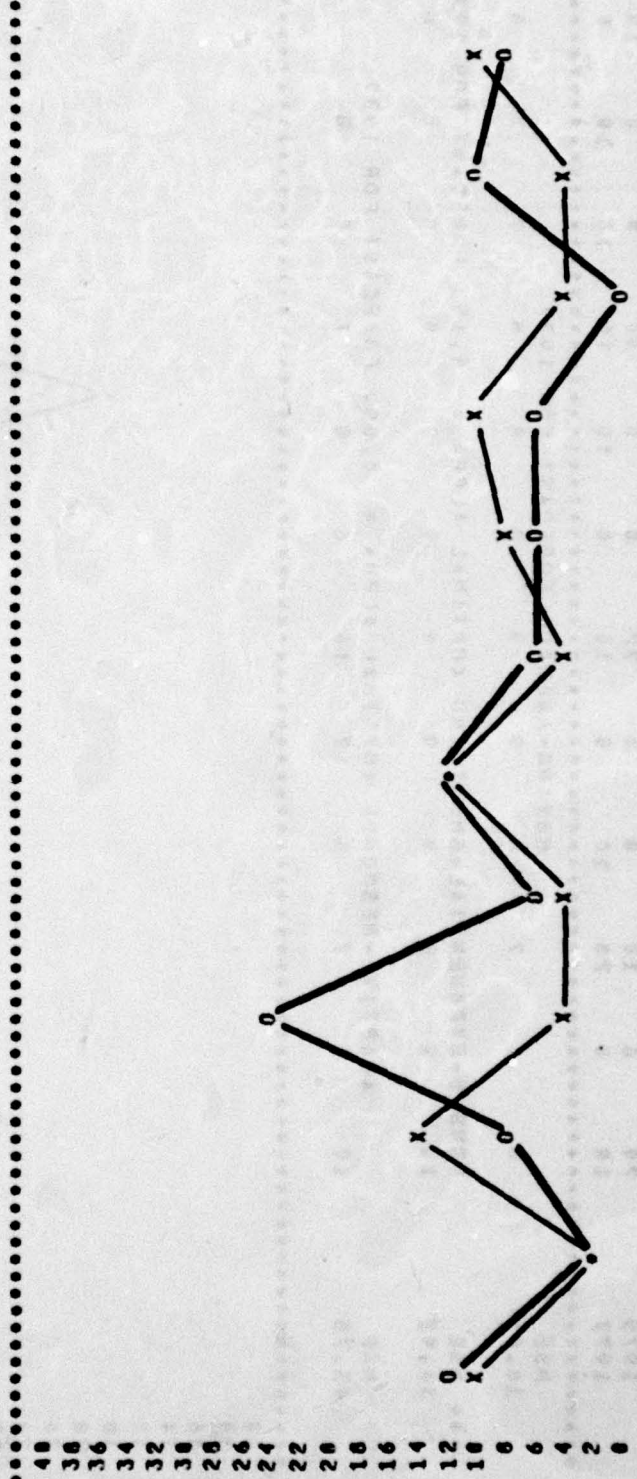
	4	3	4	4	4	3	3	3	4	4
MSE	25.03	5	5	0	2	0	1	0	0	4



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.....
BASE: WHITEMAN          MONTHLY DEMAND HISTORY  MSN: 6505006000133
YEAR  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
1975  9    2    11   4    4    9    3    6    8    4    3    7
1977  6    1    4    12   3    6    3    3    3    0    5    4
.....
MSE  10.42  6    6    6    5    6    6    5    5    5    4    4
      MOVING-AVERAGE FORECAST FOR 1977
.....
MSE  9.50  6    6    5    5    5    6    5    5    5    4    4
      DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.35> FORECAST FOR 1977
.....
MSE  12.92  3    3    5    1    1    5    .3  4    3    3    2
      ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977
.....

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.....
JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
< X = 1975 >  PERCENT OF TOTAL ANNUAL DEMAND BY MONTHS  < O = 1977 >
.....

