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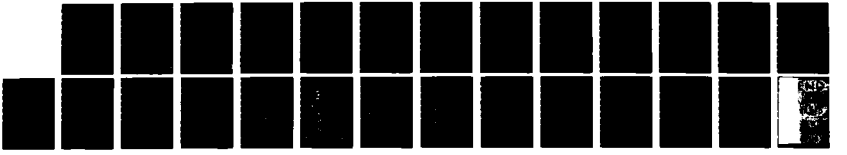

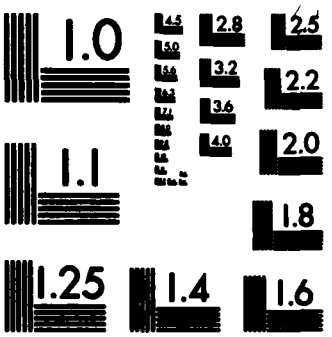

IDENTIFYING FIXED SUPPORT COSTS IN AF VAMOSC

by

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and
Dennis E. Smith

— STATISTICS —

— OPERATIONS RESEARCH —

— MATHEMATICS —

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Applied Research in Statistics - Mathematics - Operations Research

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Presented at the Resource Analysis and Management Working Group (C-2) of the 50th Military Operations Research Society Symposium (Annapolis, MD, 8-10 March 1983)

Introduction

This report is essentially a slightly expanded transcript of a presentation given at the 50th Symposium of the Military Operations Research Society (MORS) held at the U. S. Naval Academy, Annapolis, MD, in March 1983. The material represents work in progress under Contract No. F33600-80-C-0554, with the Office of VAMOSC, HQ AFLC/LO, Wright-Patterson AFB, OH. The paper describes an approach for separating installation support costs into fixed and variable components. The findings to date are tentative and are undergoing further investigation.

Background and Overview

The Air Force Visibility and Management of Operating and Support Costs (VAMOSC) System collects and displays operations and support (O&S) costs for Air Force aircraft weapon systems and ground communications-electronics (C-E) systems. Included are fuel, materiel, pay and allowances (for administration, operations and maintenance personnel), and other types of direct expenditures. Also considered are a number of overhead expenses which are incurred at base level by the host organization on behalf of all tenants. It is appropriate to assign some portion of these common costs to each tenant and then further allocate portions to the aircraft and C-E systems at the base. These common costs are referred to as installation support, which includes real property maintenance (RPM), base communications (COM), and base operating support (BOS).

The Air Force VAMOSC system is intended to portray only the variable (i.e., marginal) portion of the O&S costs incurred. Indeed, DOD's Cost

Analysis Improvement Group (CAIG), whose guidelines underlie the VAMOSC system, indicates that the costs supplied to them should not include fixed overhead.

Installation support costs within specific cost accounts do not readily lend themselves to classification as either fixed or variable. Rather each may be viewed as having fixed and variable components whose magnitudes can only be estimated. For example, consider a base's centralized personnel office. If the number of aircraft at the base is increased, the size of the personnel section may also have to increase in proportion to the additional aircraft-associated personnel. Conversely, the size of the personnel section would probably be reduced if the number of aircraft personnel were to be decreased. However, the personnel section would not be eliminated as long as the base stayed open, even if all the aircraft were removed. This illustrates that there is a fixed cost component representing the pay and allowances for those personnel section specialists required as a minimum to operate a base. There is also a variable portion which changes with the number of military personnel at the base, or which varies from base to base in proportion to base population.

There is no simple, direct method for defining the fixed and variable components of any type of overhead cost. However, there is a method for estimating these costs based on a suitable sample of cost and personnel data. This method employs the techniques of statistical regression analysis, which can be used to estimate the relationship between installation support costs and the numbers of personnel supported. A study of this kind is being conducted by Desmatics, Inc. as part of a research effort for the Air Force. This paper reports some of the findings to date.

Various relationships might exist between costs and supported

strengths, but generally a plot of the relationship may be postulated as passing through the y-axis at some point above the origin. The rationale is that this y-intercept represents the fixed portion of installation support. It is further postulated that the value of the fixed installation support cost can be estimated by fitting a regression equation to the data and calculating the value of the y-intercept. The relationship between cost and strength may be such that a straight line provides a satisfactory representation, or it may require the use of some other mathematical function. In any event, the analysis must take into consideration the customary statistical tests and diagnostic procedures.

