HERO

FINAL REPORT

FORCED CHANGES OF COMBAT POSTURE

Janice B. Fain
Richard C. Anderson
Trevor N. Dupuy
Gay M. Hammerman
Charles F. Hawkins

30 September 1988

Prepared for

U.S. Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

Under Contract No. MDA903-87-C-0807

Historical Evaluation and Research Organization

A Division of

Data Memory Systems, Incorporated

An Information Services Company

10392 Democracy Lane
Fairfax, Virginia 22030
(703) 591-3674

FORCED CHANGES OF COMBAT POSTURE

Final Report

Janice B. Fain
Richard C. Anderson
Trevor N. Dupuy
Gay M. Hammelman
Charles F. Hawkins

30 September 1988

Prepared by

DATA MEMORY SYSTEMS, INC.
10392 Democracy Lane
Fairfax, Virginia 22030

for

U.S. Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, Maryland 20814-2797

Under

Contract No. MDA903-87-C-0807

Summary

FORCED CHANGES OF COMBAT POSTURE

Objective

The objective of the study was to gain increased knowledge of the factors associated with forced changes in combat posture, in order to develop a model of forced posture changes, and thus improve representations of transitions from one posture to another in Army combat simulations and wargames.

Methodology

The study was carried out in three tasks:

- collection of information from historical combat records, structured discussions with combat veterans, and a survey of the related literature;
- compilation and analysis of factors associated with forced posture changes; and
- development of a forced posture change model for use, with appropriate parameter values, at the divisional and regimental levels.

Principles guiding the model development may be summarized:

- The model is descriptive, not causal; its factors represent conditions under which units change posture, not reasons for such changes.
- The choice of model factors was constrained by the requirement that all numerical parameters be derivable from historical data and all model factors be available in combat simulations and wargames.
- A high value was placed on simplicity.

• A primary goal of this first development was to capture first-order effects; later developments can add details.

• Methodology and structure were placed above specific results. It was considered more important to produce non-subjective, easily followed rules for deriving model parameter values from historical data than to produce a set of parameters giving the lowest error rate.

Results

Historical Data Base. The data base of military engagements started with the existing Land Warfare Data Base (LWDB). From that compilation came 59 engagements, all involving US forces, that were fought after 1940 and exhibited clear-cut forced posture changes. A central accomplishment was the formulation of a procedure for identifying the posture change for each engagement, information that was not in the LWDB.

To the LWDB cases were added 24 engagements, also all involving US forces and exhibiting forced posture changes, that were newly researched from offical records for this study. The product was an 83-engagement Breakpoints Data Base used for the model development.

Focused Discussion Groups of Veterans. Discussions were held with 36 veterans of combat engagements in which forced posture changes were believed to have taken place, and their views on the factors that were crucial in determining these events were sought, recorded, and analyzed. From these discussions came a list of 30 factors considered by group members to have been crucial.

Literature Search. A survey of the literature revealed very little work directed specifically to the question of posture changes. The most relevant were found to be works by Dorothy K. Clark, Richard C. Adkins, Robert McQuie, and Trevor N. Dupuy.

Clark's study, the earliest and probably most detailed, yielded a long list of factors Clark believed were related to loss of combat effectiveness. Adkins's thesis on modeling battlefield decision-making provided additional factors. McQuie addressed the question of posture change directly in a study of the causes of defeat in some 60 World War II battles, and provided, for the first time, a ranking of the causes of posture changes by the frequency of their occurrence in battle. Dupuy set forth specific conditions under which he believed attackers and defenders would change posture.

Compilation and Analysis of the Posture Change Factors. Lists of posture change factors were compiled from all sources and sorted into categories. With duplicates removed, there were 39 individual factors. Each one was assessed for its suitability as a component of the Breakpoint Model on the basis of its evaluation in the literature, opinions of the discussion groups, limited statistical testing with historical data, the requirements of the model, and the availability of historical data for parameter estimation.

Development and Testing of the Breakpoint Model. Factors remaining after the individual assessments fell into three general categories:

- Tactical situation,
- Relative combat power, and
- Combat losses.

Specific factors representing each general category make up the Breakpoint Model. Its structure consists of a set of if-then statements, which represent checks of combat force factors against numerical values derived from a set of historical combat engagements.

The general form of these statements is:

If Factor X is less than, or equal to, x1, then there is an attacker posture change.

If Factor X is greater than, or equal to, x2, then there is a defender posture change.

Factor X is one of the specific factors in the Breakpoint Model, and x1 and x2 are values of the corresponding model parameters.

Quantifiable factors chosen to represent the three general areas listed above are:

- Distance advanced by the attacker/Width of Front
- Personnel ratio (attacker/defender) (Event version)
- Change in personnel ratio (attacker/defender) (Time-step version)
- Attacker and defender casualties (% initial personnel)
- Casualty ratio (attacker/defender) (Event version only)

Two versions of the model were developed. One fits more naturally within a time-step ground combat model; the other is better suited to an event-sequence model.

Parameters for both versions were derived for engagements at the regimental and divisional levels. Procedures for obtaining the numerical parameter values from the historical data are fully described in the study report.

Applied to the cases in the Breakpoints Data Base, the model had the following rates of successful posture change prediction.

Engagement Level	Model Version: Event	Model Version: Time-Step
Regimental	86%	95%
Divisional	77%	74%

The overall success rate is approximately 80%, a success rate that the study team judges acceptable.

The report concludes with a discussion of those historical engagements in which the posture changes were incorrectly identified by one, or both, of the model versions.

In general, categories of cases which would be decided erroneously by a breakpoint model include

(1) Engagements in which the posture change is caused by factors exogenous to the engaged units;

(2) Engagements involving such rare circumstances that no model could hope to call them correctly, nor would it be desirable that it do so;

(3) Engagements decided by factors not currently treated by the model but that could reasonably be added to it.

Engagements in category (1) have been consciously excluded from the Breakpoints Data Base. Whether an engagement in which the side changing posture is erroneously identified by the Breakpoint Model belongs in category (2) or (3) is a question of judgment. For each of these cases, an analysis of the historical factors leading to the actual posture change is provided in Appendix F.

Conclusions

A Breakpoint Model using factors for which numerical values are normally available in a computerized combat simulation has been developed. Although attacker and defender casualties, variables often used in determining a breakpoint in simulations, are necessary to the Breakpoint Model, they are

only two of the several required. The other factors are width of front, distance advanced, and numbers of attacker and defender personnel.

There are two versions of the Breakpoint Model -- one for use in time-step simulations and one for event-sequence simulations. Parameters have been derived from historical data for each model version for use at the regimental and at the divisional levels.

The model successfully predicts forced posture changes in 74-95% of the engagements in the sets from which the parameters were derived. The next step should be testing on a new set of combat engagements -- for example, engagements from the Middle East conflicts.

In addition to the model, which was the primary goal of the project, the information collection tasks have yielded products which themselves may be useful to the military analysis community. Twenty-four new engagements have been added to the combat data base and are available for the projects -- for example, the CAA benchmark work. In addition, the veterans' discussions are a potential source of much detailed information about combat activities.

With the preparation of this report, the project tasks have been completed and the project goals have been met.

FORCED CHANGES OF COMBAT POSTURE

Table of Contents

Appendix F. Analysis of Breakpoint Model Results Inconsistent with Historical Experience

List of Figures

Final Report

FORCED CHANGES OF COMBAT POSTURE

A DMSi Report

I. Introduction

Study Objective

The objective of the study, as expressed in the statement of work of the contract, was to determine the causes of and relationships governing forced changes of tactical posture by military units in combat, for the purpose of improving the representation of transitions from one tactical posture to another in Army combat simulations and wargames.

Background of the Problem

Designers of combat simulations and wargames have long been concerned about the problem of bringing a realistic conclusion to a simulated battle or engagement. How can the model determine that the combat has reached the point at which one of the adversaries would, in real combat, shift to a less aggressive combat posture; that is, stop attacking and go on the defensive, or stop attempting to hold a position and begin a retrograde movement?

It has long been assumed that equipment or personnel losses are the most useful measure of combat effectiveness degradation, and losses as a percent of authorized or duty strength have been the most commonly used indicator that a forced posture change (or "breakpoint") will occur. Some models have considered additional factors, such as supplies remaining and force ratios. However, both factors and parameters have varied widely, and have not been

based on objective evidence. There has been considerable concern in the modeling community and the larger defense community that current techniques do not model forced posture changes with adequate realism. The request for proposal that led to this study, and the study itself, are efforts to find a way to model forced posture changes that is more firmly grounded in the reality of combat experience.

Definitions of Terms

For purposes of this study, the following definitions have been established:

The combat posture of a military force is the immediate intention of its commander and troops toward the opposing enemy force, together with the preparations and deployment to carry out that intention. The chief combat postures are attack, defend, delay, and withdraw.

A change in combat posture (or posture change) is a shift from one posture to another, as, for example, from defend to attack or defend to withdraw. A posture change can be either voluntary or forced.

A forced posture change (FPC) is a change in combat posture by a military unit that is brought about, directly or indirectly, by enemy action. Forced posture changes are characteristically and almost always changes to a less aggressive posture. The most usual FPCs are from attack to defend and from defend to withdraw (or retrograde movement). A change from withdraw to combat ineffectiveness is also possible.

Breakpoint is a term sometimes used as synonymous with forced posture change, and sometimes used to mean the collapse of a unit into ineffectiveness or rout. The latter meaning is probably more common in general usage,

while forced posture change is the more precise term for the subject of this study. However, for brevity and convenience, and because this study has been known informally since its inception as the "Breakpoints" study, the term breakpoint is sometimes used in this report. When it is used, it is synonymous with forced posture change.

The term causes is used above in stating the objective of the study, because that term was used in the request for proposal, proposal, and contract. However, it is not, strictly speaking, possible to identify causes of a phenomenon such as forced posture change, which is determined by many complex and interacting processes, all of which involve human behavior. Attempts to identify causes in such a case will almost inevitably become mired down in philosophical and semantic discussions. Therefore, although causal relationships have been explored in the course of the study, no effort has been made to identify causes definitively as part of the study's conclusions. Rather, the study team has focused on factors with which forced posture change appears to be associated in actual combat experience, factors that can serve as indicators for forced posture change in a combat model.

Study Approach

On the assumption that actual experience is the best guide to realism in simulating the dynamics of combat, and in accordance with the study proposal and contract, the study approach focused on historical experience as a major source for hypotheses as to the factors with which forced posture change is associated, and used historical data to test hypotheses and to compute parameter values for the model formulated as the end product of the study.

The study was carried out in three tasks (exclusive of planning and report preparation):

- information collection and analysis;
- hypothesis collection and examination;
- model design and development.

Each task is summarized below.

Information collection and analysis. The purpose of this task was to gather information relevant to forced posture change and to analyze it for factors with which FPC appeared to be closely associated. There were three chief sources for information:

- Historical combat data as found in primary archival sources, other primary sources, and scholarly secondary accounts, and organized into combat data bases. For this study, a Breakpoints Data Base was created, made up of 83 land-combat engagements involving US forces in World War II, all engagements in which forced posture changes occurred. World War II engagements, most of them in Europe or North Africa, were used because this is the most recent conflict for which, at least in the battles against the Germans, reasonably good records exist for both sides and are available to US researchers.

The Breakpoints Data Base was created by integrating two collections of data:

- 59 engagements, drawn from the Data Memory Systems, Inc. (DMSI), Land War Data Base (LWDB), a collection of previously researched data on 603 military engagements since 1600. These engagements formed the core of the Breakpoints Data Base.

- 24 newly researched engagements. For this study, 10 military operations in which FPCs were known to have occurred were researched in primary archival sources. From these operations, 24 discrete engagements ending in FPCs were identified. Data on these engagements were assembled, and they were added to the Breakpoints Data Base.

The 83 engagements of this combined data base were sorted into groups of 62 engagements at the division level and 21 engagements at the regimental level, to enable application of the model at these two different levels.

- Focused group discussions were held with 36 veterans of operations researched for the new-combat-data subtask described immediately above. These veterans contributed their personal observations and judgments as to the key factors with which forced posture change was associated in the engagements they experienced. The discussions were analyzed to identify the frequency with which specific factors were cited, and the significance given to each factor by the discussion participants.

- Review of earlier studies. Previous literature relevant to forced posture change was reviewed for factors that earlier analysts of this problem had found, or considered, to be important.

Hypothesis Formulation and Testing. A list of 39 key factors associated with forced posture change was drawn up on the basis of the literature review and the discussion groups' judgments, and these factors were formulated as hypotheses. The hypotheses were then tested against the Breakpoints Data Base to check their compatibility with historical experience as represented in the data base. They were also checked for the availability of a quantifiable measure of the factor, and against the question, "Is this a factor

specific to forced posture change, or is it more properly part of a more inclusive ground combat model?" On these bases the factors for the Breakpoint Model were selected.

Model design and development. Using the factors selected, a model was designed, consisting of a series of parameter checks in the form of "if-then" statements, and a method for choosing parameters was devised. The final model was developed in two forms, an event-sequence version and a time-step version.

Study Team

The study team was composed of Dr. Janice Fain, Mr. Richard Anderson, Mr. Charles Hawkins, Mrs. Gay Hammerman, and Col. Trevor N. Dupuy (USA, Ret).

Dr. Fain is a physicist who holds a Ph.D. from the University of Texas, has done postdoctoral work at the University of Paris (the Sorbonne), holds an M.A. in political science from Yale University, and has over 30 years' experience in military operations research with a major interest in the simulation of ground combat. She is co-developer of the Tactical Warfare Simulation Program (Center for Naval Analyses), and during a year at SHAPE Technical Centre (The Hague) developed an air-strike simulation used for mission planning. Dr. Fain directed this study, carried out the literature review, and designed and developed the Breakpoint Model.

Mr. Hawkins, a West Point graduate and Virginia National Guardsman, has 11 years of infantry command and operations experience, including combat in Vietnam and a rotation at the National Training Center. An experienced computer systems specialist, he carried out the research and analysis of the engagements from the Land Warfare Data Base.

Mr. Anderson, a military historian with a B.A. degree from George Mason University, carried out the archival research and analysis on the 24 new engagements that were researched for this study.

Mrs. Hammerman, a historian holding a B.A. degree from the University of North Carolina and an M.A. from Harvard University, has directed 15 previous research studies for DMSi and carried out focused discussions with veterans for two of these studies. She carried out the focused discussions with veterans for this study and analyzed the results. She is also coordinating editor of this report.

Colonel Dupuy, President of DMSi, author of scores of book-length works on military history and military affairs, and a specialist in the quantitative analysis of combat, participated in weekly meetings of the study team, providing ongoing review and advice. He is the author of Appendix F.

Lt. Col. James T. Price, USA, Ret., assisted in planning and leading the focused group discussions. Colonel Price, a Vietnam combat veteran, holds B.S., M.A., J.D., and M.M.A.S. (US Army Command and Staff College) degrees.

Consultants. The following were principal consultants for the study:

Dr. David Segal provided advice on the focused group discussions, reviewed all reports relevant to this topic, and prepared a paper summarizing literature on the reliability of long-term memory. Dr. Segal, a Professor of Sociology at the University of Maryland with a Ph.D. from the University of Chicago, is a specialist in the sociology of military service whose publications in this field include five book-length works and numerous articles. He has been editor of the journal Armed Forces and Society (1982-1988), and is Visiting Professor of Sociology at the US Military Academy, 1988-1989.

Dr. Abraham Wolf, President of the Philadelphia psychological research firm ARBOR, Inc., and a research psychologist with a Ph.D. from the Univer-

sity of Pennsylvania, is a specialist in the design of analytical tools and assessment techniques. Dr. Wolf provided advice and review on hypothesis testing.

Dr. Peter Shapiro carried out the major part of the hypothesis testing and analysis. Dr. Shapiro holds a Ph.D. in social psychology, with secondary specialization in statistics and methodology, from the University of Wisconsin (Madison), and has published work in statistics and methodology (Psychological Bulletin, 1986).

Col. John R. Brinkerhoff, USA, Ret., made contributions to the development of the model. Colonel Brinkerhoff, a military affairs specialist and model designer, has an MSA degree in operations research from George Washington University.

Description of This Report

The remaining portions of this report discuss the following:

- The three sources of hypotheses:
  - the collection and analysis of the historical data on engagements ending in forced posture changes, including data from both the DMSi Land Warfare Data Base and the newly researched engagements;
  - the planning and carrying out of the focused group discussions with veterans, and the analysis of data from those discussions;
  - the literature survey.
- Hypothesis collection and examination
- Model design and development
- Conclusions

II. Historical Data Base

Purpose

A key aspect of the study was its dependence on historical experience as a fundamental source, and the purpose of this task was to produce a systematically organized data base of combat engagements from relevant past experience.

The Breakpoints Data Base

The foundation of the Breakpoints Data Base that was produced for the study was the Land Warfare Data Base (LWDB), created by DMSi's predecessor organization in 1983 for the US Army Concepts Analysis Agency (CAA) (CAA Study Report CAA-SR-84-6, Analysis of Factors That Have Influenced Outcomes of Battles and Wars: A Data Base of Battles and Engagements, CAA Contract No. MDA903-82-C-0363). Additional research since 1983 has modified and refined the LWDB; some of these revisions have been prepared under contract to CAA, while others have been carried out and incorporated into the LWDB more recently. The LWDB in its revised form as of November 1987 was the source for LWDB data for this study.

Fifty-nine engagements from the LWDB that met the specific study criteria constituted the core of the Breakpoints Data Base. To them were added 24 engagements newly researched for this study. Figure II-1 is a list of the 83 engagements forming the Breakpoints Data Base.

Cases from the Land Warfare Data Base

The LWDB comprises 603 engagements from 1600 to 1973. As was stated in the study proposal, the data base for the study was to include only engage-

ments from the beginning of World War II; 216 engagements met this criterion. Of these, 21 were eliminated because it was determined that they included no forced posture change. As the study progressed, it became clear that for reasons of comparability of data, and the special relevance of US experience to those modeling US combat, only engagements involving US forces should be included in the data base. This eliminated another 136 engagements, leaving a data base of 59 cases since 1941 in which US forces participated and which included a forced posture change.

Determining the Forced Posture Change

The LWDB includes 96 data fields for each engagement, but, having been researched well before the inception of the current study, has no field for forced posture change per se. Thus, in order to identify engagements in which FPCs took place, and to make the data base suitable for this study, it was necessary to find a means to determine whether the posture change ending an engagement was voluntary or forced and, if forced, whether it was carried out by the attacker or the defender.

Initial screening to remove the few engagements ending in voluntary posture changes was based on a case-by-case comparison of initial and final postures and a study of engagement narratives.

The next task was to determine, for each instance of forced posture change, whether the attacker or defender changed posture. The principal fields used in making this identification were the attacker and defender resolution codes. The types of combat resolution shown in the data base are penetration, repulsion, breakthrough, pursuit, stalemate, withdrawal, withdrawal with heavy losses, and annihilation.

Figure II-2 shows the posture change type for each attacker-defender resolution pair found in the Breakpoints Data Base. It will be noted that two resolution pairs cannot be identified as to attacker or defender posture change on the basis of combat resolution alone and are indicated by a question mark in Figure II-2. In these cases, the mission accomplishment field was consulted, and the degree of mission accomplishment for the attacker was compared with the degree of mission accomplishment for the defender. In this field, mission accomplishment is evaluated on a scale from 0, for total mission failure, to 10, for total mission success. A posture change was assigned to the side with the lower score, and in the case of a tie, an attacker posture change was assumed.

The New Engagement Data Collection

In order to provide at least 20 cases from a lower aggregation level, new research was carried out on 10 World War II and Korean War operations in which forced posture changes were believed to have taken place. This research yielded 24 new cases, 16 of them at the regimental level, which were combined with the 59 cases from the LWDB to form the 83-case Breakpoints Data Base. Since there were 5 regimental-level cases among the 59 from the LWDB, 21 cases at this level were available for the Breakpoints Data Base. Figure II-3 shows the way in which the Breakpoints Data Base was derived.

Scope. It was originally planned that the data collection would include US units in both World War II and Korean War engagements. However, examination of Korean War engagements showed that accurate information for both sides was not accessible, and for this reason the Korean War engagements were eliminated. Since it was considered desirable that a number of posture

change types be examined, engagements were chosen with US units in both attack and defense, in at least equal proportions.

Methodology. The information collection had a number of requirements. First, as nearly as possible, each case was to represent a single engagement. Therefore, it was determined that each engagement should have a clearly identifiable endpoint, the most appropriate being the breakpoint itself. The second requirement was that the most reliable and consistent information, which was that found in the relevant G-1 and G-3 (or their German equivalent) records of the units in question, would be used. In some cases these records contained estimates; however, this approach yields the most accurate approximation of the information available to the commanders at the time.

The collection methodology employs the following rules:

Total unit personnel includes all personnel of the unit involved, and of attached maneuver elements and supporting artillery, who are subject to enemy direct or indirect fire.

Artillery totals include all direct-support and general-support units available to the engaged unit during the operation. The general-support artillery include only the supporting units actually used in the operation to support the maneuver unit in question, if this information is known.

Armor totals include all tracked armored fighting vehicles (AFVs) available to support the unit during the operation. However, if the information is known, all AFVs used primarily or exclusively in an indirect-fire role are included in the artillery rather than the armor totals.

Air sorties include all combat air sorties known to have been flown in support of the unit during the engagement. If the information is known, only those aircraft actually flying or configured for a close-air-support role are

included in the total. (These include fighter bombers, dive bombers, and light bombers. Unless known to have been used in a close-air-support role, medium bombers and heavy bombers are excluded.)

Sources

The records used in the data collection include

- Records of the Adjutant General, US Army, found in the Washington National Records Center, Suitland, Md. These include G-1, G-2, and G-3 journals, diaries, and after action reports and statistical reports.

- Records of the German Armed Forces found on microfilm at the National Archives, Washington, D.C. These captured records include unit diaries, message journals, and statistical records for various German units concerned. Although incomplete, these records represent the best readily available source of data for the German Army in World War II.

- Records of the German Armed Forces found at the Bundesarchiv, Freiburg, FRG. These records contain much data missing from the microfilmed records in the National Archives. They have recently become available through research being done concurrently by DMSi.

- Where considered to be appropriate, unofficial or semiofficial unit histories were used as confirmation or explanation of information found in the official records. Unless it was found to be the only information available, statistical data found in these sources was treated as secondary in nature and used only when confirmed by the official records. Included in this group are the series of postwar interviews of German officers conducted by the US Army Historical Section, Headquarters US Army, Europe.

- The official US Army Historical series on World War II (the "Green Books") were used as a source for delineating the engagements to be studied and as a reference resource for information on primary records available.

A bibliography of primary sources used will be found in Appendix A.

Estimation methods. Both US and German records were generally complete and appeared to be accurate. However some estimates were required for a small proportion of the engagements. The data items in which estimation was necessary, the extent of that estimation, and the estimation methods used are described below:

US Strengths. Personnel strengths were not explicitly stated for several units in the Sidi Bou Zid I and II engagements and the Kasserine Pass engagement. Since the units were newly arrived in the combat zone, and since other units involved in the engagements were known to be at or above Table of Organization (T/O) strength, it seemed reasonable to estimate at T/O strength the units for which strengths were not explicitly given. Equipment status was almost always stated in the records, and strengths and losses were generally reported on a daily basis; virtually no estimates were required.

German Strengths. Personnel strengths were not explicitly stated for the Sidi Bou Zid I and II, Kasserine Pass, and Mortain I and II engagements. However, the strength of the units for these engagements was indicated in general terms, i.e., "full strength," "half strength," "strong," "weak," or "burnt out." Estimates used the following percentages of T/O strengths to translate these descriptions into strength figures: full strength = 100%; half strength = 50%; strong = 85%; weak = 40%; burnt out = 25%. Equipment records, like comparable US records, generally gave complete and specific figures.

Casualties. Casualty figures in the records appeared complete and accurate, but in some cases the only casualty records available were for a reporting period longer than the duration of the engagement being studied.

This was true for the US records for the two Sidi Bou Zid engagements and for the German records for the three Bowling Alley (Anzio), two Mortain, and three Schmidt engagements. For these engagements, casualty figures were estimated as the product of the engagement duration and the average daily casualties, computed from the recorded casualty figures after removing days in which the unit was not in combat or was not actively engaged and took negligible casualties. Valuable cross-checks for these estimates were the prisoner-of-war records of the opposing forces, since the ratio of prisoner-of-war figures to casualty figures appeared to be close to constant.

The New Engagements. Figure II-4 shows the list of engagements derived from the new data collection. A careful evaluation of preliminary sets of engagements has produced this final list, consisting entirely of engagements which clearly ended in a forced posture change. The engagements have been ordered as for the model-design phase of the study, with attacker posture changes listed first.

A summary of the engagements is given below:

Type of Posture Change	Posture Change by		Totals
	Germans	US Units	
A → D	5	8	13
D → W	1	10	11
Totals	6	18	24

Two of the engagements may be termed "armor" battles, the battles of Sidi Bou Zid (Engagements R1 and R16). Of the other engagements, 12 may be considered to be armor "heavy," with armor playing a significant or dominant

role on one or both sides (Engagements R6-7, 10-11, 17, D28-29, 58-62). In the remaining 10 engagements, armor may have been present, but did not play a significant or dominant role.

Brief narratives for the newly researched engagements will be found in Appendix A, together with printouts of the data-base entries.

Evaluation of Accuracy. The new-engagement data base represents the best available estimate of conditions that obtained at the start and end of the engagements in question. The methodology of analysis was maintained in a consistent fashion throughout the data-collection and analysis phases of the task. All judgments made on the nonquantitative factors found in the data base were made by the researcher, using contemporary accounts of the engagements and later assessments by participants and historians. These judgments were further reviewed by the historical staff of DMSi.

Summary

The Breakpoints Data Base provided a systematically organized body of data, with a large number of consistently defined categories of information, quantitatively measured wherever possible, on 83 combat engagements fought since 1940 and involving US forces. Of these engagements, 62 were at divisional level and 21 at the regimental level. In all of them a forced posture change took place, usually as the endpoint of the engagement. Of the divisional-level engagements, 25 showed forced posture changes of attack to defend; 3 showed FPCs from defend to retrograde. The regimental-sized engagements comprised 14 cases of attack-to-defend FPC and 7 cases of defend-to-retrograde FPC. This data base, once formed, was available for testing hypotheses and for a number of tasks needed in model development.