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BASE: WHITEMAN MSN: 6505006873662

YEAR	MONTHLY DEMAND HISTORY											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	20	6	10	0	0	27	0	0	30	0	0	10
1977	10	0	20	10	0	10	0	10	10	10	10	0

MSE 38.08

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	8	7	7	9	9	9	8	8	8	7	8	8

MSE 36.92

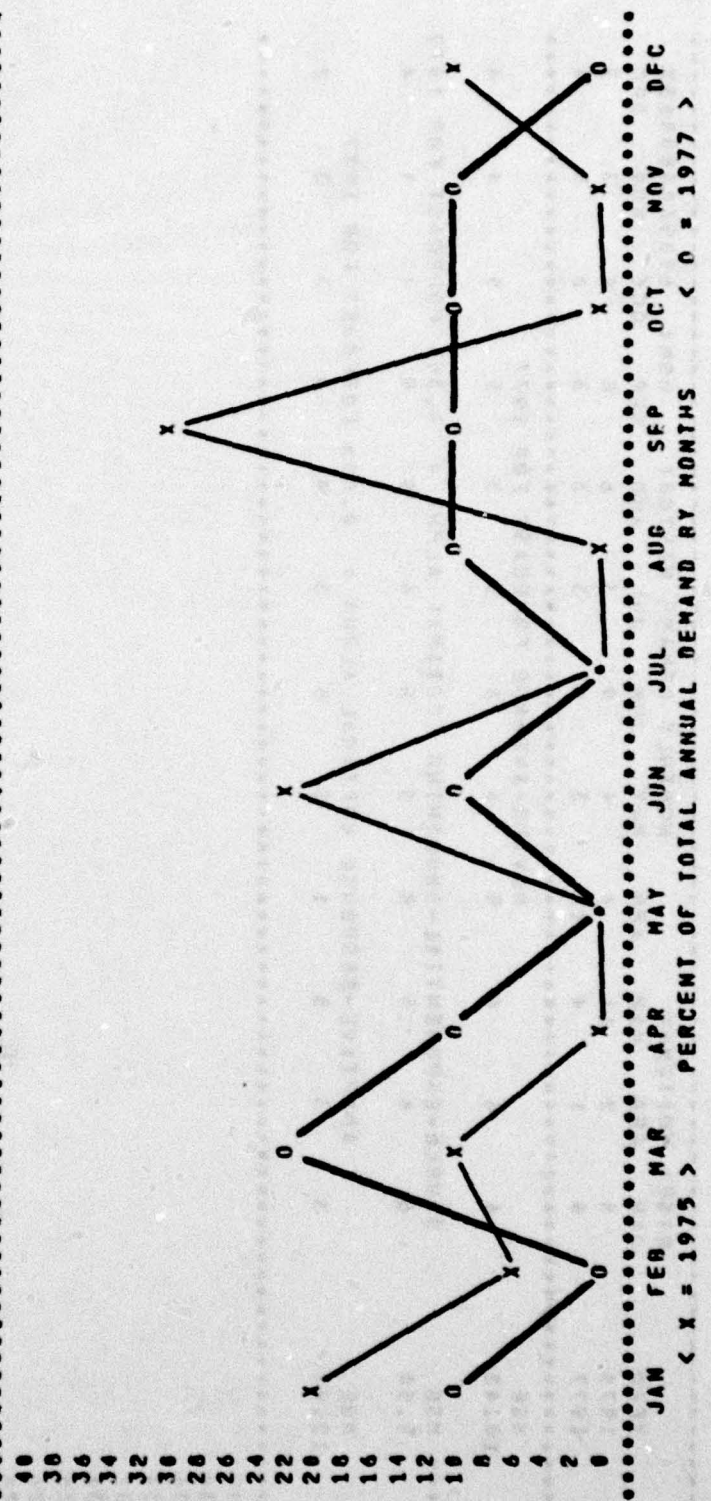
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.15> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	10	9	9	9	9	9	9	9	8	8	8	8

