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ARPA ORDER NO. 189-1

MEMORANDUM
RM-4604-ARPA
NOVEMBER 1965

TRENDS IN VIET CONG ATTACKS ON HAMLETS (U)

F. H. Denton

PREPARED FOR
ADVANCED RESEARCH PROJECTS AGENCY

The RAND Corporation
SANTA MONICA • CALIFORNIA

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ARPA ORDER NO. 189-61

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MEMORANDUM
RM-4604-ARPA
NOVEMBER 1965

TRENDS IN VIET CONG ATTACKS ON HAMLETS (U)

F. H. Denton

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PREFACE

This Memorandum reports a preliminary analysis of associations and trends detected among variables in the description of Viet Cong attacks on hamlets for the period January 1963 through August 1964. It is based primarily on summary descriptions of Viet Cong attacks given in the Daily Intelligence Summaries (DISUM's) and the Daily Situation Reports (SITREP's) published by the U.S. Military Assistance Command, Vietnam (MACV).

The work described in this Memorandum was done for the Advanced Research Projects Agency under Project AGILE.

SUMMARY AND CONCLUSIONS

During the course of the conflict in South Vietnam, a large body of data describing Viet Cong (VC) military attacks in South Vietnam has been recorded. The study reported in this Memorandum attempts to discover patterns in VC tactical behavior in the events described and to determine what conditions of battle are associated with favorable outcomes for the South Vietnam government (RVN).

This analysis has been restricted to VC attacks on hamlets occurring between January 1963 and August 1964. On the basis of analytical work such as Lanchester's theory of conflict,[1,2] and because of the emphasis placed on concentration of forces in military planning, it was felt that the relation of friendly to enemy force size would be an overriding parameter in determining the outcome of an engagement. As a result, only those engagements in which both force sizes are recorded are used in this analysis. Roughly 5 percent of all reported attacks on hamlets have both force sizes recorded. While this selection procedure significantly reduced the size of the available sample, it is felt that the 92 incidents meeting the force-size criterion do constitute a meaningful set.

The approach used here was to exhaustively examine the association between the descriptors of an engagement and the outcome in terms of casualties. Computer-conducted statistical methods were used in examining the relationships in the data.

Following are the primary results of the analysis:

Force Size

1. The VC forces are at least as large as the RVN forces in approximately 90 percent of the incidents in this sample. In the 92 incidents examined, enemy intelligence was such that the VC very seldom initiated an attack against a superior force. Since the RVN force sizes included those reinforcements that arrived in time to engage the enemy, the VC apparently had sufficient control of the situation to ensure that superior RVN forces would not entrap them during an attack on a hamlet. This is felt to be a prime characteristic of insurgent

forces; that is, insurgents attack only when they are reasonably certain of at least an equality of forces.

2. The average VC-to-RVN force ratio declines rapidly as the RVN defending force increases in size. That is, the data indicate that the VC were unable to maintain a large force advantage as the defending force increased in size. An equality of forces existed at roughly the company level. This steep decline in VC force advantage may indicate limitations due to logistics or to the size of forces that can assemble undetected.

Associations With Outcome

3. The percentage of RVN troops killed and wounded ($\%RVN_{k+w}$) is consistently higher when the VC has a large force advantage. This result is in agreement with Lanchester's theory. The success of the insurgents may, in large measure, be attributed to their ability to concentrate locally superior forces against static government positions.

4. The percentage of RVN missing in action ($\%RVN_{mia}$) is large when the VC forces are large, irrespective of force ratio--a somewhat surprising result. Equating large numbers of missing in action with high desertions would indicate that the absolute number of the enemy is more important in influencing the decision to desert than is the relative size of the enemy force.

5. The percentage of VC killed and wounded ($\%VC_{k+w}$) shows some tendency to be higher when the VC-to-RVN force ratio is lower. The statistics on VC casualties were sparse, and because of a known VC policy of concealing losses, these statistics were felt to be somewhat unreliable. Despite the limitations on reliability, there is a tendency for the VC to lose more of their force if they attack with a smaller force advantage. This result is also predictable from Lanchester's theory.

6. The presence of artillery support is associated with lower-than-average losses of friendly combat forces. Thus, the indications are that artillery support was the most effective mechanism for reducing friendly losses. The feeling is that artillery support causes the VC to break off the engagement.

7. Ground reinforcements, and to a lesser extent air strikes, are associated with higher-than-average values of $\%VC_{k+w}$. From a quite small sample of incidents, the indications are that of the support forces air and ground reinforcements are the most effective in attriting the VC.

8. Results generally look more favorable for the RVN when combat is in dry, flat to rolling terrain, as opposed to mountainous terrain or deltas. This might be expected, since the superior mobility and reserves of the RVN can be better exploited in dry, relatively level terrain.

A preliminary check was made on the validity of these relationships by examining other types of incidents for the existence of similar trends; a general agreement was noted, increasing the confidence in the findings. The presumed implications of the empirical relationships are based on a general knowledge of the conflict, but they are undoubtedly not the only interpretations possible. The difference between noting the empirically exhibited relationships (such as lower losses with a greater force advantage) and offering possible interpretations of these relationships must be kept in mind.

Overall, the general impression given is that a VC attack on a hamlet bears a strong resemblance to other types of military engagement. Most of the expected relationships hold, indicating that at least after the initiation of an engagement, insurgency bears many of the characteristics of "conventional" conflict.

ACKNOWLEDGMENT

The author would like to express his appreciation to R. D. Jones, of The RAND Corporation, for his insightful comments during this analysis.

CONTENTS

GLOSSARY OF TERMS

ARVN	Army, Republic of Vietnam
CG	Civil Guard (now called Regional Forces)
CY	Combat Youth (now included in Popular Forces)
DISUM	Daily Intelligence Summary (replaced by SITREP in March 1964)
MACV	Military Assistance Command, Vietnam
Militia	Hamlet Defenders (now included in Popular Forces)
MR	Viet Cong Military Region (regions 5 through 9 are in South Vietnam)
PF	Popular Forces (includes the former CY, SDC, and militia)
RF	Regional Forces
RVN	Republic of Vietnam
SDC	Self-Defense Corps (now included in Popular Forces)
SITREP	Daily Situation Report
VC	Viet Cong

I. INTRODUCTION

This Memorandum represents an effort to better understand the military elements of conflict in South Vietnam. The basic assumption made is that there are many patterns in military events which may be detected by a thorough analysis of the interrelations among the descriptors of a number of engagements.

In order to aid the empirical research into combat relationships and to approach an "exhaustive" study, the electronic computer was used to process the battle data.* The computer provided the routinized functions of plotting trends and computing correlation coefficients, principal-components analysis, etc. Correlation and principal-components analyses were employed to examine all combinations of descriptive variables to determine which occur together and which are associated with favorable and unfavorable outcomes. If a correlation appeared particularly interesting, a plot of the relationship was often made for more detailed examination. Use of the computer made it possible to examine a far wider range of descriptors, over more engagements, than would otherwise have been feasible.

Empirical correlation does not necessarily imply causation. Two variables may be empirically correlated because of their mutual dependence on some third variable, or because of data-recording discrepancies, or because of errors. In this analysis an attempt has been made to account for possible third variables which might "cause" a spurious correlation, and a search was made for possible biases in the data.

It should be remembered, however, that the analysis is based on material describing short incidents of high tension. These data come through a lengthy reporting channel (involving the translation from Vietnamese to English). For personal reasons or out of patriotism, any of several persons may see fit to modify the true description. Additionally, the analysis concerns a type of conflict about which we still

*A list of the parameters included in this investigation is given in Appendix A.

have much to learn. Keeping these limitations in mind, it is felt that the descriptive material in the text can provide a useful step in better understanding the conflict in Vietnam.

It is hoped that the empirical relations discovered in this analysis will be immediately useful. However, the long-run goal is to provide background experience for improving the theory of insurgency and, thus, counterinsurgency; that is, to provide a concise, easy-to-read reference on the patterns exhibited in the military conflict in Vietnam.

II. DESCRIPTION OF THE DATA

The data employed in this analysis are taken primarily from the MACV's daily summaries of enemy activity (formerly recorded in the DISUM and presently recorded in the SITREP).* These reports contain a brief description of each VC-initiated incident. For example, a relatively complete incident report might read as follows:

> 200200 August, Phuoc Long (Province), 2 VC platoons attacked Bu Nho New Rural Life Hamlet in the Vic YT045975, defended by 15 SDC and 20 CY. Friendly Losses 5 KIA, 31 MIA, 28 Rifles, 2 Pistols, 1 PRC 10 Radio. Enemy Losses Unk. (Atk)

In engagements involving similarly equipped forces it was assumed that force ratio would be a critical parameter in determining outcome; hence only those incidents in which both force sizes were reported are included in the sample.** The MACV reports were surveyed for the time period January 1963 through August 1964. For this twenty-month period, 92 VC attacks were found where both force sizes were reported. This constituted about 5 percent of all attacks on hamlets reported during the period.

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*For definitions of all abbreviations used in this Memorandum, see the Glossary, p. xi.

**Often the forces engaged were described in terms of units such as platoons or companies. Considerable variation apparently exists in the number of men actually assigned to a particular unit size. Furthermore, for any individual operation, sickness, leaves, men on patrol, etc., can result in the fighting force being somewhat smaller than the assigned force. Based on estimates of authorized strength and a few cases in which numbers of men are estimated for a unit, the following unit sizes were used:

Squad = 10 men
Platoon = 30 men
Company = 80 men
Battalion = 250 men

The value used for a battalion is probably the most uncertain. These units apparently vary in strength considerably from region to region and from one military organization to another. The conversion from unit size to an estimated number of men thus creates another source of error in the data.

One obvious question is whether the criterion of selecting incidents with known force sizes gives an unbiased sample of the population of all reported attacks. A second consideration is whether the observed regularities hold for time periods other than the one examined. To at least partially check the answers to these questions, the SITREP's for September through December 1964 were examined.* All the VC attacks on villages and hamlets recorded during this period formed a control sample against which the data used in the analysis could be checked. Because both force sizes are reported so seldom, it is not possible to check directly the trends associated with the force ratio. However, trends of force sizes and of casualties can be compared.

Table 1 lists the size and casualty trends noted in the two samples.

Table 1

COMPARISON OF SAMPLES

Item	Original Sample[a] (1/63-8/64; Both Force Sizes Known)	Control Sample (9/64-12/64; All Attacks On Hamlets)
Number of incidents	92	55
Mean RVN force size	43	41
Mean RVN killed and wounded	6.1 (7.7)	7.3
Mean RVN missing in action	2.8 (4.3)	6.2
Mean RVN weapons lost	5.9 (9.0)	11.3
Mean $\%RVN_{k+w}$ for RVN size of		
0 - 15 men	45 (46)	74
16 - 30 men	16 (20)	29
46 - 60 men	14 (17)	16
> 90 men	8 (9)	8

[a]The numbers in parentheses are corrected values reflecting the difference in the rate of reinforcement for the two samples.

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*The September through December SITREP's became available subsequent to the original analysis. Since they contained only four attacks with both force sizes given, the original sample was not updated.

There is some indication that the average friendly casualties are higher in the control sample. However, the percentage of cases in which the defenders received external support is much lower in the control sample than in the original sample. Furthermore, the presence of external support, or "reinforcements," was associated with lower friendly casualties in the main sample (see p. 29). If the association of casualties with reinforcements is assumed causal and the data in the original sample are corrected for this effect (as shown in Table 1), there appears to be only a small difference in the friendly losses for the two samples. Some indication is given that a greater number of missing in action occurred in the control sample.

The $\%RVN_{k+w}$ in the control sample shows the same trend with RVN force size as it did in the sample of 92 incidents. The control sample does show a higher percentage killed and wounded for the smaller forces. However, a chi-square test on the medians indicates a low significance level for this difference (about 0.15).* Thus, it seems that the two samples are not conclusively different in any of the outcome measures listed in Table 1.

Of the 55 attacks recorded in the September through December sample, only 4 specified VC force size. In order to provide a control on VC size, a separate sample of attacks on hamlets was taken from the Strategic Hamlet Incident Reports.** Forty-seven incidents were found with VC force size reported. These incidents occurred primarily in January, February and March of 1964. The average VC size for this sample was 72 compared with 73 for the main sample--indicating good agreement.

The RVN force size and casualty data recorded in the sample of attacks analyzed appear to be representative of the population of all attacks on hamlets in September through December of 1964. The average VC force in the original sample corresponds to the average VC force size specified in an independent sample of attacks in early 1964. An

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*See Ref. 3, p. 104, for a description of the chi-square test.

**The Strategic Hamlet Incident Reports provided a readier source of data on VC force size than did the SITREPS.

unexplained difference exists in the rate of artillery support between the original sample and the September through December sample (artillery is employed less often in the latter). The above checks do not indicate any major biases created by selecting only those incidents with both force sizes given, with the possible exception of the incidence of artillery support.

III. TRENDS IN RELATIVE FORCE SIZES

Force ratio would appear to be one of the most important parameters in determining the outcome of an engagement. Lanchester's theory of conflict expresses the outcome of an engagement in terms of force ratio.[1] Weiss has examined these equations against battle statistics and the results have generally supported Lanchester's theory.[2] The strong relationship exhibited between force ratio and casualties in these data further confirms the reasonableness of this assumption.

In defending hamlets the RVN is engaging in that most maligned of the military practices exhibited by the French in Indochina--defending many widely dispersed, fixed installations. Resultingly, the RVN troops are spread rather thin. On the other hand, the VC, operating under the cover of darkness (approximately 80 percent of this sample were night attacks), conceptually can mass forces for a local force superiority at a hamlet of their choosing. However, even in darkness, as the VC assemble larger forces they increase the chances of early detection and exposure to government air attacks or ground retaliation. It seems possible that upper force-size limits may be imposed on the VC because of the fear of detection, as well as for such other reasons as logistic limitations.

This section examines the extent to which these postulated trends are exhibited in the data.

Figure 1 shows the distribution of force sizes for both the VC and RVN in the sample of 92 attacks. The RVN force is generally that force located at the hamlet, though on occasion a reinforcing group arrived before the VC disengaged and was included in the RVN force total. The most obvious trend in Fig. 1 is that the VC generally are reported to have larger forces than the RVN. The average VC force is about 73 men, while the average RVN force is about 43 men. Figure 2 shows how this translates into relative force sizes. In 85 of the 92 cases, the VC had a force size equal to or greater than that of the defenders. A median force ratio of about 2 and a mean ratio of about 2.5 are shown. On a number of occasions (15 of 92 incidents) force advantages greater than or equal to 4 to 1 were enjoyed by the VC.