The choice of points used in applying regression analysis depends in part on the nature of the data. If suitable data were available, individual regression equations could be established for each base. This would require the use of a number of pairs of observations per base (e.g., for a number of years of annual data). At the present time, only one year's data is available. However, this does not preclude the use of the regression approach if two critical assumptions may be made. The first assumption is that although fixed costs vary from base to base, any increments in installation support costs due to variable components are incurred according to the same general relationship. The second assumption is that base-to-base variation in fixed costs is small in comparison with the variation in total installation support costs.

Under these assumptions when dealing with data that consists of one pair of values per base (e.g., the total installation support cost and the total supported personnel strength for one fiscal year), then the y-intercept represents the average fixed installation support cost for all Air Force bases. The variable portion sought may be calculated for each in-

dividual base by subtracting this world average fixed cost from the total installation support cost for the individual base. Alternatively, the regression equation could be used to compute estimates of fixed costs for each base separately.

This paper discusses application of this regression approach based on FY81 installation support costs and supported strength counts from over 100 Air Force bases. In addition to addressing some of the specific findings derived from the FY81 data, it also considers the problem of data nonhomogeneity and the possible need to treat certain special situations (e.g., depots colocated with bases) separately.

Slide #1

The Air Force Logistics Command (HQ AFLC/LO) has developed a data system called VAMOSC (Visibility and Management of Operating and Support Costs) which collects, summarizes, allocates and displays the operating and support costs for major AF inventory items. One category of such costs includes the installation support expenditures incurred at the bases where these systems are located. Desmatics contends that such costs have variable components which change proportionally with tenant requirements for support, and fixed components which are independent of tenant requirements. This paper describes an approach for estimating the magnitude of the fixed component so that variable costs can be computed which do not include a fixed component. This would enable the system to meet a user requirement that only the marginal O&S costs be portrayed.

Slide #2

The AF VAMOSC system consists of three major subsystems: (1) WSSC

(Weapon System Support Cost), which deals with USAF aircraft at the MDS level; (2) C-E (Communications-Electronics), which is concerned with ground communications and electronics systems at the TMS level; and (3) CSCS (Component Support Cost System), which provides cost data for subsystems and components of AF aircraft weapon systems.

Desmatics has been contracted to provide an independent evaluation of the first two of these three VAMOSC subsystems, and has been working on WSSC for the past two years. Desmatics is tasked to assess the adequacy of the WSSC system inputs, its processing and allocation algorithms, and the suitability of its products to satisfy user requirements. Where improvements appear warranted, Desmatics is required to indicate feasible alternatives. This paper concerns one area in which an improvement seems indicated, that of separating fixed and variable cost components, and describes a potentially feasible method for identifying fixed cost components.

Slide #3

The aircraft operating and support (O&S) costs considered by WSSC include the types of costs listed in this slide. Among them are base level installation support costs. Primarily, these include BOS (Base Operating Support), RPM (Real Property Maintenance), and COM (base-level communications).

Slide #4

This sketch depicts three problems associated with identifying and allocating installation support costs at a typical base (in this case, Seymour Johnson AFB, NC). The total of all support cost, reported in numerous individual cost accounts in the base ABDS (Accounting and Budget Dis-

tribution System), may be identified as BOS, COM or RPM, but individual accounts do not lend themselves to classification as fixed or variable. One problem, the one which is the topic of this paper, is that of identifying the variable component. Another problem is to determine the portion which constitutes the burden which may be assessed to aircraft (as distinct from that assessable to other tenants). Finally, there is the problem of allocating shares of the aircraft burden among the individual types of aircraft assigned to the base.

Originally, WSSC allocated costs among aircraft MDS's on the basis of two measures related to the aircraft themselves: (a) the percentage of the total number of planes at the base, and (b) the percentage of the flying hours logged by each MDS at the base. Since this does not appear to be the optimum basis for allocating such costs, Desmatics recommended to the Air Force that the number of supported personnel associated with each MDS was a more appropriate cost driver to use as the basis for allocation. The WSSC system has since been changed to use supported personnel strength as the basis for allocation, both among tenants and among MDS's.