MSE 43.75

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	10	7	7	5	12	10	6	0	7	0	0	0



BASE: WHITEMAN MONTHLY DEMAND HISTORY NSM: 6505007540374

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	6	0	0	0	2	0	0	0	0	1
1977	1	3	2	3	1	2	1	2	6	1	3	3

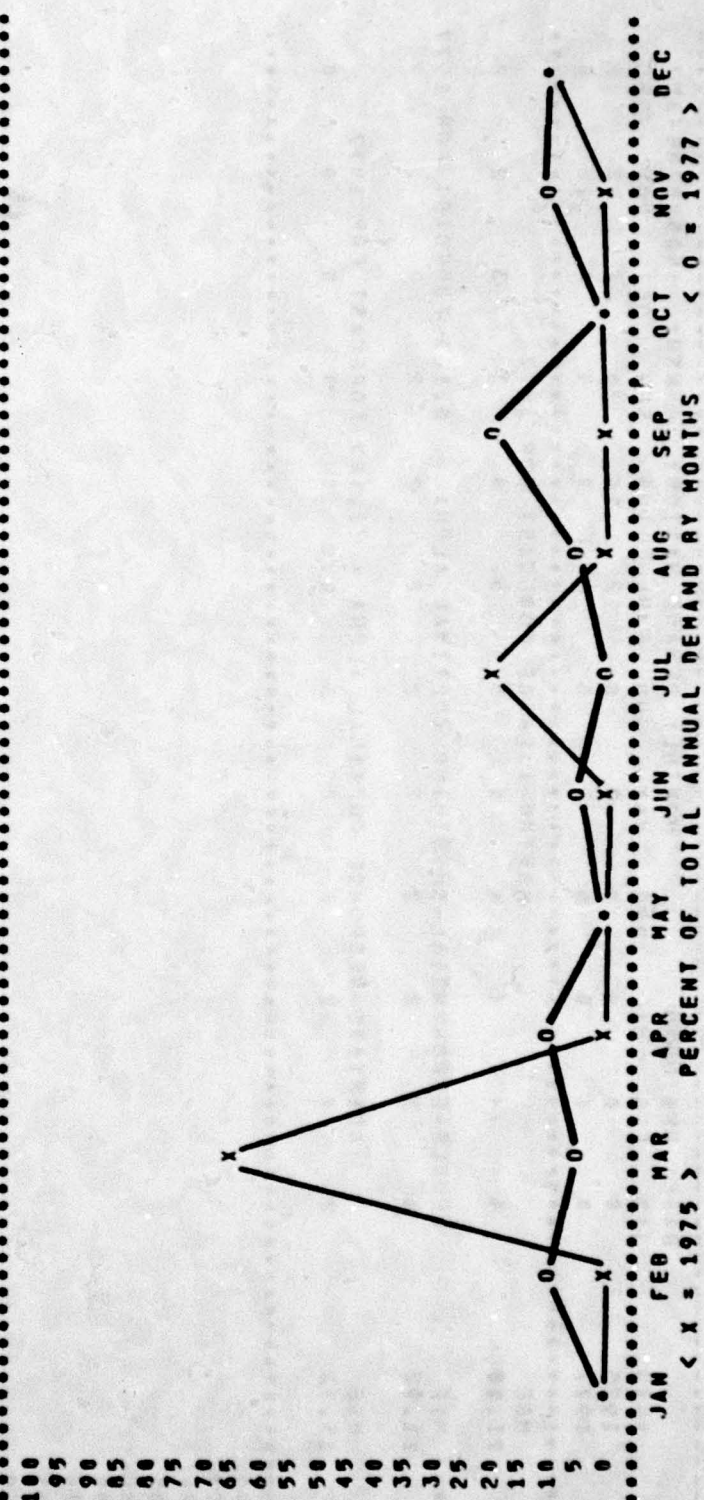
MSE 3.25 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE 2.00 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

MSE 4.42 0 0 0 2 2 2 1 1 1 1 1 5 1 1



BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 4505007054357

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	0	0	12	10	6	4	20	0
1977	0	0	0	5	0	0	1	0	0	0	12	0