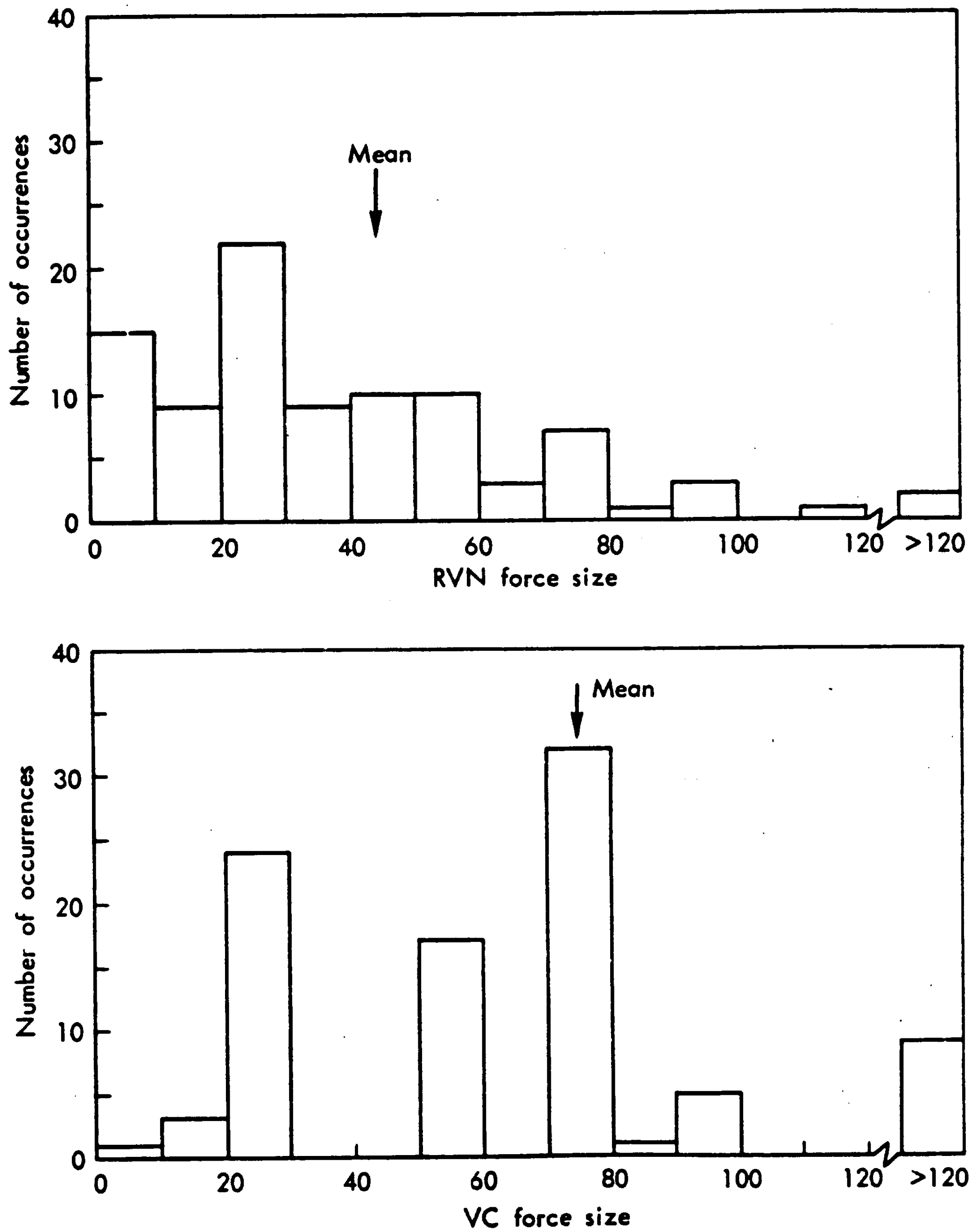

Fig.1—Force sizes of VC and RVN

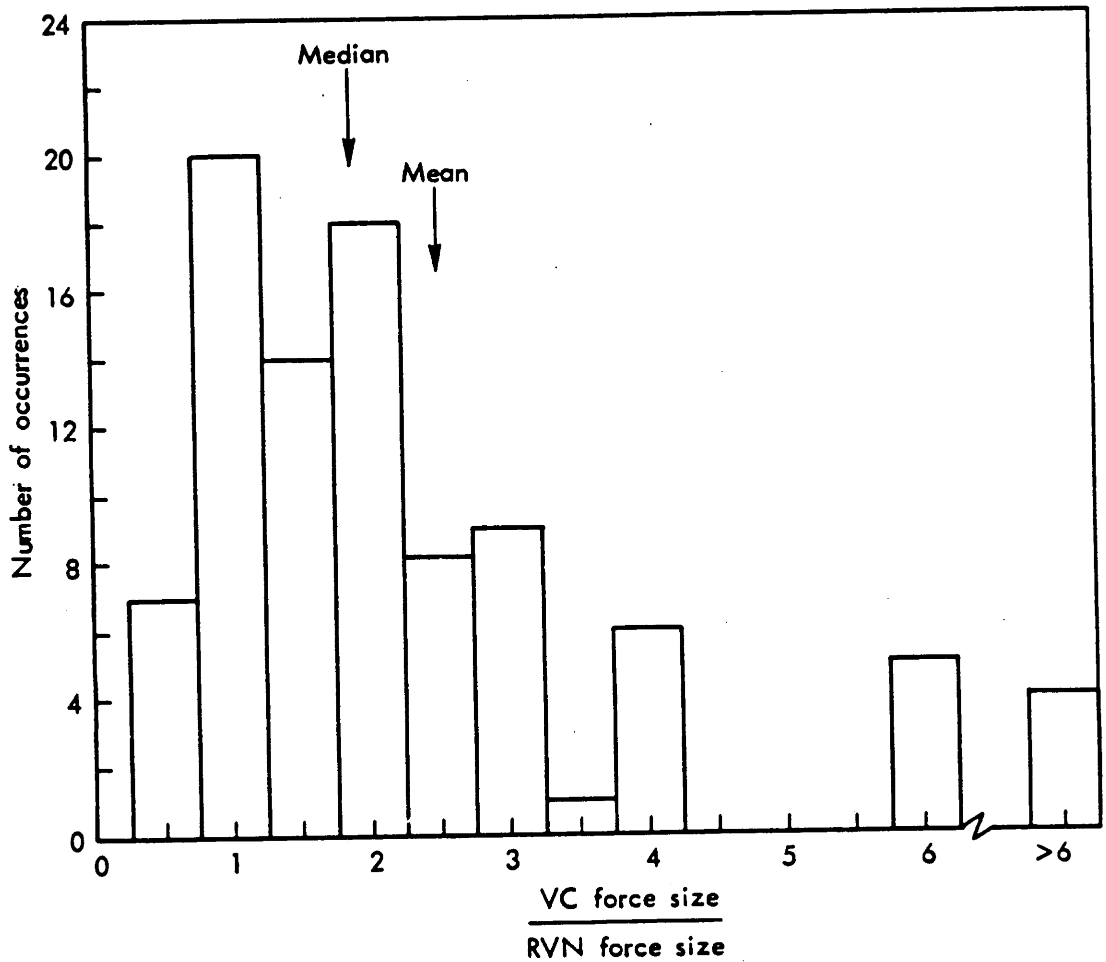

Fig. 2—Relative force sizes

Overall, the VC experienced a considerable force advantage over the RVN.* However, there are certain other consistent trends that seem important. Force ratio was found to be related to such variables as friendly force type, friendly force size, local VC strength, and geographic location.

RVN FORCE SIZE

Four categories were formed to describe the types of RVN troops involved in the reported engagements: (1) regular army troops (ARVN) and the Regional Forces (RF),** (2) Self-Defense Corps (SDC) and the Popular Forces (PF), (3) hamlet militia, and (4) Combat Youth (CY).*** These forces were deployed in characteristically different-sized units. The average ARVN unit was roughly a company (80 men); the SDC units had a mean size of about 40 men, and the militia and CY typically deployed two squads, or about 20 men. Roughly 25 percent (correlation = $\sqrt{0.25} = 0.50$) of the variance in RVN force size in the data can be accounted for by its association with force type.****

Although the sample was small, there was a tendency for RVN forces to be smaller in provinces in which the VC regular forces are reported as relatively weak and in the flat to rolling, relatively dry plains north of Saigon.

In summary, regularities in defense force size can be detected and associated with the type of RVN unit, the perception of local VC strength, and the type of terrain. The multiple correlation of these variables with RVN force size is 0.55 (30 percent of the variance). The smaller RVN defending forces found in regions of relative VC weakness and in areas of more open terrain may be indicative of an RVN strategy of allocating smaller forces to more easily defended areas.

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*There is always the suspicion that the friendly units tend to exaggerate true enemy force sizes in order to make themselves look better. In this analysis, there was no way to determine the extent to which this factor may have biased the reported material.

**Formerly called the Civil Guard.

***The militia and CY are incorporated into the PF in the later part of the sample as a result of RVN organizational changes.

****For a brief definition of "correlation" and the other statistical terms used in the Memorandum, see Appendix B.

VC FORCE SIZE

VC prisoners state that their tactics are to never attack unless they have a force at least equal to that of the defenders. The trends of overall force ratio indicated that the VC usually have better than an equality of forces (in about 90 percent of the incidents).

Figure 3 shows that the mean VC force size exhibited a strong linear relationship with RVN force size (the correlation coefficient for all points is 0.38).* For each additional defender, the VC added approximately one man to their forces. The VC are seldom reported as operating in units of less than a platoon in size. As a result, the minimum VC force size is roughly 30 men, giving the VC a very large force advantage against small RVN detachments. Since the size of the forces appears to increase at equal rates in Fig. 3, the average force ratio tends to decline with increasing RVN force size. Figure 4 illustrates this decline. A very steep decrease in relative force size is shown as the defense force increases to a platoon size (30 men). A steady, if lower-rate, decrease in relative force size is observed throughout the remainder of the region of RVN sizes exhibited in the data. It appears that a mean equality of forces exists at roughly the company level (80 men).

As mentioned earlier, there may be a tendency for the defenders to report larger enemy forces than the actual number. An indicator of the internal consistency of the data may be obtained by comparing Figs. 4 and 5. Lanchester's theories of warfare[1] predict that a strong relation should exist between relative force sizes and the percent of casualties incurred. The $\%RVN_{k+w}$ curve in Fig. 5 shows the same steep decline between 15 and 30 men as does the curve of force ratio. Although such a correspondence is not conclusive evidence of reliable data, it does provide some support for the notion that VC force size is being reported in a relatively consistent manner.

Two other seemingly consistent trends are detected in VC force size. Under the cover of darkness, the VC forces tend to be a little

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*Only the mean values for each interval are shown on Fig. 3.