It was observed that while the CAIG (Cost Analysis Improvement Group), at OSD level, desires that cost data input to them for design review purposes be based solely on the marginal costs of aircraft operations and support, WSSC currently does not provide for segregation of the fixed component. This paper describes an approach Desmatics is investigating which may provide a feasible method for estimating the fixed and variable components of installation support costs.

Slide #5

This and the following two slides list some of the more important as-

sumptions on which the proposed method is based. These assumptions are presented in a sequence which leads to the definition of the proposed methodology.

1. It is assumed that the host organization at each airbase incurs "common" costs on behalf of all tenants which can be prorated to them.

2. Support costs are assumed not to be distinctly either fixed or variable, but rather to have fixed and variable components which must be estimated.

3. The fixed cost component is the minimum required to operate a base. It is sometimes referred to as the cost of the "base opening package (BOP)."

4. Fixed costs are assumed not to vary as a function of any tenant parameter, and therefore, they are not pertinent to weapon system design decisions.

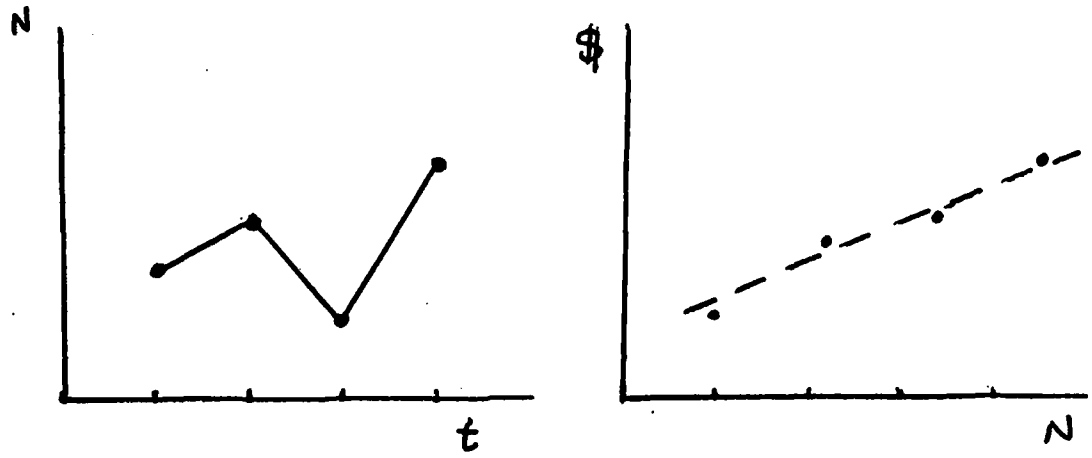
5. Variable costs, on the other hand, do change proportionally as a function of some tenant support requirement parameter.

Slide #6

6. Supported manpower strength is a cost driver which is common to all tenants, regardless of whether they are associated with aircraft, missiles, ground C-E equipment or any other type of tenant activity.

7. Variable support cost at any base is functionally related to manpower strength levels and is more directly related to this strength variable than any other readily available parameter. Unlike flying hours, it is a parameter which is common to almost all types of tenants.

The relationship expected between supported strength (N) and support cost ($) is illustrated in the two accompanying chalkboard sketches.



Base "A" may change in size, as measured by supported strength, from year to year. When costs for base "A" are plotted in order of increasing values of N (assuming appropriate adjustments for inflation), it is anticipated that a functional relationship may be established, such that the y-axis intercept represents an estimate of the fixed cost component. The same procedure may then be followed for each base.

However, at the present time there is only one data point available (FY81) for each base. Even when a second year's data is available, the prospect of determining a regression equation based on only two points is unappealing. An alternative is to pool data for one year for all bases. This requires that certain critical assumptions be met.

8. The first critical requirement is the assumption that all bases incur variable costs according to the same general relationship. (This will be illustrated later in Slide #8.)