Figure II-1: Engagements in the Breakpoints Data Base

Regimental Engagements

LWDB #	Id #	Engagement	
	1.	15 Feb 43	Sidi Bou Zid II
	2.	20-21 Jan 44	Rapido I North
	3.	21-22 Jan 44	Rapido II North
	4.	20-21 Jan 44	Rapido I South
	5.	21-22 Jan 44	Rapido II South
	6.	7 Aug 44	Mortain II
	7.	2-5 Nov 44	Schmidt I
	8.	2-3 Nov 44	Schmidt II
	9.	2-4 Nov 44	Schmidt III
	10.	17-19 Dec 44	Krinkelt-Rocherath II
	11.	7 Aug 44	Mortain I
5280	12.	4-5 May 45	Jap Counterattack I
5310	13.	24-25 May 45	Jap Counterattack II
4280	14.	7-9 Feb 44	Moletta River Defense
	15.	16-19 Dec 44	Schnee Eifel Center
	16.	14 Feb 43	Sidi Bou Zid I
	17.	19-20 Feb 43	Kasserine Pass
	18.	13-16 Dec 44	Wahlerscheid
	19.	16-17 Dec 44	Krinkelt-Rocherath I
5360	20.	12 Jun 45	Yaeju-Dake
5170	21.	20-24 Nov 43	Tarawa-Betio

Divisional Engagements

LWDB #	Id #	Engagement	
4330	1.	21-23 Feb 44	Fioccia
4300	2.	11-12 Feb 44	Factory Counterattack
3920	3.	23 Mar 43	El Guettar
4610	4.	6-12 Aug 44	Mortain
5260	5.	28-29 Apr 45	Kochi Ridge-Onaga II
5250	6.	25-27 Apr 45	Kochi Ridge-Onaga I
5400	7.	9-12 Apr 45	Kakazu and Tombstone Ridges
5440	8.	14-18 May 45	Attack on the Shuri Line's Eastern Flank II
5470	9.	10-11 Jun 45	Initial Attack on the Yuza-Dake/Yaeju Escarpment
4170	10.	6-7 Nov 43	Pozzilli
5320	11.	26-27 May 45	Shuri Envelopment, Phase II
4820	12.	6 Dec 44	Singling-Bining
5340	13.	6-8 Jun 45	Hill 95-I
4470	14.	26 May 44	Velle-ri
4740	15.	14-15 Nov 44	Bourgaltroff

Figure II-1: Engagements in the Breakpoints Data Base (continued)

5460	16.	6-9 Jun 45	Advance to the Yuza-Dake/ Yaeju Escarpment
4520	17.	29 May-1 Jun 44	Lanuvio
4510	18.	29-31 May 44	Fosso di Campoleone
4310	19.	16-19 Feb 44	Bowling Alley
4160	20.	6-7 Nov 43	Monte Lungo
4480	21.	26-28 May 44	Campoleone Station
3960	22.	11 Sep 43	Sele-Calore Corridor
4780	23.	27-29 Nov 44	Burbach-Durstel
3930	24.	13-14 Sep 43	Tobacco Factory
4690	25.	2-13 Nov 44	Schmidt
4770	26.	26 Nov 44	Baerendorf II
4620	27.	16 Aug 44	Chartres
	28.	16-19 Feb 44	Bowling Alley I
	29.	16-19 Feb 44	Bowling Alley II
	30.	16 Dec 44	Schnee Eifel South
5230	31.	19-21 Apr 45	Tomb Hill-Ouki
5350	32.	9-11 Jun 45	Hill 95-II
5370	33.	15-17 Jun 45	Hills 153 and 118
5330	34.	29-31 May 45	Shuri Envelopment Phase III
5300	35.	22-23 May 45	Shuri Envelopment, Phase I
5290	36.	6-7 May 45	Kochi Ridge IV
5240	37.	19-23 Apr 45	Skyline Ridge-Rocky Crags
5390	38.	5-8 Apr 45	Advance to Shuri Line Outpost
5420	39.	26-29 Apr 45	Maeda Escarpment
5480	40.	12-17 Jun 45	Capture of the Yuza-Dake/ Yaeju-Dake Escarpment
4390	41.	17-19 May 44	Monte Grande (Rome)
4140	42.	4-5 Nov 43	Santa Maria Oliveto
4340	43.	11-14 May 44	Santa Maria Infante
4360	44.	14-15 May 44	Castellonorato
4570	45.	13-17 Sep 44	Il Giogio Pass
4530	46.	1-2 Jun 44	Lariano
4080	47.	13-14 Oct 43	Triflisco
4410	48.	22-24 May 44	Terracina
4550	49.	1-2 Jun 44	Valmontone
5380	50.	2-4 Apr 45	Advance from the Beachhead
4580	51.	11-18 Jul 44	St. Lo
5210	52.	2-4 Apr 45	Advance from the Beach
4440	53.	23-25 May 44	Anzio Breakout
4450	54.	23-25 May 44	Cisterna
4460	55.	25-27 May 44	Sezze
4630	56.	23-25 Aug 44	Melun
3930	57.	23 Apr-6 May 43	Sedjenane-Bizerte
	58.	16 Dec 44	Schnee Eifel North I
	59.	16-17 Feb 44	Bowling Alley II
	60.	16-19 Dec 44	Schnee Eifel North II
	61.	16-18 Dec 44	Our River Center
	62.	16-17 Dec 44	Our River North

Figure II-2: IDENTIFICATION OF FORCED POSTURE CHANGES IN THE BREAKPOINTS DATA BASE

Attacker Resolution	Defender Resolution				
	Penetration	Stalemate	Withdrawal	Withdrawal w/Hvy Losses	Annihilation
Pursuit	N	N	D	D	D
Breakthrough	N	N	D	D	D
Penetration	N	?	D	D	D
Stalemate	A	?	D	N	N
Repulsion	A	A	N	N	N
Withdrawal	A	A	N	N	N
Withdrawal w/ Heavy Losses	A	A	N	N	N

A = Attacker Posture Change
D = Defender Posture Change
N = This combination did not occur
? = This combination requires a check of the mission accomplishment codes. See text, p. II-3.

Note: Rows and columns that would have consisted entirely of Ns have been omitted.

Figure II-3: THE BREAKPOINTS DATA BASE

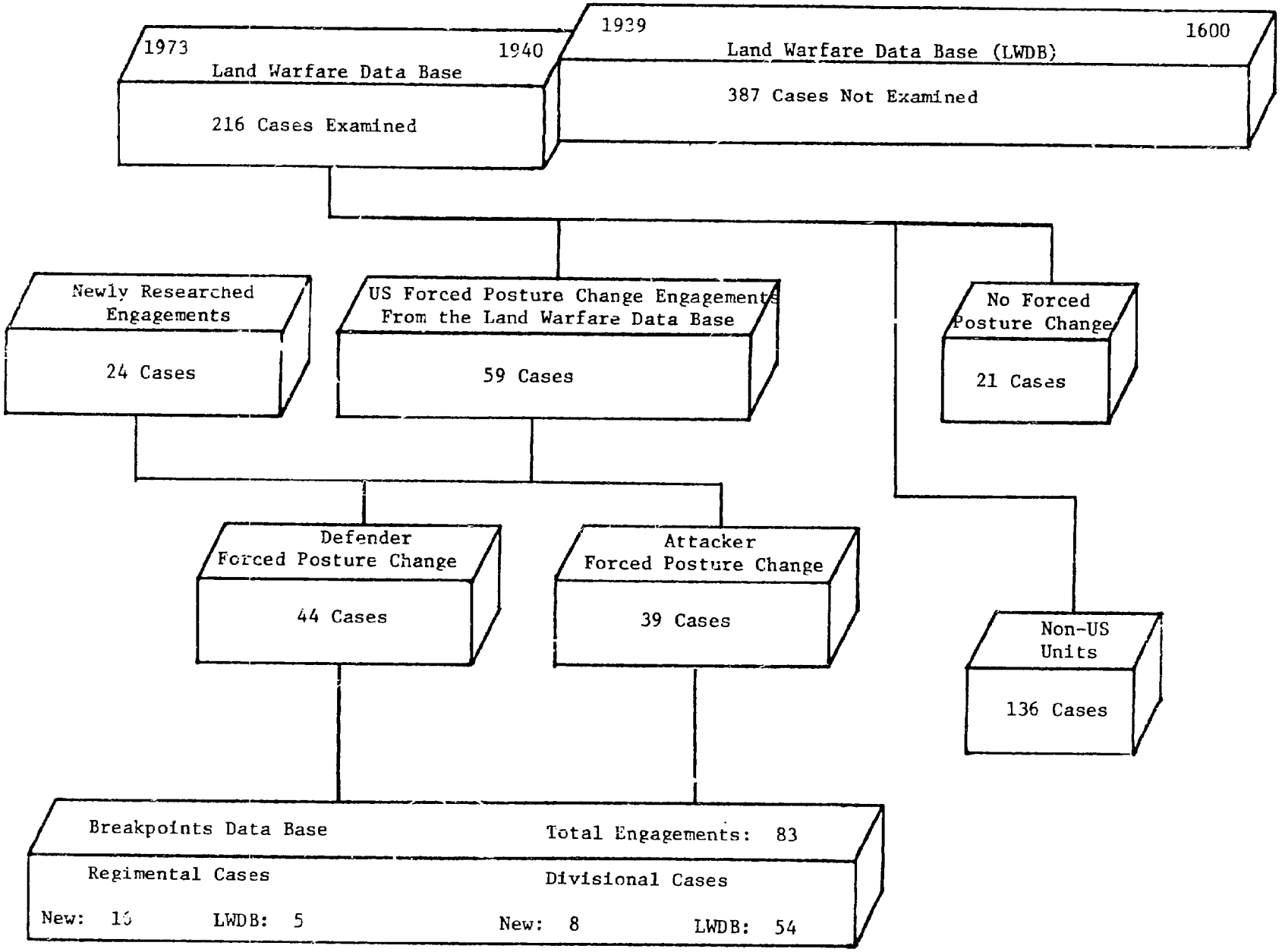


Figure II-4: THE NEWLY RESEARCHED ENGAGEMENTS

No.	Name	Posture Changer	Posture Change Type
R1	Sidi Bou Zid II	US	A → D
R2	Rapido I North	US	A → D
R3	Rapido II North	US	A → D
R4	Rapido I South	US	A → D
R5	Rapido II South	US	A → D
D28	Bowling Alley I	Ger	A → D
D29	Bowling Alley III	Ger	A → D
R6	Mortain II	Ger	A → D
R7	Schmidt I	US	A → D
R8	Schmidt II	US	A → D
R9	Schmidt III	US	A → D
R10	Krinkelt-Rocherath II	Ger	A → D
R11	Mortain I	Ger	A → D
R15	Schnee Eifel Center	US	D → W
D30	Schnee Eifel South	US	D → W
D58	Schnee Eifel North I	US	D → W
R16	Sidi Bou Zid I	US	D → W
R17	Kasserine Pass	US	D → W
D59	Bowling Alley II	US	D → W
D60	Schnee Eifel North II	US	D → W
R18	Wahlerscheid	Ger	D → W
R19	Krinkelt-Rocherath I	US	D → W
D61	Our River Center	US	D → W
D62	Our River North	US	D → W

R(+ numeral) - Regimental engagement

D(+ numeral) - Divisional engagement

A - Attack
D - Defend
W - Withdraw (or retrograde)

III. Focused Discussion Groups

Purpose

The purpose of the discussion-group task was the generation of hypotheses. The DMSi team that planned the proposal for the study believed that if all factors significantly affecting forced posture change were to be considered, it was important to have the observations and judgments of people who had actually experienced a forced change of posture in a combat situation.

Locating and Recruiting Participants

It was decided that participants in discussion groups would be drawn from combat veterans who had participated in one of the 10 military operations that were being researched for the new-engagement collection task. Thus the DMSi historians would be well informed on the details of the operations and able to lead the discussions effectively, and also the experiences of the participants could serve as a check on the fullness and accuracy of the archival data, and vice versa.

For the discussions, we were seeking veterans of 11 divisions who had been in 10 specific operations in which those divisions participated in World War II or the Korean War. We sought only veterans who lived in or near the Washington, D.C., area, as the study provided only limited funds for travel. To find these men, we asked the help of the Department of the Army (Community Relations); the Veterans Administration; veterans' organizations, including the American Legion, Veterans of Foreign Wars, and eight others; and the division associations, which might be called the alumni organizations of Army

divisions. All these groups were positive in their responses, and the division associations were especially helpful. Through them, either directly or through notices placed in newsletters, we were able to reach considerable numbers of veterans, and to find at least one veteran who was willing to participate in the research from all but one of the 10 operations.

In recruiting participants, and in all contacts with organizations, we were careful to stress the voluntary nature of the participation. Our standard formula, used with slightly varying wording in all approaches by phone or letter, was "Participation in this study is completely voluntary. We are not asking you to participate. However, we want to let you know about our work, and if you would like to talk with us, we would be very happy to talk with you."

The response from the veterans was generally very positive. Most were willing and many were eager to participate. Many brought contemporary letters, memoirs, copies of official documents, maps, and artifacts to the discussion. Most seemed to find the discussion experience rewarding.

The Participants

A total of 36 veterans, including 13 former officers and 23 former enlisted men, participated in discussions. One officer participated in two discussions, since he had served in two of the operations being studied. In addition, 3 former enlisted men who live outside the Washington, D.C., area volunteered, telephone conversations were held with them, and the information thus gathered was tabulated and used in the analysis. Thus a total of 40 individual combat experiences were represented in the data-gathering task.

The military ranks of the participants, at the time of the engagements in which they took part, ranged from private to brigadier general. The largest numbers were first lieutenants (6) or sergeants (6), with smaller numbers scattered through most other ranks. At the time of the engagements, their assignments included platoon leader, battalion commander, mortar man, company commander, medic, regimental staff officer, rifle squad leader, armorer-artificer, and rifleman, among many others.

After their military experience, about two-thirds of the men returned to civilian life. The rest remained in the Army, most of them as officers; four rose to general-officer rank. All the men appeared highly motivated to remember events accurately and to give thoughtful judgments. Almost all appeared to have reasonably clear and complete memories of the events discussed.

The research team judged that it was valuable to have the accounts and judgments of both former officers and former enlisted men. For example, only an officer who had been with a regimental commander at the time he surrendered his regiment could have provided convincing testimony as to the reasons that officer gave at the time for his decision. On the other hand, only an enlisted man could testify convincingly as to morale in the ranks before an attack began, or could report that a squad leader had not briefed his squad on their objectives in the attack, an omission so unusual that it made the unbriefed soldier fearful for the outcome.

Discussion Guide

The discussion guide was designed to encourage consideration of all aspects of the unit's background and all the circumstances of the operation

that conceivably might have been related to FPCs. Thus participants were given an opportunity to evaluate their training, the leadership of their unit, the strength of the positions they were holding or attempting to capture, and the impact of the casualties they took, among many other factors. It should be stressed that the discussion guide was planned and used to stimulate and focus, rather than to restrict, discussion. A copy of the discussion guide is attached to this study as part of Appendix B.

At the time the discussion guide was drawn up, the literature review had not yet been carried out, so the previous writings relevant to forced posture change were not used as sources for factors in the discussion guide. However, most of the factors cited in the literature were in fact included in the discussion guide.

At the end of the discussion, participants were invited to comment specifically on the reasons for the forced posture change, as they understood them. They were encouraged to distinguish between factors that were simply problems and factors that made a crucial difference, in their view, in the occurrence of the FPC.

The Discussions

An effort was made to find as many veterans as possible from the divisions and operations under study who wished to participate in the discussion groups. The configuration of groups that resulted is shown in Figure III-1. It will be noted that <u>at least</u> one veteran who wished to participate in a discussion was found for 9 of the 10 targeted operations. <u>Only</u> one veteran was found for 5 of the 9. For one operation there was a total of 17 men, meeting in four groups of 5, 4, 1, and 7 men. These men were veterans of the

106th Infantry Division in the Schnee Eifel operation of the Battle of the Bulge. For one other operation, the defense of St. Vith, there was also a relatively large representation: 10 men in three groups of 1, 6, and 3 men. The other two operations were each represented by single groups of 2 and 3 men.

Both the larger groups and the single-person discussions proved to be good sources of data. In the group discussions, participants could stimulate, confirm, supplement, and correct each other's memories -- an important advantage. However, most of the single-person discussion participants were very good witnesses, by reason of their opportunity to see the action and/or decision-making process, and their clear memories and thoughtful analysis.

Analysis of Discussion Results

Reports were prepared on each discussion group, summarizing the discussion and identifying the factors considered by members of the group to have been crucial in determining the breakpoint. (These reports on each discussion were submitted to CAA as part of the progress report on Task 3.2 of this study. Summaries of the discussions, grouped by military operation, will be found in Appendix B.) Thirty factors were listed as crucial by members of 13 groups representing 8 military operations. (The discussion for one of the 9 original operations did not yield any key breakpoint factors.) These can be assigned no hierarchical value, as the numbers of participants and operations were too small. Nevertheless, the study team found it instructive for an understanding of forced posture change, and in evaluating hypotheses to be tested for the Breakpoint Model, to see the array of factors and note those that were most often cited. The factors are shown in Figure III-2.

An immediately striking feature of Figure III-2 is the frequency with which tactical factors were cited, and especially the fact that a flanking or enveloping maneuver was cited for six of the eight operations. In one of the two operations for which it was not cited, the force experiencing the forced posture change had placed itself in a tactical situation virtually indistinguishable from envelopment. This pattern is all the more striking because there was no item in the discussion guide that dealt specifically with enemy maneuver. The pattern fits well with the analysis of the operations on the basis of the historical-record data; that is, these operations did indeed include the threat or achievement of envelopment by the enemy.

Aside from the fact that maneuver is cited in most cases, the other striking pattern is the very large number of factors cited by groups from Operation D, the 106th Infantry Division at the Schnee Eifel. This pattern may be partly due to the large number of participants for this operation, and the correspondingly large number of views and ideas they brought; partly due to the magnitude of the disaster to the 106th, which undoubtedly intensified the search for answers over the years; and partly to the fact that the division did indeed have many problems, and it was probably difficult for the veterans to distinguish between those that were crucial to the breakpoints and those that were simply severe obstacles and hardships. The factors that stood out, and were cited by three or more of the four discussion groups for this operation were poor communications, low ammunition, lack of combat experience, and a history of high personnel turnover in the division.

An additional analysis task was carried out in order to tabulate the judgments of the discussion groups on all 42* breakpoint factors, including the 12 factors found in the earlier literature and not specifically cited by

* Note that these were later consolidated to 39 factors.

the group. The historians who had met with the groups reviewed reports and tapes of the meetings and assessed the groups' implied judgments on all factors.

In order to distinguish among factors that were present but not considered by the veterans to have played a significant role in bringing about the breakpoint, on the one hand, and factors that were simply not present, on the other, each factor was rated as having been seen by the veterans as decisive, significant, present but not significant for the breakpoint, not present, presence unknown, or present but with effect unknown. Figure III-3 shows the results of this analysis.

The results were fundamentally the same as for the previous analysis: No other factor was cited as frequently or strongly as enemy maneuver. The veterans had described this factor in such terms as "they cut us off," or "they were moving in behind us." Another factor frequently implied in the veterans' discussions, though not so often cited specifically, was the tactically vulnerable position of the men's own force. The men had made such statements as these: "We never should have been out there." "If a more aggressive corps commander had . . . seized key terrain [originally], that would have made a difference [in the breakpoint]."

Not present in as many cases, but judged by the groups as crucial or important when they were present, were the factors of poor communications and low ammunition. The other factors were fairly widely scattered.

Summary

The discussion groups proved to be the most productive area of research for suggesting hypotheses as to the factors with which forced posture change is most closely associated. Their findings also supported and supplemented

the primary archival research. Further, they provided concrete examples of abstract military concepts and showed how such concepts as forced posture change are experienced in real combat. Probably their chief contribution to the substance of the study was the emphasis they gave to the significance of tactical factors.

Figure III-1. Focused Discussion Groups of Veterans

Discussion Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Division	106 Inf	7 Amd	36 Inf	106 Inf	2 Inf	106 Inf	7 Amd	28 Inf	1 Amd	24 Inf	106 Inf	7 Amd	2 Inf	45 Inf
Operation	Schnee Eifel	St. Vith	Rapido River	Schnee Eifel	Krinkelt-Rocherath	Schnee Eifel	St. Vith	Schmidt	Sidi-Bou-Zid	Taejon	Schnee Eifel	St. Vith	Kunu-Ri	Anzio
Location	Germany	Belgium	Italy	Germany	Belgium	Germany	Belgium	Germany	Tunisia	Korea	Germany	Belgium	Korea	Italy
Dates	Dec 44	Dec 44	Jan 44	Dec 44	Dec 44	Dec 44	Dec 44	Nov 44	Feb 43	Jul 50	Dec 44	Dec 44	Nov 50	Feb 44
Number in group	5	1	3	4	1	1	6	2	1	1	7	3	1	1
Date of meeting (1988)	5-6 Jan	13 Jan	18 Jan	21 Jan	3 Feb	6 Feb	9 Feb	15 Feb	17 Feb	18 Feb	23 Feb	24 Feb	29 Feb	3 Mar

Figure III-2: Key Factors in Breakpoints, As Judged by Veterans

Factors	Operations A 36 Div Rapido	B 45 Div Anzio	C 28 Div Schmidt	D 106 Div Schnee Eif	E 2 Div Krink-Roch	F 7 Amd Div St. Vith	G 24 Div Taejon	H 2 Div Kunu-Ri
Force Strength Factors								
High enemy-friendly force ratio		X						X
Low troop-frontage ratio				X				
High casualty rate			X	X				
Tactical Factors								
Enemy maneuver/flank/envelop		X	X	X		(X)	X	X
Force tactically vulnerable	X	X						
High-level intelligence failure				X				X
Environment Factors								
Terrain broken by crevasses				X				
Terrain hilly/heavily forested			X					
Poor roadnet			X					
Means and Materiel Factors								
Poor communications			X	(X)			X	
No antitank weapons				X	X			
Low ammunition			X	(X)	X			
No air support				X				
No/poor artillery support					X			
No air supply				X				
Poor/no mans				X				
Low/no food				X				
Human Factors								
Poor leadership				X				
Poor staff work				X				
Poor cohesion/esprit				X				
Inexperienced officers for inexperienced troops				X				
Poor training and fitness				X				
Poor training for specific operation	X							
Poor joint engineer/infantry training and coordination	X							
Little/no unit combat experience				(X)				
High personnel turnover/replacements	X			(X)				
Little time in position before operation				X				
Troop expectation of quiet sector				X				
Confusion among troops as to orders and objectives	X			X				
Exhaustion/time in combat in current operation						X		
Source Descriptors								
Number of groups	1	1	1	4	1	3	1	1
Total participants	3	1	2	17	1	10	1	1
Group identification number(s)	#3	#14	#8	#1,4,6,11	#5	#2,7,12	#10	#13
Level at which operation seen	pltn/bn	div	pltn/co	co/bn/regt	co	pltn/co/ cmbt cmd	btry	regt
Participant(s) at command level	no	yes	no	yes	yes	yes	no	yes

X = Factor cited by at least one group.
(X) = Factor cited by at least three groups in this multigroup operation.

Figure III-3. Summary of Factor Assessments by the Discussion Groups

FACTOR	RATINGS D	S	I	N	U	E	%
High enemy/friendly force ratio	2	2		3		1	80
Perception of high enemy/frendly force ratio	1	3	2	1		1	57
Heavy enemy artillery attacks		3	2	3			60
Heavy air attacks			1	7			0
Heavy personnel casualties	2	1	4	1			42
Severe equipment losses		2	2	1	3		50
Defective tactical plan		2		4	1	1	67
Low troops-to-frontage ratio	1	2	1	1	3		75
Enemy maneuver--flanking,envelopment,penetration	6			2			100
Enemy occupied key terrain		5		3			100
Surprise by enemy		1	3	4			25
Unfavorable movement rate		2	1	4		1	50
Unfavorable status of unit in adjacent sector		3		4	1		100
Force in tactically vulnerable position	2	5	1				88
Hasty unit commitment on new ground			2	6			0
Lack of artillery support	1	3	1	3			80
Lack of air support		1	4	3			20
Inadequate weapons	2	1	1	4			75
No reserves left		1	3	2		2	17
Troop exhaustion during combat		1	3	2	1		25
Supply shortage		1	2	5			33
Low ammunition	3	1		4			100
Lack of food; hunger			4	4			0
Communications failure	3	2		3			100
Troop confusion over orders,objectives	2		2	3	1		50
Poor reconnaissance		1	1	3	3		50
Poor staff work	1		1	3	3		50
Intelligence failure	2			4	2		100
Poor overall level of training		1		7			100
Lack of combat exerience	1			7			100
High personnel replacements	1	1	4	2			33
Poor training for specific operation	1		1	6			50
Inadequate combined arms training	1			7			100
Little time in line before engagement	1		3	4			25

Figure III-3. Summary of Factor Assessments by the Discussion Groups (continued)

FACTOR	RATINGS D	S	I	N	U	E	%
Pre-combat fatigue			4	4			0
Poor morale		1		6	1		100
Poor leadership	1			6	1		100
Poor, or no, maps	1	1	2	1	3		50
Low mission urgency		1		6			100
Poor roadnet		2	4	2			33
Weather change			1	7			0
Unfavorable terrain	1	3	1	3			80

The ratings are: D, Decisive
S, Significant
I, Present, but insignificant
N, Not Present
U, Presence unknown
E, Present, but effect unknown
Numbers in ratings columns indicate numbers of discussion groups; total discussion groups = 8.
% = Percent of cases in which the factor was present that it was decisive or significant = (D+S)/(D+S+I)

IV. Literature Survey

Purpose and Scope

The literature search was conducted as part of the search for hypotheses as to why and under what circumstances combat units change posture.

The DMSi proposal included a comprehensive survey of literature directly treating the subject of forced posture changes by combat units and, in addition, a review of related works in sociology, psychology, and organizational theory. During contract negotiations, this proposed broad literature search was drastically curtailed to "those works already known to DMSi analysts." This list of works was augmented by a search through the National Technical Information Services (NTIS) files.

Methodology

Each item located in the information collection task was reviewed for its potential contribution to the breakpoints project. This review was not intended to be a complete evaluation of each author's work; only those aspects of direct interest to the breakpoints project were covered.

Three classes of literature were found:

- Works addressing directly the topic of forced posture changes in combat;
- Works which, while not directly relevant, provided background material; and
- Works not useful to the project.

Works in the first group were studied carefully and all suggestions regarding posture changes were retrieved as potential Breakpoint Model factors.

Works in the second group were listed in an annotated bibliography, while those in the final group were not considered further.

Results

The literature on breakpoints appears to focus principally, but not exclusively, on casualties. A major theme is that while casualties are used frequently in models and war games to terminate engagements, in real combat, neither high casualties nor high casualty rates appear to be the sole cause of breakpoints, or posture changes. The historical evidence cited is two-fold:

- The large number of cases in which a unit suffered high casualties and did not break; and
- The wide range of casualties taken by units which did undergo a forced posture change.

A number of the papers used historical data to investigate this point, but provided no further suggestions about alternative factors. The following five studies that did suggest factors which, in addition to casualties and losses, might be related to posture changes, were reviewed.

- Adkins, Richard. Analysis of Unit breakpoints in Land Combat.
- Clark, Dorothy. Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion.
- Dupuy, Trevor. "Representing Battle Termination in Combat Simulations: The Modeling of 'Defeat Criteria.'"
- McQuie, Robert. "Battle Outcomes: Casualty Rates as a Measure of Defeat" (published article).
- McQuie, Robert. "Causes of Defeat in Battle (1941-1942)" (unpublished paper).

Discussions of these primary sources, together with full citations for them, will be found in Appendix C.