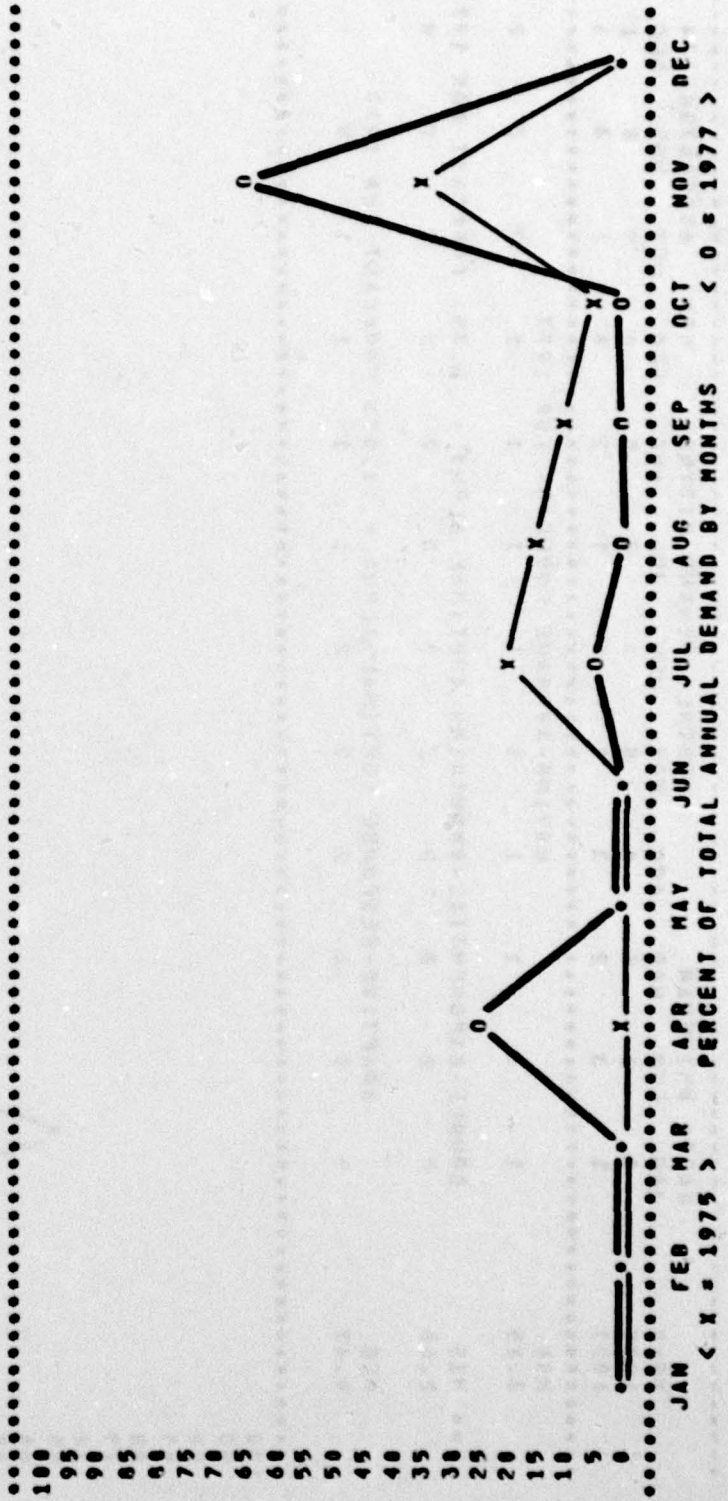
MSE 21.00

MOVING-AVERAGE FORECAST FOR 1977

MSE	4	4	4	5	5	4	3	2	2
11.92	1	2	2	2	2	2	2	2	2
15.33	2	4	2	0	0	3	0	0	0

DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.10> FORECAST FOR 1977



BASE1 WHITEMAN MONTHLY DEMAND HISTORY MSN: 65050000R96653

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	0	0	0	0	4	0	0	0	0	0	6	0
1977	0	3	1	0	0	0	0	0	2	0	0	0