9. A regression equation may then be fitted to pooled data from several bases and the equation may be solved for the y-intercept to provide an estimate of the fixed cost component. If the previous critical assumption is not met and a single, general functional relationship does not apply to all bases, then one model is insufficient to describe all the bases. Additional models may be necessary if the bases are not found to be sufficiently homogeneous with respect to the relationship between

supported strength and cost.

Slide #7

10. A second critical requirement is that base-to-base variation in fixed cost is small in comparison with the variation in total installation support costs.

11. It goes almost without saying that the data used in an analysis of this kind should be reasonably accurate and that no significant portion of the costs or strengths should be omitted for any base.

12. Until the analysis is initiated, it may be impossible to insure that all bases fit a single model. However, if bases tend to fall into more than one cluster, there are grounds for considering the possibility that more than one population is represented, and therefore, more than one model is required to account for the observed variability.

Slide #8

Shown here is a plot of supported strength (N) versus support cost ($) for a set of bases which theoretically satisfy all of the required assumptions. Solid dots represent data from several bases for the same period (e.g., FY81). The long dashed line is the fitted regression line. Its intercept represents the fixed cost component. Bases "A" and "B" are assumed to follow the same general relationship, as do all the other bases. The open dots joined by dashes represent the trends for bases "A and "B", and are shown to parallel the regression line.

One way of applying the method would be to compute one single fixed-component value to be applied to every base. An alternative would be to compute the regression coefficients using all the data points and then solve the regression equation separately for each base using the computed coefficients, the base's actual strength and its actual total support cost. This would yield a separate y-intercept for each base, representing its individual fixed cost component.

Slide #9

This depicts the results of applying the proposed fixed cost component identification technique to real FY81 data for 120 bases. The results have been altered slightly to emphasize certain features.

While the majority of bases appear to approximate a linear relationship between supported strength and support cost, a number of outlier conditions were observed. Unless a satisfactory means of allowing for the outliers is developed, their presence constitutes a barrier to application of the technique.

Details concerning some of the outliers have been examined in an attempt to determine why they fail to conform more closely to the postulated trend. Interesting results were obtained. Outlier "A" is Wright-Patterson AFB, and its known base population is greater than that reported in the WSSC files used to construct this plot. On further investigation, it was found that WSSC includes Logistics Command supported personnel but excludes Systems Command supported personnel. On the other hand, the support costs undoubtedly include all commands. Thus, if Systems Command supported personnel were brought in, point "A" would move to the right and might then fall into line.

"C" represents the USAF Academy, a separate operating agency whose support costs are not currently included in the WSSC system input. However, some support costs for the Academy are found in records for ATC and are included. If the bulk of the Academy's support costs which are missing here were brought in, point "C" would move up and might then fall into line.

Cluster "B" represents the five ALC depots operated by the Air Logistics Command. Perhaps depots constitute a population distinct from other

bases (e.g., have lower average support costs per supported person). However, this is counter-intuitive. One would expect the more specialized and extensive facilities at a depot to result in higher than average costs per supported person rather than lower. Yet if depots are distinctly different from other bases, they should be fit to a different model.

As indicated earlier, this paper reports work in progress. The task of investigating outliers will continue until it is determined whether the data is available which can support the proposed cost component estimation technique.