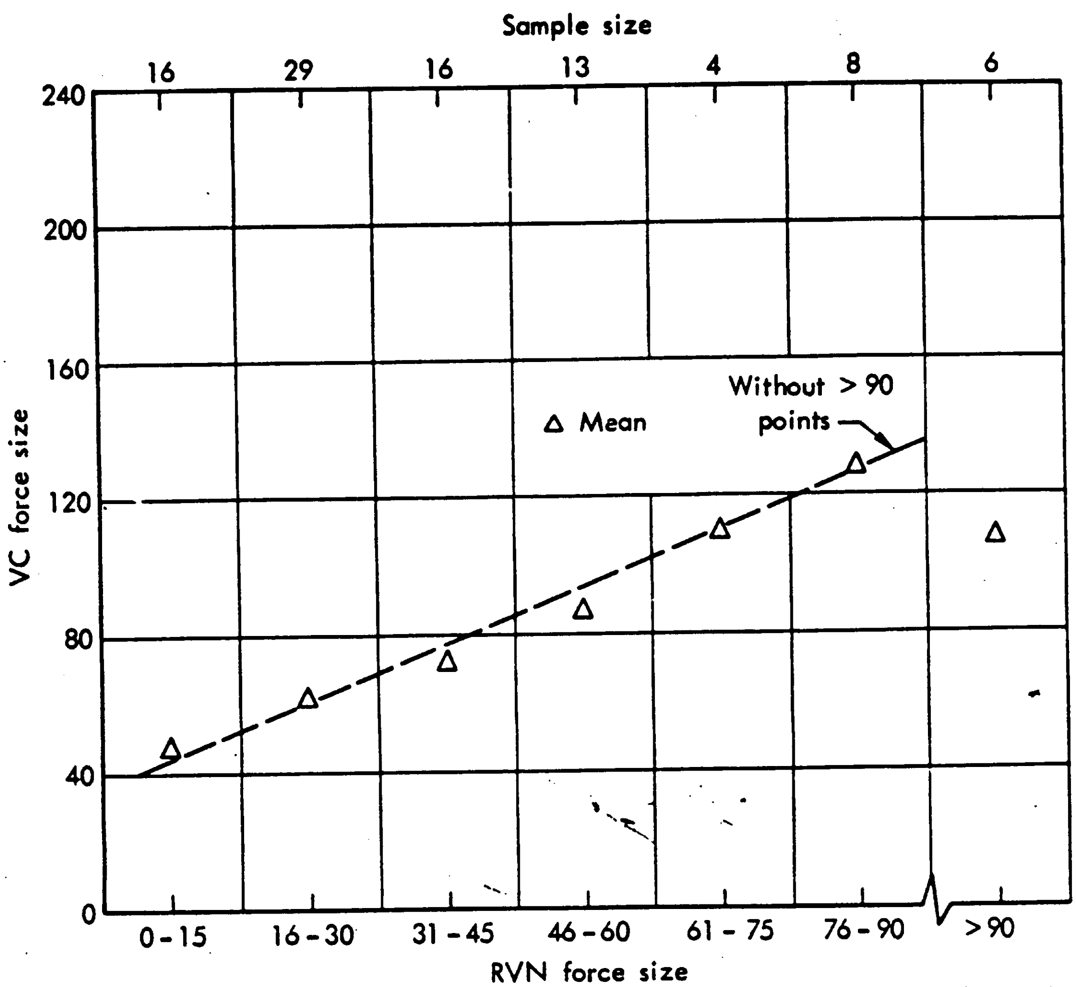

Fig.3—Correlation of VC force size and RVN force size

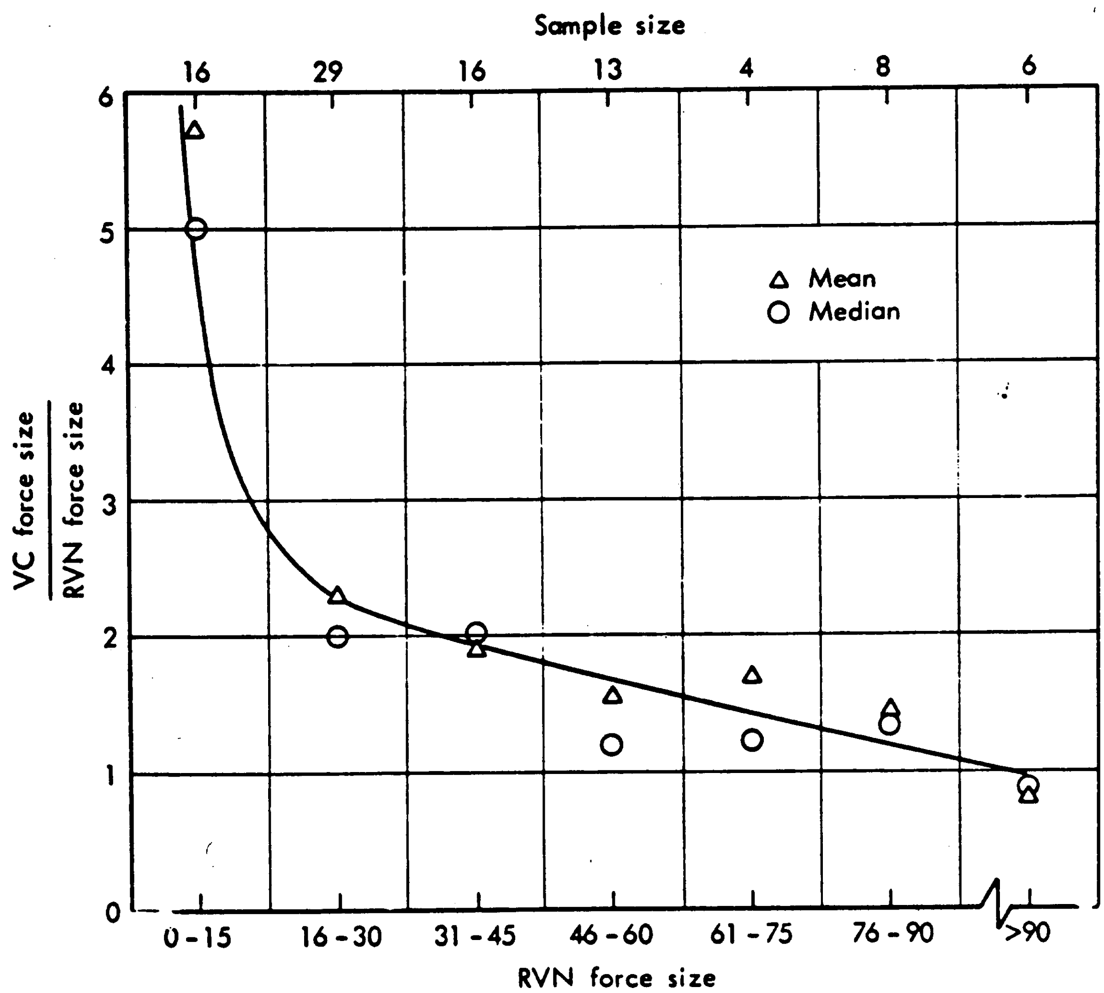

Fig.4—Force ratio and RVN force size

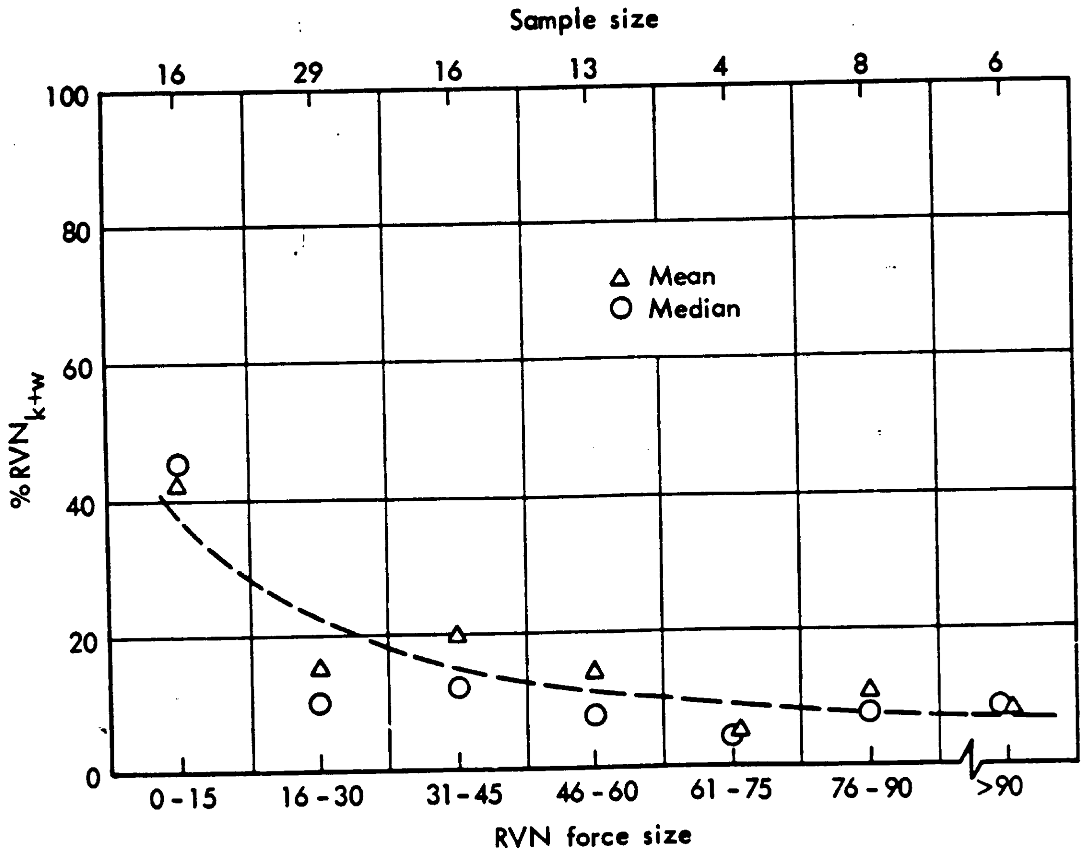

Fig. 5—RVN force size and $\%RVN_{k+w}$

larger; and in VC MR 5 (the region bordering North Vietnam) the reported VC forces are considerably larger than in other regions of the country. The multiple correlation of VC size with RVN size, night operations, and MR 5 is 0.47. Considering the difficulties of determining the enemy's size under conditions of darkness, and considering the possible "noise" in the data, this correlation appears quite high.*

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*Another way of explaining such a relationship would be a consistent reporting doctrine on the part of the RVN troops, but no evidence is on hand to support this. It is mentioned to re-emphasize the point that empirical events can usually be explained in more than one way.

IV. ASSOCIATION OF OUTCOME WITH INITIAL CONDITIONS

A primary concern in this analysis was that of examining any associations of the outcome of engagements with the initial conditions: force sizes and ratios, presence or absence of reinforcements, local VC strength, terrain, day or night, and so forth. This section will define the outcome measures selected and their associations with the available descriptors of initial circumstances.

MEASURES OF OUTCOME

The measures of outcome reported consistently are friendly casualties and equipment losses. Also available but with less consistency are reports of VC casualties. These variables probably do not represent all of the important ramifications of an engagement. Whether the hamlet was overrun, the psychological influence of a battle, and that ill-defined concept of "control" of an area, without doubt are all significant outcomes. These effects are probably not unrelated to casualties; similarly, they are not determined exclusively by the casualties inflicted. Thus, while the available measures of outcome are known to be limited, they are felt to be related to most of the important aspects of outcome.

The following measures were investigated:

1. Number of RVN killed and wounded (RVN_{k+w})
2. Percent of RVN killed and wounded ($\%RVN_{k+w}$)
3. Number of RVN missing (RVN_{mia})--includes captured, deserters, and unaccounted for
4. Percent of RVN missing ($\%RVN_{mia}$)
5. Number of RVN weapons lost (RVN_{wpns})
6. Number of VC killed and wounded (VC_{k+w})
7. Percent of VC killed and wounded ($\%VC_{k+w}$)
8. Number of VC captured (VC_{capt})
9. Percent of VC captured ($\%VC_{capt}$)
10. Number of VC weapons captured (VC_{wpns})

A preliminary analysis indicated that two variables could represent most of the variance in friendly outcome: the $\%RVN_{k+w}$ and the $\%RVN_{mia}$. These variables have close to a zero correlation, indicating perhaps two aspects of outcome. One possible interpretation is that the $\%RVN_{k+w}$ tends to represent battle casualties, while the $\%RVN_{mia}$ variable is more dependent on desertions and failures to fight. The number of RVN weapons lost is almost completely determined by the above two variables (the multiple correlation is 0.96).

The data on VC losses are much sparser than those on friendly losses. Only about 30 percent of the incidents in the study had killed or wounded recorded for the VC, and the number of VC captured was reported only twice. VC weapons captured was highly correlated (0.63) with VC_{k+w}. As a result, a single measure, $\%VC_{k+w}$, is used as representative of VC losses.

AN OVERVIEW

This study included over 40 variables describing the conditions of the engagement (see Appendix A). A sequential discussion of the relationships between these descriptors and the outcome of an engagement is by necessity lengthy and somewhat difficult to follow. An overview which summarizes these relationships can be shown with two diagrams.

Since the first overview, Fig. 6, displays the correlations in an unusual way, it seems appropriate to first briefly describe its meaning. Under certain conditions the correlation between two variables is numerically equivalent to the cosine of the angle between these two variables treated as vectors.[4] Thus, by constructing for each variable a vector emanating from a common origin, and by placing these vectors so that the cosine of the separation angle between each pair of vectors is equal to their correlation coefficient, it is possible to geometrically represent a matrix of correlations. In general, if more than three variables are involved, it will not be possible to construct this "space" of vectors in the three spatial dimensions. The greater-than-three-dimension space can only be handled numerically. However, examining

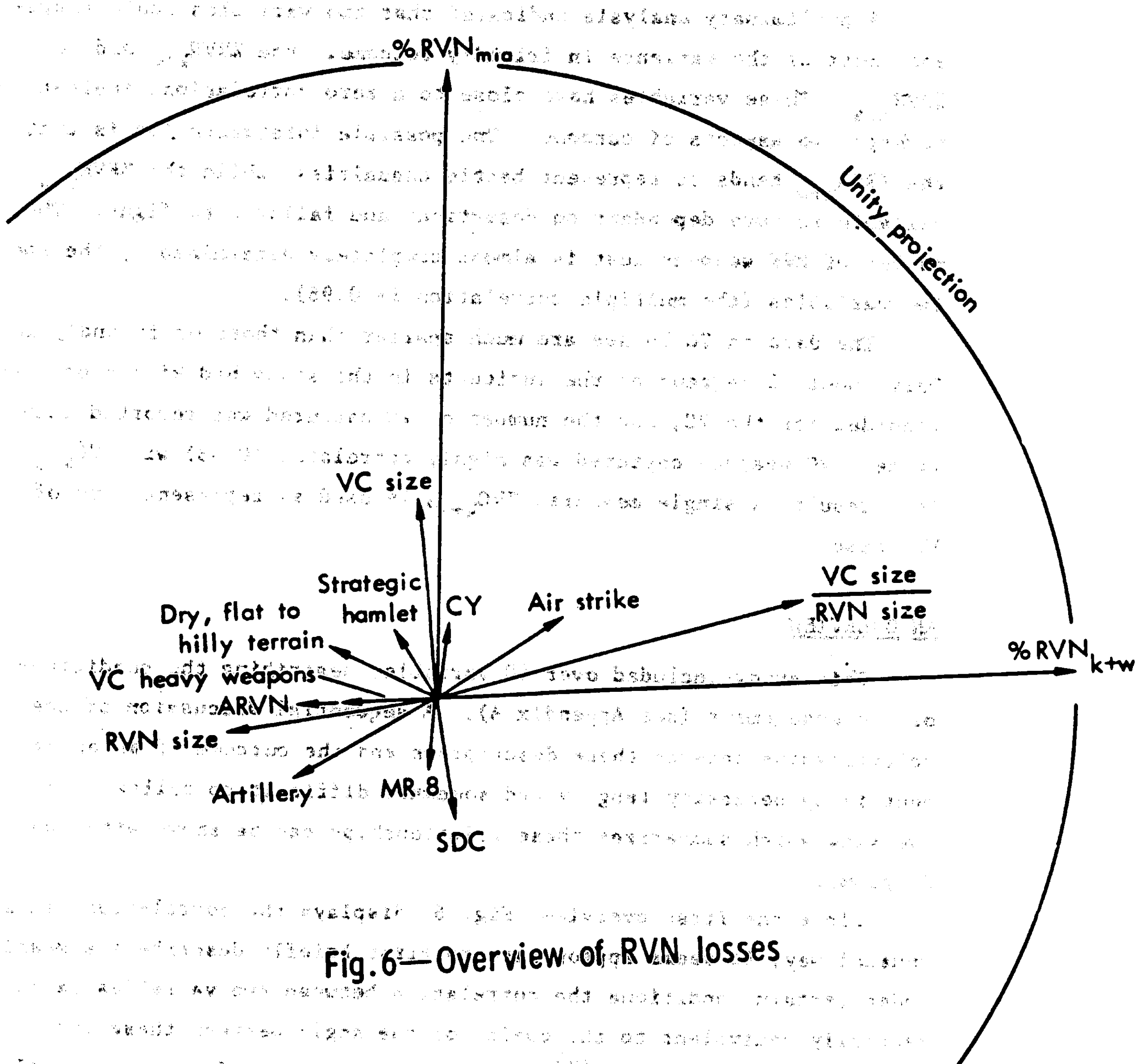

Fig. 6—Overview of RVN losses

planes from this higher-dimension space that contain the variables of interest can provide a useful summary of many interrelations in a single picture.

Figure 6 is the plane formed by unit-length vectors of the two measures selected as representing the two separate types of RVN losses--$\%RVN_{k+w}$ and $\%RVN_{mia}$. The other vectors shown are the projections of the initial-condition variables into this outcome plane. In the full space each vector has a length of 1.0, its normalized variance. The lengths of these vectors in the $\%RVN_{k+w}$ and the $\%RVN_{mia}$ plane represent their multiple correlations with these outcome measures. The in-plane portion of these vectors may be projected onto the $\%RVN_{k+w}$ or the $\%RVN_{mia}$ vector; the length of this projection of a vector is its correlation with the respective outcome variable. The correlation is positive if the projection is on the positive end of the outcome vector, and the correlation is negative if the projection is on the negative (reflection) end of the outcome vector. The smaller the angle separating the condition vector and the outcome vector, the greater will be its projection; thus the higher the correlation. Therefore, artillery correlates -0.23 with $\%RVN_{k+w}$ and -0.13 with $\%RVN_{mia}$. That is, $\%RVN_{mia}$ and $\%RVN_{k+w}$ were lower on the average for those cases involving artillery support than they were when artillery was not used.

With this explanation in mind, let us examine the trends shown in Fig. 6. The variables having the strongest relation (longest projections in the plane) with friendly outcome are force ratio, VC and RVN size, and artillery support. The VC-to-RVN force ratio is, as theory predicts, positively correlated with $\%RVN_{k+w}$ and to a lesser extent positively related to $\%RVN_{mia}$. VC size is uncorrelated with $\%RVN_{k+w}$ and has a moderate positive correlation with $\%RVN_{mia}$. RVN size and artillery support are associated with lower values (negatively correlated) of $\%RVN_{k+w}$ and to a limited extent of $\%RVN_{mia}$.

Several other variables are plotted, although their projections in this plane are small (and thus their correlations with the outcome variables are small). These associations do provide certain clues for additional research and may have a <u>negative</u> import. For example, VC heavy weapons is negatively correlated with $\%RVN_{k+w}$. While the correlation is small, it certainly indicates that in this sample the use of mortars, recoilless rifles, and machine guns brought no spectacular benefits to the VC.

Figure 7 is the other overview representation. Since only one measure (one dimension) of VC loss is employed, it is possible to picture the correlations on a line rather than in a plane.