Figure IV-1 summarizes the factors mentioned in the literature as causing, or being associated with, unit breaks, or forced posture changes. Although several factors appear similar, there were differences in the wording that could be significant. For example, consider the following:

"Relative tactical posture of opposing forces" -- Adkins

"Tactical plan" -- Clark

"In an adjacent sector, the opponent is 10 km behind the defending (attacking) unit's FEBA." -- Dupuy

"Enemy occupied key terrain" -- McQuie

Although all these descriptions seemed to have been addressing the same basic notion of the opponents' relative tactical positions, they were all retained in Figure IV-1 as independent factors at this stage of the study.

The factors in Figure IV-1 have been grouped into the following categories:

1. Force strengths, casualties, and losses
2. Maneuver, tactical positions
3. Resources
4. Physical environment
5. Exogenous factors

Of the four authors, only McQuie placed the factors into categories. The categories presented here are adapted from those of his published paper.

Summary

This examination of the literature led to a few conclusions which may be briefly summarized.

- The subject of breakpoints, or posture changes, has not been widely studied and literature relevant to this project is not extensive.
- While making the point that casualties alone are not sufficient for a posture change, the authors generally agree that casualties, casualty rates, and relative force strengths are relevant and must be considered.
- Relative battlefield positions are critical.
- The Breakpoint Model must depend in some measure on unit size. The structure of the regimental model may be the same as the divisional model, but the parameter values will be different.

Figure IV - 1. Summary of Factors Mentioned in the Literature As Associated With Posture Changes by Combat Units

Factor	Mentioned By* CL	McQ	AD	DU
Force Strengths, Casualties, Losses				
Combat power ratio				X
Force ratio			X	X
Perception of relative force size				
Enemy opposition	X			
Heavy artillery and air attacks by enemy		X		
Casualties or equipment losses		X		
Number of casualties (inc. key personnel)			X	
Casualty rates			X	X
Maneuver, Tactical Positions				
Tactical plan	X			
Relative tactical posture of oppposing forces			X	
Opponent's position				X
Envelopment, encirclement, penetration		X		
Enemy occupied key terrain		X		
Attacker's advance rate				X
Adjacent friendly unit withdrew		X		
Status of adjacent units			X	
Resources				
Fire support and reinforcement	X		X	
No reserves left		X		
Proportion of reserves committed			X	
Supply shortage		X		
Availability of critical supplies			X	
Logistical support	X			
Amount of ammunition remaining			X	
Communications	X			
Reconnaissance	X			
Enemy achieved surprise		X		
Enemy reinforced		X		
Availability of means to evacuate and treat casualties			X	
Status of the forces				
Condition of troops at the beginning	X			
Training and experience level of friendly unit	X		X	
Fatigue and motivation			X	
Morale	X			
Leadership	X			

* CL = Clark; McQ = McQuie; AD = Adkins; DU = Dupuy

Figure IV - 1. Summary of Factors Mentioned in the Literature As Associated With Posture Changes by Combat Units (Contd.)

Factor	Mentioned By* CL	McQ	AD	DU
Mission				
The imperative of the assigned mission	X			
Mission and associated objectives			X	
Physical Environment				
Unusual environmental stress	X			
Change in the weather		X		
Weather and terrain conditions			X	
Exogenous Factors				
Truce or surrender		X		
Orders to withdraw		X		

* CL = Clark; McQ = McQuie; AD = Adkins; DU = Dupuy

V. Collection and Examination of Hypotheses

Purpose and Scope

This task was, in effect, a bridge between the three data-gathering tasks and the design of the breakpoint model. For this task, all hypotheses as to factors with which breakpoints were associated were assembled from all sources -- including the survey of literature, the opinions of combat veterans as revealed during the focused discussions, and the historical research carried out to add new engagements to the data base. The hypotheses were then organized as building blocks for the model.

Methodology

These were the steps leading to the identification of breakpoint model building blocks:

- collecting the factors and placing them in categories;
- removing duplicates, thus creating a comprehensive organized list of posture change factors; and
- evaluating each factor's potential contribution to the breakpoint model.

Collection of Factors. Figure V-1 displays all the factors thought to play a significant role in a forced posture change as they appeared in the various sources; there has been no attempt here to remove duplicates or to organize the factors beyond sorting them into categories.

It will be noted that there are two modes in which factors are expressed. Clark and Adkins were listing factors which the analyst must think about in creating a breakpoint model. These factors are, therefore, stated

in nonspecific neutral terms. For example, Clark lists the general area of logistical support as a factor to be considered.

In contrast to the abstract Clark-Adkins list, McQuie and the discussion groups were citing factors known, or believed, to have been responsible for posture changes in real engagements. Their factors are generally phrased in specific, negative terms. Thus while McQuie would agree that logistical support is important, it is supply shortage that is listed as a contributing factor. Again, Adkins mentions amount of ammunition remaining as a factor to be considered, while the discussion groups listed low ammunition as responsible for a posture change.

Organizing the Factors. The first step in organizing the factors in Figure V-1 is pairing the general factors of Clark and Adkins with the corresponding specific factors. This pairing is shown in Figure V-2 where the factors in parentheses are not in the original list, but were added to complete the table. Then, Figure V-3 drops the general factors, which are unsuitable for testing, and lists only the specific ones.

It will be noted that the title of this section mentions hypothesis examination while the discussion so far has centered on factors. For clarity in the tables and to reduce the verbiage in the text, the factors have not been reduced to formal statements of hypotheses. However, it should be understood that listing a factor is intended to be equivalent to a statement of the form:

> A forced change of posture by a combat unit is associated with [FACTOR].

For example, listing the factor low ammunition is intended to imply the hypothesis:

A forced change of posture by a combat unit is associated with low ammunition.

Evaluating the Factors. The factors shown in Figure V-3 were considered from the point of view of the combined information provided by the literature, the discussion group assessments, and the historical data. Wherever possible, statistical checks of factors were made against the Breakpoints Data Base. (See Appendix D.)

Results

On the basis of this combined information, coupled with the needs of the breakpoint model, each factor was judged on its potential contribution to that model. Discussion of the individual factors is given in Appendix D.

This evaluation produced the list of potential breakpoint model factors in Figure V-4. This list was the starting point for the breakpoint model design.

Figure V-1. Combined Summary of Factors Associated with Forced Posture Changes

FACTOR (1)*	SOURCE											
	Lit (2)*				Operations (3)								His (4)
	C	M	A	D	A	B	C	D	E	F	G	H	
FORCE STRENGTH AND ATTRITION													
Unit strength Combat power ratio	x			x									
Force ratio High enemy/friendly force ratio			x			x							
Perception of relative force size Enemy opposition	x		x										
Heavy enemy artillery and air attacks Casualties or equipment losses		x x											
No. casualties(inc.key personnel) Casualty rates			x x	x				x	x				
TACTICS AND MANEUVER													
Tactical plan Relative tactical posture	x			x									
Enemy maneuver Envelopment, encirclement, penetration		x			x	x	x	x		x	x	x	
Enemy achieved surprise Enemy occupied key terrain		x											x
Force in tactically vulnerable position Adjacent friendly unit withdrawal		x				x							
Status of adjacent units Withdrawal by adjacent friendly defensive unit				x									x
Failure of adjacent friendly attacking unit to advance Low troops-to-frontage ratio								x					x
Ineffective friendly maneuver Hasty unit commitment on new ground													x x
Attacker's advance rate				x									

* See notes at the end of the table.

Figure V-1. Combined Summary of Factors Associated with Forced Posture Changes (continued)

FACTOR	SOURCE: Lit C	Lit M	Lit A	Lit D	Operations A	Operations B	Operations C	Operations D	Operations E	Operations F	Operations G	Operations H	His Res
RESOURCES AND CURRENT STATUS OF FORCES													
Fire support and reinforcement	x		x										
Lack of effective fire support													x
Lack of artillery support	x		x						x				
Lack of air support								x					
No reserves left		x											x
Proportion of reserves committed			x										
Troop exhaustion										x			
Supply shortage		x											
Logistical support	x												
No air supply								x					
Amount of ammunition remaining			x										
Low ammunition							x	x	x				x
No antitank weapons								x	x				
Lack of food; hunger								x					
Communications	x							x			x		
Troop confusion over orders, objectives					x			x					
C3I failure													x
Reconnaissance	x												x
Intelligence failure								x				x	
Enemy achieved surprise		x											
Enemy reinforced		x											
Poor staff work								x					
PRE-ENGAGEMENT STATUS OF FORCES/ PRIOR PREPARATION													
Condition of troops at the beginning	x												
Length of combat exerience	x												
Lack of combat exerience								x					
Training and experience level	x		x										
Poor overall level of training	x							x					
Previous training for current situation													
Poor training for specific operation					x								
Inadequate combined arms training					x								
Time in line before engagement								x					
Poor physical fitness of troops								x					

Figure V-1. Combined Summary of Factors Associated with Forced Posture Changes (continued)

Factor	Source										
	Lit				Operations								His
	C	M	A	D	A	B	C	D	E	F	G	H	Res
Nature of latest combat experience	x												
Fatigue and motivation			x										
Morale	x												
Esprit de corps								x					
Poor unit cohesion and esprit de corps								x					
Prior expectation of a 'quiet' sector								x					
Number of new replacements	x												
High personnel turnover/replacements					x			x					
Leadership	x												
Poor leadership								x					
Poor staff work								x					
Troop confusion over orders/objectives					x			x					
Poor maps								x					
MISSION													
Imperative of the assigned mission	x												x
Mission and associated objectives			x										x
PHYSICAL ENVIRONMENT													
Unusual environmental stress	x												
Previous experience in this terrain	x												
Previous experience in this climate	x												
Change in the weather		x											
Rugged terrain (steep, narrow crevasses)								x					
Hilly and heavily forested terrain							x						
Poor roadnet							x						
EXOGENOUS FACTORS													
Truce or general surrender		x											
Orders to withdraw	x	x											

Notes for Figure V-1

1. The horizontal lines are added to assist the reader. There is no significance in the order of the factors other than the placement into general categories.

2. Literature

C = Clark (Clark listed 11 general factors, several of which were aggregates of two or more specific factors. Both kinds are listed in this table.)

M = McQuie

A = Adkins

D = Dupuy

3. Operations discussed by the groups

A,B,C, ... H = Operation identification codes. See Appendix B.

4. Historical Research

Factors coming out of the historical research for the new data collection.

Figure V-2: Separation of Posture Change Factors into General and Specific Categories

GENERAL FACTORS	SPECIFIC FACTORS
Combat power ratio, force ratio	1. High enemy/friendly force ratio
Perception of relative force	2. (Perception of high enemy/friendly force ratio)
Casualties and equipment losses	3. (Heavy personnel casualties) 4. (Severe equipment losses)
Tactical plan	5. (Defective tactical plan)
Relative tactical posture and opponent's position	6. Low troops/frontage ratio 7. Force in tactically vulnerable position 8. Surprise by enemy 9. Enemy occupied key terrain 10. Unfavorable status of unit in adjacent sector
Enemy maneuver; attacker's advance rate	11. Flanking, envelopment, penetration 12. Unfavorable advance rate by the attacker
Fire support and reinforcement	13. Lack of artillery/air support 14. Heavy enemy artillery and air attacks
Proportion of reserves left	15. Lack of reserves
Logistical support	16. Supply shortage 17. Inadequate weapons 18. Lack of food; hunger 19. Low ammunition
Communications	20. Communications failure
Reconnaissance, intelligence	21. Poor reconnaissance 22. Intelligence failure
Condition of troops at the beginning	23. Precombat fatigue 24. Little time in line before engagement 25. Hasty unit commitment on new ground
Training and experience	26. Poor overall training and experience 27. Poor training for specific operation 28. Inadequate combined arms training

Fatigue	29. Troop exhaustion during combat
Morale and motivation	30. Poor morale 31. High personnel turnover/replacement 32. Low mission urgency
Leadership	33. Poor leadership 34. Poor staff work 35. Troop confusion over orders, objectives 36. Poor, or no, maps
Unusual environmental stress	37. Poor roadnet 38. Weather change 39. Unfavorable terrain

Figure V-3: Factors Considered for the Breakpoint Model

1. High enemy/friendly force ratio
2. Perception of high enemy/friendly force ratio
3. Heavy personnel casualties
4. Severe equipment losses
5. Defective tactical plan
6. Low troops/frontage ratio
7. Force in tactically vulnerable position
8. Surprise by enemy
9. Enemy occupied key terrain
10. Unfavorable status of unit in adjacent sector
11. Flanking, envelopment, penetration
12. Unfavorable advance rate by the attacker
13. Lack of artillery/air support
14. Heavy enemy artillery and air attacks
15. Lack of reserves
16. Supply shortage
17. Inadequate weapons
18. Lack of food; hunger
19. Low ammunition
20. Communications failure
21. Poor reconnaissance
22. Intelligence failure
23. Precombat fatigue
24. Little time in line before engagement
25. Hasty unit commitment on new ground
26. Poor overall training and experience
27. Poor training for specific operation
28. Inadequate combined arms training
29. Troop exhaustion during combat
30. Poor morale
31. High personnel turnover/replacement
32. Low mission urgency
33. Poor leadership
34. Poor staff work
35. Troop confusion over orders, objectives
36. Poor, or no, maps
37. Poor roadnet
38. Weather change
39. Unfavorable terrain

Figure V-4: Factors Retained as Potential Elements of the Breakpoint Model

1. High enemy/friendly force ratio
2. Heavy personnel casualties
3. Severe equipment losses
4. Force in tactically vulnerable position
5. Enemy occupied key terrain
6. Unfavorable status of unit in adjacent sector
7. Flanking, envelopment, penetration
8. Unfavorable advance rate by the attacker
9. Lack of reserves
10. Supply shortage
11. Low ammunition
12. Communications failure
13. Poor morale

VI. Model Description

Purpose of this Section

This section presents the Breakpoint Model and the results of applying it to the engagements in the Breakpoints Data Base. The history and philosophy of its development will be discussed in the next section; this section is confined to a description of the model and its use. Computation of the parameter values is covered in Appendix E.

Factors for the Breakpoint Model

The model development started with the list of factors shown previously in Figure V-4. After elimination of factors for which there are no numerical values in the historical data base, three general areas of concern were left:

- The tactical situation
- Relative combat strength, and
- Combat losses

Figure VI-1 shows the factors selected from those available in the data base to be representative of these three general areas.

The Model Structure

The Breakpoint Model has been developed as a sub-model to be incorporated into ground combat simulations and war games for the purpose of terminating combat engagements. The model is a set of factor checks in the form of if-then statements. The general form is:

If factor 1 is less (greater) than or equal to X1, then

there is an attacker posture change.

If factor 1 is greater (less) than or equal to X2, then

there is a defender posture change.

X1 and X2 are parameters representing the model factors. Their numerical values are to be determined from the historical data.

Two versions of the Breakpoint Model were developed. They share a common view of forced posture changes and employ similar, although not identical, factors. Their differences lie primarily in the way in which they are related to simulated time.

The first version, termed the event version, is called once at the end of the engagement to determine which side changed posture. At the start of the engagement, the engagement duration must be determined so that the call to the Breakpoint Model may be scheduled by the parent ground combat model.

The second, the time-step version, is called periodically to determine if conditions for a posture change exist. The duration of the engagement is obtained from the simulated time at which these conditions are met. How often the time-step version is called depends on the basic time-step of the parent model. The versions described here are based on a one-day time-step, since one day is the basic time unit in the Breakpoints Data Base.

For each model version, two sets of parameters are derived -- one for the divisional-level engagements and one for the regimental-level engagements.

The Event Version

Duration Times. Figure VI-2 shows an operational flow diagram of the event version of the Breakpoint Model showing the factors checked at the end of the engagement to identify the side changing posture. Before a call to

this version of the model can be scheduled, the duration of the engagement must be determined. There are several options.

The first option makes use of the historical distribution of engagement durations, shown in Figure VI-3. The simplest procedure is to set all durations to the median values -- three days for the divisional-level engagements and one day for the regimental-level engagements.

An alternative to using a constant duration for all engagements is to choose a random duration from the historical distribution.

A third option is to estimate the duration time on the basis of some factor representing information available before the engagement starts. One such factor is the initial personnel ratio. Figure VI-4 shows scatter plots of this ratio versus the engagement durations. There is clearly no strong relationship in either the divisional-level or the regimental-level cases.

The step-function shown for divisional engagements in the scatter plot corresponds to the following table:

Initial Personnel Ratio	Engagement Duration (Days)
< 1.0	1
1.0-1.9	2
2.0-2.9	3
3.0-4.9	4
5.0-6.9	5
≥ 7.0	6

This is an example of a step-function that might be used, but it is obvious from the figure that there are others that would be equally appropriate. This particular step-function leads to the distribution of d visional engagement durations given in Figure VI-5, which appears similar to the historical one. Looking at the engagements individually, it is found that there are 16 durations estimated correctly plus 24 which are correct to within one day.

In the regimental cases, the relationship between personnel ratio and duration is too weak to permit such an estimation. For the regimental model, then, a constant duration of one day will be used.

Model Parameters. From the flow chart previously shown in Figure VI-2, it was seen that the following seven parameters are required:

A1 - If the attacker has advanced no farther than this distance (relative to the width of the front), then the attack is essentially halted and the attacker is forced to defend.

A2 - If the attacker has penetrated this far, then the attack is successful and the defender must withdraw.

If the distance advanced (relative to the front width), is between A1 and A2, then this factor is not determining, and the model proceeds to check the personnel ratio.

B1 - If the personnel ratio (attacker/defender) is below this figure, then the attacker has been halted by superior defensive strength.

B2 - If the personnel ratio (attacker/defender) is above this figure, then the defender has been overwhelmed by superior attacker strength.

If the personnel ratio is between B1 and B2, then this factor is not determining, and the model proceeds to check the attacker casualties.

C - The attacker must change to a defensive posture if his total casualties (expressed as a percent of his initial force) exceed this amount.

D - The defender must withdraw if his total casualties (expressed as a percent of his initial force) exceed this amount.

E - The attacker must change to a defensive posture if the value of the casualty ratio (attacker/defender) is equal to, or greater than, this parameter. Otherwise, there is a defender posture change.

It can be seen that this last factor, casualty ratio, will assure that no engagement will emerge from the Breakpoint Model without identification of the side changing posture.

The procedure for obtaining parameter values from the data base is described in Appendix E. Their values are summarized in Figure VI-6.

The Time-Step Version

Figure VI-7 shows a flow diagram for the time-step version of the Breakpoint Model. This version uses the following parameters:

A1 - If the attacker has advanced no farther than this distance (relative to the width of the front), then the attack is essentially halted and the attacker is forced to defend. While in the event version A1 is a constant, the time-step parameter A1 is an increasing function of simulated time. Since it represents a cumulative advance that must be attained if the attack is to continue, a value suitable for the first day of the engagment would not be appropriate for subsequent days.

There are not sufficient data to determine the functional form. The simple linear relationship shown below is assumed:

$$A1 = (M - 1) \times A0$$

where: A1 is computed by the time-step version of the model to check the factor distance advanced/front width for an attacker posture change;

M is the day of the engagement;

A0 is the parameter, whose value is determined from the historical data, used by the model to compute A1.

Figure VI-8 illustrates the use of A1 in a hypothetical case in which A0 = 0.10 and the attacker is advancing at an average rate of 0.08 km. per day across a 1-km. front. The column labeled A1 shows the value of the model parameter on each day of the engagement. The next column shows the distance advanced by the attacker through each day. As long as the distance advanced is greater than A1, there is no posture change (at least by this factor). At the end of the fifth day, the values are equal and there is an attacker posture change.

A2 - If the attacker has penetrated this far, then the attack is successful and the defender must withdraw.

If the distance advanced (relative to the front width) is between A1 and A2, then this factor has not determined the posture change, and the model must proceed to the next factor.

B1 - If the change in the personnel ratio since the start of the engagement is above this figure, then the defender has been overwhelmed by the superior strength of the attacker.

Like A1, this parameter is taken to be a function of simulated time. The same simple linear form assumed for A1 is used:

$$B1 = (M - 1) \times B0$$

where: B1 is computed by the time-step version of the model to check the factor change in personnel ratio for an attacker posture change;

M is the day of the engagement;

B0 is the parameter, whose value is determined from the historical data, used by the model to compute A1;

B2 - If the change in personnel ratio since the start of the engagement is above, or equal to, this value, then the defender has been overwhelmed by the superior strength of the attacker.

If the change in the personnel ratio is between B1 and B2, then the posture change has not been determined and the model must proceed to the next factor.

C - If the attacker's cumulative casualties equal, or exceed, this value, then the attacker must change to a defensive posture.

D - If the defender's cumulative casualties equal, or exceed, this value, then the defender must withdraw.

If the posture change has not been determined after this last factor check, then the engagement continues and the factor checks are repeated during the next time period.

Figure VI-9 summarizes the parameter values. Details of their derivation from the historical data are given in Appendix E.

Results

Both versions of the Breakpoint Model have been tried on the engagements in the Breakpoints Data Base. In Figures VI-10 through VI-13 the posture

changes assessed by the models are compared with the historical posture changes. The percent of correct identifications are summarized below:

Percent of the Posture Changes Correctly Identified

Level	Event Version	Time-Step Version
Regimental	86	95
Divisional	77	74

The overall success rate is approximately 80%.

Model Errors

Successful prediction rates of 74-95% suggest that the Breakpoint Model is a more-than-adequate representation of the posture changes in this set of engagements. Although cases in which the posture changes are correctly identified generate confidence in the model, the more interesting cases are those in which the model results do not match the historical outcomes.

A detailed discussion of the misidentified posture changes is given in Appendix F. In brief, the incorrectly identified cases include

- engagements that were incorrectly decided by the model on the basis of personnel strength, and in which the personnel strength of the historically successful side was significantly enhanced by air support, artillery, or, most frequently, armor -- factors the model does not include;
- engagements in which a determined defender made use of favorable terrain features and accepted unusually high casualties to force an attacker FPC; in most of these cases the defenders were Japanese forces, whose national military culture put an especially high value on choosing death over surrender;

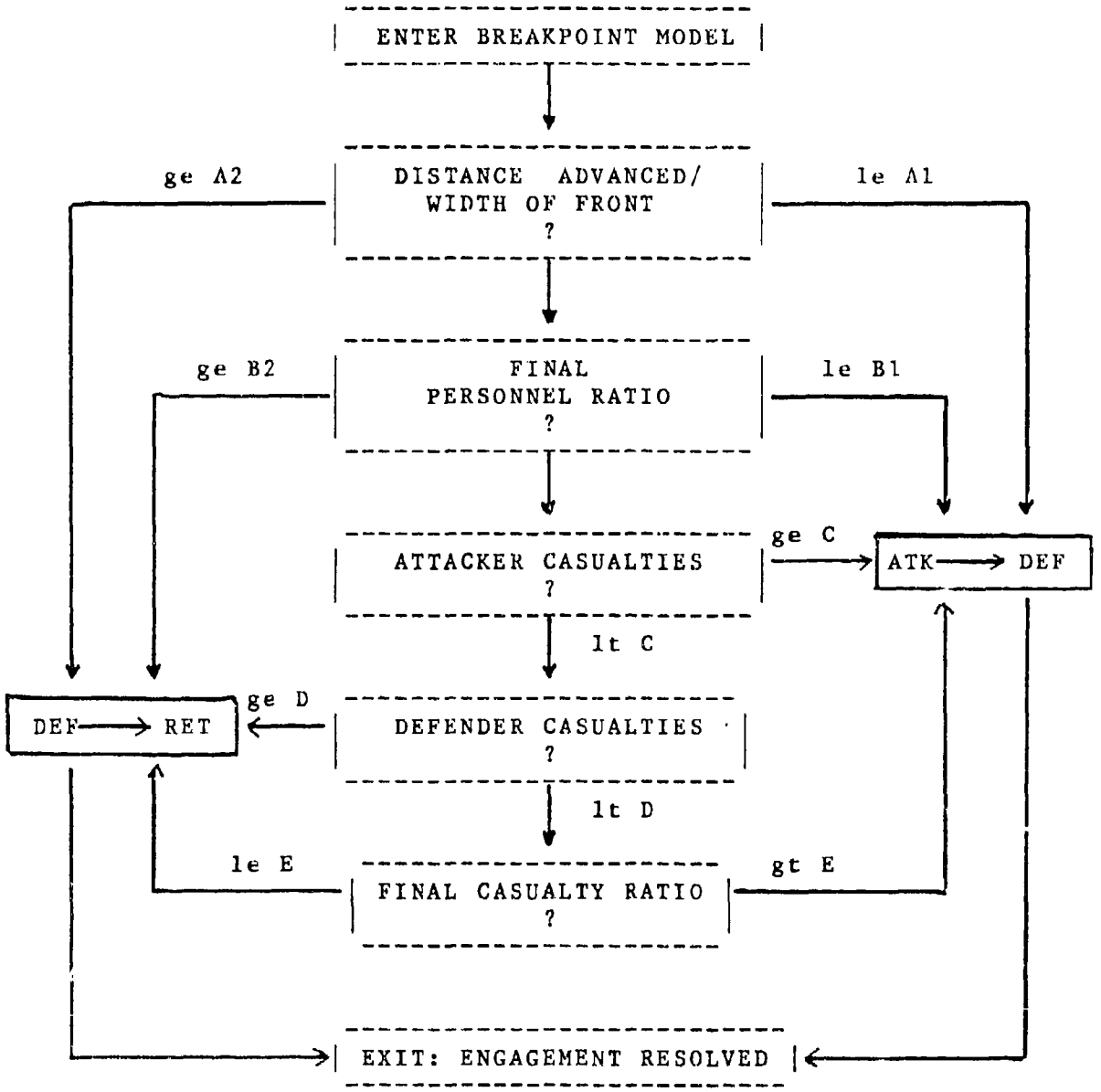
- engagements that were extremely close, hard-fought battles that could have gone either way.

Additional factors influential in the engagement outcomes are discussed in Appendix F.

Figure VI-1. The Breakpoint Model Factors

General Category	Specific Factor From the Database
Tactical Situation	Total Distance Advanced/Width of Front
Relative Combat Strength	Personnel Ratio (Attacker/Defender)
Combat Losses	Attacker Casualties
	Defender Casualties
	Casualty Ratio (Attacker/Defender)

Figure VI-2. Operational Flow Diagram of the Event Version of the Breakpoint Model



ge = Greater than, or equal to
gt = Greater than
le = Less than, or equal to
lt = Less than

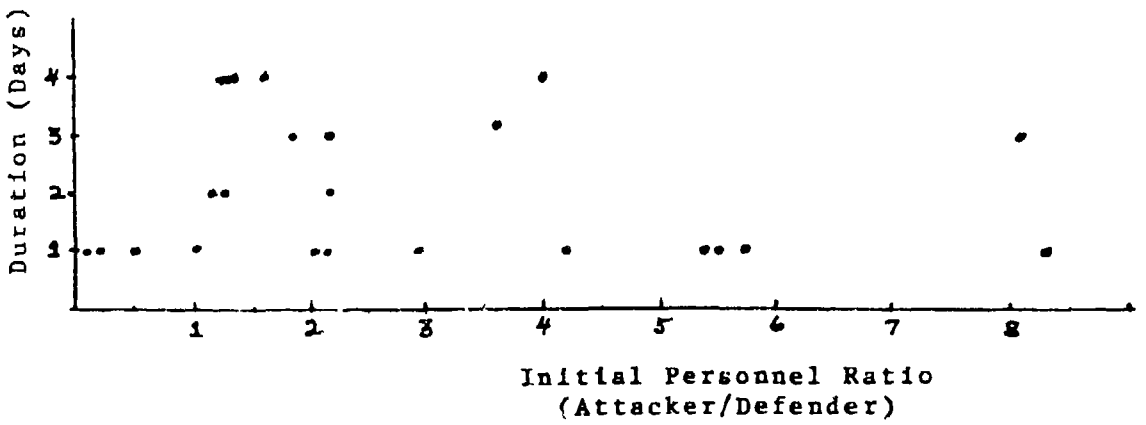
See Figure VI-6 for regimental and divisional parameter values.