MSE 1.50

MOVING-AVERAGE FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	2	2	2	1	1	1	1	1	1	1	1

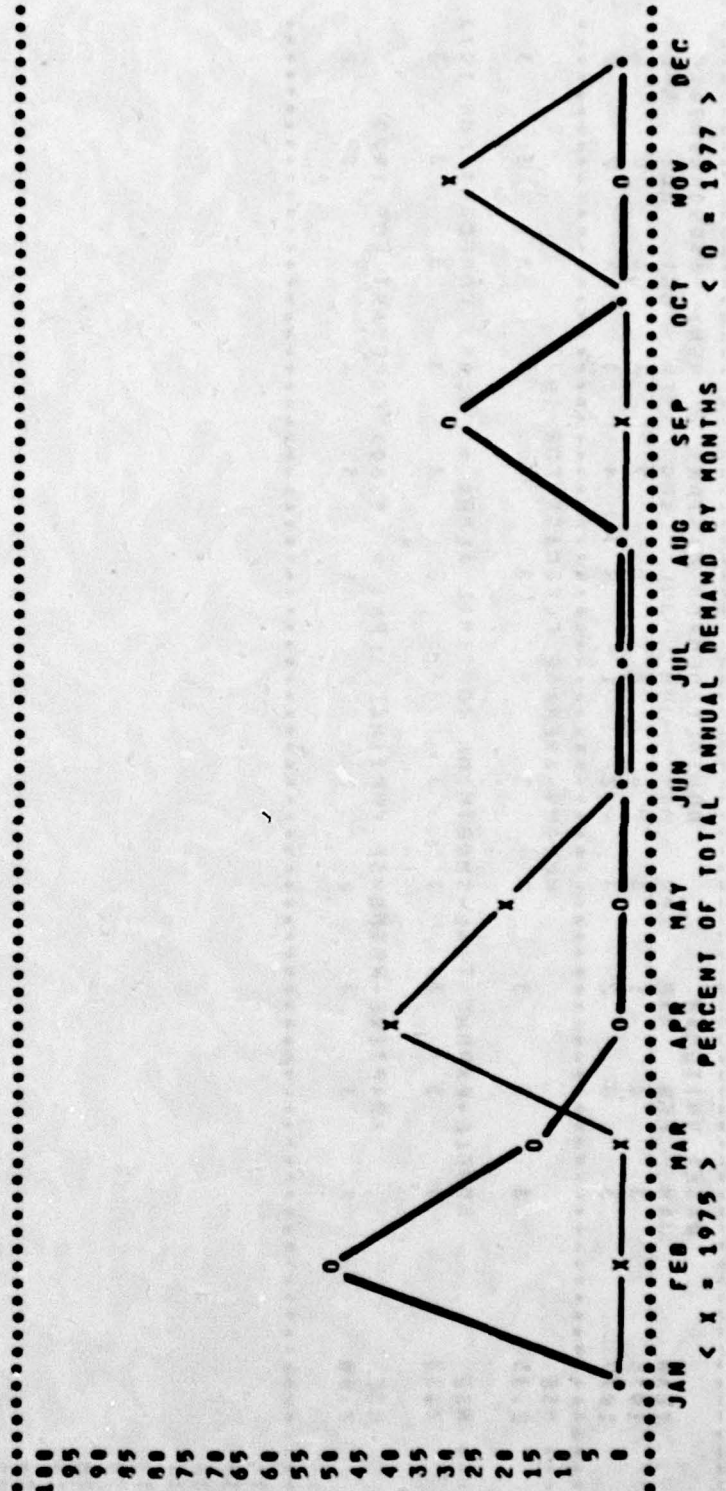
DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.05> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	0	0	0	0	0	0	0	0	0	0	0	0

MSE 1.00

ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.25> FORECAST FOR 1977

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1977	2	0	0	1	1	0	0	0	0	0	0	1