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IDENTIFYING FIXED SUPPORT COSTS IN AF VAMOSC

ROBERT L. GARDNER

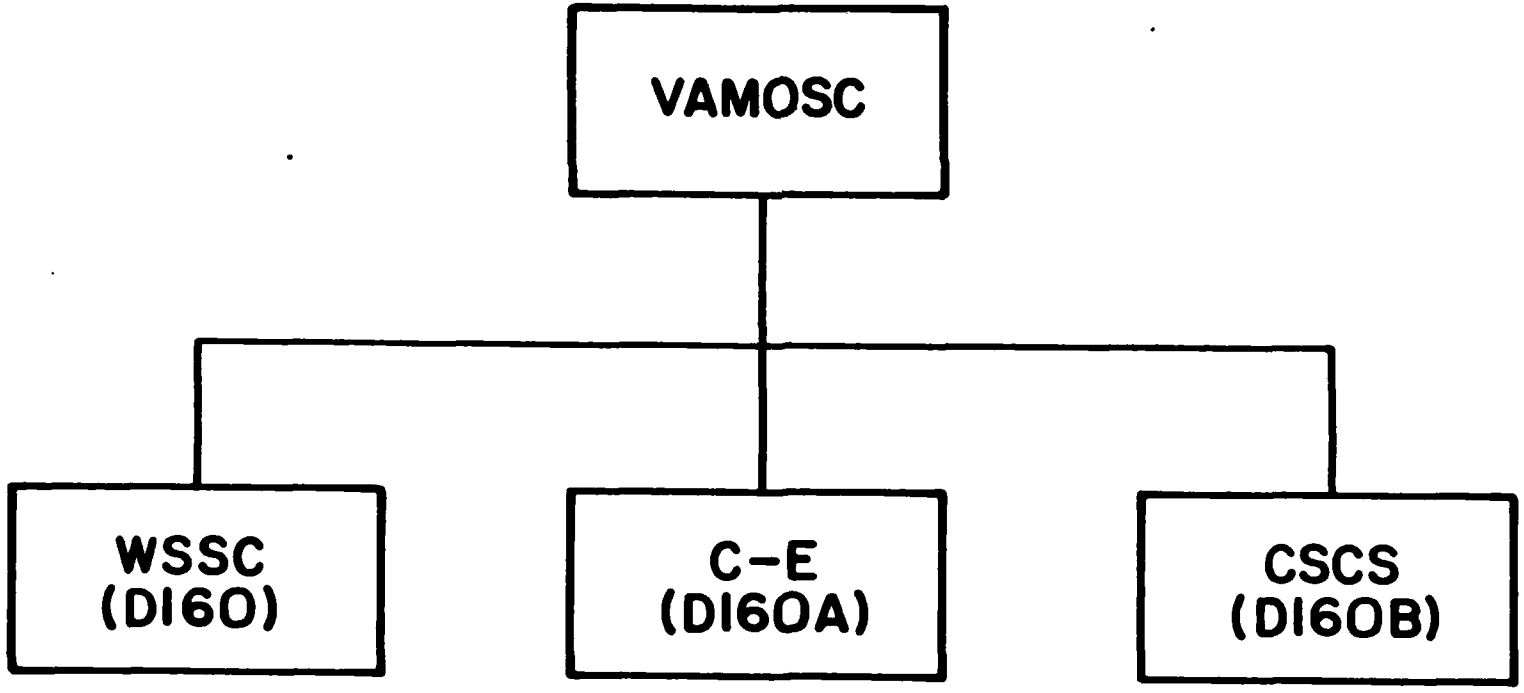
AND

DENNIS E. SMITH

DESMATICS, INC.