Figure VI-3. Distribution of Durations for the Historical Engagements

Engagement Duration (Days)	Number of Engagements	
	Regimental	Divisional
1	11	8
2	4	18
3	2	19
4	3	9
5	1	3
6	0	2
7	0	0
8	0	1
9	0	0
10	0	0
11	0	1
12	0	1
Totals	21	62

Figure VI-4. Engagement Duration vs Initial Personnel Ratio

Regimental Engagements



Divisional Engagements

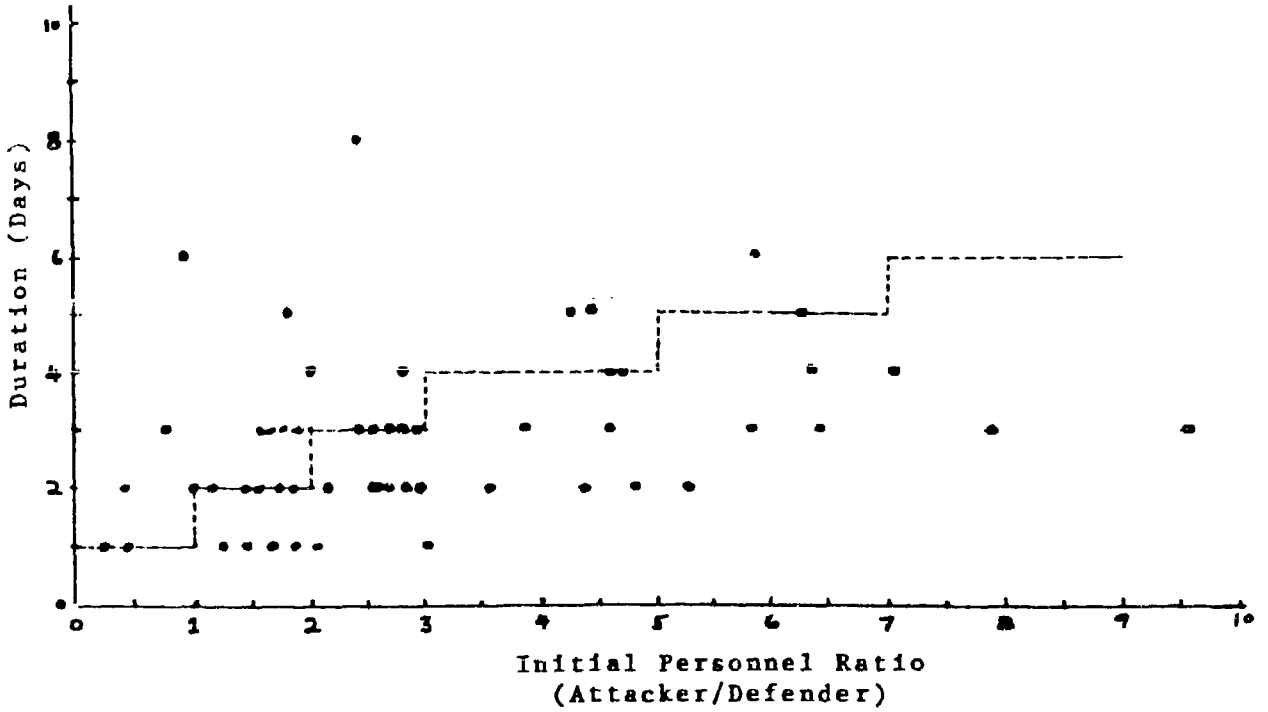


Figure VI-5. Distribution of Estimated Durations for the Divisional-Level Engagements

Engagement Duration (Days)	Number of Engagements	
	Estimated*	Historical
1	3	8
2	12	18
3	21	19
4	14	9
5	7	3
6	5	2
7	0	0
8	0	1
9	0	0
10	0	0
11	0	1
12	0	1
Totals	62	62

---

* Using the step function shown in Figure VI-4.

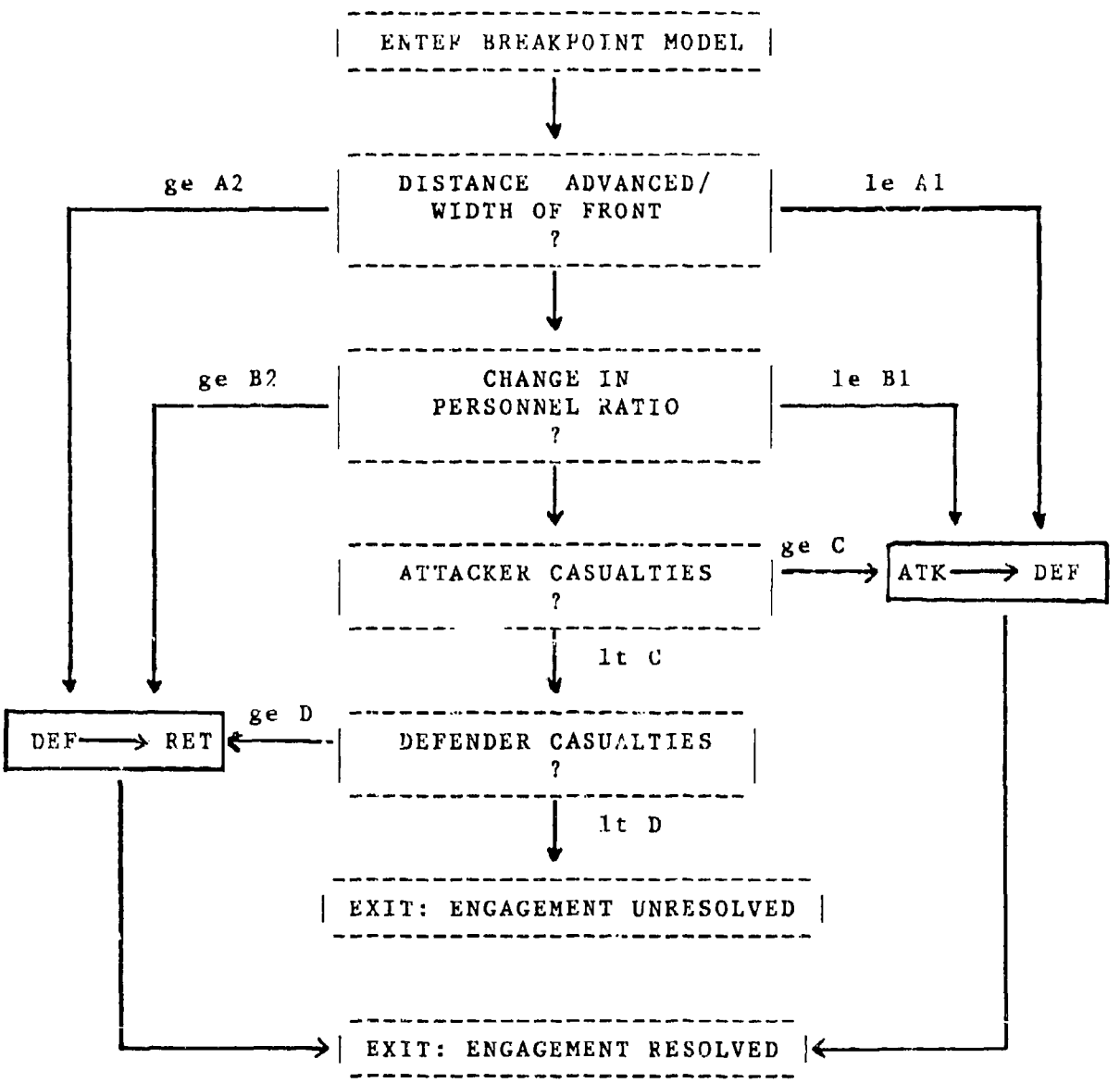
Figure VI-6. Parameter Values for the Event Version of the Breakpoint Model

Parameters	Engagement Level	
	Divisional+	Regimental*
A1	0.115	0.175
A2	1.59	2.00
B1	1.53	1.41
B2	7.19	5.56
C	16.6	5.0
D	39.8	17.1
E	0.405	0.31

* See Figures E-3 through E-7 in Appendix E

\+ See Figures E-8 through E-12 in Appendix E

Figure VI-7. Operational Flow Diagram of the Time-Step Version of the Breakpoint Model



ge = Greater than, or equal to le = Less than, or equal to
lt = Less than

See Figure VI-9 for regimental and divisional parameter values.

Figure VI-8. Illustration of the Use of Al in an Hypothetical Engagement

	Simulated Time (Days)	Value of Al	Cumulative Distance Advanced/ Width of Front	
	1	0.00	0.08	
	2	0.10	0.16	
	3	0.20	0.24	
	4	0.30	0.32	
-->	5	0.40	0.40	Atk Pos Chng

Assumptions

- Al = (Day - 1) x 0.10
- Attacker's movement rate = 0.08 (km/day)
- Width of front = 1 (km)

Figure VI-9. Parameter Values for the Time-Step Version of the Breakpoint Model

Parameters*	Engagement Level	
	Divisional	Regimental
A0	0.089	0.647
A2	1.04	2.02
B0	0.052	0.013
B2	7.05	0.33
C	4.83	4.27
D	36.6	13.6

*
See pages E-7 through E-8 in Appendix E

Figure VI-10. Breakpoint Model (Event Version) Output: Regimental Posture Changes vs History

Eng Id	Historical Dur (Days)	Historical Pos Chg	Model Results Dur (Days)	Model Results Pos Chg
1	1	A	1	A
2	1	A	1	A
3	1	A	1	A
4	1	A	1	A
5	1	A	1	A
6	1	A	1	A
7	4	A	1	A
8	2	A	1	A
9	3	A	1	A
10	3	A	1	A
11	1	A	1	A
12	2	A	1	A
13	1	A	1	A
14	2	A	1	A
15	4	D	1	(A)
16	1	D	1	D
17	2	D	1	(A)
18	4	D	1	D
19	1	D	1	D
20	1	D	1	D
21	5	D	1	(A)

A = Posture change by the attacker.
D = Posture change by the defender
(O) = Posture change identified incorrectly.

Figure VI-11. Breakpoint Model (Time-Step Version) Output:
Regimental Posture Changes vs History

Eng Id	Historical Dur (Days)	Historical Pos Chg	Model Results Dur (Days)	Model Results Pos Chg
1	1	A	1	A
2	1	A	1	A
3	1	A	1	A
4	1	A	1	A
5	1	A	1	A
6	1	A	1	A
8	2	A	1	A
9	3	A	1	A
11	1	A	1	A
12	2	A	1	A
13	1	A	1	A
14	2	A	1	A
15	4	D	1	D
16	1	D	1	D
19	1	D	1	D
20	1	D	1	D
21	5	D	1	(A)
7	4	A	2	A
10	3	A	2	A
18	4	D	2	D
17	2	D	3	D

A = Posture change by the attacker.
D = Posture change by the defender.
(O) = Posture change identified incorrectly.

Figure vI-12. Breakpoint Model (Event Version) Output:
Divisional Posture Changes vs History

Eng Id	Historical Day	Historical PC	Model Day	Model PC
1	3	A	1	A
2	2	A	2	A
3	1	A	1	A
4	6	A	1	A
5	2	A	4	A
6	3	A	3	A
7	4	A	6	(A)
8	5	A	4	(D)
9	2	A	4	(D)
10	2	A	3	A
11	2	A	5	(D)
12	1	A	4	A
13	3	A	4	(D)
14	1	A	2	(D)
15	2	D	2	(A)
16	4	D	4	D
17	4	A	3	A
18	3	A	2	A
19	4	A	3	A
20	2	A	3	A
21	3	A	2	A
22	1	A	2	A
23	3	D	3	D
24	2	A	2	A
25	12	A	2	A
26	1	D	3	D
27	1	A	2	(D)
28	4	A	4	A
29	4	A	3	A
30	1	D	3	D
31	3	D	4	D
32	3	D	5	D
33	3	D	6	D
34	3	D	5	D
35	2	D	4	D
36	2	D	3	D
37	5	D	5	D
38	4	D	5	D
39	4	D	4	D
40	6	D	5	D
41	2	D	3	D
42	2	D	3	(A)
43	3	D	3	D
44	2	D	3	(A)
45	5	D	4	D
46	2	D	2	D
47	2	D	3	(A)
48	3	D	3	D
49	2	D	3	(A)
50	3	D	6	D
51	8	D	3	(A)
52	3	D	6	D
53	3	D	2	D
54	3	D	2	(A)
55	3	D	3	D
56	3	D	3	D
57	11	D	4	D
58	1	D	5	D
59	2	D	4	D
60	4	D	4	D
61	3	D	6	D
62	2	D	3	D

A = Posture change by the attacker.
D = Posture change by the defender.
○ = Posture change identified incorrectly.

Figure VI-13. Breakpoint Model (Time-Step Version) Output: Divisional Posture Changes vs History

Eng Id	Historical Day	Historical PC	Model Day	Model PC
1	3	A	1	A
2	2	A	1	A
3	1	A	1	A
4	6	A	1	A
5	2	A	1	A
6	3	A	1	A
10	2	A	1	A
19	4	A	1	A
20	2	A	1	A
22	1	A	1	A
24	2	A	1	A
25	12	A	1	A
27	1	A	1	(D)
29	4	A	1	A
47	2	D	1	(A)
52	3	D	1	D
56	3	D	1	D
60	4	D	1	D
7	4	A	2	A
8	5	A	2	A
14	1	A	2	A
15	2	D	2	(A)
21	3	A	2	A
23	3	D	2	(A)
28	4	A	2	A
31	3	D	2	(A)
32	3	D	2	D
33	3	D	2	D
34	3	D	2	D
38	4	D	2	D
39	4	D	2	D
42	2	D	2	(A)
50	3	D	2	D
53	3	D	2	D
54	3	D	2	D
58	1	D	2	D
59	2	D	2	D
61	3	D	2	D
9	2	A	3	(D)
12	1	A	3	(D)
18	3	A	3	A
26	1	D	3	D
30	1	D	3	(A)
36	2	D	3	D
37	5	D	3	D
40	6	D	3	D
44	2	D	3	D
46	2	D	3	D
49	2	D	3	D
51	8	D	3	(A)
55	3	D	3	D
62	2	D	3	D
13	3	A	4	(D)
57	11	D	4	(A)
17	4	A	5	A
11	2	A	6	(D)
35	2	D	6	D
43	3	D	6	(A)
45	5	D	6	D
48	3	D	6	(A)
16	4	D	7	D

A = Posture change by the attacker.
D = Posture change by the defender.
(X) = Posture change identified incorrectly

VII. History and Philosophy of the Model Development

In this project we set out to accomplish a task which had not been done before. We ourselves thus had no role model and no textbook solutions. The purpose of this section is to present a broad discussion of our developmental philosophy, and to lay out, as well as we can, some of the reasons why the Breakpoint Model is what it is.

We started with the concept that there is, fundamentally, only one source for knowledge -- namely, human experience. Obviously, for our task, we could not produce an experimental war to gain direct personal experience; we would have to draw on the experience of others. So we began trying to find out what had already been discovered, or concluded, about forced posture changes. And we used a systematically organized body of data on past combat engagements to serve as a resource of military experience in which we could check out our informed guesses.

There were two initial sources for information: studies by military analysts and the comments and observations of veterans who volunteered to talk with us about their combat experiences. A third source which proved valuable was the detailed historical research undertaken to add new engagements to the historical data base.

As in all research, there was neither sufficient information of exactly the right kind, nor sufficient time to ponder thoroughly the information we did acquire. But having collected what information we could, we tried to put it all together to see if a coherent picture of the posture change phenomenon emerged. The principal obstacle to a combining of information from different sources was the multitude of viewpoints represented.

But after much drawing up of factor lists and sorting of factors into categories, some common ideas did become apparent. The first, and strongest, idea was the overwhelming importance of tactics. To a combat veteran or military historian, this is not really a new or radical idea. To an analyst brought up on Lanchester theory or other erudite mathematical formulations, it may be. We knew, then, almost from the beginning, that some element representing tactics or maneuver or spatial configurations on the battlefield must be a part of the model.

A second critical element to come out of our information-gathering was the importance of some representation of relative combat power. Power is an ill-defined term; like "beauty," it lies in the eye of the beholder. We can list the commonly accepted elements of power: men, weapons, leadership, training, experience, morale, motivation, and even the elusive factor, luck, and still feel that we have not yet captured its essence. But whatever shape it would ultimately assume, we knew we needed a representation of that quality which, if you have enough of it, you can win battles.

A third conviction began to form. In the past a major role in determining the outcome of warfare had been assigned to casualties. It was logical to assume that the fear of being killed would influence the individual soldier as would the prospect of losing his forces lead a commander to a decision to halt an attack or withdraw from a defensive position. In addition, casualties are (relatively) easy to count and, given sophisticated mathematical techniques, to compute in a combat simulation or war game. The very success -- or wide acceptance -- of casualties as a "battlefield scorecard" led critics to examine the historical data to find evidence for, or against, this practice.

There was much evidence against it. Two observations about historical warfare were cited:

(1) The casualty levels suffered by units changing posture during combat vary greatly. Some units (admittedly few) are essentially wiped out before changing posture while others give up after very low losses, and

(2) There are some cases in which units suffered very high losses without changing posture.

Thus, casualties appear to be neither a necessary nor a sufficient condition for a posture change. We therefore started the project with the notion that casualties would not play a prominent role in the Breakpoint Model.

One of the surprises of the information collection effort was the discovery that, examined closely, military analysts were not saying that casualties did not matter, only that the level at which they mattered varied widely according to circumstances of the battle.

A little reflection will suggest reasons why this might be so. Suppose, for the sake of argument, that two commanders had decided that they would break off an attack when their cumulative casualties reach 30%. Consider the difficulties of actually determining, on the ground, exactly when casualties reached that figure. One commander who happened to be in the most active combat zone might conclude that his unit was suffering high losses and change to a defensive posture while his actual losses were still low. The other commander might lose communication with his subordinates and continue the attack well past his intended breakpoint.

Now to this difficulty of determining when casualties actually reach a pre-determined point, add all those circumstances that would change the

values of that pre-determined point from engagement to engagement, and the reasons for the wide variation in the casualties suffered by unit changing posture becomes apparent. We concluded that casualties, and combat losses in general, do play a major role in determining the outcome of combat; ascertaining the level at which they influence a commander is the problem.

Thus, we entered the model development phase of the project with the conviction that three areas would be critical to the model:

- Tactics and enemy maneuver,
- Relative combat strength, and
- Combat losses.

The model structure now began to take shape. We had determined that we could not handle a causal model; we do not now know, we may never know, why one combat force gives up exactly when it does. But, however intellectually satisfying it would be to pin down the real reasons for success, or failure, in combat, it is not really required to satisfy the goals of this project. What we needed to do was to establish the conditions under which a unit changes posture -- that is, we needed a description of a unit changing posture, not a list of the reasons why.

This suggested a model in the form of conditions to be checked. If condition A, then a posture change. If not A, then check the next condition. If B, then a posture change. If not B, then check C, and so forth.

Now our model had a primitive structure: it would be a series of if-then statements.

The next step was to find specific conditions to represent each of the three general areas we had determined to be critical. In choosing specific

factors, we were guided by the idea that what is of primary importance is testing the major concepts. The important questions at this point were these: Could the model we were attempting to develop actually be developed? Could we get numerical values for it? Would its predictions come anywhere close to the historical results? We felt that the important thing was to get the big picture approximately right; the details could be added later.

The first area was tactics. Now we began to perceive that we would be limited by the available data. We might describe elaborate and compelling tactical factors, but unless we had numerical values from which we could compute model parameters -- the levels against which the factors in an individual engagement might be checked -- the tactical factors would be useless.

After a careful consideration of what we had available in the data base, we chose distance advanced by the attacker as the most realistic representation of how the attack is progressing.

We perceived a difficulty with this measure. The model should handle a reasonably wide variety of engagements, and this measure had no scale tying it to specific circumstances. Surely the meaning, or effect, of an advance depended on how big the attack was -- that is, how much space it covered. Knowing that the attacker has advanced one kilometer is certainly some information, but not enough to be decisive until you know the scale of the engagement.

So we looked through the data base to find a measure of distance specific to each engagement. We found only one -- the width of front. Thus, we now had a "unit of distance" (the front width) in which to measure the attacker's advance. This produced our first factor:

Distance Advanced/Width of Front

The next critical area was that of relative combat power. Our choice was driven by two considerations. The first was a desire for simplicity. As we noted earlier, power can be a very complex notion. Rather than create an elaborate measure that attempted to cover this many-faceted concept, we decided to be content at this stage with one that would capture the first-order effect -- that is, that would get it about right.

The second consideration was quite practical. As in the case of the factor chosen to represent tactical considerations, we had to be able to get numerical values. So, we based our second factor on the number of combatants. We know this isn't exactly right, but unless a host of modifiers--training, experience, weapons, leadership, and many others -- are taken into account (and there goes simplicity), the head count is our best rough-cut estimate of combat power. Again, to get a factor scaled to the particular engagement, we took a ratio of the number of men for both sides. To minimize confusion, we established the convention that all ratios (personnel, casualty) will be expressed as attacker divided by defender, regardless of the nationalities involved.

This provided our second factor:

Personnel Ratio (Attacker/Defender)

For one of the model versions, we substituted change in personnel ratio for the personnel ratio itself. Using the change (a crude first derivative) made the trend easier to identify -- low or negative changes indicate trouble for the attacker; larger changes are evidence that the defender is in difficulties.

Finally, as indicative of the losses suffered by each side, we chose attacker casualties to check for attacker posture changes and defender casualties to check for defender posture changes. Again, these factors need to be scaled; absolute numbers are not very meaningful. So, we expressed casualties as a percent of the initial personnel strength.

These became our next factors:

Attacker Casualties (% initial personnel)

Defender Casualties (% initial personnel)

One of the model versions required a "safety net" to catch any engagements not resolved by this set of checks. We added a factor that represents the relative combat losses of the two sides to provide the last factor:

Casualty Ratio (Attacker/Defender)

With the factors selected, we could draw the model flow diagrams shown earlier (Figures VI-2 and VI-7). The model parameters are shown in the diagrams as the abstract quantities A1, A2, B1, and so forth. The next task was to obtain numerical values for them.

After careful consideration, we concluded there was nothing structurally different about posture changes by a division and those by its next subordinate unit -- in the historical engagements, the regiment. Therefore, the same model could be used for both, although the parameter values would be different.

We separated the Breakpoints Data Base into divisional and regimental-level engagements for the parameter computations. The methods used to extract parameter values from the historical data were based on a very simple idea. When the list of engagements is ordered by numerical values of one of the model factors, say personnel ratio, it is found that the cases with

attacker posture changes are clustered at one end and the cases with defender posture changes at the other. We chose as parameter values those factor values that would minimize the number of errors if the posture change was identified on the basis of that factor. To be very conservative, values close to either extreme (either low or high) were selected. This left cases in the middle that were not assessed by this one factor, but were left for further checking.

The procedure for computing parameter values is described in great detail in Appendix E. It is pointed out that this procedure does not necessarily give the lowest error rate for this particular set of historical engagements. Better results might be obtained by a few ad hoc changes here and there. However, these changes would have no better justification than that they worked. We resisted this course of action for two reasons:

- At this point, we are more interested in procedures and model structures than in improving our scorecard of correct predictions. Once the model and parameter estimation procedures have been used and understood, then there will be time for adding details. Then, it should be the model that is modified rather than the parameter estimation.

- Just how these parameter "tweakings" might be done is almost entirely intuitive at this point. If these manipulations were used, it would be impossible to record them as a part of a procedure that all other investigators could follow, and developing such a procedure is more important than the results for these particular engagements.

VIII. Conclusions

The project goals have been accomplished. The study team has:

- To the extent permitted by the project resources, surveyed what others have written on the subject of forced posture changes,
- Gathered groups of veterans to discuss their experiences in an orderly, systematic fashion, and analyzed their contributions,
- Collected data for a new group of engagements in which forced posture changes occurred,
- Combined the new engagements with previously researched engagements that met the study requirements to form a Breakpoints Data Base of 83 historical cases, comprising 62 divisional and 21 regimental engagements, all of which include forced posture changes,
- Created a model suitable for use in a combat simulation or war game to terminate combat engagements,
- And, finally, produced voluminous documentation for each step of this process.

The Next Steps

The Breakpoint Model developed in this project could be described as a first-order model. We think it captures the essence of the posture change phenomenon. It is still lacking in the finer details, but the details are useless if the basic structure is flawed, and getting the basics right has been the purpose of this project.

It is the judgment of the study team that enough work has now been done on the model; what is needed is additional testing and experience in applying

it. This will provide information on the model's strengths and weaknesses, so that we will know what about it needs to be changed and what additional data will be needed to change it.

Since all of the parameter estimation and model testing have been done on World War II engagements, an obvious next step is to apply the model to later combat data -- Korean War data, where available, and, especially, the extensive data on the Middle East conflicts.

If the model, with its current parameter values, produces acceptable "first-order" results for these engagements, this will be evidence that the nature of modern combat retains much in common with the combat of World War II, and that combat in Europe is much like combat in the Middle East.

If, as seems more likely, the model requires new estimations of the parameter values, then we can say that, while details change, the same basic factors are critical.

If the model, even with new parameters, fails to reproduce the essence of the historical engagements, then we must conclude that the model structure is flawed and must be modified. However, should this prove to be the case, the new model development need not start from scratch, but may go forward from the point reached here.

Appendix A

THE NEWLY RESEARCHED ENGAGEMENTS

Introduction

This appendix presents information on the 24 engagements that were researched specifically for this study, and that form part of the Breakpoints Data Base. The appendix includes three bodies of material:

- narratives of the engagements;
- a list of sources used in researching the engagements;
- printouts of the data entered in the Breakpoints Data Base for the engagements.

Sidi Bou Zid I, 14 February 1943 (R)*

CCA, 1st Armored Division, with the attached 168th RCT (-), was given the mission of defending the Eastern Dorsal mountain passes in Tunisia. The positions chosen were widely separated and not mutually supporting. Before first light on 14 February elements of the 10th and 21st Panzer Divisions attacked to envelop these positions and destroy CCA. Moving swiftly, the German forces overran the outposts of CCA, and isolated the 168th RCT. The main body of CCA counterattacked against superior German forces, was outflanked, and was forced to withdraw with heavy losses.

Significance. RCT 168 was isolated. CCA was rendered combat ineffective and was unable to support the counterattack to relieve RCT 168 on the following day.

---

* R following an engagement name indicates a regimental-level engagement; D indicates a divisional-level engagement.