RVN size, RVN ground reinforcements, dry, flat to rolling terrain, and CY show moderate positive correlations with VC losses. Force ratio, MR 7, artillery, and so forth, show small to moderate negative correlations with VC losses. Of the original set of more than 40 descriptors of an engagement, these are the ones that have shown some correlation with the outcome as measured by losses. These correlations will be discussed in more detail in the following sections.

FORCE SIZE AND RATIO

Figure 8, which plots $\%RVN_{k+w}$ versus VC-to-RVN force ratio, shows a consistent increase in $\%RVN_{k+w}$ as the VC force advantage increases. A linear-regression equation was fitted to the 92 points. The regression equation and line are shown on Fig. 8. This fitting gave a multiple correlation of 0.59, a value which seems to be quite significant, considering the probable inaccuracies in the data. The force-ratio variable, of course, compresses the region of friendly-force advantage. A better fit in the region to the left of VC size equal to RVN size would probably be the dashed line on Fig. 8.

Figure 5, which plots $\%RVN_{k+w}$ as a function of initial RVN force size, shows much the same trend as does Fig. 4, which plots force ratio versus RVN force size. Using expected values and predicting the $\%RVN_{k+w}$ on Fig. 5 from the values on Figs. 4 and 8, a fairly good reproduction of Fig. 5 is possible. Thus, the primary reason for a lower percentage loss for the larger RVN forces would appear to be the typically better friendly-force ratio which the larger RVN forces enjoyed. However, some indication is given that $\%RVN_{k+w}$ is lower at large values of RVN size than might be expected from force ratio alone. To clarify this trend, a technique for "removing" the effect of force ratio from the

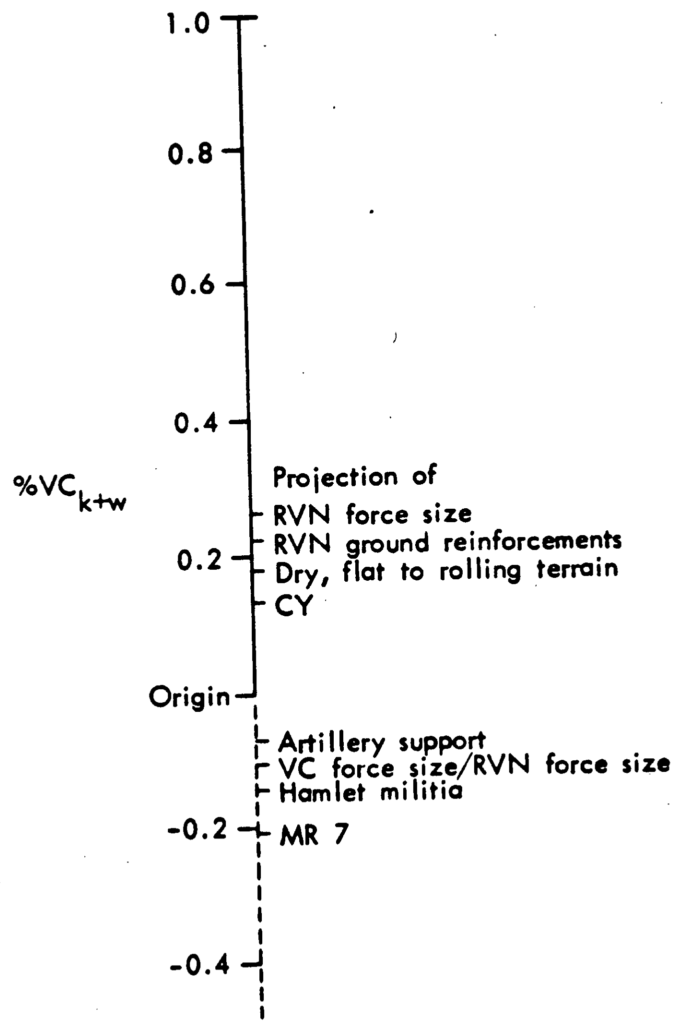

Fig. 7—Overview of VC losses

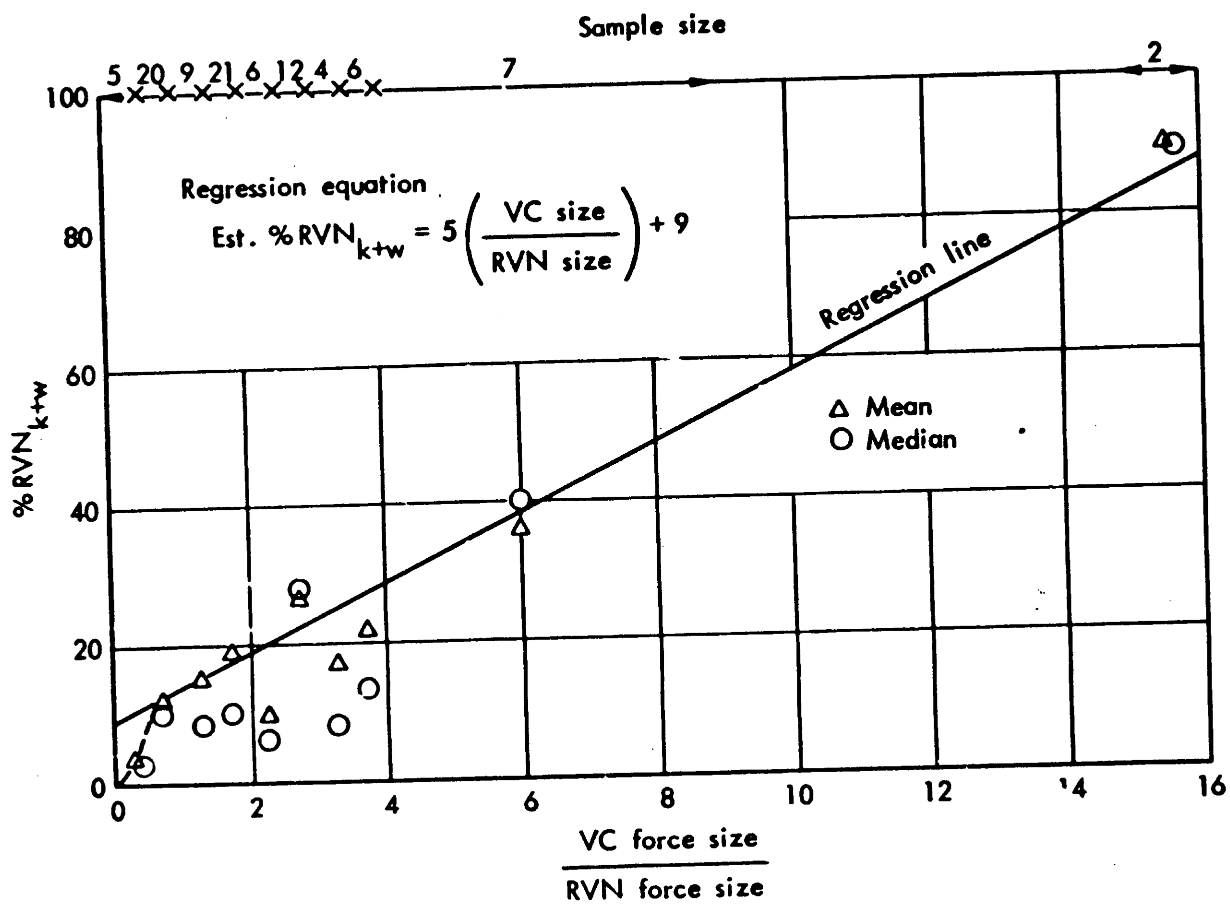

Fig.8—Force ratio and $\%RVN_{k+w}$

relationship has been employed. The resulting residual $\%RVN_{k+w}$* is plotted as a function of force size in Fig. 9. It can be seen that a tendency exists for casualties to be lower in larger units than would be expected from a linear estimate based on force ratio only.

The $\%RVN_{mia}$ is weakly related to the VC force advantage and is strongly related to the absolute VC size. Thus, large numbers of missing tended to occur more frequently when the VC had a large force than when they had a large force advantage, as shown in the correlation table below.

	$\%RVN_{mia}$
$\frac{\text{VC force size}}{\text{RVN force size}}$	0.16
VC force size	0.31

Whether this is an actual trend or a quirk in the reporting system is not determined at this point. This may be a reflection of a psychological reaction of an individual soldier to an "overwhelming" number of enemy troops. This same trend is noted in data on other types of engagements in Vietnam. An "explanation" of the soldier reacting more to the number of enemy soldiers than to his own forces does not seem unreasonable and would be consistent with the exhibited trend. However, additional analysis would be needed to test the validity of such an explanation.

The data on VC killed and wounded are sparser and intuitively more suspect than are the reported friendly losses. For one thing, the VC are known to often carry away many of their dead and wounded. In only 29 of the 92 cases were VC casualties listed.

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*The term in brackets in the following equation is the linear regression of $\%RVN_{k+w}$ on force ratio. See Appendix B for a further description of the regression technique.

$$\text{Residual } \%RVN_{k+w} = \text{Actual } \%RVN_{k+w} - \left[5\left(\frac{\text{VC force size}}{\text{RVN force size}}\right) + 9\right]$$

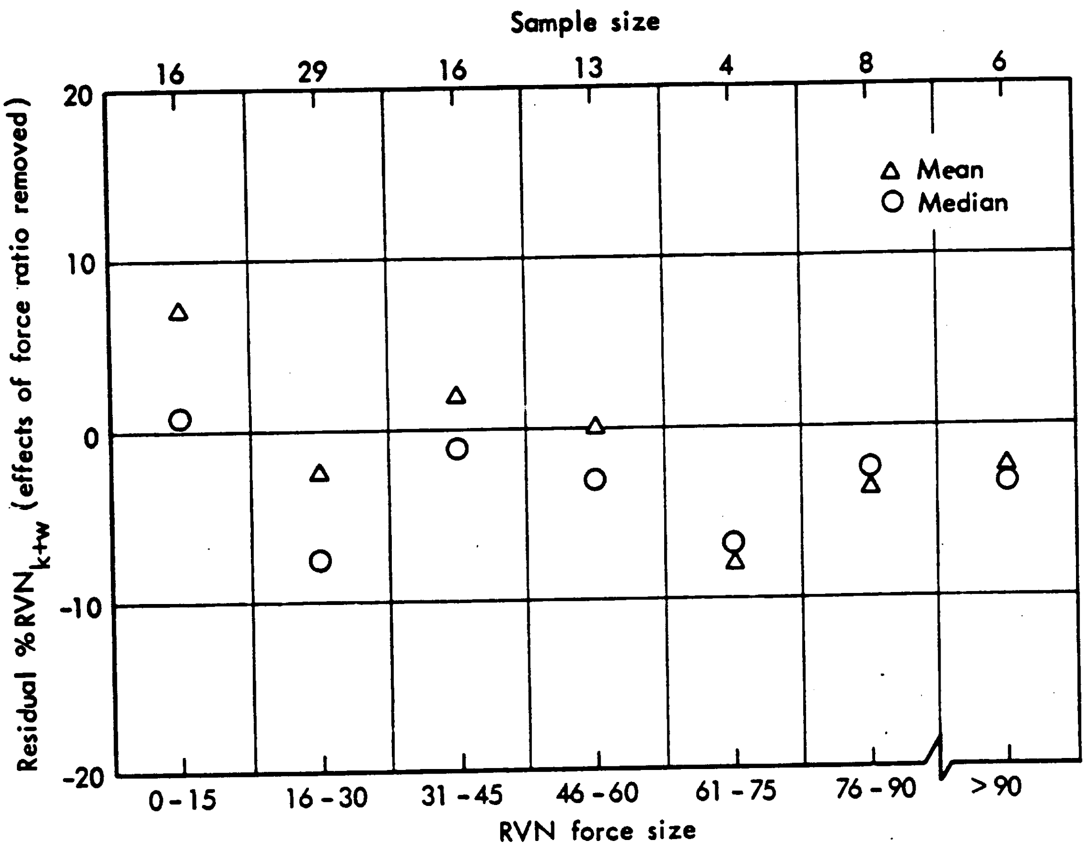

Fig. 9—Residual $\%RVN_{k+w}$

Figure 10, which plots these 29 cases, shows much the same trends for $\%VC_{k+w}$ versus the opponents' force advantage as were exhibited in Fig. 8 for $\%RVN_{k+w}$. In the lower graph of Fig. 10, the regression line of $\%RVN_{k+w}$ on VC force size/RVN force size is shown as an estimator of $\%VC_{k+w}$ versus RVN force size/VC force size. The regression curve* generally "fits" the data. That is, means and medians of the data points lie in the same region as the curve. The number of incidents, unfortunately, is too small to provide conclusive support for such a finding. Although not presented in the previous curves, one difference should be pointed out: The ratio of RVN wounded to killed is 1.20, the ratio of VC wounded to killed is 0.34. Undoubtedly it is difficult to detect all enemy wounded. Since there are no apparent reasons to think that the ratios of wounded to killed should be so widely different, it seems likely that the number of VC wounded is underestimated. On the other hand, there also may be an offsetting tendency to exaggerate enemy kills to make oneself look good.

The indications in the data (with reservations for the reasons noted) are that for a given force ratio, the number of VC killed and wounded is roughly equivalent to or a little higher than the number of friendly forces killed and wounded. However, the normal VC force advantage would result, on the average, in a lower percentage of casualties on their part.

REINFORCEMENTS

If reinforcements are considered in the defensive role, their purpose is to negate the enemy attack. In terms of available data, friendly casualties appear to be the best measure of how well this negation is accomplished. A second function of reinforcements might be to inflict casualties on the enemy. Particularly in counterinsurgency, where it is difficult to conduct offensive operations against the insurgents, an enemy concentration for attack purposes provides an opportunity to inflict casualties if forces can be brought to bear with sufficient

*The use of this curve is based on the assumption that the VC and RVN loss rates are similar, given a similar force advantage or disadvantage.