Slide #1

USAF VAMOSC SYSTEM ELEMENTS



Slide #2

AIRCRAFT COSTS

UNIT PERSONNEL

UNIT CONSUMPTION

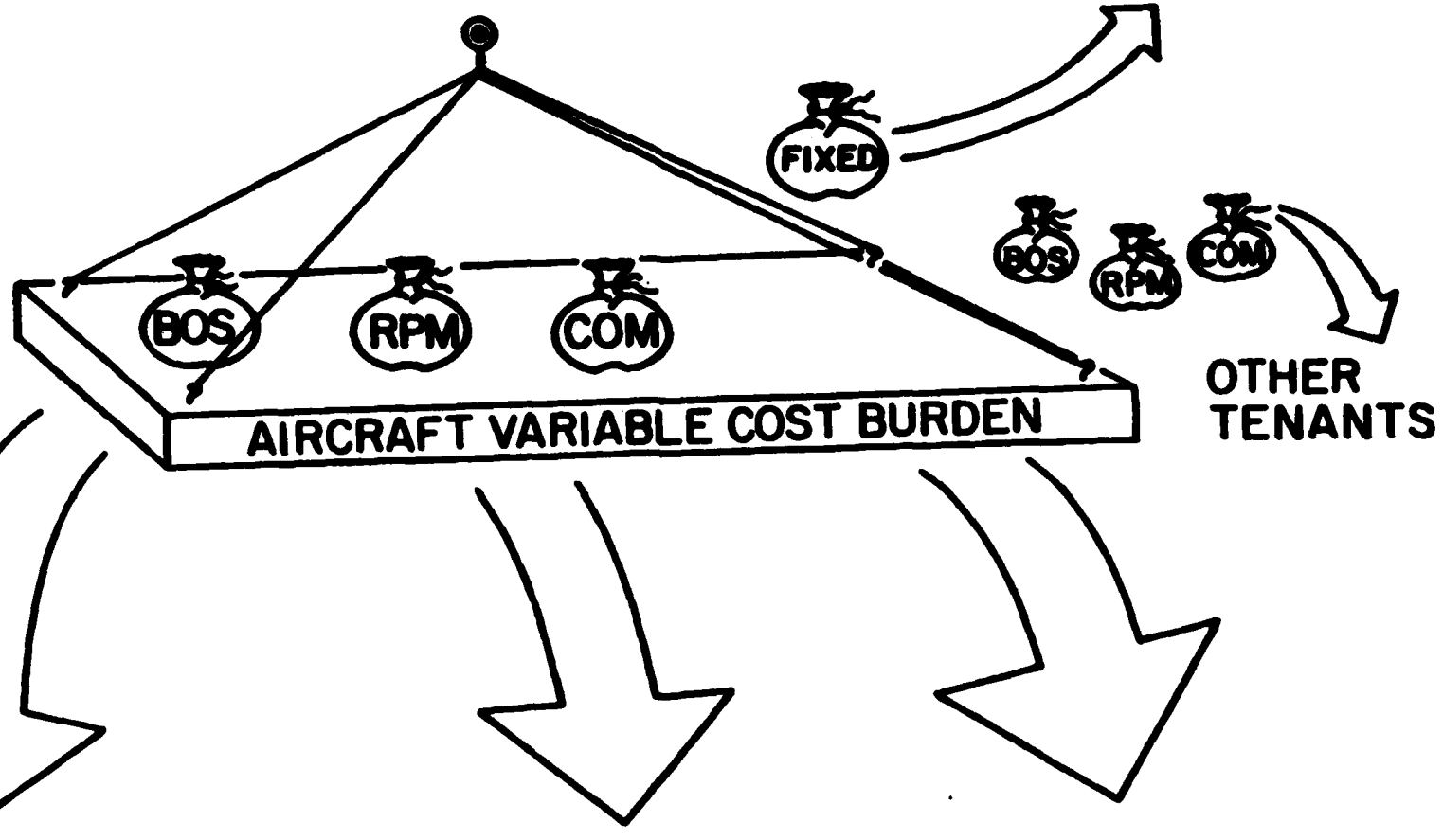
BASE-LEVEL AIRCRAFT MAINTENANCE

DEPOT MAINTENANCE & SUPPORT

BASE-LEVEL INSTALLATION SUPPORT

-
-
-

ALLOCATION OF INSTALLATION SUPPORT COSTS



- 72 TAC F4E'S
- 17280 FH/YR
- 180 CREW
- 1917 TOTAL STRENGTH

- 15 SAC B52G'S
- 5010 FH/YR
- 113 CREW
- 839 TOTAL STRENGTH

- 15 SAC KC135A'S
- 5490 FH/YR
- 76 CREW
- 393 TOTAL STRENGTH

Slide #4

ASSUMPTIONS

1 - HOST-INCURRED COMMON COSTS CAN BE PRORATED TO TENANTS

2 - SUPPORT COSTS HAVE FIXED AND VARIABLE COMPONENTS