Sidi Bou Zid II, 15 February 1943 (R)

CCC, 1st Armored Division, was to attack from the northwest to clear an escape route for RCT 168(-), trapped by the German attack of the previous day. The attack was to be made by the armored elements of CCC, supported by artillery and with tank destroyers on its flanks. Initial resistance was minimal, consisting mainly of effective harassing attacks by German dive bombers on the supporting US artillery. By late afternoon advanced US armored units had penetrated to Sidi Bou Zid. There the US forces were trapped in a well-planned German antiarmor ambush. German tanks then counterattacked, threatening both flanks of CCC, which subsequently withdrew to the west with heavy loss.

Significance. Half the armored strength of the 1st Armored Division had been rendered combat ineffective in two days of combat. The isolated RCT 168(-) attempted to break out on the night of 16-17 February, but most of its men were captured.

Kasserine Pass, 19-20 February 1943 (R)

Allied forces were attempting to develop new positions to protect the logistical installations exposed by the collapse of the southern flank of II Corps in the battles of Sidi Bou Zid. Task Force Stark, 1st US Infantry Division, was to defend positions on the high ground flanking Kasserine Pass with tanks and tank destroyers, supported by artillery. On the evening of 18 February a German attempt to seize the pass by coup de main failed. A more methodical assault on 19 February seized commanding terrain on the left flank of the US forces. By early morning of 20 February commanding terrain on both flanks was in German hands, and the US forces withdrew in disorder.

Significance. Although forced to withdraw, US forces delayed the Germans long enough to allow II Corps reserves to occupy strong positions to the northwest. The depleted German forces were unable to penetrate these positions and withdrew on 22 February.

Rapido River North I, 20–21 January 1944 (R)

The 36th Infantry Division's 141st Infantry Regiment (+) was to make an assault crossing of the Rapido River north of St. Angelo. On the night of 20 January boat parties met effective artillery, mortar, and small arms fire, and portions only of the 1st Battalion were able to cross. These elements were isolated by the loss of their footbridge and were wiped out by a German counterattack on the morning of 21 January.

Rapido River North II, 21–22 January 1944 (R)

A second attempted assault crossing of the Rapido River was made on the night of 21 January and was partially successful, with the 2d and 3d battalions, 141st Infantry Regiment, crossing and advancing about 1,000 meters into the German position. However, effective German fire again destroyed the unit's bridges and isolated the battalions that had crossed. The two battalions defended themselves against increasingly strong counterattacks but were overwhelmed on 22 January.

Significance. The US attack failed completely with heavy losses. No German reserves were drawn to the area, so the secondary intention of diverting forces from the vicinity of the intended Anzio landings failed as well.

Rapido River South I, 20–21 January 1944 (R)

As part of the US 36th Infantry Division's attempt to cross the Rapido River, the 143d Infantry (+) was to make an assault crossing of t river south of St. Angelo. Elements of the 1st Battalion crossed on the night of 20 January. Attempts by the 3d Battalion to cross were frustrated by minefields and effective German artillery and mortar fire. On the morning of 21 January the US troops were withdrawn to their assembly areas, having made little or no progress.

Rapido River South II, 21–22 January 1944 (R)

A second attempted assault river crossing by the 2d and 3d battalions on the evening of 21 January also failed. The US units crossed the river but were disorganized by heavy mortar and small arms fire. Unable to advance more than 700 meters and under heavy counterattack, the survivors withdrew early on 22 January.

Significance. The US attack failed completely with heavy losses. No German reserves were drawn to the area, so the secondary intention of diverting forces from the vicinity of the intended Anzio landings failed as well.

Bowling Alley I, 16–19 February 1944 (D)

On 22 January 1944 the US VI Corps established a beachhead at Anzio. Although initial resistance was minimal, the Germans reacted rapidly, moved reserves to the area, and blocked expansion of the beachhead. Hitler made the elimination of the beachhead a priority. A decisive attack was to be made when sufficient forces were available. This attack began on 16 February, with the main effort directed at the center of the Allied line, held by the US 45th Infantry Division.

The 157th Infantry, with a single battalion in the line, held the left of the division's position. Initial German assaults on 15 February were repulsed with heavy loss to the attackers. During the night of 16/17 February German armor and infantry moved south on the Rome-Anzio highway, attacked along the highway at the boundary between the 157th Infantry and the 179th Infantry on its right, and succeeded in enveloping the right flank of the 157th. The 157th withdrew to its left and went into a perimeter defense, opening the highway to German movement. Further German attacks on the unit failed, and the German assault ended on 19 February as Allied counterattacks developed strength.

Significance. The withdrawal by the 157th Infantry on 17 February exposed the left flank of the neighboring 179th Infantry, which withdrew with heavy losses (see Bowling Alley II). However, the strong defense by the 157th in its new position prevented the Germans from widening their penetration of the 45th Division sector and aided materially in stopping the overall German offensive.

Bowling Alley II, 16-17 February 1944 (D)

The 179th Infantry, with two battalions in line, held the center of the US 45th Infantry Division's sector during the German offensive at Anzio. Strong German attacks on 16 February were repulsed with heavy loss. However, the withdrawal of the 157th Infantry on the 179th's s left, on the morning of 17 February, exposed the regiment to envelopment. The 179th withdrew while in contact with the Germans, and two of its battalions suffered heavy casualties. The regiment was hard-pressed to hold its new line under the continuous enemy pressure. The arrival of division and corps reserves on 18

February allowed the two disorganized battalions of the 179th to pass into reserve to reorganize.

Significance. The near destruction of the 179th Infantry created a serious threat to the Allied beachhead. Only by heavy use of air and artillery assets, and by the commitment of reserves, was the situation stabilized.

Bowling Alley III, 16-17 February 1944 (D)

The right of the 45th Division at Anzio was held by the 180th Infantry with two battalions in the line. The German attacks of 16-17 February were repulsed with heavy loss. The collapse of the 179th Infantry on the 180th's left, on 17 February, forced the regiment to refuse its left flank to prevent envelopment from that quarter. This was skilfully done, the companies disengaging under protective fire from supporting artillery. The new position was maintained until the German attack halted on 19 February.

Significance. The defense by the 180th Infantry was material in limiting the German penetration of the 45th Division's line. The great skill with which the regiment's left flank battalion withdrew was in marked contrast to the withdrawal of the 179th Infantry, which virtually collapsed.

Mortain I, 7 August 1944 (R)

The US 30th Infantry Division was to defend the left flank of VII Corps, and prepare to continue its advance to the east and southeast. On the morning of 7 August the German Avranches counterattack struck the US position between Mortain and St. Barthelemy. The 1st and 3d Battalions, 117th Infantry, held the village of St. Barthelemy and the high ground to its west against heavy German attack. The 3d Battalion was forced back some 700 meters, but

continued to control the main road Juvigny - St. Barthelemy. The 1st Battalion was penetrated on the evening of 7 August and withdrew west to new defensive positions on the right of the 3d Battalion. These positions were held against repeated assault until elements of the 119th Infantry and CCB/3d Armored Division arrived to stabilize the situation on 8 August.

Significance. With the arrival of the reserves the 117th Infantry was able to counterattack, eventually forcing the Germans to withdraw on 12 August. The German attack failed to penetrate the US lines, and, with their armored forces engaged at Mortain, the Germans were unable to prevent the breakout by US forces east into the flank and rear of the German armies in France.

Mortain II, 7 August 1944 (R)

The initial German attacks on the 30th Infantry Division isolated the 2d Battalion, 120th Infantry, on Hill 317 east of Mortain. The 1st Battalion, 120th Infantry, was forced westward, where it was joined in defending Hill 285 by the 2d Battalion, 117th Infantry. Effective artillery fire called down by observers on Hill 317 broke up further German attacks on Hills 285 and 317. Effective artillery fire was also brought to bear on the German attacks on the 117th Infantry (see Mortain I). The situation stabilized with the arrival of elements of the 119th Infantry on 8 August.

Significance. With the arrival of reserves, the 120th Infantry was able to counterattack, forcing the Germans to withdraw by 12 August. The German attack failed to penetrate US lines, and with their armored forces engaged at Mortain, the Germans were unable to prevent the breakout by US forces eastward into the flank and rear of the German armies in France.

Schmidt I, 2-5 November 1944 (R)

The US 28th Infantry Division was assigned the mission of advancing through the Huertgen Forest to the Roer River. All three regiments of the division were to attack simultaneously along three divergent axes. In the center, the 112th Infantry was successful initially. The village of Vossenack was captured on 2 November. On 3 November the 2d and 3d Battalions continued the advance, seizing Kommerscheidt and Schmidt against little opposition. The Germans counterattacked on 4 November, forcing the 3d Battalion out of Schmidt. The rugged terrain delayed the supporting armor, and US tanks were only able to intervene to aid the 2d Battalion at Kommerscheidt. By 5 November elements of the 2d and 3d Battalions were able, with armor support, to stabilize a defense which held against repeated attacks until 8 November, when the two battalions withdrew.

Significance. After initial success the US attack was halted by the rapid German response. The lack of armor support was a critical factor in the collapse of the 3d Battalion. With the exception of Vossenack, none of the objectives captured were held.

Schmidt II, 2-3 November 1944 (R)

The second of the three 28th Division attack axes was on the right flank. The attack was made by the 110th Infantry. The 2d and 3d Battalions made repeated but unsuccessful attacks against strong German positions on 2 November. Little ground was gained, and the Germans mounted a minor counterattack, which was repulsed, on the night of 2-3 November. The attack was continued on 3 November, but with little success. On 4 November the two battalions went over to the defense, their new mission being to support by fire a new flanking attack by the 1st Battalion.

Significance. The failure of the 110th to advance resulted in the sole divisional reserve, its 1st Battalion, being released to conduct a flank attack, which was ultimately unsuccessful. This reserve was then not available to support the 112th Infantry at Schmidt.

Schmidt III, 2-4 November 1944 (R)

The third 28th Division attack axis was on the left flank. The attack was made by the 109th Infantry. This attack met with some success on 2 November. The 3d Battalion advanced some 500 meters against light resistance before halting for the night. The regiment resumed the attack on 3 November and immediately encountered strong resistance and local counterattacks. On 4 November the attack bogged down completely under heavy artillery, mortar, and small arms fire. German infiltration into the flank and rear of the 109th, along with strong counterattacks, forced the regiment over to the defense, which was maintained until the 12th Infantry relieved the 109th on 6 November.

Significance. The 109th Infantry incurred heavy casualties for little gain. Unable to carry out its mission, the regiment was also unavailable to support the advance of the 112th Infantry -- the only attack that showed some possibility of success.

Wahlerscheid, 13-16 December 1944 (R)

The US 2d Infantry Division was to drive northeast from Krinkelt-Rocherath to take the Roer River defenses from the flank and rear in concert with an attack by the 8th Infantry Division from the west. The German defenses at Wahlerscheid, although weakly held, were well sited and camou-

flaged. Initial attacks by the 9th Infantry made little progress and resulted in heavy casualties. On 15 December a combat patrol finally succeeded in penetrating on a narrow front at a point where the German wire and minefields were not covered by fire. This penetration was exploited on 16 December, and the German defenses were taken in flank and rear on a 1,000-meter front. Many prisoners were taken, and the 38th Infantry was alerted to pass through the 9th Infantry and expand the penetration further.

Significance. Although the 2d Division had a local success, the value of the penetration was negated by the opening of the German Ardennes offensive on 16 December. The offensive forced the division to withdraw south and west to prevent its encirclement in the salient created at Wahlerscheid.

Krinkelt-Rocherath I, 17 December 1944 (R)

At the beginning of the German Ardennes offensive (16 December 1944) the US 2d Infantry Division was in a vulnerable position. The bulk of the division, the 9th and 38th Infantry and attached units, was deployed in the Wahlerscheid salient with a single road its only route of withdrawal to the south and west. This route was threatened by heavy pressure that was forcing back the 99th Infantry Division on the 2d Division's right rear. To stabilize the situation the 23d Infantry was committed from 2d Division reserve to counterattack to restore the position of the 99th Division.

The 3/23d Infantry took position east of Krinkelt-Rocherath to cover the withdrawal of elements of the 99th Division on 17 December. The battalion was struck almost immediately by strong German infantry attacks. Although it lacked artillery support and was hampered by poor fields of fire, the 3/23d held out until German armor penetrated the positions of its left flank com-

pany. The remnants of the battalion then withdrew to Krinkelt-Rocherath with heavy losses.

Significance. The 23d Infantry was unsuccessful in its counterattack mission. However, the stand in the woods east of Krinkelt-Rocherath did succeed in delaying the German advance long enough for the 99th and 2d Divisions to withdraw to new positions at Krinkelt-Rocherath. As a result the 3/23d Infantry played a key role in stopping the northern pincer of the German Ardennes offensive.

Krinkelt-Rocherath II, 17-19 December 1944 (R)

The leading elements of the 3/38th Infantry, 2d Infantry Division, plus attached troops, were withdrawn from the Wahlerscheid salient on the night of 16/17 December to take up defensive positions at Krinkelt-Rocherath. Initial German attacks on 17 December penetrated into the positions at Rocherath but suffered heavy losses. Strong German armored and infantry forces then attempted to seize Krinkelt during the night of 17/18 December, but without success. Additional elements of the 38th Infantry and fragments of other units of the 2d and 99th Divisions arrived to bolster the defense during this period. Combat was at close quarters, and losses were heavy on both sides. The Germans, unable to exploit their superiority in armor in the confines of the village streets, made little progress. Critical to the defense was the concentration of artillery north and west of the villages, with over 11 battalions available to fire in support of the 38th Infantry and attached units. Further German attacks on 19 December were also repulsed. The arrival of the 1st Infantry division to the west allowed the defenders at Krinkelt to withdraw to new positions on Elsenborn Ridge during the night of 19/20 December.

Significance. The defense of the villages was critical in stopping the German Ardennes offensive. The losses and delay inflicted on the German spearhead wrecked the timetable for the advance to the Meuse River. Enough time was gained for the arrival of US reinforcements and for the withdrawal of the 2d and 99th Divisions from their exposed positions.

Schnee Eifel Center, 16-19 December 1944 (R)

The 423d Infantry, 106th Infantry Division, was deployed in defensive positions on the Schnee Eifel on 16 December 1944. It was intended that the division should gain combat experience in a quiet sector of the front. On the morning of 16 December the German Ardennes offensive opened, with elements of the 18th Volks Grenadier Division forcing the provisional battalion of the 423d Infantry (Cannon Company, Antitank Company, and C/820th Tank Destroyer Battalion) out of Bleialf. The 423d then committed elements of Headquarters Company and B/81st Engineers, regaining Bleialf on the evening of 16 December. The regiment was again forced from the village on the morning of 17 December. The German forces moved north to link up at Schoenberg with the right wing of the 18th Volks Grenadier Division, encircling the US forces on the Schnee Eifel. The 423d Infantry attempted to break out on 18-19 December, but failed and was forced to surrender.

Significance. The collapse of the Schnee Eifel position led to the largest mass surrender by the US Army in Europe during World War II. The German attack opened a major hole in the VIII Corps line, allowing the Germans to develop their planned penetration to the Meuse River.

Schnee Eifel South, 16 December 1944 (D)

Deployed to the south of the 423d Infantry on the Schnee Eifel, the 424th Infantry was to be the only major element of the 106th Division to remain intact during the German Ardennes offensive. The 424th was in good defensive positions, utilizing in part elements of the German Westwall defenses captured by the 28th Division in October 1944. These positions allowed the 424th to stop frontal attacks made by the Germans on 16 December. On the regiment's left flank, however, was a line of outposts manned by the 424th Regimental Cannon Company (fighting as infantry), the Division Cavalry Troop, and B/18th Cavalry Squadron. Much outnumbered, these light forces were forced back to the Our River on 16 December. Their withdrawal threatened the rear of regimental elements remaining to the east of the Our River, which, although reinforced by elements of CCB/9th Armored Division, withdrew on the night of 16 December.

Significance. The withdrawal of the 424th Infantry to the west of the Our River increased the isolation of the two regiments of the 106th Division on the Schnee Eifel. The 424th suffered severe losses but withdrew relatively intact and became a needed addition to the defenders of St. Vith.

Schnee Eifel North I, 16 December 1944 (D)

On 16 December the 14th Cavalry Group manned outposts in the Losheim Gap, on the left flank of the 106th Infantry Division. The outposts covered a front some six kilometers wide, with company-sized strongpoints. These positions were so widely scattered that no coherent, mutually supporting defense was possible. German assault teams were able, in most cases, to infiltrate the positions unobserved. These teams then were able to ambush

elements of 14th Cavalry Group that attempted to counterattack. By noon on 16 December the forward elements of 14th Cavalry Group withdrew, where able. By the evening of 16 December the remnants of the 14th Cavalry Group had broken contact with the Germans and were attempting to reorganize in the woods northeast of St. Vith.

Significance. The failure of the 14th Cavalry Group to hold the Losheim Gap exposed the left flank of the 106th Division on the Schnee Eifel to envelopment. By failing to remain in contact with the Germans, the 14th Cavalry could not provide the 106th Division the vital information needed to assess the scope and objectives of the German attack.

Schnee Eifel North II, 16-19 December 1944 (D)

On the morning of 16 December elements of the 18th Volks Grenadier Division, after breaking through the positions of the 14th Cavalry Group (Schnee Eifel North I), enveloped the left rear of the 422d Infantry. The German penetration threatened US artillery positions southwest of Auw. Elements of Headquarters Company and L Company were committed to block the penetration, but were then diverted to meet a threat to the regimental CP at Schlausenbach. With their route unimpeded, the Germans were able to advance to Andler on the Our River and, by morning of 17 December, to capture Schoenberg. The loss of Schoenberg closed the withdrawal route of th. 422d Infantry and the adjacent 423d Infantry (Schnee Eifel Center). The trapped regiments prepared to break out on 18 December but were met with heavy fire; they surrendered on 19 December.

Signi icance. The loss of the 42.d and 423d Infantry marked the largest mass surrender by the US Army in Europe during World War II. The collapse of

the 106th Division and the attached 14th Cavalry Group opened a major hole in the VIII Corps line, allowing the Germans to develop their planned penetration to the Meuse River.

Our River Center, 16-18 December 1944 (D)

The 110th Infantry, 28th Infantry Division, was defending the line of the Our River on 16 December 1944. The regiment had been hard hit in the Huertgen Forest in November, and was absorbing replacements for its losses. The Germans attacked before first light, and before the commencement of their artillery preparation. Assault parties crossed the Our River and infiltrated through the company strongpoints that were dispersed over a 12-kilometer front. With one battalion in division reserve, the 110th Infantry had only two battalions available for the defense. The strongpoints inflicted heavy casualties and delayed the Germans, but were unable to stop the advance. Some units in strongpoints held out until 18 December, while others withdrew to the regimental CP at Wiltz. The defense of Wiltz collapsed on 18 December, and from that point the 110th Infantry existed only in scattered remnants. It was not reconstituted as a regiment until the middle of January.

Significance. Given the length of front to be defended, the 110th Infantry was unable to maintain a coherent defense. The hours gained by the tenacious defense of the strongpoints delayed the German attack long enough for the 101st Airborne Division to arrive to defend the critical road junction at Bastogne.

Our River North, 16-17 December 1944 (D)

On 16 December the 112th Infantry, 28th Infantry Division, was defending the line of the Our River with two battalions east of the river and one west.

The German attack, by elements of the LVIII Panzer Corps, struck the left flank and front of the US position. The 112th Infantry was well prepared, utilizing sections of the captured German Westwall fortifications in its defense. The German attack on the left was stopped, and heavy casualties were inflicted on the attackers. The 424th Infantry (Schnee Eifel South) aided the defense by bringing effective fire on the flank of the German attack. On the right, however, German infantry was able to infiltrate and threaten the 112th's withdrawal route over the Our River. This threat, and a threat to the left flank caused by the withdrawal of the 424th Infantry on 17 December, forced the 112th Infantry to withdraw under heavy pressure on the evening of 17 December.

Significance. The 112th Infantry was able to maintain a coherent defense until the threat to its flanks made withdrawal imperative. The delay imposed by the 112th slowed the completion of German bridges over the Our River, preventing full employment of the German armor until 18 December. The US regiment broke contact on 18 December and moved north, where it became a welcome reinforcement to the defense of St. Vith.

Sources for Data for Newly Researched Engagements

Archival Sources

The records may be found as follows:

- **RG407** (Record Group 407) may be found at the Washington National Records Center, National Archives and Records Administration (NNMF).
- **T** numbered records are microfilmed German records found at the National Archives, Washington, DC.
- **R** numbered records are German records found at the Bundesarchiv-Militararchiv, Freiburg, FRG.

Sidi Bou Zid

RG407, Box 14916, 601-TK(1)-0.2, History, 1st Armored Regiment, 8 Nov 42-9 May 43

RG407, Box 23700, TDBN-6701-0.3, Operations Report, 701st Tank Destroyer Bn, 21 Jan 43-16 Feb 43

RG407, Box 14816, 601-CCA-3.0, Narrative, CCA 1st Armored Div, 23 Jan 43-26 Feb 43

RG407, Box 9417, 334-0.3, Operations Report, 34th Infantry Div, 3 Jan 43-13 May 43

RG407, Box 14767, 601-3.2, Operations Reports, 1st Armored Div, 30 Jan 43-14 Feb 43

RG407, Box 9425, 334-1.16, 34th Infantry Div, Report of Casualties, Feb 43

RG407, Box 14967, 601-INF(6)-0.3, 6th Armored Infantry, Report of Operations, 19 Feb 43-23 Feb 43

RG407, Box 3172, 2020-3.2, Operations Reports, II Corps, 15 Feb 43-20 Feb 43

RG407, Box 14923, 601-TK(13)-0.1 to 0.2, History, 13th Armored Regiment, 10 Jan 43-9 May 43

T313 Roll 416 Frame 8709090, 5th Panzer Army, Special Report on Supply Situation and Combat Forces of the Army, 15 Feb 43

T313 Roll 416 Frame 8709617-8709618, 5th Panzer Army, Operations Report, 15 Feb 43

T313 Roll 416 Frame 8709751 and 8709756, Artillery Strength Reports, 10th and 21st Panzer Divisions, 6 Feb 43

Kasserine Pass

RG407, Box 5952, 310-INF(26)-0.3, Operations Report, 26th Infantry, 8 Nov 42-8 May 43

RG407, Box 19525, ENGR-19-0.3.0, Diary and File, 19th Engineers, 19 Jul 42-18 Jul 43

RG407, Box 5899, 301-FA(33)-0.3, Operations Report, 33rd Field Artillery Bn, 8 Nov 42-28 Feb 43

RG407, Box 23768, TDBN-805-0.1 to 0.7, 804th Tank Destroyer Bn, Engagement in Combat, 10-24 Feb 43

T314 Roll 21 Frame 001198, 15th Panzer Division, Report of Operations, 15 Feb 43

T314 Roll 23 Frame 000296, 15th Panzer Division, Strength Report, 7 Feb 43

T313 Roll 460 Frames 8756888 and 8757131, Afrika Korps, War Journal and Quartermaster Reports, Feb 43

Rapido River

RG407, Box 9934, 336-INF(141)-0.3, Operations Report, 141st Infantry, 1-31 Jan 44

RG407, Box 9794, 336-0.3, Operations Report, 36th Infantry Div, Jan 44

RG407, Box 9804, 336-1.0 to 1.2, 36th Infantry Div, G-1 Journal, Jan 44

RG407, Box 97840, 336-3.2, G-3 Journal and File, 36th Infantry Div, 19 Dec 43-19 Jan 44

RG407, Box 9841, 336-3.2, G-3 Journal and File, 36th Infantry Div, 20 Jan 44-19 Feb 44

RG407, Box 9992, 336-INF(143)-0.3, Operations Report, 143rd Infantry, 10-31 Jan 44

T312 Roll 410 Frame 7605294, 10th Army, Strength and Losses Jan 44

T312 Roll 83 Frames 7606014 and 7606306, 15th Panzer Grenadier Division, Armor and Artillery Strength Reports, 19-21 Jan 44

T312 Roll 83 Frames 7606256 and 7606513, 15th Panzer Grenadier Division, Casualty Report, 20-21 Jan 44

T312 Roll 83 Frame 7606301, 15th Panzer Grenadier Division, Strength Report, 20 Jan 44

Bowling Alley

RG407, Box 107890, 345-1.16 to 1.17, 45th Infantry Div, G-1 Report on Personnel Statistics, Feb 44

RG407, Box 16638, ARBN-191-0 to 0.3, 191st Tank Bn, Historical Record and G-3 Journal, Feb 44

RG407, Box 23640, TDBN-645-0.7, 645th Tank Destroyer Bn, Unit Journal, 1 Jan 44-29 Feb 44

RG407, Box 10957, 345-3.2, 45th Infantry Div, G-3 Journal and File, 11 Feb 44-20 Feb 44

RG407, Box 11057, 345-INF(157)-0 to 0.3, 157th Infantry, Operations Summary, Feb 44

RG407, Box 10866, 345-1.2, G-1 Journal and File, 45th Infantry Div, 20 Feb 44-31 Mar 44

RG407, Box 11068, 345-INF(157)-3 to 3.2, G-3 Journal and File, 157th Infantry, 1 Jan 44-31 Aug 44

RG407, Box 3635, 206-1.2 to 1.6, VI Corps, G-1 Journal and File, Feb 44

RG407, Box 3762, 206-3.2, VI Corps, G-3 Journal and File, 16-20 Feb 44

RG407, Box 3596, 206-0.3, VI Corps, After Action Report, Jan-Jun 44

RG407, Box 11077, 345-INF(179)-0.3, 179th Infantry, History, 1 May 43-30 Apr 44

RG407, Box 11083, 345-INF(179)-0.7, 179th Infantry, G-3 Journal and File, 1 Jan 44-31 Mar 44

RG407, Box 11097, 345-INF(180)-0.3, 180th Infantry, Operations Report, Feb 44

RG407, Box 11112, 345-INF(180)-3.2, G-3 Journal and File, 180th Infantry, 1 Jan 44-29 Feb 44

T312 Roll 483 Frames 8073981 - 8073985, 14th Army, Report on Troops, 16 Feb 44

T312 Roll 483 Frame 8074390 - 8074399, 14th Army, Artillery Composition, Feb 44

T312 Roll 483 Frame 8074031, 14th Army, Weapons Losses, Feb 44

T312 Roll 483 Frame 8074705, 14th Army, Personnel Losses, Feb 44

GMDS combined British, Canadian, and US Staff. The German Operation at Anzio. NP, ND. (Translation of 14th Army War Diary)

Mortain

RG407, Box 8895, 330-INF(117)-0.7, 117th Infantry, Unit Journal, 14 Jun 44-13 Sep 44

RG407, Box 23847, TDBN-823-0.1 to 0.7, 823rd Tank Destroyer Bn, Unit History, Aug 44

RG407, Box 23850, TDBN-823-0.8, 823rd Tank Destroyer Bn, Unit Reports, 19 Jul 44-8 Aug 44

RG407, Box 23851, TDBN-823-0.8, 823rd Tank Destroyer Bn, Unit Reports, 9 Aug 44-31 Aug 44

RG407, Box 3827, 207-0.3, VII Corps, After Action Reports, Aug 44

RG407, Box 8733, 330-1.2, 30th Infantry Div, G-1 Journal and File, 1 Aug 44-30 Sep 44