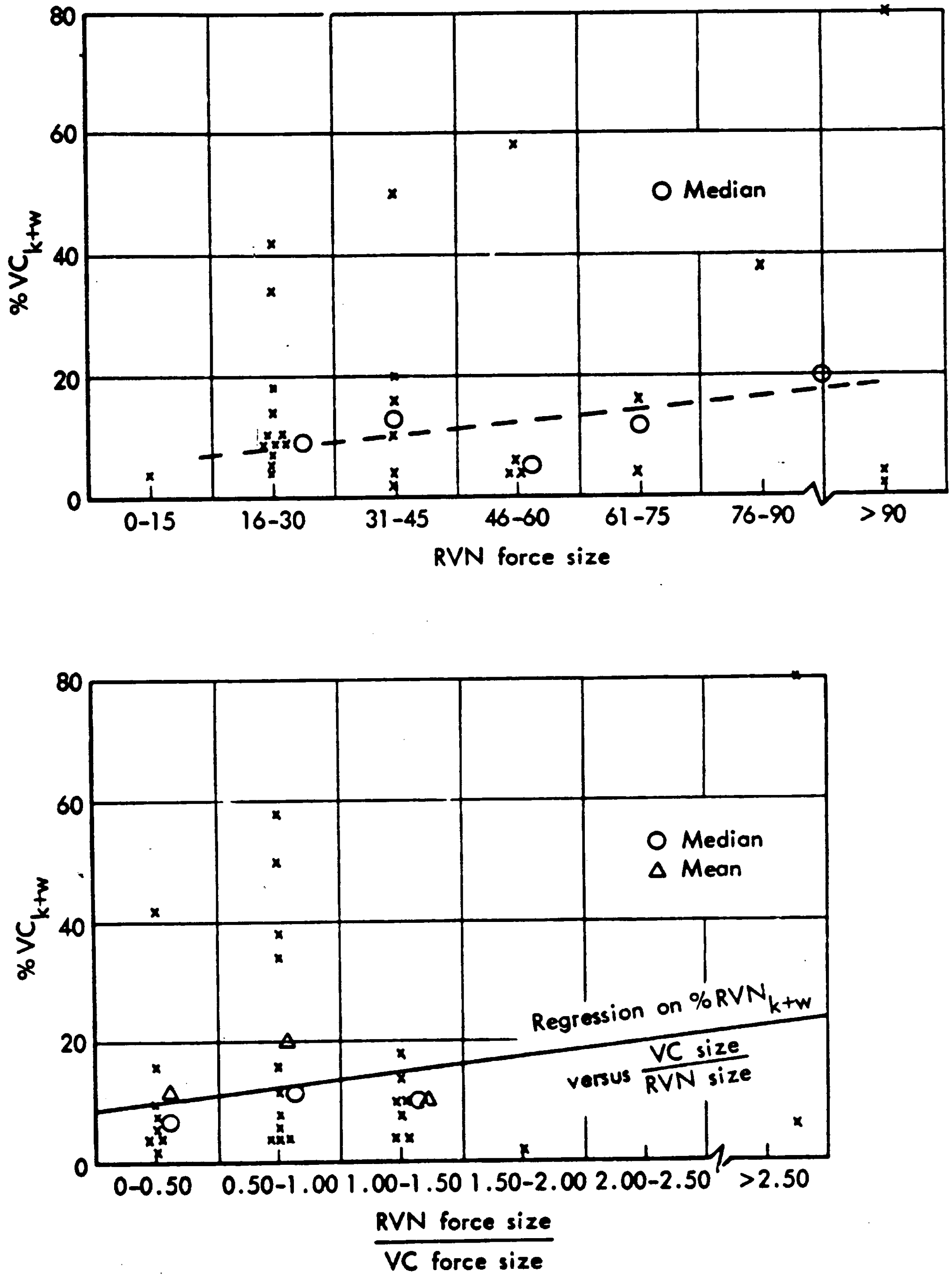

Fig. 10—VC losses

rapidity. The association between friendly and enemy casualties and the presence or absence of reinforcements is investigated here. Combinations of four general categories of reinforcements are discussed: (1) artillery, (2) air strike, (3) flareship, and (4) ground troops (infantry and armor).*

<u>Reinforcement Reaction Time</u>. The engagement descriptions, with a few exceptions, do not specify the reaction time of the reinforcements. This is an important parameter in aiding the interpretation of the correlations of outcome with the type of reinforcement used. A primary means of reducing RVN killed and wounded would be to force the VC to break off the attack earlier than normal or before the defenders gave up the fight.

Separate references were consulted in an effort to determine "typical" response times for each type of reinforcement. A number of response times for artillery and ground forces were found in the Strategic Hamlet Incident Reports.(6) These reports, plus the second Air Division's daily operational summaries, provide limited data on the response time of flareships and air strikes.(7) Table 2 summarizes the data that are available on response times. These data are from incidents in early and late 1964.

Purportedly, these reaction times are measured from the time <u>the VC initiated the attack</u>. Artillery has by far the shortest reaction time. The data on air strikes indicate quite lengthy delays; however, a word of explanation seems appropriate here. Most of the air-strike cases in this sample apparently are not direct requests for air support. The Second Air Division "Operational Summary," a press-release document, describes a typical incident:

> At 1:05 a.m., this morning, a VNAF C-47 arrived over an outpost in the plains northeast of Bien Hoa where the Viet Cong had launched a midnight attack. The VNAF crew dropped 27 flares before being relieved by a USAF C-123 at 2:00 a.m. The C-123 pilot <u>called</u> for fighter support, and two A-1H's rendezvoused over the hamlet a few minutes

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*Reference 5 contains additional data on the association of reinforcements with outcome in hamlet incidents.

Table 2

REINFORCEMENT REACTION TIMES

Reaction Time (min)	Number of Occurrences			
	Artillery	Air	Flareship	Ground
0 - 5	21	0	0	0
6 - 10	18	0	0	1
11 - 15	9	0	1	6
16 - 30	11	1	3	6
31 - 60	2	4	4	3
61 - 120	1	0	4	2
121 - 180	0	8	1	1
> 180	0	5	0	3
Total cases	62	18	13	22

> later....The attack was finally broken off at about 4:00 a.m. (15 November 1964)

The long reaction time of air strikes is probably a result of command delays and of the allocation of scarce resources. Air strikes seemingly are reserved for the more beleaguered defenders. This interpretation agrees with the correlation exhibited between air strikes and high VC-to-RVN force ratios. Pragmatically, in these data, air strikes probably have a long reaction time; the cause itself is not relevant to the results.*

Occasionally, ground reaction time is surprisingly short, in several cases 15 min or less. Several cases in excess of 4 hr are also noted.

RVN Casualties. As discussed above, apparently the most consistently important parameter in determining $\%RVN_{k+w}$ is force ratio. It is also apparent from the data that certain types of reinforcement (air in particular) are associated with nonaverage force ratios. In order to have more consistent conditions for comparing different types of

*It is understood that the air-strike request system has been changed in recent months.

reinforcements, the residuals of $\%RVN_{k+w}$ are used. The residuals are given by

$$\text{Residual } \%RVN_{k+w} = \text{Actual } \%RVN_{k+w} - \left[5.0\left(\frac{\text{VC size}}{\text{RVN size}}\right) + 9\right]$$

Figure 11 compares reinforcement cases with nonreinforcement cases. Five reinforcement conditions are considered: (1) artillery only, (2) artillery with other types of reinforcements, (3) air strike and others, (4) flareship and others, and (5) ground reinforcements and others. The distributions are highly skewed (unusually large percentages of casualties occur on occasion). In order to more completely represent the data, regions are shown indicating the values which mark 25, 50, 75, and 100 percent divisions in the data. For example, in the no-reinforcement case, 25 percent of the 52 incidents had losses 13 to 30 percent less than average for the given force ratios, or in the artillery-reinforcement case, 50 percent of the incidents had losses from 12 to 30 percent below average for the given force ratios.* By definition, the average residual for the entire sample is 0 percent.

Perhaps the most obvious trend in the reinforcement data is the reduction in friendly "catastrophes," that is, a very high percent of friendly killed and wounded. For the no-reinforcement case, in 15 percent of the incidents residual $\%RVN_{k+w}$ exceeds 28 percent. The maximum residual in the five reinforcement columns is 27 percent.

Artillery appears to be by far the most effective type of support in reducing friendly losses. For example, 75 percent of the residuals, for cases involving artillery support only, are below -9 percent. That is, when artillery support only was involved, 75 percent of the incidents had $\%RVN_{k+w}$ nine percentage points or more below the average $\%RVN_{k+w}$. When artillery is combined with other types (mostly "ground"), friendly casualties still remain lower than in any other case.

When the influence of force ratio is removed, ground reinforcements appear to be associated with average to slightly-above-average

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*Residuals from -13 to -30 percent on Fig. 11.

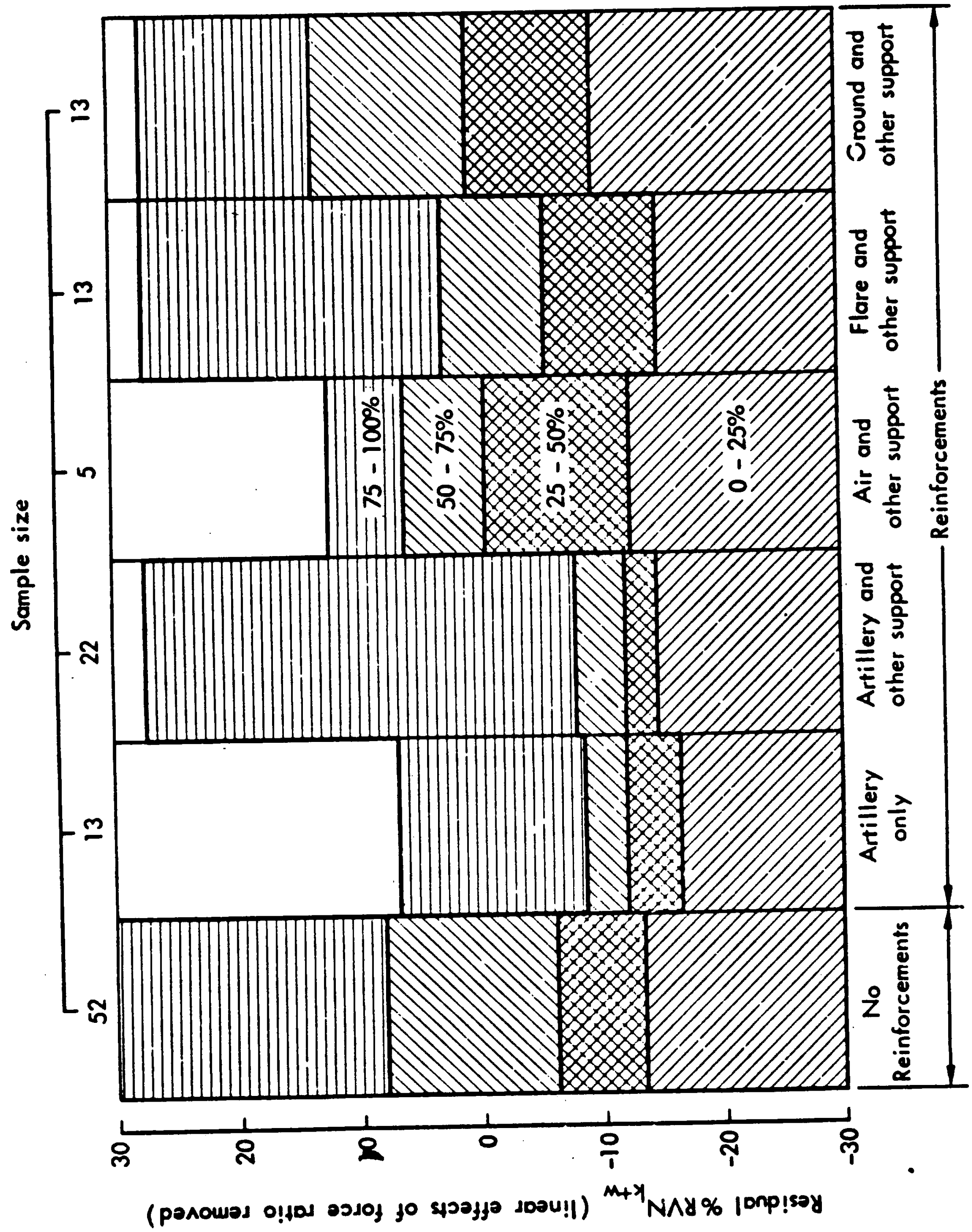

Fig. 11—Outcome versus reinforcement type

losses. However, in this sample the "catastrophe" cases are <u>still eliminated</u>.

Somewhat in between these cases are the air-strike and flareship incidents. It appears that in each case the residual $\%RVN_{k+w}$ is somewhat lower than average. Only five cases of air strike are included in the data. Neither type seems to be as effective a means of reducing friendly losses as does artillery. The maximum residual for the air-support cases is also quite low. It may be that the response time of air is such that typical friendly losses are incurred prior to the arrival of the air strike. If the arrival of air support causes VC disengagement, then extreme values (presumably resulting as the VC gradually wear down the defenders' will to resist) are avoided. Psychological influences may be at work as well.

Artillery shows some tendency to be associated with lower-than-average values of missing in action. The correlation of artillery and $\%RVN_{mia}$ is -0.14. The other types of reinforcement appear to be unrelated to friendly missing in action.

<u>VC Losses</u>. Another suggested measure of the utility of reinforcements is their association with VC casualties. The following correlations exist between reinforcement types and the $\%VC_{k+w}$.

	$\%VC_{k+w}$
Artillery	-0.07
Air	0.05
Flareship	-0.16
Ground	0.34

Thus, the concept of artillery causing early disengagement by the VC seems to be reinforced. Artillery that is often fired at preplanned coordinates without knowing precisely the enemy's location may not be an effective casualty-producing agent if the enemy breaks off the attack and disperses at first warning.

Air is associated with higher enemy kills; however, the sample is a small one. In this sample of engagements, ground troops are the reinforcement type that is by far the most strongly associated with $\%VC_{k+w}$.

VC HEAVY WEAPONS

There were eight incidents recorded in which the VC employed either mortars, recoilless rifles, machine guns, or some combination of these. The influence of these weapons on the outcome appears to have been small. Table 3 shows the correlations between outcome and VC heavy weapons.

Table 3

EFFECTS OF VC HEAVY WEAPONS

VC Weapons	Residual[a] RVN_{k+w}	$\%RVN_{mia}$	$\%VC_{k+w}$
Mortars	-0.10	-0.04	-0.03
Recoilless rifles	-0.18	-0.02	-0.08
Machine guns	-0.16	-0.00	-0.04

[a]Force-ratio effects removed.

The battles involving these weapons are typified by lower casualties on both sides. Even though the sample is small, it would appear that the use of these weapons has brought no major advantage to the VC in their attacks on hamlets.

RVN FORCE TYPES

Various RVN force types are involved in the reported actions, and these forces are known to vary considerably with respect to training and equipment. How are these differences manifested in the outcome? Four force-type variables were included in the analysis in an attempt to shed some light on this question. Table 4 defines these variables and the number of occurrences of each type. The total incidents exceed 92 because composite forces with roughly equal distribution by type were recorded under each force type represented. Composite forces of more than 75 percent of a particular type were recorded as only that type. Also shown in Table 4 is a recording of the correlations of these force variables with measures of the outcome. Most of the relations are not very strong.

It is interesting to note that while the CY are associated with higher friendly losses, they have the second-highest association with enemy losses as well. It would appear that the SDC, PF, and the militia were engaged in less intense battles than either the ARVN or CY.

Table 4

CORRELATION OF RVN FORCE TYPE AND OUTCOME

Force Category[a]	Number of Cases	Residual $\%RVN_{k+w}$	$\%RVN_{mia}$	$\%VC_{k+w}$
1. ARVN, RF	21	-0.04	-0.03	0.09
2. SDC, PF	60	-0.06	-0.13	-0.08
3. Militia	18	-0.16	-0.13	-0.15
4. CY	21	0.04	0.06	0.02

[a]The SDC, militia, and CY have been combined and are now referred to as the PF.

TERRAIN

It seems reasonable that terrain might have an influence on the battle outcome. Ease of VC movement and ease of friendly reinforcement would be related to terrain and to outcome. Four different types of terrain were represented in the analysis: (1) flat, seasonally inundated, (2) flat, permanently wet, (3) dry, flat to hilly, (4) dry, mountainous. As shown in Fig. 12, RVN results seem somewhat better in the dry, flat to hilly region, where only 27 percent of the incidents resulted in RVN losses in excess of 20 percent. For VC attacks on hamlets in all other types of terrain, RVN losses exceeded 20 percent of its force in 40 percent of the incidents.