3 - FIXED COSTS REPRESENT MINIMUM TO OPERATE A BASE

4 - FIXED COSTS ARE NOT TENANT-DEPENDENT AND SHOULD BE EXCLUDED

5 - VARIABLE COSTS ARE PROPORTIONAL TO TENANT SUPPORT NEEDS

MORE ASSUMPTIONS

6 - SUPPORTED STRENGTH IS THE COST DRIVER COMMON TO ALL TENANTS

7 - VARIABLE COST AT ANY BASE IS PROPORTIONAL TO SUPPORTED STRENGTH

8 - MOST BASES REFLECT THE SAME RELATIONSHIP BETWEEN COST & STRENGTH

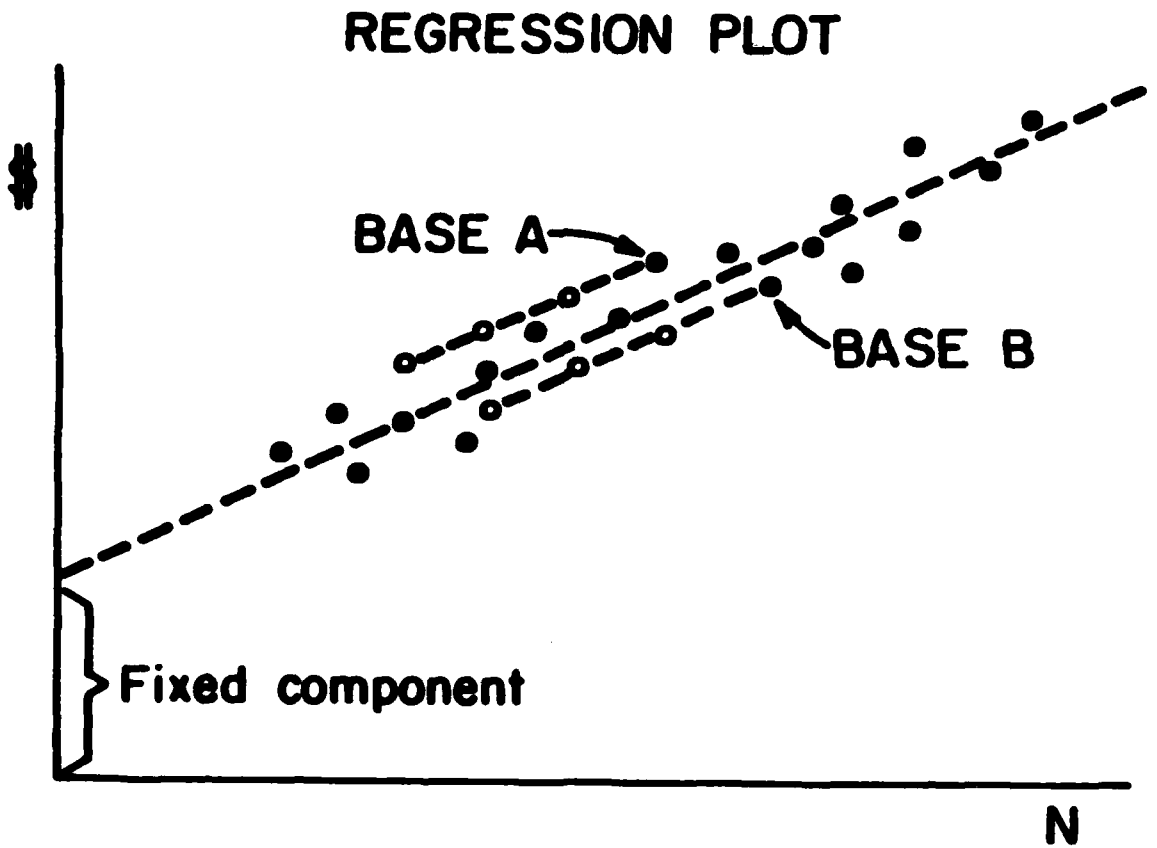
9 - A REGRESSION EQUATION MAY BE FITTED TO DATA FROM HOMOGENEOUS BASES

FURTHER ASSUMPTIONS

10 - VARIATION ABOUT REGRESSION LINE IS RELATIVELY SMALL.