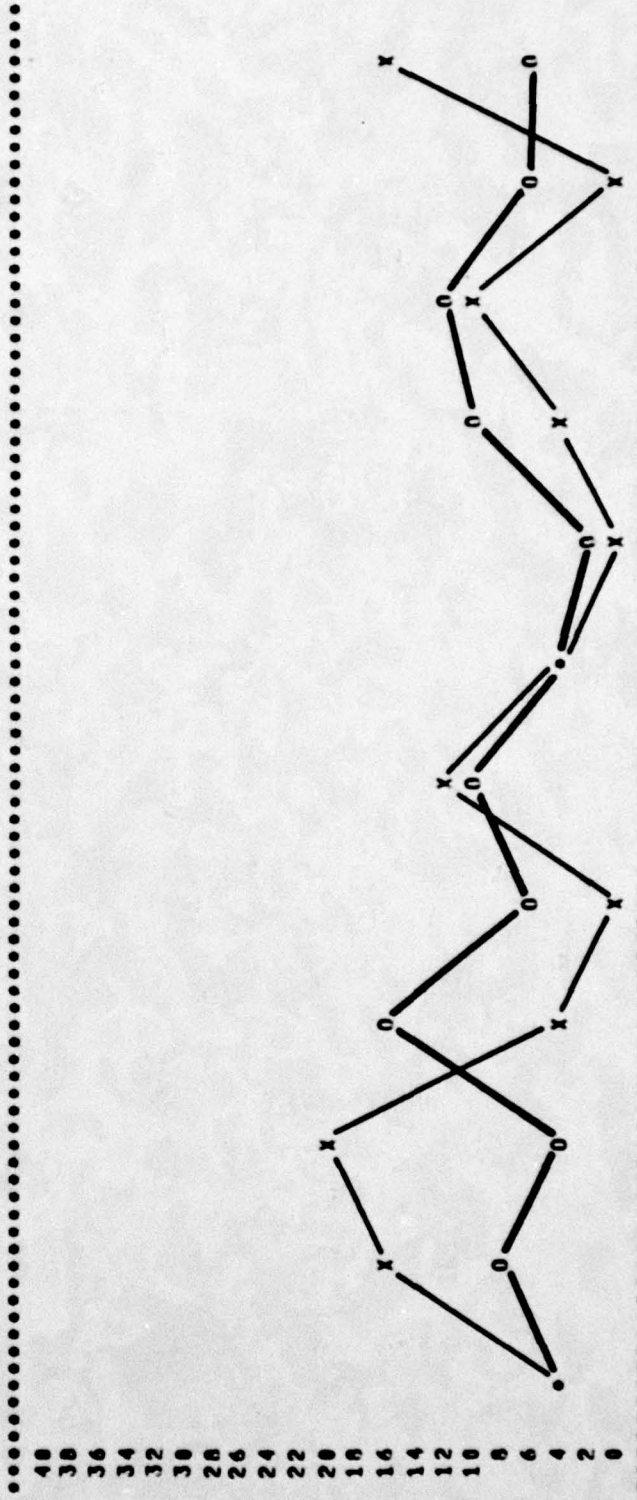


BASE: WHITEMAN MONTHLY DEMAND HISTORY MSN: 6505009857110

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975	24	72	96	24	0	60	24	0	24	40	0	72
1977	10	16	0	20	12	20	7	5	10	24	12	12
MSE	MOVING-AVERAGE FORECAST FOR 1977											
200.25	37	36	31	24	24	25	22	20	21	20	18	19

\*\*\* MSE DOUBLE-EXPONENTIAL-SMOOTHING <OPTIMAL ALPHA = 0.45> FORECAST FOR 1977  
 130.17 33 30 27 22 22 20 19 16 13 13 16 15

MSE ADAPTIVE-RESPONSE <OPTIMAL ALPHA = 0.00> FORECAST FOR 1977  
 170.50 45 14 14 12 12 14 17 12 6 17 22 12



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