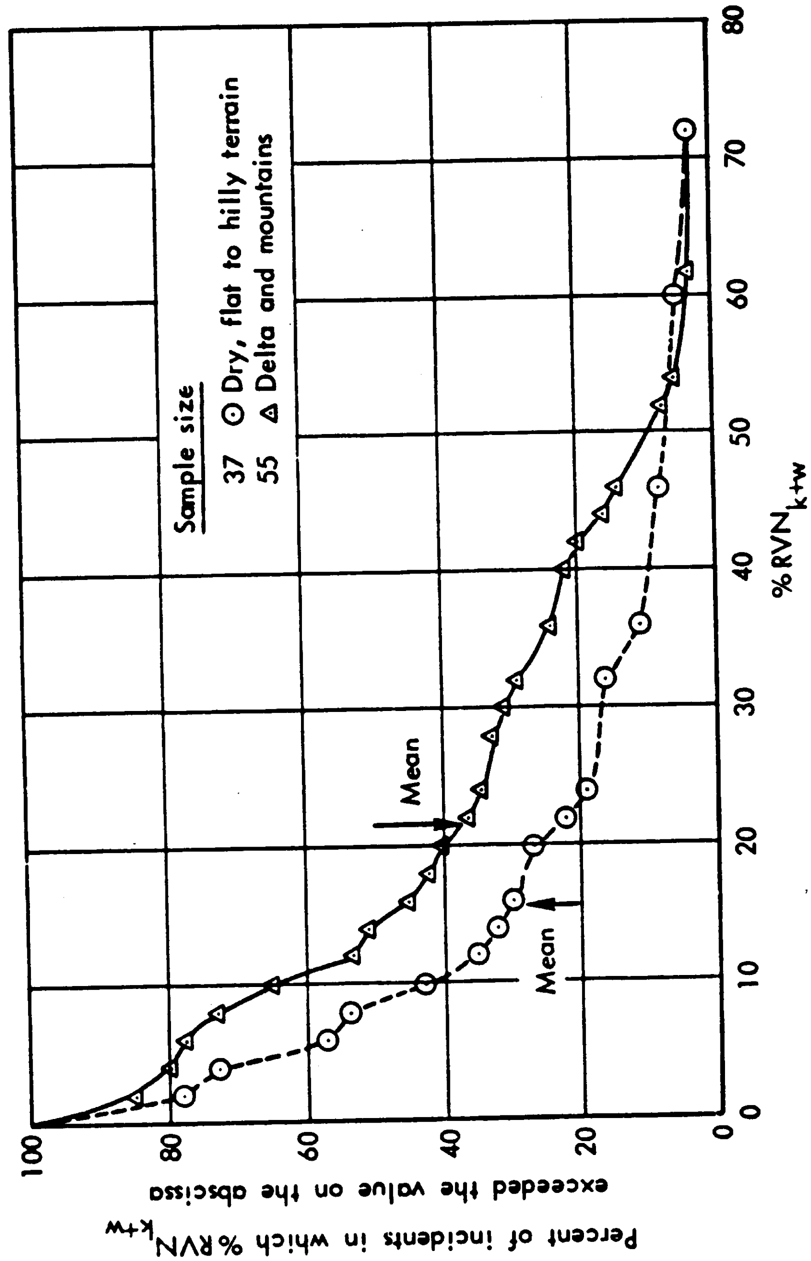

Fig. 12—Terrain type and %RVN$_{k+w}$

Appendix A

RAW DATA

This appendix contains a listing of the variables used in this analysis followed by a reproduction of the data as it was stored on punched cards. The list of variables specifies the location (by card and column number on the card) for each item in the data listing.

In the listing of the data, the 92 separate engagements are given sequentially. Five punched cards are required to record each engagement (12F6.0 format). One row in the printout represents one punched card. Thus, the first five cards (rows) represent engagement one, the second five cards, engagement two, and so forth. Twelve variables are recorded on each card in the first 72 columns (first 12 entries). (The last eight columns on each card contain an identification number which may be ignored. Similarly, the fifth card in each engagement contains identification information which may be ignored.)

The data is thus on the first 72 columns of each of the first four cards in an observation group (5 cards). Variables 1 - 12 are on card 1, 13 - 24 on card 2, 25 - 36 on card 3, and 37 - 46 on card 4. The decimal point is implied after the last digit in each case.

Variable Number	Card	Column	Variable Definition
1	1	1-6	Friendly force size (number of men)
2	1	7-12	VC force size (number of men)
3	1	13-18	$\frac{\text{VC force size}}{\text{Friendly force size}} \times 100$
4	1	19-24	Friendly killed and wounded in action (number of men)
5	1	25-30	Friendly missing in action (number of men)
6	1	31-36	Friendly weapons lost (number)
7	1	37-42	VC killed and wounded in action (number of men)
8	1	43-48	VC captured (number of men)
9	1	49-54	VC weapons captured (number)
10	1	55-60	% of friendly force killed and wounded in action

Variable Number	Card	Column	Variable Definition
11	1	61-66	% of friendly force missing in action
12	1	67-72	% of VC force killed and wounded in action
13	2	1-6	% of VC force captured
14	2	7-12	$\left(\frac{\text{VC force size}}{\text{Friendly force size}}\right)^2 \times 100$
15	2	13-18	$\left[\frac{\text{Variable 10}}{100} - \left(\frac{\text{Variable 10}}{100}\right)^2\right] \times 100$
16	2	19-24	Artillery reinforced, friendly (yes = 1; no = 0)
17	2	25-30	Airstrike reinforced, friendly (yes = 1; no = 0)
18	2	31-36	Flareship reinforced, friendly (yes = 1; no = 0)
19	2	37-42	Infantry reinforced, friendly (yes = 1; no = 0)
20	2	43-48	Armor reinforced, friendly (yes = 1; no = 0)
21	2	49-54	VC employed mortars (yes = 1; no = 0)
22	2	55-60	VC employed recoilless rifles (yes = 1; no = 0)
23	2	61-66	VC employed machine guns (yes = 1; no = 0)
24	2	67-72	Friendly forces, ARVN or RF (yes = 1; no = 0)
25	3	1-6	Friendly forces, SDC or PF (yes = 1; no = 0)
26	3	7-12	Friendly forces, militia (yes = 1; no = 0)
27	3	13-18	Friendly forces, CY (yes = 1; no = 0)
28	3	19-24	Time by month
29	3	25-30	Time of day (1900 to 0500 = 1; 0500 to 1900 = 0)
30	3	31-36	VC strength in province* (military strong = 1; military not strong = 0)
31	3	37-42	VC strength in province* (grass roots strong = 1; grass roots not strong = 0)
32	3	43-48	VC strength in province* (military weak = 1; military not weak = 0)
33	3	49-54	Penetration of hamlet reported (yes = 1; no = 0)

*See Ref. 8.

Variable Number	Card	Column	Variable Definition
34	3	55-60	Incident in VC MR 5 (yes = 1; no = 0)
35	3	61-66	Incident in VC MR 6 (yes = 1; no = 0)
36	3	67-72	Incident in VC MR 7 (yes = 1; no = 0)
37	4	1-6	Incident in VC MR 8 (yes = 1; no = 0)
38	4	7-12	Incident in VC MR 9 (yes = 1; no = 0)
39	4	13-18	Target a Strategic Hamlet (yes = 1; no = 0)
40	4	19-24	Average hamlet population in district of the attack (number of people)
41	4	25-30	Local terrain flat, seasonally wet (yes = 1; no = 0)
42	4	31-36	Local terrain flat, permanently wet (yes = 1; no = 0)
43	4	37-42	Local terrain dry, flat to hilly (yes = 1; no = 0)
44	4	43-48	Local terrain hills to high mountains (yes = 1; no = 0)
45	4	49-54	Traitors reported aiding VC (yes = 1; no = 0)
46	4	55-66	$15\left(\frac{\text{VC force size}}{\text{Friendly force size}}\right) + 1 - \%RVN_{k+w} - \%RVN_{mia} + 100$

80	250	313	6	5	10	0	0	0	8	6	0	1	1
0	982	768	1	0	1	0	0	1	1	1	1	1	2
0	0	0	1	1	0	0	0	0	1	0	0	1	3
0	0	1	500	0	0	1	0	0	134			1	4
1	0	0											
45	100	222	3	0	0	20	0	0	7	0	20	2	5
0	490	675	1	0	0	0	0	0	0	0	0	2	6
1	0	1	1	1	0	0	0	0	0	0	0	2	7
1	0	0	1600	1	0	0	0	0	128			2	8
1	0	0											
45	80	177	41	0	8	40	0	0	91	0	50	3	9
0	313	5000	0	0	0	0	0	0	0	0	0	3	10
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1	0	0											
60	80	133	4	2	0	46	2	7	7	3	58	5	17
3	177	657	0	0	0	1	1	0	0	0	0	5	18
0	0	1	2	0	0	0	0	0	1	0	0	5	19
0	0	1	2190	0	0	0	1	0	111			5	20
1	0	0											
35	80	228	6	10	17	0	0	0	17	29	0	6	21
0	520	1560	0	0	0	0	0	0	0	0	0	6	22
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1	0	0											
20	30	150	1	0	20	0	0	0	5	0	0	7	25
0	225	488	0	0	0	0	0	0	0	0	0	7	26
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1	0	0											
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0	64	1800	0	1	1	0	0	0	0	0	1	8	30
1	0	0	2	1	1	1	0	0	0	0	0	8	31
0	1	1	1000	1	0	0	0	0	84			8	32
1	0	0											
30	30	100	1	0	0	5	0	2	3	0	17	9	33
0	100	325	0	0	0	0	0	0	0	0	0	9	34
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0	0	1	225	1	0	0	0	0	103			11	44
1	0	0											

30	60	200	1	0	0	3	0	1	3	0	5	12	45
0	400	296	1	0	0	0	0	0	0	0	0	12	46
1	0	0	2	1	1	0	0	0	0	0	1	12	47
0	0	1	500	0	0	1	0	0	128			12	48
1	0	0											
20	30	150	0	2	2	0	0	0	0	10	0	13	49
0	225	0	0	0	0	0	0	0	0	0	0	13	50
0	0	1	2	0	0	0	0	0	1	0	0	13	51
0	0	1	625	0	0	0	1	0	114			13	52
1	0	0											
30	60	200	00	19	11	0	0	0	0	63	0	14	53
0	400	0	0	0	0	0	0	0	0	0	0	14	54
0	0	1	2	1	1	0	0	0	0	0	1	14	55
0	0	1	300	0	0	1	0	0	69			14	56
1	0	0											
38	30	79	4	0	7	0	0	0	10	0	0	15	57
0	62	995	0	0	0	1	0	0	0	0	0	15	58
1	0	0	2	1	0	0	0	0	1	0	0	15	59
0	0	1	870	0	0	0	1	0	103			15	60
1	0	0											
10	60	600	5	0	7	0	0	0	50	0	0	16	61
0	3600	3750	0	0	0	0	0	0	0	0	0	16	62
0	0	1	2	1	0	0	0	0	1	0	0	16	63
0	0	1	2000	0	0	0	1	0	100			16	64
1	0	0											
30	30	100	0	0	0	1	0	1	0	0	3	17	65
0	100	0	0	0	0	0	0	0	0	0	1	17	66
0	0	0	2	0	0	0	0	0	1	0	0	17	67
0	0	1	120	0	1	0	0	0	116			17	68
1	0	0											
30	80	267	10	18	28	6	0	0	33	60	8	18	69
0	710	2800	0	0	0	0	0	0	0	0	0	18	70
0	0	0	2	1	1.	0	0	0	0	0	1	18	71
0	0	1	550	0	0	1	0	0	49			18	72
1	0	0											
60	20	33	0	0	0	1	0	0	0	0	5	19	73
0	11	0	0	0	0	0	0	0	0	0	0	19	74
1	0	0	3	1	0	0	0	0	1	0	0	19	75
0	0	0	1520	0	0	1	0	0	105			19	76
1	0	0											
56	80	143	12	4	23	3	0	0	21	7	4	20	77
0	204	1660	0	0	0	0	0	0	0	0	0	20	78
1	0	1	3	0	0	0	0	0	0	1	0	20	79
0	0	1	160	0	0	0	1	0	95			20	80
1	0	0											
51	160	314	0	0	0	0	0	0	0	0	0	21	81
0	985	0	0	0	0	0	0	0	0	0	0	21	82
1	1	0	3	1	0	0	0	1	0	0	1	21	83
0	0	1	820	0	0	1	0	0	149			21	84
1	0	0											
42	100	238	0	10	6	0	0	0	0	24	0	22	85
0	565	0	0	0	0	0	0	0	0	0	1	22	86
1	1	0	3	1	0	0	0	1	0	0	1	22	87
0	0	1	820	0	0	1	0	0	114			22	88
1	0	0											

45	100	222	2	0	2	0	0	0	4	0	0	23	89
0	494	420	0	0	0	0	0	0	0	0	0	23	90
1	1	0	3	1	0	0	0	1	0	0	1	23	91
0	0	1	820	0	0	1	0	0	131			23	92
1	0	0											
46	30	65	7	0	0	0	0	0	15	0	0	24	93
0	42	1390	1	0	0	0	0	0	0	0	0	24	94
1	0	0	3	1	0	0	0	1	0	0	1	24	95
0	0	1	1100	0	0	0	1	0	96			24	96
1	0	0											
80	20	25	1	0	0	0	0	0	1	0	0	25	97
0	6	99	0	0	0	0	0	0	0	0	1	25	98
0	0	0	3	1	1	0	0	0	0	0	1	25	99
0	0	1	260	0	0	1	0	0	101			25	100
1	0	0											
70	80	114	4	0	20	2	0	0	6	0	3	26	101
0	130	582	0	0	0	1	0	1	0	0	0	26	102
1	1	0	3	0	0	0	0	1	0	0	1	26	103
0	0	1	2741	0	0	1	0	1	112			26	104
1	0	0											
39	30	77	5	3	11	3	0	0	13	8	10	27	105
0	59	1215	0	0	0	0	0	0	0	0	0	27	106
1	0	1	3	0	0	0	0	1	0	0	0	27	107
1	0	1	1600	0	1	0	0	0	99			27	108
1	0	0											
21	80	381	11	3	8	0	0	0	52	6	0	28	109
0	1450	3850	1	0	1	0	0	0	0	0	0	28	110
1	0	0	3	1	0	0	0	1	0	0	0	28	111
1	0	1	1300	0	1	0	0	0	100			28	112
1	0	0											
5	80	1600	4	1	5	0	0	0	80	20	0	29	113
0	25500	4800	0	1	1	0	0	0	0	0	0	29	114
1	0	0	4	1	0	1	0	1	0	0	0	29	115
1	0	1	750	1	0	0	0	0	50			29	116
1	0	0											
47	100	212	0	0	0	0	0	0	0	0	0	30	117
0	450	0	1	0	1	0	0	0	0	0	0	30	118
1	1	0	4	1	0	1	0	0	0	0	0	30	119
1	0	1	1	0	0	0	0	0	132			30	120
1	0	0											
98	80	82	0	0	0	3	0	0	0	0	4	31	121
0	67	0	0	0	0	0	0	0	0	0	1	31	122
0	0	0	3	1	0	1	0	1	0	0	0	31	123
1	0	1	1	0	0	0	0	0	114			31	124
1	0	0											
12	80	670	5	5	8	0	0	0	42	42	0	32	125
0	4470	3500	0	1	1	0	0	0	0	0	0	32	126
1	0	0	3	1	0	1	0	1	0	0	0	32	127
1	0	1	240	1	0	0	0	0	66			32	128
1	0	0											
60	160	267	1	0	0	0	0	0	2	0	0	33	129
0	710	198	1	0	0	0	0	0	1	0	0	33	130
1	1	0	3	1	0	1	0	1	0	0	0	33	131
1	0	1	480	1	0	0	0	1	140			33	132
1	0	0											