RG407, Box 8853, 330-ART-0.7, 30th Infantry Div, Artillery Operations Report, Aug 44

RG407, Box 8918, 330-INF(120)-0.3, 120th Infantry, History, Aug 44

RG407, Box 6707, ARBN-743-0.3 to 3.2, S-3 Journal, 743rd Tank Bn, Aug 44

T312 Roll 1569 Frames 000205 and 000359, XXXXVII Panzer Corps, Strength Reports, 7 Jul 44 and 7 Aug 44

T311 Roll 4 Frames 3913, 4329, and 4330, Strength Reports, 2nd Panzer Div and 1st SS Panzer Div, 11 Aug 44 and 13 Aug 44

T314 Roll 1604 Frames 1373 - 1375, 17th SS Panzer Grenadier Div, Strength Report, 23 Jul 44

T314 Roll 1496 Frame 1011, 2nd SS Panzer Div, Casualty Report, 8 Aug 44-9 Aug 44

T314 Roll 1496 Frames 1027, 1037, and 1069, Strength Report, 2nd SS Panzer Div, 10 Aug 44-13 Aug 44

Schmidt

RG407, Box 3530-3532, 205-3.2, V Corps, G-3 Reports, 1 Nov 44-14 Nov 44

RG407, Box 8607, 328-INF(112)-0.1 to 1.13, Unit Reports, 112th Infantry, Nov 44

RG407, Box 3586, 205-ART-0.7, V Corps Artillery, Staff Journal and File, Nov 44-Mar 45

RG407, Box 3409, 205-0.1 to 0.3, V Corps, G-2 Historical Record, Oct-Nov 44

RG407, Box 16680, ARBN-707-0.1 to 3.0.1, 707th Tank Bn, S-3 Journal, Nov 44

RG407, Box 3592, 205-ART-3.2, V Corps Artillery, Unit Reports, Sep-Dec 44

RG407, Box 23673, TDBN-893-0.1 to 3.2, 893rd Tank Destroyer Bn, G-3 Journal and File, Nov 44

RG407, Box 8596, 328-INF(110)-0.1 to 0.3, 110th Infantry, Unit Reports, Nov 44

RG407, Box 8600, 328-INF(110)-0.7, 110th Infantry, G-3 Journal and File, 1 Nov 44-30 Nov 44

RG407, Box 8593, 328-INF(109)-0.3 to 0.7, 109th Infantry, Unit Reports, Nov 44

T78 Roll 414 Frame 6383262, Army Surgeon Generals Report, Casualties of 7th Army, 1 Nov 44-10 Nov 44

Wahlerscheid, Krinkelt-Rocherath

RG407, Box 3410, 205-0.3, V Corps, After Action Report, 1 Dec 44-31 Dec 44

RG407, Box 23636, TDBN-644-0.3, After Action Report, 644th Tank Destroyer Bn, 1 Dec 44-31 Dec 44

RG407, Box 16703, ARBN-741-0.1, Unit Journal, 741st Tank Bn, 1 Dec 44-31 Dec 44

RG407, Box 6011, 302-INF(9)-0.7, G-3 Journal, 9th Infantry, Sep-Dec 44

RG407, Box 6036, 302-ART-0.7, 2nd Infantry Div Artillery, G-3 Journal and File, Nov 44-Mar 45

RG407, Box 6070, 302-INF(23)-0.2 to 0.7, 23rd Infantry, Unit History, Dec 44

RG407, Box 23571, TDBN-612-0.1 to 0.3, 612th Tank Destroyer Bn, History, Dec 44

RG407, Box 6081, 302 INF(38)-0.3, 38th Infantry, After Action Report, 6 Jun 44-9 May 45

T311 Roll 18 Frames 020-025, Tank Strength, Army Group B, 16 Dec 44

T311 Roll 18 Frames 716-720, Organization, Army Group B, 16 Dec 44

T311 Roll 18 Frames 1031-1039, Artillery Strength, Army Group B, 14 Dec 44

T78 Roll 414 Frame 6383249, Army Surgeon Generals Report, Casualties of 6th Panzer Army, 11 Dec 44-20 Dec 44

T354 Roll 155 Frames 3799006-3799025, 12th SS Panzer Div, 3rd/25th SS Panzergrenadier Rgt, Strength Report, 15 and 21 Dec 44

RH 10/321, Bundesarchiv-Militararchiv, Freiburg, 12th SS Panzer Div, Strength Reports, 4 Nov 43-1 Feb 45

Our River

RG407, Box 4029, 208-3.2, VIII Corps, G-3 Journal and File, 9 Dec 44-17 Dec 44

RG407, Box 8481, 328-1.2, 28th Infantry Div, G-1 Journal and File, 16 Dec 44-16 Jan 44

RG407, Box 8542, 328-4.2, 28th Infantry Div, G-4 Journal and File, 16 Dec 44-16 Jan 44

RG407, Box 8518, 328-3.2, 28th Infantry Div, G-3 Journal and File, 9 Dec 44-20 Dec 44

RG407, Box 8519, 328-3.2, 28th Infantry Div, G-3 Journal and File, 20 Dec 44-31 Dec 44

T314 Roll 1134 Frame 280, 2nd Panzer Div, Strength Report, 8 Dec 44

T314 Roll 1134 Frames 348-351, 116th Panzer Div, Strength Report, 2 Dec 44

T314 Roll 1134 Frame 1126, 116th Panzer Div, Casualty Report, 16 Dec 44-31 Dec 44

Schnee Eifel

RG407, Box 14745, 3106-ART-0.1 to 0.3, 106th Infantry Div, Artillery History, Dec 44

RG407, Box 14733, 3106-3.3, 106th Infantry Div, G-3 Journal and File, 5 Dec 44-15 Dec 44

RG407, Box 4029, 208-3.2, VIII Corps Artillery, G-3 Journal and File, 9 Dec 44-17 Dec 44

106th Infantry Div, General Orders No. 51, Award of the Combat Infantryman Badge to Officers and Enlisted Men of the 423rd Infantry, Effective 16 Dec 44 (Copy from private source, currently unlocated at National Archives)

RH 26-62/138, Bundesarchiv-Militararchiv, Freiburg, 62nd Volks Grenadier Div, 164th Grenadier Rgt, Casualty Report, 16 Dec 44-24 Dec 44

RW 6/V-577, Bundesarchiv-Militararchiv, Freiburg, 5th Panzer Army, Casualty Report, 11 Dec 44-20 Dec 44

Manuscript Sources

The following manuscripts consist of postwar memoirs and answers to questionnaires completed by former German officers under the direction of the Historical Section, Headquarters, US Army, Europe. These materials were produced during the period 1945-1954 and may be found at the Office of the Chief of Military History, Washington, DC.

Mortain

MS# A-904. Luettwitz, General der Panzertruppen Heinrich Freiherr von. Avranches. OCMH, 1945.

MS# A-921. Gersdorff, Generalmajor R. von. Avranches Counterattack Seventh Army. OCMH, 1945.

MS# B-358. Wisch, Generalmajor der Waffen SS Theodor. Leibstandarte Adolf Hitler in Aug 1944. OCMH, 1946.

Schmidt

MS# A-891. Gersdorff, Generalmajor R. von. The Battle of the Hurtgen Forest. OCMH, 1945.

MS# B-804. Schmidt, Generalmajor Hans. 275 Infantry Division. OCMH, 1947.

MS# B-810. Schmidt, Generaleutnant Hans. 275 Infantry Division. OCMH, 1947.

ETHINT-56. Gersdorff, Generalmajor R. von, and Waldenburg, Generalmajor Siegfried von. 116 Panzer Division in the Hurtgen Forest. OCMH, 1945.

Wahlerscheid, Krinkelt-Rocherath

MS# A-877. Priess, General der Waffen SS H. Commitment of the I SS Panzer Corps During the Ardennes Offensive. OCMH, 1946.

MS# B-273. Viebig, Generalmajor Wilhelm. 277 Volks Grenadier Division. OCMH, 1946.

MS# B-522. Kraas, Generalmajor Hugo. 12th SS Panzer Division. OCMH, 1947.

MS# B-779. Lehmann, Oberst der Waffen SS Rudolf. I SS Panzer Corps. OCMH, 1948.

Our River

MS# A-873. Waldenburg, Generalmajor Siegfried von. Commitment of the 116th Panzer Division in the Ardennes. OCMH, 1946.

MS# A-941. Bayerlein, Generalleutnant F. Panzer Lehr Division. OCMH, 1945.

MS# B-151. Manteuffel, General der Panzertruppen Hasso von. Fifth Panzer Army. OCMH, 1946.

Schnee Eifel

MS# A-929. Lucht, General der Artillerie Walter. Ardennes Campaign. OCMH, 1945.

MS# B-028. Kittel, Generalmajor Friedich. 62nd Volks Grenadier Division. OCMH, 1946.

MS# B-477. Lucht, General der Artillerie Walter. LXVI Corps. OCMH, 1946.

MS# B-592. Remer, Generalmajor Otto. Fuhrer Begleit Brigade. OCMH, 1947.

MS# B-838. Remer, Generalmajor Otto. Fuhrer Escort Brigade. OCMH, 1948.

Data for Newly Researched Engagements

#	Engagement	War	Campaign	Year	Start	End	Attacker	Attacker Commander
16	Sidi Bou Zid I	World War II	Northwest Africa	1943	2/14/43	2/14/43	Ger Elms 10th and 21st PD	Gen Ziegler
1	Sidi Bou Zid II	World War II	Northwest Africa	1943	2/15/43	2/15/43	US CCC, 1st Arm Div	Col Stack
17	Kasserine Pass	World War II	Northwest Africa	1943	2/19/43	2/20/43	Ger Afrika Korps (-)	FM Rommel
2	Rapido North I	World War II	Cassino	1944	1/20/44	1/20/44	US 141st RCT 9+), 36th ID	Col Wyatt
3	Rapido North II	World War II	Cassino	1944	1/21/44	1/21/44	US 141st RCT (+), 36th ID	Col Wyatt
4	Rapido South I	World War II	Cassino	1944	1/20/44	1/20/44	US 143rd RCT (+), 36th ID	Col Martin
5	Rapido South II	World War II	Cassino	1944	1/21/44	1/21/44	US 143rd RCT (+), 36th ID	Col Martin
28	Bowling Alley I	World War II	Anzio	1944	2/16/44	2/19/44	Ger LXXVI Pnz Corps (-)	Gen Mackenson
59	Bowling Alley II	World War II	Anzio	1944	2/16/44	2/17/44	Ger LXXVI Pnz Corps (-)	Gen Mackenson
29	Bowling Alley III	World War II	Anzio	1944	2/16/44	2/19/44	Ger LXXVI Pnz Corps (-)	Gen Mackenson
11	Mortain I	World War II	Normandy	1944	8/07/44	8/07/44	Ger Elms 1st SS and 2nd PD	Gen Luettwitz
6	Mortain II	World War II	Normandy	1944	8/07/44	8/07/44	Ger Elms 2nd SS PD and 17th	Col Baum
7	Schmidt I	World War II	Siegfried Line	1944	11/02/44	11/05/44	US 112th Inf(+), 28th ID	Col Peterson
8	Schmidt II	World War II	Siegfried Line	1944	11/02/44	11/03/44	US 110th Inf (+), 28th ID	Col Seely
9	Schmidt III	World War II	Siegfried Line	1944	11/02/44	11/04/44	US 109th Inf (+), 28th ID	Col Strickler
18	Wahlerscheid	World War II	Siegfried Line	1944	12/13/44	12/16/44	Us 9th Inf (+), 2nd ID	Col Hirschfelder
19	Krinkelt-Rocherath I	World War II	Ardennes	1944	12/17/44	12/17/44	Ger 12th SS PnzDiv (-)(+)	Col Kraas
10	Krinkelt-Rocherath II	World War II	Ardennes	1944	12/17/44	12/19/44	Ger 12th SS PnzDiv (-)(+)	Col Kraas
15	Schnee Eifel Center	World War II	Ardennes	1944	12/16/44	12/19/44	Ger 293rd VGRgt, 18th VGD	Col Hoffman-Schonbor
30	Schnee Eifel South	World War II	Ardennes	1944	12/16/44	12/16/44	Ger 62nd VGDiv (+)	Gen Kittel
58	Schnee Eifel North I	World War II	Ardennes	1944	12/16/44	12/16/44	Ger 18th VGDiv (-)(+)	Col Hoffman-Schonbor
60	Schnee Eifel North II	World War II	Ardennes	1944	12/16/44	12/19/44	Ger 18th VGDiv (-)(+)	Col Hoffman-Schonbor
61	Our River Center	World War II	Ardennes	1944	12/16/44	12/18/44	Ger XLVII Pnz Corps	Gen Luettwitz
62	Our River North	World War II	Ardennes	1944	12/16/44	12/17/44	Ger LVIII Pnz Corps	Gen Krueger

#	Engagement	Defender	Defender Commander	Dur	WOF	D Pos	Terrain	Wth	Ssn	A/S	Location
16	Sidi Bou Zid I	US CCA, 1st Arm Div (+)	BG McQuillion	1 days	22 km	HD	FB/RgB	DSC	WD	A	Tunisia
1	Sidi Bou Zid II	Ger Elms 10th and 21st PD	Gen Ziegler	1 days	4 km	HD	FB/RgB	DOC	WD	D	Tunisia
17	Kasserine Pass	US 26th RCT (-)(+)	Col Stark	2 days	4 km	HD	RgB	WHC	WD	A	Tunisia
2	Rapido North I	Ger 1st/129th PGR, 15th PGD	Gen Rodt	1 days	1 km	FD	FB/M	WOC	WT	A	Italy
3	Rapido North II	Ger 1st/129th PGR, 15th PGD	Gen Rodt	1 days	1 km	FD	FB/M	WOC	WT	A	Italy
4	Rapido South I	Ger 3rd/104th PGR, 15th PGD	Gen Rodt	1 days	1 km	FD	FB/M	WOC	WT	A	Italy
5	Rapido South II	Ger 3rd/104th PGR, 15th PGD	Gen Rodt	1 days	1 km	FD	FB/M	WOC	WT	A	Italy
28	Bowling Alley I	US 2nd/157th Inf (+), 45th ID	Col Brown	4 days	2 km	PD/FD	FB/RgB	DST	WT	D	Italy
59	Bowling Alley II	US 179th Inf (-)(+), 45th ID	Col Kammerer	2 days	2.4 km	PD/FD	FB	DST	WT	D	Italy
29	Bowling Alley III	US 180th Inf (-)(+), 45th ID	Col Dulaney	4 days	2.6 km	PD/FD	FB	DST	WT	D	Italy
11	Mortain I	Us 117th Inf (-)(+), 30th ID	Col Johnson	1 days	2 km	HD	RM	DST	ST	D	France
6	Mortain II	US 120th Inf (-)(+), 30th ID	Col Birks	1 days	3 km	HD	RgM	DST	ST	D	France
7	Schmidt I	Ger LXXIV Corps (-)	Gen Straube	4 days	1.7 km	PD/FD	RM/RgM	WLT	FT	A	Germany
8	Schmidt II	Ger LXXIV Corps (-)	Gen Straube	2 days	2 km	PD/FD	RgW	WLT	FT	A	Germany
9	Schmidt III	Ger LXXIV Corps (-)	Gen Straube	3 days	1.2 km	PD/FD	RW	WLT	FT	A	Germany
18	Wahlerscheid	Ger LXVII Corps (-)		4 days	1 km	PD/FD	RW	WLC	WT	A	Germany
19	Krinkelt-Rocherath I	US 3rd/23rd Inf, 2nd ID	Col Tuttle	1 days	2.5 km	HD	RgW	WLC	WT	D	Belgium
10	Krinkelt-Rocherath II	US 38th Inf (-)(+), 2nd ID	Col Boos	3 days	3 km	HD	RB/RM	WLC	WT	D	Belgium
15	Schnee Eifel Center	US 423rd Inf, 106th ID	Col Cavender	4 days	1 km	PD/FD	RgW/RM	DOC	WT	D	Germany
30	Schnee Eifel South	US 424th Inf (+), 106th ID	Col Reid	1 days	9 km	PD/FD	RgW	DOC	WT	D	Germany
58	Schnee Eifel North I	US 14th Cav Grp (+)	Col Devine	1 days	6 km	HD	RM	DOC	WT	D	Germany
60	Schnee Eifel North II	US 422nd Inf (+), 106th ID	Col Descheneux	4 days	1 km	PD/FD	RgW	DOC	WT	D	Germany
61	Our River Center	US 110th Inf (-)(+), 28th ID	Col Fuller	3 days	12 km	HD/PD	RgW	DOC	WT	D	Luxembour
62	Our River North	US 112th Inf (+), 28th ID	Col Nelson	2 days	4 km	HD/PD	RgW	DOC	WT	D	Luxembour

#	Engagement	Surprise?	Surpriser?	Level	Atk Str	Def Str	A/D Str Rat	Atk Tot Arm	Def Tot Arm	A/D Arm Ra
16	Sidi Bou Zid I	Y	A	Substantial	6400	5333	1.20	135	69	1.96
1	Sidi Bou Zid II	N	-	-	2738	8380	0.33	66	135	0.49
17	Kasserine Pass	N	-	-	7000	5303	1.32	54	13	4.15
2	Rapido North I	N	-	-	8000	2200	3.64	50	14	0.00
3	Rapido North II	N	-	-	7600	2200	3.45	50	14	0.00
4	Rapido South I	N	-	-	7700	1800	4.28	15	14	0.00
5	Rapido South II	N	-	-	7538	1800	4.19	15	14	0.00
28	Bowling Alley I	Y	A	Substantial	14600	4500	3.24	40	37	1.08
59	Bowling Alley II	Y	A	Substantial	15736	5050	3.12	60	25	2.40
29	Bowling Alley III	Y	A	Substantial	10000	4625	2.16	20	7	2.86
11	Mortain I	Y	A	Substantial	8150	3700	2.20	50	0	0.00
6	Mortain II	Y	A	Substantial	8500	4600	1.85	30	8	3.75
7	Schmidt I	N	-	-	6200	5025	1.23	44	60	0.73
8	Schmidt II	N	-	-	4350	3450	1.26	0	0	0.00
9	Schmidt III	N	-	-	4950	3700	1.34	0	6	0.00
18	Wahlerscheid	N	-	-	8300	1400	5.93	28	0	0.00
19	Krinkelt-Rocherath I	N	-	-	3900	1357	2.46	11	5	2.20
10	Krinkelt-Rocherath II	N	-	-	9100	6600	1.38	121	33	3.67
15	Schnee Eifel Center	Y	A	Complete	4100	3900	1.05	10	0	0.00
30	Schnee Eifel South	Y	A	Complete	11000	4300	2.56	26	0	0.00
58	Schnee Eifel North I	Y	A	Complete	14300	2050	6.98	50	34	1.47
60	Schnee Eifel North II	Y	A	Complete	12800	4150	3.08	120	0	0.00
61	Our River Center	Y	A	Complete	43800	5340	8.20	212	73	2.90
62	Our River North	Y	A	Complete	16000	5740	2.79	78	4	19.50

#	Engagement	Atk Lt Arm	Def Lt Arm	Atk MBT	Def MBT	Atk Arty	Def Arty	A/D Arty Ratio	Atk Air	Def Air	A/D Air Rat
16	Sidi Bou Zid I		16	135	53	35	47	0.74	180	0	0.00
1	Sidi Bou Zid II			66	135	26	35	0.74	0	125	0.00
17	Kasserine Pass	24	0	30	13	46	30	1.53	0	0	0.00
2	Rapido North I	0		50	14	105	42	0.00	0	0	0.00
3	Rapido North II	0		50	14	105	42	0.00	0	0	0.00
4	Rapido South I	0		15	14	122	42	0.00	0	0	0.00
5	Rapido South II	0		15	14	122	42	0.00	0	0	0.00
28	Bowling Alley I	0	0	40	37	100	70	1.43	100	267	0.37
59	Bowling Alley II	0	0	60	25	100	70	1.43	70	165	0.42
29	Bowling Alley III	0	0	20	7	100	70	1.43	100	267	0.37
11	Mortain I	0	0	50	0	18	34	0.53	66	300	0.22
6	Mortain II	0	0	30	8	24	34	0.71	66	300	0.22
7	Schmidt I	0	0	44	60	71	38	1.87	72	0	0.00
8	Schmidt II	0	0	0	0	53	38	1.39	0	0	0.00
9	Schmidt III	0	0	0	6	53	38	1.39	12	0	0.00
18	Wahlerscheid	0	0	28	0	124	12	10.33	0	0	0.00
19	Krinkelt-Rocherath I	0	0	11	5	36	12	3.00	0	0	0.00
10	Krinkelt-Rocherath II	0	0	121	33	99	52	1.90			0.00
15	Schnee Eifel Center	0	0	10	0	68	18	3.78	0	0	0.00
30	Schnee Eifel South	0	22	26	0	66	59	1.12	0	0	0.00
58	Schnee Eifel North I	0	34	50	0	160	46	3.48	0	0	0.00
60	Schnee Eifel North II	0	0	20	0	120	38	3.16	0	0	0.00
61	Our River Center	0	18	212	57	325	30	10.83	0	0	0.00
62	Our River North	0	0	78	4	248	59	4.20	0	0	0.00

#	Engagement	Atk Loss	Def Loss	A/D Loss Ratio	Atk %/Day	Def %/Day	%/Day Ratio	Atk Arm Loss	Def Arm Loss
16	Sidi Bou Zid I	20	920	0.02	0.31	17.2	0.02	0	48
1	Sidi Bou Zid II	367	50	7.34	13.4	0.6	22.33	48	10
17	Kasserine Pass	200	327	0.38	1.4	5	0.28	2	4
2	Rapido North I	408	13	31.38	5.1	0.59	0.00	0	0
3	Rapido North II	666	13	51.23	8.76	0.59	0.00	0	0
4	Rapido South I	162	13	12.46	1.58	0.72	0.00	0	0
5	Rapido South II	575	13	44.23	7.63	0.72	0.00	0	0
28	Bowling Alley I	1129	442	2.55	1.93	2.46	0.78	22	21
59	Bowling Alley II	613	750	0.82	1.95	7.43	0.26	19	9
29	Bowling Alley III	439	199	2.21	1.1	1.08	1.02	0	0
11	Mortain I	700	400	1.75	8.59	10.81	0.79	5	0
6	Mortain II	375	600	0.63	4.41	13.04	0.34	4	0
7	Schmidt I	640	850	0.75	2.58	4.23	0.61	21	10
8	Schmidt II	163	100	1.60	1.87	1.45	1.29	0	0
9	Schmidt III	350	200	1.75	2.36	1.8	1.31	0	2
18	Wahlerscheid	370	250	1.48	1.11	4.46	0.25	0	0
19	Krinkelt-Rocherath I	100	400	0.25	3.03	29.48	0.10	2	2
10	Krinkelt-Rocherath II	900	720	1.25	3.3	3.64	0.91	41	13
15	Schnee Eifel Center	200	3700	0.05	1.22	23.7	0.05	0	0
30	Schnee Eifel South	200	300	0.67	1.8	3.5	0.51	7	0
58	Schnee Eifel North I	50	127	0.39	0.35	6.2	0.06	2	7
60	Schnee Eifel North II	200	3535	0.06	0.39	21.3	0.02	2	0
61	Our River Center	900	3300	0.27	0.68	20.6	0.03	43	59
62	Our River North	770	700	1.10	2.41	6.1	0.40	20	3

#	Engagement	Atk Arm %/Day	Def Arm %/Day	Atk Arty Loss	Def Arty Loss	Atk Arty %/Day	Def Arty %/Day
16	Sidi Bou Zid I	0	69.6	0	35	0	74.5
1	Sidi Bou Zid II	72.7	7.4	4	0	15.4	0
17	Kasserine Pass	1.8	15.4		8		13.3
2	Rapido North I	0	0				
3	Rapido North II	0	0				
4	Rapido South I	0	0				
5	Rapido South II	0	0				
28	Bowling Alley I	13.8	14.2		0		0
59	Bowling Alley II	15.8	18		0		0
29	Bowling Alley III	0	0		0		0
11	Mortain I	10					
6	Mortain II	13.3	0				
7	Schmidt I	11.9	4.2	0		0	
8	Schmidt II	0	0	0		0	
9	Schmidt III	0	11.1	0		0	
18	Wahlerscheid	0	0	0			
19	Krinkelt-Rocherath I	18.2	40				
10	Krinkelt-Rocherath II	11.3	13.1				
15	Schnee Eifel Center	0	0		18		25
30	Schnee Eifel South	26.9	0				
58	Schnee Eifel North I	4	20.6		2		4.3
60	Schnee Eifel North II	0.02	0		28		18.4
61	Our River Center	6.8	26.9		2		2.2
62	Our River North	12.8	37.5		0		0

#	Engagement	Atk Air Loss	Def Air Loss	Atk % Sorties	Def % Sorties	CE	Ldr	T&E	Mrl	Lgst	Mob	Int	Tech	In
16	Sidi Bou Zid I					x/-	-/o	-/o	C	C	x/-	-/x	C	x/-
1	Sidi Bou Zid II					o/-	o/-	o/-	C	C	-/x	o/-	C	-/>
17	Kasserine Pass					x/-	x/-	x/-	-/o	C	x/-	-/o	C	x/
2	Rapido North I					N	o/-	C	C	x/-	N	o/-	C	o/-
3	Rapido North II					N	o/-	C	C	x/-	N	o/-	C	o/-
4	Rapido South I					N	o/-	C	C	x/-	N	o/-	C	o/-
5	Rapido South II					N	o/-	C	C	x/-	N	o/-	C	o/-
28	Bowling Alley I					C	C	C	C	C	x/-	N	C	x/
59	Bowling Alley II					C	C	C	C	C	x/-	N	C	x/-
29	Bowling Alley III					C	C	C	C	C	x/-	N	C	x/-
11	Mortain I					N	N	C	C	-/x	N	N	C	x/-
6	Mortain II					N	N	C	C	-/x	N	N	C	x/-
7	Schmidt I	2		0.7		C	C	C	C	O/-	N	N	C	N
8	Schmidt II					C	C	C	C	C	N	N	C	N
9	Schmidt III					C	C	C	C	C	[illegible]	N	C	N
18	Wahlerscheid					C	C	x/-	C	C	N	o/-	C	x/-
19	Krinkelt-Rocherath I					C	C	-/x	C	C	x/-	C	C	x/-
10	Krinkelt-Rocherath II					C	C	C	C	C	x/-	C	C	x/-
15	Schnee Eifel Center					N	N	-/o	C	N	x/-	-/O	C	x/-
30	Schnee Eifel South					N	N	-/o	C	N	x/-	-/O	C	x/-
58	Schnee Eifel North I					N	N	C	C	N	x/-	-/O	C	x/-
60	Schnee Eifel North II					N	N	-/o	C	N	x/-	-/O	C	x/-
61	Our River Center					C	C	C	C	C	x/-	-/O	C	x/-
62	Our River North					C	C	C	C	C	x/-	-/O	C	x/-