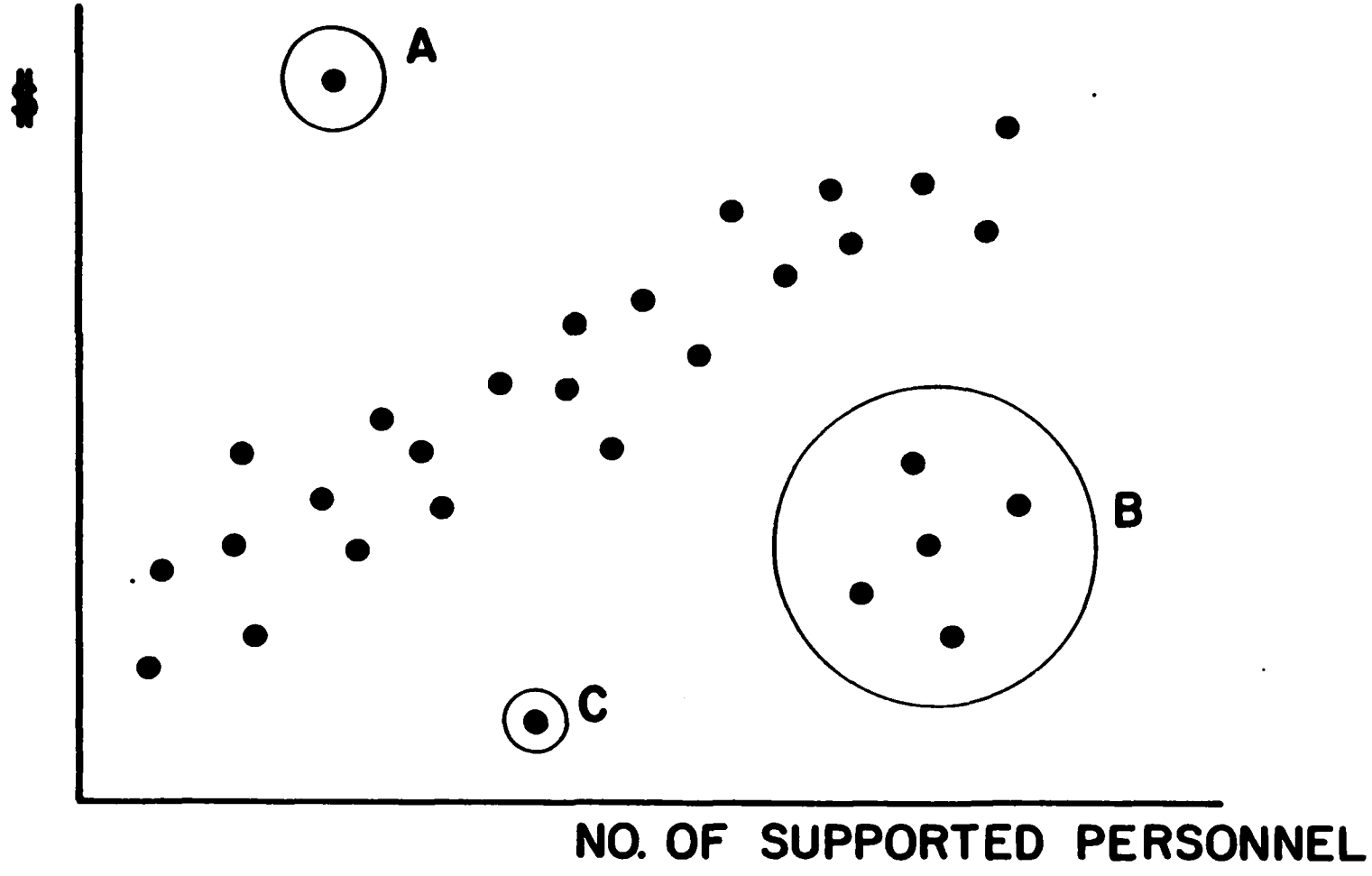
11 - THE AVAILABLE DATA IS ACCURATE

12 - ALL BASES ARE HOMOGENEOUS REGARDING SUPPORT COSTS



Slide #8

EXAMINATION OF FY81 DATA



Slide #9

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VAMOSC

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Air Force Visibility and Management of Operating and Support Costs (VAMOSC) system collects and displays operations and support costs of Air Force weapon systems and ground communications-electronics systems. This report describes the investigation of an approach for separating installation support costs within AF VAMOSC into fixed and variable components. In addition to discussing some specific findings derived from FY81 data, the report considers the problem of data nonhomogeneity.

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