37	80	271	2	0	0	0	0	0	5	0	0	34	133
0	733	488	0	0	0	0	0	0	0	0	0	34	134
1	1	0	3	1	0	1	0	0	0	0	0	34	135
1	0	1	590	1	0	0	0	0	138			34	136
1	0	0											
50	80	160	6	0	0	0	0	0	12	0	0	35	137
0	256	1128	1	0	1	0	0	0	0	0	0	35	138
1	1	0	4	1	1	0	0	1	0	0	1	35	139
0	0	1	625	0	1	0	0	0	113			35	140
1	0	0											
34	90	294	2	14	0	0	0	0	6	41	0	36	141
0	962	582	1	0	0	0	1	0	0	0	1	36	142
0	0	0	4	1	1	0	0	1	0	0	1	36	143
0	0	1	1400	1	0	0	0	0	99			36	144
1	0	0											
30	60	200	1	3	2	4	0	1	3	10	7	37	145
0	400	295	0	0	0	1	0	0	0	0	0	37	146
1	1	0	4	1	1	0	0	1	0	0	1	37	147
0	0	1	1000	0	0	1	0	0	118			37	148
1	0	0											
60	80	133	0	1	1	0	0	0	0	2	0	38	149
0	176	0	1	0	0	1	0	0	0	0	0	38	150
1	1	0	4	1	1	0	0	1	0	0	1	38	151
0	0	1	550	1	0	0	0	0	119			38	152
1	0	0											
20	80	400	3	1	1	0	0	0	15	5	0	39	153
0	1600	1380	1	0	0	0	0	0	0	0	0	39	154
1	1	0	3	1	1	0	0	1	0	0	1	39	155
0	0	1	480	0	1	0	0	0	138			39	156
1	0	0											
30	60	200	0	0	0	0	0	0	0	0	0	40	157
0	400	0	1	0	0	0	0	0	0	0	0	40	158
1	0	0	3	1	1	0	0	0	0	0	1	40	159
0	0	1	380	1	0	0	0	0	131			40	160
1	0	0											
70	30	43	0	0	0	0	0	0	0	0	0	41	161
0	19	0	0	0	0	0	0	0	0	0	1	41	162
1	1	0	3	1	1	0	0	0	0	0	1	41	163
0	0	1	360	1	0	0	0	0	108			41	164
1	0	0											
70	80	114	1	5	7	9	0	0	1	6	11	42	165
0	130	99	0	0	0	0	0	1	0	1	0	42	166
1	1	0	3	1	1	0	0	1	0	0	1	42	167
0	0	0	2000	0	0	1	0	0	110			42	168
1	0	0											
4	60	1500	4	0	4	3	0	0	100	0	0	43	169
0	22500	5000	0	0	0	0	0	0	0	0	0	43	170
1	0	0	3	0	1	0	0	1	0	0	1	43	171
0	0	1	240	0	0	1	0	0	50			43	172
1	0	0											
45	100	222	12	9	22	2	0	0	27	20	2	44	173
0	492	2350	0	0	0	1	0	0	0	0	0	44	174
1	1	0	3	1	0	0	0	1	0	1	0	44	175
0	0	1	160	0	0	0	1	1	88			44	176
1	0	0											

30	30	100	0	1	0	0	0	0	0	3	0	45	177
0	100	0	0	0	0	0	0	0	0	0	0	45	178
1	0	0	3	1	0	0	0	0	0	1	0	45	179
0	0	1	1000	0	0	1	0	0	114			45	180
1	0	0											
10	60	600	1	0	0	0	0	0	10	0	0	46	181
0	3600	995	0	0	1	0	0	0	0	0	0	46	182
1	0	0	3	1	0	0	0	1	0	0	1	46	183
0	0	1	2700	0	0	1	0	0	140			46	184
1	0	0											
20	80	400	2	0	0	0	0	0	10	0	0	47	185
0	1600	995	0	1	1	0	0	0	0	0	0	47	186
0	0	1	3	1	0	1	0	0	0	0	0	47	187
1	0	1	1200	1	0	0	0	0	138			47	188
1	0	0				0							
10	30	300	0	2	0	0	0	0	0	20	0	48	189
0	900	0	1	0	0	0	0	0	0	0	0	48	190
0	0	1	4	1	0	0	0	0	0	0	1	48	191
0	0	1	150	0	0	1	0	0	127			48	192
1	0	0											
34	30	88	3	0	2	0	0	0	9	0	0	49	193
0	78	860	0	0	0	0	0	0	0	0	0	49	194
0	0	1	4	1	0	1	1	0	0	0	0	49	195
1	0	1	700	1	0	0	0	0	105			49	196
1	0	0											
10	60	600	3	0	0	0	0	0	30	0	0	50	197
0	3600	2550	0	0	0	0	0	0	0	0	0	50	198
1	0	0	4	1	0	0	0	1	0	1	0	50	199
1	1	0	1400	0	0	1	0	0	120			50	200
1	0	0											
10	30	300	2	3	4	0	0	0	20	30	0	51	201
0	900	1800	0	0	0	0	0	0	0	0	0	51	202
0	0	1	4	1	0	0	0	0	1	0	0	51	203
0	0	1	1100	0	0	1	0	0	98			51	204
1	0	0											
32	80	250	7	0	13	2	0	0	22	0	3	52	205
0	625	1960	1	0	0	1	0	0	0	0	0	52	206
1	0	1	4	1	1	0	0	0	0	0	1	52	207
0	0	1	900	0	0	1	0	0	117			52	208
1	0	0											
35	60	171	3	0	14	0	0	0	9	0	0	53	209
0	292	840	0	0	0	0	0	0	0	0	0	53	210
1	0	1	4	1	0	0	0	0	0	0	1	53	211
0	0	1	2700	0	0	1	0	0	118			53	212
1	0	0											
30	30	100	1	0	0	0	0	0	3	0	0	54	213
0	100	300	1	0	0	0	0	0	0	0	0	54	214
1	0	0	4	0	0	0	0	0	1	0	0	54	215
0	0	1	2550	0	0	1	0	0	114			54	216
1	0	0											
6	20	333	3	0	1	0	0	0	50	0	0	55	217
0	1110	3750	0	0	0	0	0	0	0	0	0	55	218
0	0	1	4	1	0	0	0	0	0	0	1	55	219
0	0	1	680	0	1	0	0	0	100			55	220
1	0	0											

10	60	600	3	0	10	0	0	0	30	0	0	56	221
0	3600	2550	0	0	0	0	0	0	0	0	0	56	222
1	0	0	4	1	0	0	0	0	1	0	0	56	223
0	0	1	100	0	0	0	1	0	120			56	224
1	0	0											
24	30	125	2	0	0	0	0	0	8	0	0	57	225
0	156	768	0	0	0	0	0	0	0	0	0	57	226
1	0	0	4	1	0	0	0	0	0	0	1	57	227
0	0	1	800	0	0	1	0	0	112			57	228
1	0	0											
10	30	300	2	1	1	1	0	0	20	10	3	58	229
0	900	1800	0	0	0	1	0	0	0	0	0	58	230
1	0	0	4	1	0	0	0	0	1	0	0	58	231
0	0	0	100	0	0	0	1	0	115			58	232
1	0	0											
10	30	300	7	1	3	0	0	0	70	10	0	59	233
0	900	4550	0	0	0	0	0	0	0	0	0	59	234
1	0	0	4	1	0	0	0	1	1	0	0	59	235
0	0	0	3600	0	0	1	0	0	65			59	236
1	0	0											
12	10	83	6	0	0	0	0	0	50	0	0	60	237
0	69	3750	0	0	0	0	0	0	0	0	0	60	238
0	1	0	4	1	1	0	0	0	0	0	1	60	239
0	0	1	1200	1	0	0	0	0	65			60	240
1	0	0											
30	30	100	6	0	3	4	0	0	20	0	13	61	241
0	100	1800	0	0	0	0	0	0	0	0	0	61	242
1	0	0	5	1	0	0	0	0	0	1	0	61	243
0	0	0	500	0	0	1	0	0	97			61	244
1	0	0											
20	30	150	0	0	0	0	0	0	0	0	0	62	245
0	225	0	1	0	0	0	0	0	0	0	0	62	246
1	1	0	5	1	1	0	0	0	0	0	1	62	247
0	0	1	800	0	0	1	0	0	124			62	248
1	0	0											
60	80	133	26	15	37	0	0	0	43	25	0	63	249
0	177	3170	0	0	0	0	0	0	0	0	0	63	250
0	0	1	5	0	0	1	1	0	0	0	0	63	251
1	0	1	860	1	0	0	0	0	53			63	252
1	0	0											
100	80	80	1	0	0	0	0	0	1	0	0	64	253
0	64	99	1	0	0	0	0	0	0	0	0	64	254
1	0	0	5	0	0	0	0	0	1	0	0	64	255
0	0	1	1100	0	0	0	1	0	113			64	256
1	0	0											
30	30	100	5	0	0	3	1	4	17	0	10	65	257
3	100	1560	0	0	0	0	0	0	0	0	0	65	258
1	0	0	5	1	0	0	0	0	1	0	0	65	259
0	0	0	1700	0	0	1	0	0	100			65	260
1	0	0											
80	80	1[illegible]0	8	3	12	0	0	0	10	4	0	66	261
0	100	995	0	0	0	0	0	0	0	0	1	66	262
1	0	0	5	0	0	0	0	0	1	0	0	66	263
0	0	1	800	0	0	1	0	0	103			66	264
1	0	0											

30	60	200	3	0	0	0	0	0	10	0	0	67	265
0	400	995	0	0	1	0	0	0	0	0	1	67	266
0	0	0	5	1	0	1	1	0	0	0	0	67	267
1	0	0	800	1	0	0	0	0	121			67	268
1	0	0											
90	160	178	0	13	19	0	0	0	0	14	0	68	269
0	313	0	0	0	0	0	0	1	1	1	0	68	270
1	0	0	6	1	0	0	0	0	1	0	0	68	271
0	0	1	910	0	0	1	0	0	114			68	272
1	0	0											
40	80	200	13	0	0	3	0	4	33	0	16	69	273
0	400	2750	0	0	0	0	0	0	0	0	1	69	274
0	0	0	6	0	0	0	0	0	1	0	0	69	275
0	0	0	2000	0	0	1	0	0	98			69	276
1	0	0											
63	250	400	6	29	35	38	0	0	10	60	15	70	277
0	1600	995	0	0	0	0	0	0	0	0	0	70	278
1	0	0	6	0	0	0	0	0	1	0	0	70	279
0	0	1	260	0	0	0	1	0	80			70	260
1	0	0											
80	30	38	2	0	0	0	0	0	3	0	0	71	281
0	14	296	0	0	0	0	0	0	0	0	1	71	282
0	0	0	1	1	0	0	0	1	0	1	0	71	283
0	0	1	750	0	0	1	0	0	103			71	284
1	0	0											
30	250	833	12	4	14	0	0	0	40	13	0	72	285
0	7000	3200	0	0	0	0	0	0	0	0	0	72	286
1	0	0	1	1	0	0	0	1	1	0	0	72	287
0	0	0	1900	0	0	0	1	0	97			72	288
1	0	0											
30	30	100	3	0	0	2	0	0	10	0	7	73	289
0	100	995	0	0	0	0	0	0	0	0	0	73	290
1	0	0	1	1	1	0	0	0	0	0	0	73	291
1	0	0	540	1	0	0	0	0	107			73	292
1	0	0											
30	80	267	4	1	3	5	0	0	13	3	6	74	293
0	712	1220	0	0	0	0	0	0	0	0	1	74	294
0	0	0	1	0	0	0	0	0	0	0	1	74	295
0	0	1	900	0	0	1	0	0	117			74	296
1	0	0											
50	80	160	21	3	17	0	0	0	42	6	0	75	297
0	256	3100	0	0	0	0	0	0	0	0	1	75	298
0	0	0	1	0	1	0	0	1	0	0	1	75	299
0	0	1	1000	1	0	0	0	1	77			75	300
1	0	0											
60	80	133	8	4	11	0	0	0	13	7	0	76	301
0	177	1220	0	0	0	0	0	0	0	0	0	76	302
1	0	0	1	1	0	1	0	0	0	0	0	76	303
1	0	1	550	1	0	0	0	0	101			76	304
1	0	0											
30	60	200	17	0	2	10	0	0	57	0	33	77	305
0	400	4067	0	0	0	0	0	0	0	0	0	77	306
1	0	0	1	0	0	0	0	0	0	1	0	77	307
0	0	1	1350	0	0	1	0	0	74			77	308
1	0	0											

80	160	200	34	27	40	60	0	0	43	34	38	78	309
0	400	3400	0	0	0	1	0	0	0	0	1	78	310
0	0	0	1	0	0	0	0	1	1	0	0	78	311
0	0	1	600	0	0	1	0	1	54			78	312
1	0	0											
60	80	133	20	5	16	3	0	3	33	8	4	79	313
0	176	2750	0	0	0	1	0	0	0	0	1	79	314
1	0	0	1	1	1	0	0	0	0	0	1	79	315
0	0	1	520	1	0	0	0	0	80			79	316
1	0	0											
30	80	267	11	0	0	8	0	0	37	0	10	80	317
0	712	3000	1	0	0	1	0	1	0	0	0	80	318
1	0	1	1	0	0	0	0	1	1	0	0	80	319
0	0	1	260	0	0	0	1	0	105			80	320
1	0	0											
20	30	150	0	0	0	0	0	0	0	0	0	81	321
0	225	0	1	0	0	0	0	0	0	0	0	81	322
0	0	0	1	1	0	1	0	0	0	0	0	81	323
0	1	1	950	1	0	0	0	0	123			81	324
1	0	0											
80	80	100	11	1	2	0	0	0	14	1	0	82	325
0	100	1300	0	0	1	0	0	0	0	0	0	82	326
1	0	0	1	1	1	1	0	0	0	0	0	82	327
0	1	1	1000	1	0	0	0	0	102			82	328
1	0	0											
20	80	400	5	0	0	33	0	2	25	0	41	83	329
0	1600	2180	1	1	0	0	0	0	0	0	0	83	330
1	0	0	1	1	0	1	1	0	.0	0	0	83	331
1	0	1	800	1	0	0	0	0	125			83	332
1	0	0											
160	80	50	11	0	8	1	0	1	7	0	1	84	333
0	25	675	0	0	1	0	0	0	0	0	1	84	334
1	0	0	1	1	0	0	0	0	0	0	0	84	335
1	0	1	1800	1	0	0	0	0	101			84	336
1	0	0											
80	250	313	6	5	10	0	0	0	8	6	0	85	337
0	980	768	1	0	1	0	0	1	1	1	1	85	338
0	0	0	1	1	0	0	0	0	1	0	0	85	339
0	0	1	500	0	0	1	0	0	123			85	340
1	0	0											
219	80	37	24	0	9	70	2	11	11	0	87	86	341
3	14	1004	0	0	0	1	0	0	0	0	1	86	342
0	0	0	1	0	0	0	0	0	0	0	0	86	343
1	0	1	1200	0	0	1	0	0	97			86	344
1	0	0											
10	60	600	5	0	6	0	0	0	50	0	0	87	345
0	3600	3750	0	0	0	0	0	0	0	0	0	87	346
1	0	0	1	1	0	0	1	1	1	0	0	87	347
0	0	1	720	0	1	0	0	0	100			87	348
1	0	0											
15	60	400	1	0	0	0	0	0	7	0	0	88	349
0	1600	676	0	0	0	0	0	0	0	0	0	88	350
0	0	1	5	1	0	1	1	0	0	0	0	88	351
1	0	1	1000	1	0	0	0	0	143			88	352
1	0	0											