#	Engagement	FQual	Rsrv	Mobl	Air Sup	FPrep	Wthr	Tern	Ldr2	Plan	Surp	Manv	Lgst2	Fort	Depth
16	Sidi Bou Zid I	x/-	-/o	x/-	X/-	x/-	N	-/x	C	X/-	x/-	X/-	N	N	-/o
1	Sidi Bou Zid II	-/x	o/-	C	-/x	-/x	N	-/x	C	o/-	N	-/x	N	N	-/x
17	Kasserine Pass	-/O	-/o	x/-	N	N	N	-/x	x/-	-/O	N	x/-	N	-/x	-/o
2	Rapido North I	N	O/-	C	N	x/-	o/-	O/-	o/-	O/-	N	o/-	N	-/X	-/x
3	Rapido North II	N	O/-	C	N	x/-	o/-	O/-	o/-	O/-	N	o/-	N	-/X	-/x
4	Rapido South I	N	O/-	C	N	x/-	o/-	O/-	o/-	O/-	N	o/-	N	-/X	-/x
5	Rapido South II	N	O/-	C	N	x/-	o/-	O/-	o/-	O/-	N	o/-	N	-/X	-/x
28	Bowling Alley I	N	N	N	-/x	x/-	-/x	N	N	x/-	x/-	x/-	N	-/x	-/x
59	Bowling Alley II	N	N	N	-/x	x/-	-/x	N	N	x/-	x/-	x/-	N	-/x	-/x
29	Bowling Alley III	N	N	N	-/x	x/-	-/x	N	N	-/x	x/-	x/-	N	-/x	-/x
11	Mortain I	N	-/x	N	-/X	x/-	N	/x	N	N	x/-	x/-	N	N	N
6	Mortain II	N	-/x	N	-/X	x/-	N	-/x	N	N	x/-	x/-	N	N	N
7	Schmidt I	C	-/x	N	N	N	-/x	-/X	n	o/-	N	N	o/-	-/x	-/x
8	Schmidt II	C	-/x	N	N	N	-/x	-/X	N	o/-	N	N	N	-/X	-/x
9	Schmidt III	C	-/x	N	N	N	-/x	-/x	N	o/-	N	-/x	N	-/x	-/x
18	Wahlerscheid	x/-	>/-	C	N	x/-	-/x	-/x	C	C	N	x/-	N	-/x	-/x
19	Krinkelt-Rocherath I	C	x/-	C	N	x/-	x/-	-/x	C	C	N	x/-	-/O	N	-/o
10	Krinkelt-Rocherath II	C	x/-	x/	N	x/-	x/-	-/x	C	o/-	N	x/-	C	N	-/x
15	Schnee Eifel Center	C	-/O	C	N	-/x	x/-	C	C	X/-	X/-	X/-	-/o	N	-/O
30	Schnee Eifel South	C	-/x	C	N	N	x/-	-/x	C	C	X/-	N	N	-/x	-/o
58	Schnee Eifel North I	C	-/O	-/x	N	X/-	x/-	-/o	C	X/-	X/-	X/-	N	N	-/O
60	Schnee Eifel North II	C	-/O	C	N	x/-	x/-	C	C	X/-	X/-	X/-	-/o	N	-/O
61	Our River Center	C	x/-	x/-	N	X/-	x/-	-/x	C	C	X/-	X/-	N	N	-/O
62	Our River North	N	x/-	N	N	N	x/-	-/x	C	N	N	x/-	N	N	-/O

#	Engagement	Main Attk Type	Sec. Attk Type	Def Scheme	Atk MAS	Def MAS	Dist Adv	Victor
16	Sidi Bou Zid I	EE	-	D/O, F	8	3	16 km	A
1	Sidi Bou Zid II	F	-	D/O, EE	2	9	0 km	D
17	Kasserine Pass	F	EE	D	7	3	3 km	A
2	Rapido North I	F, RivC	-	D/O, EE	2	8	0.7 km	D
3	Rapido North II	F, RivC	-	D/O, EE	2	8	1 km	D
4	Rapido South I	F, RivC	-	D/O, E	2	8	0.5 km	D
5	Rapido South II	F, RivC	-	D/O, E	2	8	0.8 km	D
28	Bowling Alley I	F	E(RF)	D	6	6	0.75 km	D
59	Bowling Alley II	F	E(LF)	D	7	6	2 km	A
29	Bowling Alley III	F	E(LF)	D	3	6	0.2 km	D
11	Mortain I	F	-	D	3	6	0.8 km	D
6	Mortain II	F	-	D	4	7	4 km	D
7	Schaidt I	F	-	D/O, EE	4	7	0.85 km	D
8	Schaidt II	F	E(RF)	D/O, F	3	9	0.15 km	D
9	Schaidt III	F	-	D/O, F	4	6	0.5 km	D
18	Wahlerscheid	F	-	D	7	4	1.1 km	A
19	Krinkelt-Rocherath I	F	E(LF)	D	5	4	5 km	A
10	Krinkelt-Rocherath II	F	-	D	3	7	0.3 km	D
15	Schnee Eifel Center	F	E(RR)	D	7	2	1 km	A
30	Schnee Eifel South	F	E(LF)	D	6	5	2 km	A
58	Schnee Eifel North I	F	-	D/O, F	8	2	4 km	A
60	Schnee Eifel North II	E(LR)	-	D	8	2	1.5 km	A
41	Our River Center	F, RivC	EE	D	6	5	3.25 km	A
42	Our River North	F	E(RF)	D	6	5	2 km	A

* Engagement numbers reflect the ordering of the engagements for model parameter computation (see Appendix E). Engagements are presented here in chronological order, as are the preceding engagement narratives.

Appendix B

SUPPLEMENTARY MATERIAL ON FOCUSED DISCUSSIONS

Introduction

This appendix includes two items:

- A copy of the discussion guide used for the focused group discussions of combat veterans.
- A summary of the discussions, arranged by the military operations in which the men participated.

These items will be found on the following pages.

Guide for Discussions with Veterans

Before meeting begins. Greet each participant and ask him to read and sign release form.

Introductions. Go around table, with each person giving his name and anything else, briefly, that he feels is relevant.

Introduction to the discussion. Explain confidentiality. A list of participants must be submitted to the client agency as one of our deliverables, to show that we carried out this part of the study. That list will not, however, be in the study report. In the study report, statements made by participants may be quoted, but will not be attributed to them by name, and no participant's name will appear in the study report. Participants may be identified by rank at the time of the operation, assignment, and/or branch of service.

Stress the focus of the study: to learn more about breakpoints, that is, about that time in a combat engagement when a unit is forced to shift from attack to defense, or to shift from holding a position to fighting a delaying action, or withdrawing, or surrendering. State that we wish to learn more about the circumstances that make that happen, so that the Army can model combat more realistically. Stress that we are not concerned with apportioning blame or credit, but rather with determining which factors are crucial in forcing a change of combat posture.

Stress that the main purpose of the discussions is generating hypotheses; that is, we especially want to know the participants' thoughts on why things happened the way they did.

Ask participants to identify themselves by a first or last name, nickname, or unit and rank in 1944 before each remark, to help us sort out the tape. State that we know some of them have done a great deal of thinking about this, in some cases much research, and that this is great and is why we're so especially glad to have them here, but that we don't want anyone who hasn't thought about the engagement since 1944 [for example] to feel overhumble. We want everyone to contribute, and we count on everyone to give everybody else a chance. We also want them to try to distinguish between what they observed and experienced at the time and what they may have read later, and to base their comments and judgments as much as possible on the former.

Note that the other people working on this study would like to have a chance to sit in briefly on our discussions, and that we would like to have them, if the participants have no objection. Mention Dr. Janice Fain, Lt. Col. Chuck Hawkins, and Lt. Col. Tom Price, with brief information on each.

Plan for the meetings. Outline the plan for the discussions: First, Mr. Anderson will give a summary of the action as we understand it. Then Mrs. Hammerman will throw out some questions for which we'd like the participants' answers. Finally, we will have a general discussion of what happened and why, as the participants see it.

Briefing by DMSI historian. Briefly introduce Mr. Anderson. He will give a brief summary of the operation as we understand it, with use of maps. (Dates should be made very clear, so that boundaries of the action being discussed are understood.) Friendly and enemy positions before engagement will be pointed out, and there will be a summary of events, including what we see as the breakpoint, or posture change, with date and time.

Questions for discussion

1. Placing the participants in the action. Where were you at the beginning of the action [give specific time]? What did you see and do?

2. Earlier history of the unit from your experience, and your own earlier military experience.

a. Training. Tell us a little about your training. Did you feel it was thorough? Did you feel competent to do what you were asked to do in this engagement?

b. Unit cohesion. Did the men work together well? Was there pride in the unit? [Note what unit the men identify with -- platoon, company, battalion, regiment, division. Leave the question open ended.]

c. Personnel turbulence. How long had each of you been with the unit? Had most of the men in the unit been with it about that long? Had there been recent replacements?

d. Combat experience. How much combat experience had the unit had?

e. Quality of replacements. How good were the recent replacements? Do you remember what efforts were made to orient them to the situation and integrate them into the unit?

f. Leadership. Which leaders do you think were important? Tell us something about these leaders.

g. Staff work. [For those who had a chance to observe it.]

3. Circumstances of the action.

a. Physical stress at the time. How long had you been in combat when the engagement began? How long had you been in your positions? How did you get there? by foot? vehicle? How long did it take? In general, how did you feel before the action started? How did you assess the way the other men, or the men under your command, felt?

b. Weather. What was the weather like? How did it affect how hard it was to do your job? Was there rain? snow? mud? fog? other visibility problems?

c. How did the terrain and vegetation affect operations, as you saw it?

d. Unit's position. What did you think of the unit's position before the engagement? Did there seem to be enough men to hold the position [or carry out the attack]? What about fields of fire? Flanks covered? Did you have confidence in the units on your flanks? Were you attacking [or holding] high ground in relation to the enemy? Was there adequate cover and concealment?

e. Fire support. Did you have adequate artillery support? armor support? air support?

f. Engineer support. [In operations where this question is relevant.] Did you have adequate engineer support -- for example, road building, bridge building, mine clearing, boat supply?

g. Weapons. Did you have the weapons you needed within the unit? Antitank weapons? Grenade launchers? Others?

h. Ammunition. Did you have enough ammunition? Was there any specific category of ammunition that was in short supply?

i. Fuel. [When relevant for the operation.] Did you have adequate fuel to support the mission you were given?

j. Rations. What was your situation on food? Were you short of rations? How long had it been since you had had a hot meal?

k. Water. What was your situation as to drinking water? Was there a problem of troops being dehydrated?

l. Maps. Did you have maps of the area adequate for your needs?

m. Medical services. Did you have confidence that the wounded were being and would be properly cared for?

n. Communications. Any problems with communications?

o. Intelligence. Do you think you had fairly good information on enemy strength and dispositions?

p. Enemy weapons. How much incoming fire did the unit experience? Which enemy weapons played an especially important role?

q. Casualties. What was your impression, during the engagement, of the number of casualties your unit was taking? What about the rate of casualties (for example, casualties per hour out of a 200-man company)?

4. The posture change (breakpoints). When and why did you first suspect that things were not going well? When did you first learn that [the attack was being stopped and you were going on the defensive, moving back, etc.]? How did you get the word?

5. Discussion: Significant factors in the posture change. Why do you think [the attack failed, you pulled back, the unit was forced to surrender, etc.]?

Do you think the decision was made to change posture -- for example, stop the attack and go on the defensive -- largely because of what had happened already in the operation, because of what was happening at the time, or because of what the commander anticipated was going to happen?

Summaries of Focused Group Discussions by Combat Veterans

Operation A: 36th Infantry Division at the Rapido River (Group #3)

For this operation, there was one discussion group of three veterans. Two of these men had been enlisted men, one a rifle squad leader and one a mortar man in a weapons platoon. The other was an artillery battalion staff officer. The officer could discuss problems of artillery support, but it was the enlisted men who could give the best view of the operation: the crossing of the Rapido River against strong enemy resistance. The two men were from the same company, but had not seen each other for over 40 years when they met for the discussion. Both had made the crossing on the second night, and had been among the minority of those who crossed who were able to withdraw back across the river when the attack failed.

These men had convincingly clear, detailed memories of the crossings and preliminary events, and they seemed to make a careful and conscientious effort to speak accurately and exactly. With the use of a map of the area provided by the research team, they were able to reconstruct their separate actions, agreeing on the location of landmarks.

The picture that emerged was of a fine National Guard division

- that had seen considerable combat and was suffering from having many recent replacements who were not fully integrated into their units
- that was engaged in a kind of operation for which it was not properly trained
- with inadequate joint infantry-engineer training and coordination
- with confusion among at least some of the troops as to their orders and objectives before the operation began

- whose attacking force was threatened with encirclement because it was placed on a hostile shore in intense crossfire from massed enemy weapons.

The factors listed above were those the men judged crucial to the breakpoint.

Casualties were heavy in this operation, but these men were not aware of large numbers of casualties until they were already on their way back across the river. They made individual decisions to turn back, primarily to avoid being captured. They were out of touch with any officers, and had no targets to fire at.

Operation B: 45th Infantry Division at Anzio Beachhead (Group #14)

There was a single one-person discussion. The participant was a retired general officer, an extremely vigorous man with a clear memory of the operation. This was an intense German counteroffensive against the 45th Division sector of the Anzio beachhead that resulted in withdrawals but created no permanent penetration of the Allied line at Anzio. The participant served as assistant division G-2 during the operation, and was thus able to see the operation from division level.

In this officer's judgment, the key breakpoint factors were effective enemy maneuver, the tactical deficiencies (as he saw them) that had placed the Allied force in such a vulnerable position, and the high enemy-friendly force ratio. (It might be noted that this force ratio was in itself a tactical achievement by the enemy; the Germans did not have a larger strength pool to call on, but had succeeded in concentrating a greatly superior force at the point of attack.)

Operation C: 28th Infantry Division at Schmidt (Group #8)

It was difficult to find veterans of this Pennsylvania National Guard division who had been at Schmidt and were in the Washington, D.C., area. The group consisted of two men, a former enlisted man who had been a combat engineer and another former enlisted man, a medic, who had been wounded before Schmidt, was hospitalized during Schmidt, and was back with the division for the Ardennes counteroffensive. He became a military historian after the war, and his writing on the 28th Division in the Ardennes has been published. He and the Schmidt participant knew each other, and he was invited to join the discussion to provide background data on the division and to help trigger the other participant's memory.

As an engineer, the participant played an important role at Schmidt, where road repair and bridge construction were vital. However, he was not in a position to observe much combat or judge combat-related breakpoint factors, since Schmidt was a collection of small actions in broken, forested terrain, and his engineer unit experienced no breakpoint. The poor roadnet and the physically and psychologically isolating effect of the terrain are listed as key factors on the basis of the discussion.

This group was further enhanced by telephone conversations with three 28th Division veterans of Schmidt who were combat soldiers. These men contacted the study team as a result of a notice placed in their division association newsletter, even though the notice stated that only veterans in the Washington, D.C., area would be able to participate in the research. The men all had clear memories of the action, and each man had been with a different one of the three regiments that attacked at Schmidt. The decision was made to hold telephone discussions with each of these veterans and invite

their views on factors that were crucial to the breakpoints. Memoranda of the conversations were added to the report that was prepared on the Schmidt discussions, and the comments of these men have been incorporated into Figure III-2 of this report.

These infantrymen each saw different parts of the action, but the picture that emerges from talking with them is one of high casualties, very heavy enemy shelling, frequent small German counterattacks and infiltration, ammunition shortages, and poor communications. One or more of them cited the following factors as key to the breakpoints: high casualty rate, enemy flanking maneuvers, communications failures, and ammunition depletion.

Operation D: 106th Infantry Division at the Schnee Eifel (Groups #1, #4, #6, #11)

The 17 men representing this operation were seen in three groups of 4-7 men, plus one 1-person discussion. There were 4 former officers (2 platoon leaders and 2 staff officers), and 13 former enlisted men. Representing the two regiments caught on the Schnee Eifel and cut off were 5 veterans (including 1 platoon leader) of the 422d Infantry, and 6 veterans (including 1 platoon leader and 1 battalion staff officer) of the 423d Infantry. There was 1 enlisted man from the 424th Infantry, the regiment that was able to maintain contact with the unit on its right flank, resist effectively, fall back in good order, and join in the defense of St. Vith. There were also 3 artillerymen, including an officer on the division artillery staff and a forward observer for corps artillery who was caught with the 106th on the Schnee Eifel. Finally, there were 2 members of a cavalry squadron attached to the 106th and assigned to screen one of the lower-lying areas adjacent to the ridges.

A number of points need to be made about this group of 17 participants. For almost all of them, the three days (16-19 December 1944) on and near the Schnee Eifel made up their only combat experience of World War II -- and for the great majority, their only combat experience. This experience was a disaster for the 106th Division and a severe defeat for US arms, and the division received a good deal of negative publicity at the time. Many of these men have spent a great deal of time during the decades since in trying to decide what the chief causes of the division's failure were, and what, if anything, they personally could have done to make things come out better. It is probably partly for this reason, plus the fact that there were so many men participating in the discussions, and also because of the dimensions of the failure, that these participants listed so many key breakpoint factors -- by far the largest number listed for any operation. It should be stressed that these were not by any means all the factors discussed or stated to be present, but only those that most members of a discussion group felt were crucial, that they felt made a real difference in whether or when the breakpoint occurred.

The high enemy-friendly force ratio was cited by the cavalrymen caught in one of the thinly held, vulnerable gaps through which the German forces poured. One of the discussion groups stressed the German maneuver of pushing through these weak spots, plus infiltrating behind the Americans, so that the troops on the Schnee Eifel were surrounded before they realized the danger.

The high casualty rate, and especially the loss of a battalion commander and the concern about being able to care for the wounded, were listed as key factors in the surrenders by one discussion group, partly on the basis of the testimony of a staff officer who had been with one of the surrendering

regimental commanders when he made his decision.

The high-level intelligence failure, which meant that this division was caught almost completely by surprise by the greatest German counteroffensive of the war in Western Europe, was stressed by one discussion group. Men in all the groups reported that they had heard evidence of massive German movements before the attack, and most expressed frustration that despite their units' having reported this activity, no notice seemed to have been taken by higher headquarters.

Officers in one discussion group cited the terrain which, once the men moved off the Schnee Eifel, was broken by many narrow, steep-sided crevasses, as unusually conducive to fragmentation of units, especially when they were moving at night, as was the case here. Other groups did not think the terrain a major factor, describing it as like Rock Creek Park in Washington, D.C., or like West Virginia -- broken terrain, but nothing extraordinary.

Poor communication was the one factor cited by all four discussion groups. As one officer said, "Communications were better during the Civil War; we didn't have horsemen." Veterans at all levels expressed frustration over the inability to get information and stressed the importance of this factor.

Low ammunition allotments and depletion of ammunition were cited by three groups. Absence of air support and artillery support, plus the absence of needed and expected supply by air, were also cited. A member of one group stressed strongly the importance of maps in the hands of officers and noncommissioned officers down to the level of first sergeant, and the group seemed to agree.

A large number of human factors were cited by one or more of the groups

as crucial to the breakpoints. Most often cited were the division's history of extremely high personnel turnover (it had been drastically stripped for overseas replacements after it had completed its training and division maneuvers), its complete lack of combat experience, and weaknesses in the leadership. Although most groups could cite some examples of good leadership, one group (the one-person group) stressed poor platoon and company leadership, another stressed poor company and battalion leadership, and in two other groups poor regimental and division leadership seemed clearly implied as a key factor. Poor staff work was cited by two groups; it was felt that many of the division's problems, including communications and supply, were partly caused by, or were exacerbated by, inefficiency or lack of initiative and aggressiveness among staff officers.

In the case of staff work as well as many other things that went wrong for the division, its complete lack of combat experience -- it had just arrived in Europe and had been in the line only five days when the Germans launched their counteroffensive -- was felt to be an underlying and important factor. Three discussion groups gave inexperience as a key factor in the breakpoints. One group also cited the short time the units had been in their positions, with little time to develop plans to meet a counterattack or to get their communications net in working order, for example.

Other human factors listed were poor unit cohesion, the fact that these completely inexperienced troops were given equally inexperienced officers to lead them; poor training and fitness of the troops; the troops' expectation that they were being sent to a quiet sector and would not be called on to fight; hunger among the troops; and a confusion among the troops as to orders and objectives, a confusion that developed before they made contact with the

enemy. These six factors were all listed only by the participant in the one-man discussion group. He was a relatively young man (early sixties) with clear, precise memories, and as company medic he had been in a good position to judge the men's fitness and to evaluate the company leadership, confidence, and cohesion. A professional psychologist, he appeared to bring a balanced, thoughtful approach to the discussion. Nevertheless, he was only one man from one company, whereas other factors listed for this operation came out of discussions among four to seven men.

Not all participants agreed that whatever weaknesses in cohesion, training, and leadership the 106th Division had were of critical importance to the breakpoints. One participant pointed out that the 424th Infantry Regiment, which happened to be deployed to the right of the main German thrust and was not caught on the Schnee Eifel ridge, did not experience the same kind of breakpoints, but rather fought effectively and fell back in good order (the withdrawal being necessitated by its open left flank). It was made up of the same kinds of troops and officers as the 422d Infantry and 423d Infantry.

Operation E: 2d Infantry Division at Krinkelt-Rocherath (Group #5)

There was a single one-person discussion. The participant had been commander of a company in this operation, and had dealt with the operation entirely at the company level. It happened that this man, the only veteran of this division who had participated in the operation and could be found in the Washington area, is a military historian who has written on this operation and on the Battle of the Bulge as a whole. His memory of the action was very clear, and he has had the opportunity to revisit its site several times.

He has a clear understanding of the breakpoint concept, and carefully discriminate' between factors that were present but not critical to the breakpoint and factors that were critical.

The participant cited the lack of antitank weapons to counter enemy tanks, depletion of ammunition, and the weakness of artillery support as the critical factors leading to the withdrawal of his company. He stated that casualties were light and were perceived by him as light at the time. He also stated specifically that enemy maneuver was not a factor, although eventually it would have become one if the company could have held the position much longer. At the time of the breakpoint, his unit was under frontal attack only; the men were threatened with being overrun because they had no weapons to use against the tanks that were firing on them and little or no ammunition of any kind.

Operation F: 7th Armored Division at St. Vith (Groups #2, #7, #12)

For this operation, there were two groups of 6 and 3 men, plus a one-person discussion. The one-person discussion was with the retired general officer who had commanded Combat Command B of the 7th Armored Division, plus the other units that carried out the defense of St. Vith. This officer was in his late eighties, but generally still clear in his memories of events. He seemed a convincingly sound source on his reasons for ordering withdrawals when he did.

The other 9 men included 5 former officers and 4 former enlisted men. Two of the officers were artillerymen, another was a reconnaissance platoon leader, and another was adjutant of a tank battalion. The fifth officer was adjutant of a cavalry reconnaissance squadron. He returned from hospitaliza-

tion near the end of the St. Vith defense and took little part in the operation, but was invited to join the group because of his good knowledge of the division's personnel, training, and previous experience.

One of the enlisted men was sergeant in the reconnaissance platoon led by one of the officers; another was acting personnel sergeant major in an armored infantry battalion; a third was motor sergeant in the headquarters company of a tank battalion; and the fourth was a jeep driver with a reconnaissance troop.

All these veterans had clear and precise memories of the operation, with the exception of the jeep driver, whose memories were very limited. One of the officers was markedly less articulate than the others, but appeared to be clear about his memory of the details he contributed.

The groups for this operation cited fewer factors as critical to the breakpoint than those for any other operation. Essentially, what they said was that the force withdrew because it would have been cut off and surrounded by the enemy if it had not. Although the men listed a number of problems, including inadequate cold-weather clothing, inadequately trained replacements, and leadership deficiencies, they agreed that none of these problems was significantly responsible for the withdrawal. They raised the legitimate question of whether there was any true breakpoint in this operation. They did not see their withdrawal as a posture change forced by enemy action against them, but rather as the completion of an assignment to hold St. Vith for a specified time period (extended five days). Holding out longer would have done no good, because the center of gravity of the German attack had shifted westward. They would have been isolated and cut off without contributing anything further to the Allied effort.

The other breakpoint factor, cited by one group, of exhaustion following five days of intense combat, was offered by one of the officers (and agreed to by the group) more as a reason why it was sensible to withdraw at that point than as a factor precipitating a breakpoint. The feeling was that while the units could have held on longer, officers and men were reaching the point of diminishing returns in energy expenditure, since their decision-making and effectiveness of action were beginning to be affected by physical exhaustion.

Operation G: 24th Infantry Division at Taejon [Kum River] (Group #10)

There was a single one-person discussion. The participant had been an enlisted man, a gunner in the crew of a 105mm towed gun in an artillery battery. He was not with his battalion at Taejon, but he was able to give a very clear account of the destruction of his battery at the Kum River, a few miles north of Taejon, and of the last stages of the defense of Taejon as they appeared to a soldier making his way through the city with a small group of stragglers.

This man's memories seemed clear and precise, and his comments and judgments were thoughtful. He appears to have been mistaken by two days in the dates of the events he describes, but otherwise his account fits well with the Army's official history and, of course, provides considerably more detail.

The participant discussed a number of factors, including his unit's inexperience and sudden introduction to combat, but decided that the key factors in the unit's breakpoint at the Kum River were the breakdown of its communications and, especially, the enemy enveloping maneuver. The battery

was caught between a strong enemy frontal attack and an enemy roadblock on its withdrawal route. The survivors were ordered to destroy their weapons and withdraw on foot cross-country.

Operation H: 2d Infantry Division at Kunu-Ri (Group #13)

This operation was represented by a single one-person discussion group. The participant was a retired Regular Army officer who was also a veteran of one of the targeted World War II operations and had participated in an earlier discussion of that operation. He served as regimental G-2 during the Kunu-Ri operation. His memories were clear, full, and precise.

The operation followed the massive entry of Chinese forces into the Korean conflict. The 2d Infantry Division was caught in an attack posture with extended supply lines, and while aware that some Chinese troops had entered the war, had no idea of the very large numbers; corps and theater headquarters were equally ignorant. This operation is considered to begin when the 2d Division had already shifted from an attack posture to a delay posture. During the operation there were two breakpoints -- the decision to break contact with the enemy and withdraw some distance to the south, and the shift from withdrawal to military ineffectiveness for two regiments of the division as they attempted to withdraw through a six-mile pass between ridges, under almost continuous enemy fire.

The participant saw only two factors as crucial to both breakpoints: the high-level intelligence failure on the size and location of Chinese forces and the effective enemy flanking maneuvers. For the first breakpoint, the very unfavorable force-strength ratio was also a factor; decision makers had by that time realized that US(UN) forces were greatly outnumbered. On

the other hand, the 2d Division troops in the pass were not outnumbered and did not believe they were outnumbered, although the Chinese strength was much greater than the Americans realized; the local strength ratio was about 1:1. In the pass, the overwhelming enemy superiority was not in numbers but in tactical position, achieved by effective flanking maneuver that made maximum use of terrain characteristics.

Appendix C

DISCUSSION OF LITERATURE

Introduction

Following is a discussion of the earlier works that were found to be most relevant to an understanding of forced posture change. Full citations for these works, and for other works that were consulted and found to provide useful background material, are listed in the bibliography that follows this discussion.