60	60	100	1	0	0	0	0	0	2	0	0	89353
0	100	199	1	0	0	0	0	0	0	0	0	89 354
1	0	0	5	1	0	1	1	0	0	0	0	89 355
1	0	1	1000	1	0	0	0	0	115			89 356
1	0	0										
30	60	200	11	0	0	0	0	0	37	0	0	90 357
0	400	3000	0	0	0	0	0	0	0	0	0	90 358
0	0	1	5	1	0	1	1	0	0	0	0	90359
1	0	1	1000	1	0	0	0	0	95			90 360
1	0	0										
30	60	200	1	0	0	0	0	0	3	0	0	91 361
0	400	296	0	0	0	0	0	0	0	0	1	91 362
0	0	0	5	0	0	0	1	0	1	0	0	91 363
0	0	1	500	0	0	0	1	0	129			91 364
1	0	0										
120	250	208	10	105	104	0	0	0	8	88	01	90 758
0	432	768	0	0	0	0	0	0	0	0	01	90 757
1	0	0	7	1	0	0	0	1	1	0	01	90 759
0	0	1	1500	0	0	1	0	0	36		1	90 760
1	0	0										

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Appendix B

STATISTICAL SUMMARY

Although a number of statistical terms used in the body of the Memorandum can be found in standard statistical texts, it seems worthwhile to provide a readily available reference for the nonstatistician. Therefore, this appendix gives a brief heuristic definition of the terms employed. No attempt is made to duplicate the mathematical precision of the reference texts.

Mean. The mean is a measure of the central location of a set of observations. It is equivalent to the average; that is, it is calculated by summing all observed values and dividing by the number of observed values.

Median. The median is another measure of central location of a set of values. It is defined in such a way that 50 percent of the observed values are larger than it, and consequently 50 percent of the observed values are smaller than it. The median is considered a better measure of the central location of skewed distributions than is the mean (see Fig. 13). In the lower curve of Fig. 13 the median is located near the most frequently occurring values, while the mean is influenced by the low-frequency, relatively large observations and is located in a lower-frequency region.

Variance. Variance is a measure of dispersion or variation in the data. To say that variable A accounts for 25 percent of the variance in B implies that 25 percent of the variation in the value of variable B from observation to observation could be predicted from a knowledge of the value of A for each observation. Thus, in the text 30 percent of the variation in RVN force size can be predicted from a knowledge of force type, local VC strength, and terrain type.

Correlation. Correlation is a mathematical technique for measuring the similarity of behavior for a pair of variables over all observations. That is, it measures the consistency with which variable A is large when variable B is large and is small when variable B is small. The correlation coefficient is restricted to a range from -1.0

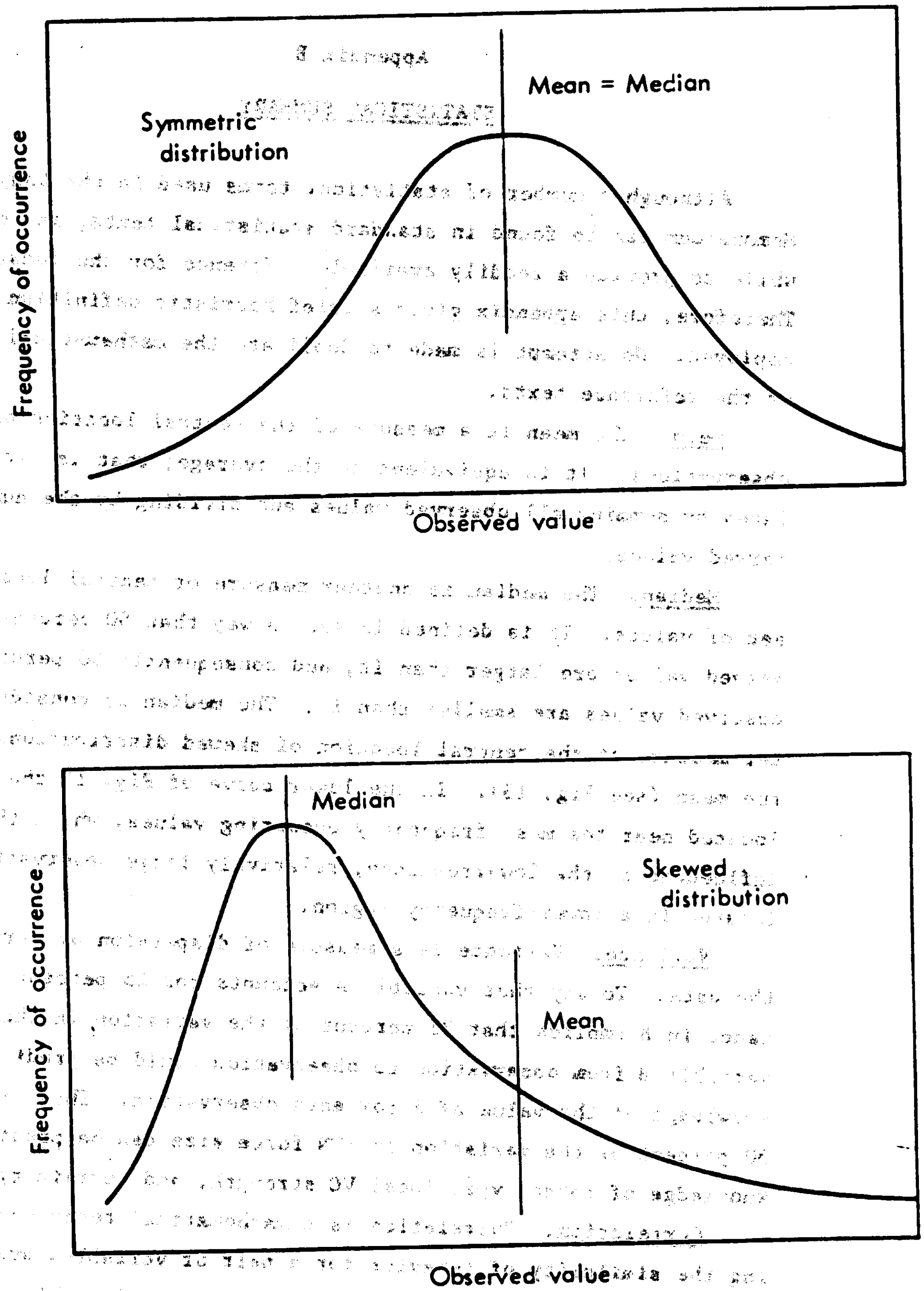

Fig. 13—Mean and median.

to +1.0. Plus 1.0 represents a perfect positive correlation; -1.0 represents a perfect negative correlation; and 0 represents no correlation, that is, unrelated behavior. Figure 14 illustrates correlation.

In plot (a) of Fig. 14, the variation in killed and the variation in wounded are shown over a hypothetical sample of attacks. When one is high, the other tends to be high. The number killed is plotted versus the number wounded in plot (b). It is seen that a straight line would provide a good fit to these data points. If all points fell on a straight line, the correlation would be 1.0; the closer the points are to a straight line, the closer the correlation is to 1.0.

Plot (c) shows an essentially zero-correlation condition. The value on the vertical axis is equally likely to be large or small for any value on the horizontal axis. Plot (d) illustrates a high negative correlation. That is, as one variable gets larger, the other tends to decrease. Figure 4 in the text is an example of such a relationship.

Correlation represents the degree to which one variable may be predicted from another. However, it does not tell the magnitude of the relationship among variables. That is, given

$$Y = 6X$$

$$\text{or } Y = 12X$$

X and Y would correlate 1.0 in each case.

Regression. Regression is a technique for solving for the best* estimate of a in the equation

$$Y = aX$$

Thus, regression can supplement correlation by estimating the magnitude of an empirical relationship, where correlation indicates the

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*Best in the sense of minimizing the sum of the squared deviations (see Ref. 9, p. 126).

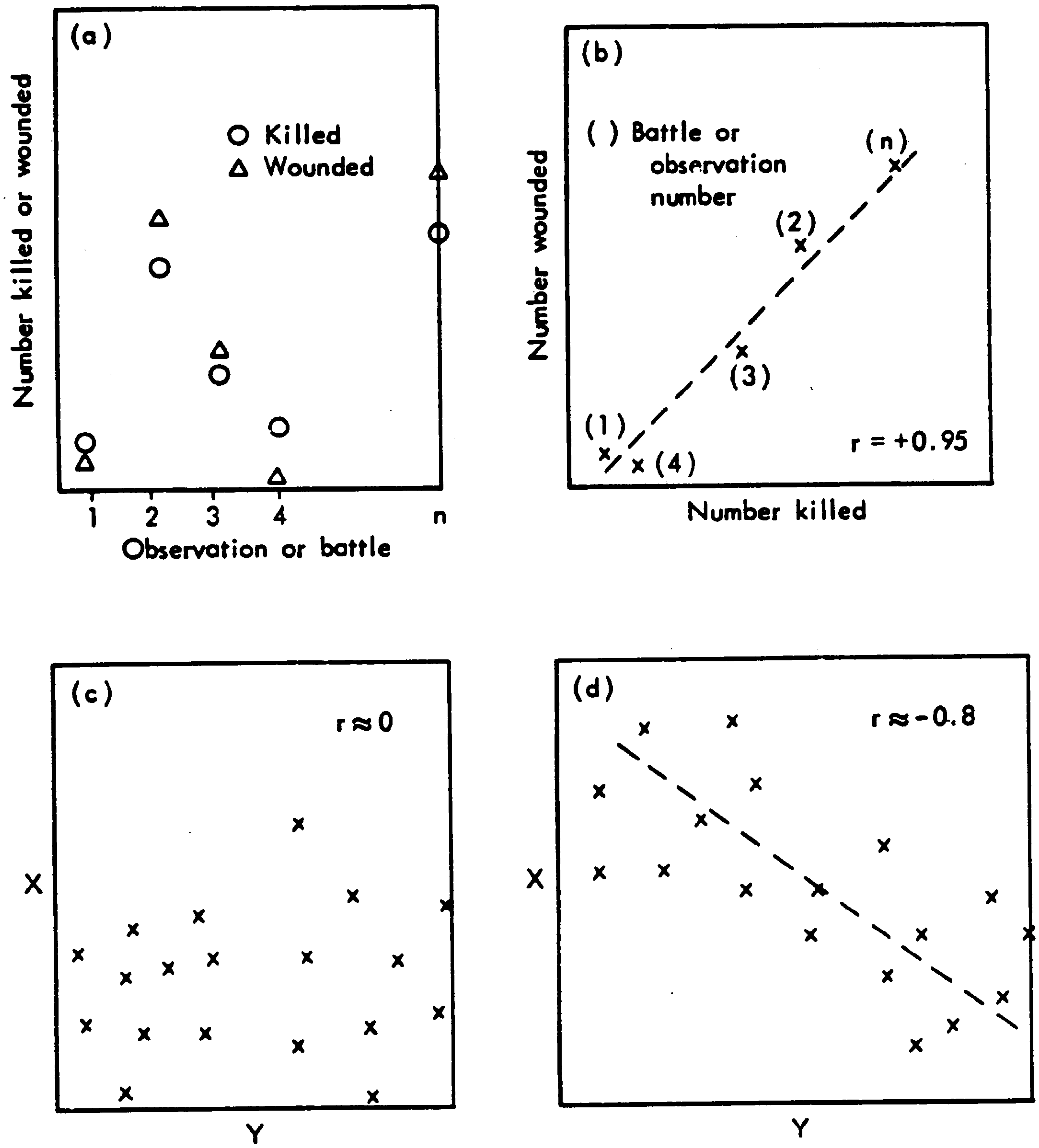

Fig. 14—Correlation

consistency. Regression and correlation are very similar. The regression coefficient, a, can be computed from a knowledge of the correlation of X and Y and the means and variances of X and Y.

Residuals. In complex situations such as in combat, many variables change from observation to observation. Some variables may have a more powerful influence on the outcome than do others. Furthermore, some variables may vary together in a systematic manner tending to cancel or perhaps reinforce one another. It is often desirable to examine the associated variation of a pair of variables without the influence of a third variable which has also changed. For example, assume

$$Y = aX + bZ$$

It is desired to examine the association of Y with X in a sample of data independent of Z. Regression may be used to estimate b and the residual variation of Y, that is, (Y - bZ) can be examined.

In the text the estimated effects of force ratio are often subtracted from $\%RVN_{k+w}$ and the residual is correlated with the remaining variables. If, as is hypothesized, force ratio is a very important parameter in determining outcome, the residual provides the variation in outcome with force ratio controlled. For example, air strikes which were used when the RVN had unfavorable force ratios have a positive correlation with $\%RVN_{k+w}$; that is, RVN combat losses were worse than average when air was present. However, air strikes show a negative correlation with residual $\%RVN_{k+w}$. This might then be interpreted as indicating that the use of air tends to reduce casualties over what would be expected without the use of air. Examining the correlation of air strikes with the unmodified $\%RVN_{k+w}$ would give the opposite impression.

Multiple Correlation. Multiple correlation is almost identical to ordinary correlation. In effect, a new variable is created from a composite of two or more variables. This new variable is created so as to maximize its correlation with some variable not involved in the composite variable. The correlation between the composite variable (or between the variables in the composite) and some outside variable is referred to as the multiple correlation. That is, the correlation between A and the composite of B, C, and D is the multiple correlation of A with B, C, and D. The multiple correlation defines the maximum prediction of A which can be obtained from a knowledge of B, C, and D.

The above descriptive definitions lack the precision which is possible with mathematical terminology. For more detailed definitions see Refs. 9 through 12.

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10. ABSTRACT

An analysis of Viet Cong attacks on South Vietnamese hamlets from January 1963 through August 1964. The information is based on summary descriptions of Viet Cong attacks. Patterns of Viet Cong behavior are described to determine what conditions of battle are associated with favorable outcomes for the South Vietnam government. Computer-conducted statistical methods are used to examine relationships in the data. (C)

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