The Clark Report

An early work on casualties and combat effectiveness by Dorothy Clark was undertaken to "... investigate the validity of the statement that a unit may be considered no longer combat effective when it has suffered N% casualties."(1) N had been estimated to fall in the range of 20% to 30%, with the value 30% widely used.

Clark's data set consisted of the activities of 44 US infantry battalions taking part in seven engagements in the European Theater during World War II. She defined an engagement as "... the period of combat during which the parent division fought to carry out a specific mission, its termination being marked by a period of relative inactivity following a definite success or failure in achieving the mission."(2) Her principal conclusion was this:

> The statement that a unit can be considered no longer combat effective when it has suffered a specific casualty percentage is a gross oversimplification not supported by combat data.(3)

A major reason for Clark's conclusion was the wide range of casualties associated with breakpoints as illustrated in the following table.

Table 1. Clark's Range of Cumulative Casualties by Breakpoint Type

Type of Breakpoint	Cumulative Casualties % (Men and Officers)
Attack-Reorganization-Attack	0 - 55
Attack-Defense	6 - 99
Defense-Withdrawal	11 - 73

Clark did find that the average casualties for the first two breakpoint types fell into the 20-30% range and speculated that this finding might be the basis for the frequently made assumption that casualties of this magnitude destroy a unit's ability to carry out its mission. This, she said, was a gross oversimplification, and she noted that such statements must be very carefully qualified. Her more accurate description of the evidence from the combat data follows.

1. Cumulative losses of enlisted men in the range of 7 to 48% (average 26%) are associated with the inability of an attacking infantry battalion to fulfill its mission. The unit may be able to continue the attack after a few hours if more than half the losses are incurred in a short time (no longer than 24 hours); otherwise it must revert to defense.
2. Cumulative losses of enlisted men in the range of 37 to 69% (average 52%) are associated with the withdrawal of an infantry battalion in defense to prevent its collapse which may be presumed to be imminent.(5)

However, Clark pointed out that the use of cumulative casualties was not the most meaningful approach to the data because it left out any consideration of time. Yet merely dividing the cumulative casualties by the length of the engagement to compute an average loss per day "... produced a wide spread of data and no illumination."(6) Her approach to taking time into consideration was to partition her data base into three time periods and to compute casualties for each period. She chose the periods 2-4 days, 6-11 days, and 13-22 days. She does not explain this choice of periods; apparently her data set had no 5-day or 12-day engagements.

Although Clark rejected casualties as the sole determinant of breakpoints, she provided a detailed discussion of the relationships among casualties, replacements, and timing for the breakpoint categories. Her discussion is based primarily on the information given in her Table 2.(7) The following tables are based on that table, but are somewhat simplified.

Table 2, below, shows the numbers of engagements whose durations fell into each of the three time periods.

Table 2. Distribution of Clark's Cases by Duration of the Engagement

Breakpoint Category	2-4 Days	6-11 Days	13-22 Days	Totals
Atk-Reorg-Atk	6	3	0	9
Atk-Def	9	8	4	21
Def-Withdraw	0	9	4	13
Totals	15	20	8	43

Table 3 shows the average cumulative and net casualties by breakpoint category and duration of the engagement. The casualty figures have been rounded to the nearest percent.

Table 3. Clark's Average Percent Cumulative and Average Percent Net Casualties

Breakpoint Category	Rank	Duration of the Engagement					
		2-4 Days		6-11 Days		13-22 Days	
		Cum	Net	Cum	Net	Cum	Net
Atk-Reorg-Atk	Enlisted Men	15	14	19	16	25	17
	Officers	12	11	16	8	22	9
Atk-Def	Enlisted Men	6	5	14	7	28	9
	Officers	5	4	12	7	26	8
Def-Withdraw	Enlisted Men	13	11	26	22	52	38
	Officers	9	6	25	19	46	32

Cum = Cumulative casualties from the start of the engagement to the breakpoint
Net = Cumulative casualties minus replacements

In addition to casualties, Clark discussed other factors involved in producing breakpoints. Her list is given below.

- **Condition of the troops at beginning of the engagement.** Here Clark discussed three main areas of concern: experience, strength, and training. She identified three aspects of experience: actual combat experience, length of the rest period just prior to the current engagement, and the nature of the unit's latest combat activities in terms of difficulty and performance level.

Strength components were actual unit strength in relation to authorized strength and the number of new replacements. Training included previous combat experience in the same terrain and climate, training for some special type of service, and training for the particular situation in the current engagement.

- **Unusual environmental stresses.** Clark did not discuss this factor, but merely observed that "A unit which might be able to carry out its mission in fair weather and level terrain might be unable to continue under the added stresses of cold, rain and mountainous country."(8)

- **The imperative of the assigned mission.** Clark suggested that the urgency of the mission must "certainly influence" the decisions of the commanders. She suspected that the manner in which officers transmit orders downward will influence the determination of the individual soldiers, at least in well-integrated groups.

- **Morale.** Clark identified two aspects of morale -- the attitude of the troops toward the political purpose of the war and their pride and confidence in their own units.

- **Leadership.** This was recognized as a major factor. As far as the battalion was concerned, Clark thought that the battalion and company-level officers probably had greater influence than those at regimental and divisional level.

- **Tactical plan.** A defective tactical plan may be impossible to carry out. Clark noted that "Defects in tactics may, of course, occur at any level with the possibility of equally disastrous effects...."(9)

- **Reconnaissance.** Clark concluded that "... lack of reconnaissance may seriously affect the outcome of battle because both terrain and the enemy strength and positions are unknown."(10)

- **Enemy opposition.** Clark listed this factor with the observation "The opposing enemy forces may prove to be too strong to be handled by the units committed or in reserve."(11)

This factor is a strange one to place on the list. First, it is always present when a unit is forced to change posture; by definition, a posture change indicates that the opposition was too strong to be handled. Second, it is certainly covered by other factors -- for example, poor leadership, poor tactical planning and/or reconnaissance failures.

- **Fire support and reinforcement.** The value of these factors is self-evident. The only criticism is that they were listed together, since they are certainly independent; the presence (or absence) of one does not indicate the presence (or absence) of the other.

- **Logistical support.** The logistical failure of most immediate and direct effect on the battle is running out of ammunition or fuel. In the engagements studied by Clark this factor did not play a major role in breakpoints, although it is easy enough to imagine circumstances in which it would, and a list of critical factors could not be considered complete without it.

- **Communications.** Clark noted that communication failures were present in all breakpoint cases studied. They were, however, "... usually preceding and often contributive but apparently never the decisive factor."(12)

Clark's discussion of contributing factors is logical, plausible, even compelling, but nothing is "proved." She gives anecdotal evidence but there is no counting or measuring frequencies of occurrence. Her data base apparently had no quantitative data except daily strengths, replacements, and casualties.

This observation is likely to be true of the majority of studies based on historical data, since these numbers are the most readily available. Other quantitative data such as numbers and types of equipment, and troop locations (and thus, movement rates), can be obtained by some digging through the records. Other nonquantitative information like weather, terrain, morale, leadership, and tactical planning can sometimes be identified and coded for insertion into a data base. However, logic, plausibility, and confirming cases are likely to be the basis of most models of combat operations.

The McQuie Study

The idea that casualties do not, by themselves, generally produce a defeat in battle was the conclusion of a recent study of 80 battles by Robert McQuie. McQuie looked at cumulative casualties as well as at all reasonable variants -- casualty rates, relative casualties, and, for battles dominated by armor, tank losses. His results are summarized in Table 4, which provides median values of the specified casualty and casualty-related factors.

Table 4. Median Values of Critical Factors at Engagement Termination (McQuie Study)

Engagement Terminated By	Median Values When The Engagement Was Terminated			
	Cumulative Casualties	Casualty Rate	Casualty Ratio	Force Ratio
Attacker	LT 4%	LT 0.2%/hr	2:1	1.3:1
Defender	LT 8%	LT 0.4%/hr	0.8:1	1.7.1

LT = Less than

Having concluded that the range of casualties at which units changed posture was too great to assign casualties the major role in producing such changes, McQuie looked carefully at the engagements to determine the causes and produced the lists given in Table 5, below. As indicated above, McQuie's work has been presented in two papers, one published and one unpublished, which differ enough to make it worthwhile to examine both. Lists from both papers are given to show the two ways of categorizing the factors.

Table 5. Reasons Listed by McQuie for a Force Abandoning an Attack or a Defense

List 1	List 2
PRESENT UNIT CONDITION	MANEUVER BY ENEMY
Adjacent Unit Withdrew	Envelopment, encirclement, penetration
No Reserves Left	Adjacent friendly unit withdrew
Casualties or Losses	Enemy occupied key terrain
Surprised	Enemy achieved surprise
Supply Shortage	Enemy reinforced
POTENTIAL ENEMY ACTION	
Envelopment, Encirclement or Penetration	FIREPOWER BY ENEMY
	Casualties or equipment losses
Enemy Occupied Key Terrain	Heavy artillery and air attacks by enemy
Enemy Reinforced	
Heavy Artillery & Air Attacks by Enemy	OTHER REASONS
	No reserves left
EXTERNAL INFLUENCES	Supply shortage
Truce or General Surrender	Truce or surrender
Change in weather	Change in weather
Mission was to withdraw	Orders to withdraw
(Source: Unpublished paper)	(Source: Published paper)

These lists illustrate two ways of viewing posture changes. The category titles of List 1 suggest a focus on time; the first category, present unit condition, refers to conditions existing at the current time, and the second category, potential enemy actions, refers to possible actions in the future. The grouping of the factors themselves, however, suggests a focus on the actors; the factors in the present category are all described as actions, or conditions, of the friendly unit, while the factors in the potential category refer to the opponent. In spite of the title, the factors themselves are not future conditions. Except for heavy artillery and air attacks by enemy which could be ongoing actions, the factors are all related to past actions.

The significance of this grouping of factors is the implied recognition that a unit's own actions may be instrumental in producing posture changes. This implication is not present in the categories of List 2, which focus principally on the enemy, dividing the factors into those involving maneuver and those involving firepower. Those factors related to the friendly side are lumped into a miscellaneous other category.

These McQuie categories suggest a recognition of two key questions:

- Are forced posture changes due primarily to present conditions or primarily to expectations of future conditions? and
- Are forced posture changes more strongly influenced by friendly force failures and errors or more strongly by enemy successes and avoidance of errors?

McQuie provides no definitive answers. We appear now to be able to say only "Yes and no; it all depends on the particular situation."

The Adkins Thesis

Richard Adkins sees engaging in, or ceasing to engage in combat as the result of a decision-making process based on the values of state variables which describe the combat system Casualties is mentioned as one of these. His list is given below:

- Mission and associated objectives
- Number of casualties and number of key personnel who are casualties
- Rate at which casualties are occurring
- Availability of critical supplies*
- Availability of communications with subordinate units and higher HQs
- Force ratio of friendly and enemy combatants**
- Relative tactical posture of friendly and enemy combatants
- Training and experience level of friendly combatants
- Fatigue and motivation
- Proportion of reserves committed
- Status of adjacent units
- Weather and terrain conditions
- Availability of reinforcements and supporting fires
- Availability of means to evacuate and treat casualties(13)

In discussing the concept of state variables, Adkins makes three important points:

- The list above is by no means exhaustive, and the variables listed are not all independent...(14)

---

* In another section, Adkins mentions ammunition specifically.
** In another section, Adkins lists "perception of relative force size."

• The state variables describe the state of nature at any point in time, and the value of any particular state variable might or might not be relevant to the commander's decision process.

• According to U.S. Army doctrine the state variables which should be relevant are those influencing the unit's capability to perform the mission. This same statement might not generally be applicable to all other armies in all tactical situations because of differences in doctrine, training and motivation.(15)

Adkins does not discuss the individual factors further nor provide reasons for his particular choices. This is not surprising, since creating such a list was not one of his goals; the list is provided only to illustrate the concept of state variable.

Adkins's principal contribution to this project is the idea that not all of the variables are relevant in all situations; circumstances will dictate which factors a commander will consider when deciding on a posture change in a specific situation. It may be observed that, in considering the posture change to be the result of the commander's decision making, Adkins ignores the (rare) cases of spontaneous posture changes by the troops themselves.

The Dupuy Paper

The works discussed so far have identified factors responsible for, or associated with, posture changes, but they have not specified precise relationships between the factors and posture changes. Only the Dupuy paper lists specific conditions under which an attacker and a defender will change posture. Dupuy does not derive his parameter values directly from historical data, but rather suggests them as historically reasonable interim values, to be corrected by analysis of a large number of forced posture changes.

For a defending force, according to Dupuy, three out of the following four states are sufficient for a posture change:

- The combat power ratio (defender/attacker) is less than .5
- The defender is suffering casualties at a rate greater than 6% (division); 15% (brigade); 42% (battalion).
- The attacker is advancing at a rate greater than 1 km/day.
- In an adjacent sector, the opponent is 10 km behind the defending unit's FEBA.

For an attacking force, Dupuy suggests that three out of the following four states are sufficient for a posture change:

- The combat power ratio (defender/attacker) is less than 1.1.
- The attacker is suffering casualties at a rate greater than 4% (division); 10% (brigade); 28% (battalion).
- The attacker is advancing at a rate less than 1 km/day.
- In an adjacent sector, the opponent is 10 km behind the attacking unit's FEBA.

Two observations are immediately obvious. Dupuy focuses on actual conditions, not perceptions of conditions, and he uses both current values and rates. This is made clearer below.

Table 6. Factors in the Dupuy Posture Change Conditions

Factor Category	Current Value	Rate
Force strength	Combat power ratio	Casualty rate
Tactical position	Opponent's position	Attacker's advance rate

It should be noted that the current value and the rate do not refer to the same variable. That is, the casualty rate is not the time derivative of the combat power ratio, but both are related to force strength.

The statement of these conditions suggests that Dupuy sees posture changes as due to both current conditions and future expectations; by confining his factors to the primary, or direct, categories of maneuver and firepower, he avoids the question of who is at fault. As far as a posture change is concerned, it does not matter, for example, whether the attacker's advance rate is low because of difficult terrain, loss of vehicles or the defender's fire.

A major contribution by Dupuy is the idea that factors operate together. That is, it is not the existence of a single factor that will produce a posture change, but rather the coming together of several unfavorable circumstances.

Notes

Please note that full citations for all works will be found in the Bibliography.

1. Clark, Casualties as a Measure of the Loss of Combat Effectiveness of an Infantry Battalion, p. 1.
2. Ibid., p. 8.
3. Ibid., p. 34.
4. Ibid., p. 21.
5. Ibid., p. 20.
6. Ibid.
7. Clark, p. 21.
8. Ibid., p. 30.
9. Ibid., p. 31.
10. Ibid., p. 32.
11. Ibid.
12. Clark, p. 33
13. Adkins, "Analysis of Unit Breakpoints in Land Combat," pp. 36-37.
14. Ibid., p. 37.
15. Ibid., p. 32.

Bibliography

LITERATURE ON POSTURE CHANGES

Group 1

Adkins, Richard C. Analysis of Unit Breakpoints in Land Combat. Monterey, Calif.: Naval Postgraduate School, 1975.

Clark, Dorothy K. Casualties as a Measure of the Loss of Effectiveness of an Infantry Battalion. ORO-T-289. Baltimore, Md.: Operations Research Office, The Johns Hopkins University, 1954.

Dupuy, Col. T.N. (USA, Ret). Representing Battle Termination in Combat Simulations: The Modeling of "Defeat Criteria." (Prepared for Sandia Laboratories.) Fairfax, Va.: Data Memory Systems, Inc., 1987.

McQuie, Robert. "Battle Outcomes: Casualty Rates as a Measure of Defeat." Army, November 1987, pp. 31-34.

_____. "Causes of Defeat in Battle (1941-1982)." Bethesda, Md.: U.S. Army Concepts Analysis Agency (unpublished paper). 1987.

Group 2

Best, Robert J. Analysis of Personnel Casualties in the 25th Infantry Division. ORO-T-22(FGC). Baltimore, Md.: Operations Research Office, The Johns Hopkins University, 1952.

_____. Casualties and the Dynamics of Combat. McLean, Va.: Research Analysis Corporation, 1966.

Goure, Dan. "Disruptions of Soviet Military Operational Plans." (Unclassified Excerpts from a 1985 Draft Input to a Report). Vienna, Va.: Science Applications International Corp., 1988.

Helmbold, Robert. Decision in Battle: Breakpoint Hypotheses and Engagement Termination Data. R-772-PR. Santa Monica, Calif.: RAND, 1971.

_____. Combat History Analysis Study Effort (CHASE): Progress Report for the Period August 1984-June 1985. Bethesda, Md.: U.S. Army Concepts Analysis Agency, 1986.

Sloan, John, and others. Soviet Style Wargames. Vienna, Va.: Science Applications International Corp., 1986.

Spring, S.G., and S.M Miller. FASTVAL: Relationships among Casualties, Suppression, and the Performance of Company-Sized Units. Santa Monica, Calif.: RAND, 1970.

Willard, D. Staff Memorandum on the Duration of a Battle. McLean, Va.: Research Analysis Corporation, 1963.

Appendix D

DISCUSSION OF POSTURE CHANGE FACTORS

Purpose

Figure V-3 in the main body of the report listed the posture change factors collected from the literature, discussion groups, and historical research. The purpose of this appendix is to present a discussion of each factor and the assessment that was made of its potential as a building block for the breakpoint model.

Methodology

Each factor was considered individually on the basis of the literature survey, assessment by the discussion groups, and, where available, of data from the Breakpoints Data Base.(1) Each factor was then either retained or rejected as a potential building block for the breakpoint model.

When numerical data are shown, they are presented in one of two forms:

- Averages are used for variables like personnel ratios, casualty rates, and advance rates.
- Cross tabulations are used to relate factor classes to the major posture change classes -- attacker posture changes and defender posture changes.

Where appropriate, tests of significance (Chi-square and Fisher's exact test) were made. The results are summarized in Figure D-27.

Discussion of the Factors

1. High Enemy/Friendly Force Ratio

Clearly, an opponent's combat strength, relative to a unit's own strength, will influence what that unit is able to do in combat. In some form, this factor was on every list.

In discussing it, Clark defines a unit's combat strength as: "Actual unit strength in relation to authorized strength at the beginning."(2) The actual unit strength takes care of the denominator; the numerator may be related to the factor Clark calls enemy opposition. This term is never clearly explained, possibly because she considered an explanation unnecessary. She merely remarks: "The opposing forces may prove to be too strong to be handled by the forces committed or in reserve." Here she appears to be thinking in terms of a ratio.

Adkins lists force ratio, but it was not among McQuie's set of factors causing breaks, although, of course, some factors on his list would logically accompany a high enemy/friendly ratio.

Dupuy lists combat power ratio, which depends in part on numbers of personnel, weapons, and equipment, but also on operational, environmental, and (in some cases) quantified compilations of intangible factors.

For the operations discussed by the veterans, the force ratio was high in 63% of the cases (5 of 8). In these cases, it was decisive in 2, significant in 2, and of unknown effect in the remaining 1.

Unlike the procedure for the other factors, judgments on the presence and significance of the force ratio were made by DMSi historians, not the veterans, since the actual personnel force ratio is a matter of the

historical record, while the combatants could not have had this information at the time. Their perceptions of the force ratio and their judgments of its effect are given in the discussion of the next factor.

Figures D-1 and D-2 show the averages of attacker/defender ratios for personnel, armor, artillery, and supporting air sorties for both attacker and defender posture changes.(3)

The divisional-level cases indicate that, for all force types -- personnel, armor, artillery and supporting air -- lower initial force ratios are associated with attacker posture changes. For example, on the average, engagements starting with personnel force ratios (A/D) of 1.9 end with attacker posture changes; at initial force ratios of 2.7, they end with defender posture changes.

On the other hand, in the regimental-level engagements, lower initial attacker/defender force ratios are associated with defender posture changes. Since U.S. units were the defenders in the majority of the defender posture change cases, these constitute a highly biased sample. What is seen in Figure D-2 may reflect a difference in U.S. policy toward posture changes rather than a universal relationship between initial force ratios and posture changes.

An analytical difficulty with these initial ratios is that they represent only the situation at the beginning of the engagement. We know that casualties do not occur to both sides at the same rate, so these initial ratios do not represent the situation immediately prior to the posture change.

Figure D-3 compares the average initial and final personnel ratios. Since there is evidence that heavy casualties are suffered by units while

executing a posture change, the final ratios may not represent the actual pre-posture-change situation, but they provide another piece of information.

The suggestion has been made (4) that perhaps it is neither the initial nor the final ratio that is critical to a posture change, but rather a sudden, unfavorable change in a ratio. Figure D-3 suggests that while a modest increase in the attacker/defender personnel ratio occurs when the attacker changes posture, a dramatic change accompanies a defender posture change. Unfortunately, as mentioned above, we cannot be sure whether the final ratio is a cause of the posture change or a result of it.

We believe that a factor representing a unit's relative combat capability must be included in the breakpoint model. This conclusion is based on the literature, the assessment by the discussion groups and a conviction that the counter-conclusion (i.e., that a positive change is unrelated to relative combat capability) would be difficult to justify. This factor was retained for further consideration in the breakpoint model development.

2. Perception of High Enemy/Friendly Force Ratio

This factor was mentioned by Adkins, who sometimes referred to the force ratio and sometimes to the perception of the force ratio.

For 7 of the 8 operations for which there were discussion groups, the discussion group members judged the enemy/friendly force ratio to be high. They felt that this perception was decisive in 1 case and significant in 3 cases in bringing about the breakpoint. As interesting as this question is, we have no quantitative data on the influence the commanders' perceptions had upon the decision to change posture.

Considering how subjective this factor is and how unlikely we are to have adequate information on it for future conflicts, we concluded that it should not be included in the breakpoint model.(5)

3. Heavy Personnel Casualties

Clark made several important observations about casualties:

- Before the subject can be discussed, it must be clear just what is meant by "casualties." She examined the following:

  - Casualties and net casualties, in percent, on the day of the breakpoint

  - Cumulative casualties and cumulative net casualties, in percent, for the day of breakpoint plus the two days preceding

  - Cumulative casualties and cumulative net casualties, in percent, from the start of the engagement to the breakpoint

- Average casualty rates, computed by dividing the cumulative casualties from the start of the engagement by its duration, do not appear to be useful. As Clark remarked, computing these rates "produced a wide spread of data and no illumination."

- On the basis of her data, casualties on the day of the breakpoint appear to be more significant than casualties on this day plus the two preceeding days.(6)

- However, and this was Clark's principal conclusion regarding casualties:

> The statement that a unit can be considered no longer combat effective when it has suffered a specific casualty percentage is a gross simplification not supported by combat data.(7)

McQuie lumped personnel casualties and equipment losses into one factor and reported that it was the cause of breaks in 10% of his cases. Adkins listed both casualties and casualty rates as factors to be considered. Dupuy chose casualty rates as one of the test variables used to determine if a break takes place.(8)

The effects of casualties as judged by the discussion groups are: decisive, 2 cases; significant, 1 case; insignificant, 4 cases; and not present, 1 case.

In one of the discussion-group cases in which the effect of casualties was coded insignificant, the only discussant was a division staff officer who, because of his assignment, was in a position to know the basis on which the decisions had been made. He said that no unit of the division, even those cut in half by casualties, gave up, stopped fighting, or withdrew without orders. He also stated that decisions to order withdrawals were not made on the basis of casualties, but rather because of the tactical situation.

Similarly, participants described the tactical situations in the other cases that were coded insignificant as such that withdrawal or, in one case, destruction of the unit as a military force, could not have been avoided, however low the casualty rate at the time of the breakpoint.

On the other hand, an enlisted man, discussing another operation, was asked what factors were most important in bringing about the breakpoint. He unhesitatingly pointed to "casualties" as the sole determining factor.

For the breakpoint model, we judge that either casualty rates or casualties -- possibly both -- should be included. We do not think that Clark's negative view of casualty rates is completely justified. Since she defined the start of an engagement in terms of the parent division's actions, she may have averaged casualties over days in which the unit was not in combat as well as periods in which its mission changed. It is, thus, not surprising that her average casualty rate was a meaningless figure.

4. Severe Equipment/Weapon Losses

Equipment losses as a separate factor did not show up on any list. As noted above, McQuie lumped personnel casualties and equipment losses together and reported that this combination was responsible for breakpoints in 10% of his cases.

Equipment losses were known to be severe in 4 of the operations discussed by the groups. They judged these losses to have been significant in 2 of these operations and insignificant in the other 2.

Figures D-4 and D-5 show the average percent losses in armor and artillery for attacker and defender posture changes. No clear pattern emerges. When the divisional-level attacker changes posture, his average artillery losses are higher than those of his opponent, but his average armor losses are lower. When the defender changes posture, his average armor losses are higher than those of his opponent. This factor was retained for further consideration although there is a lack of supporting quantitative data.

5. Defective Tactical Plan

This factor was mentioned by both Clark and Adkins, but it is not one of McQuie's breakpoint causes. Clark observes:

> A unit may be unable to carry out its mission if the tactical plan, or the implementation of the plan, is poorly conceived. Defects in tactics may, of course, occur at any level with the possibility of equally disastrous effects on an infantry battalion. (9)

However, in spite of the extreme importance of well-conceived, realistic tactical plans to mission success, we do not think that this factor is suit-

able for the breakpoint model -- in part, for the same reasons that it does not appear on the McQuie list.

It is not the existence of a defective tactical plan that is a direct cause of a posture change, but rather the consequences of attempting to carry out that plan. For example, a bad plan may leave a flank exposed, but this will not, by itself, lead to a posture change unless the enemy takes, or threatens to take, advantage of it. The exposed flank could have arisen in a number of other ways -- for example, the forced withdrawal of an adjacent unit or the lack of adequate reserves. Including defective tactical plan in the breakpoint model would represent an attempt to find first causes for the circumstances leading to the posture change rather than to provide descriptions of those circumstances. Therefore, the factor was rejected for the model.

6. Low Troops/Frontage Ratio

This factor refers to the disposition of the friendly forces. It differs from the enemy/friendly force ratio in that it refers to the relationship of the troops to territory rather than the relationship of their numbers to the numbers of their opponent.

This factor was contributed by the discussion groups. The results were: decisive, 1 case; significant, 2 cases; insignificant, 1 case; and not present, 4 cases.

Figures D-6 and D-7 show the distribution of engagements by defender troops/frontage ratios. At both the divisional and regimental levels, the majority of the engagements fell into the range below 2,000 men per kilometer, with nearly even numbers of attacker and defender posture changes.

This factor was rejected for the breakpoint model. The tables do not

suggest a strong relationship to posture changes, and in any case, the effect of this factor is adequately represented by force ratios.

7. Force in Tactically Vulnerable Position

While tactical factors were on most lists, only the veteran's groups discussed this specific situation. It was the only one judged to be present in all operations and was judged significant or decisive in all but one. The veterans described it in these terms: "We never should have been there." "If a more aggressive corps commander had ... seized key terrain [originally], that would have made a difference [in the breakpoint]." "Our positions were fine for attacking, but not for defending [at the end of a fragile supply line with poor communications]."

This is one of a group of tactical factors that was retained for further consideration.

8. Surprise by Enemy

McQuie found surprise to be a cause of breaks in 8% of his cases. The discussion groups judged it significant in 1 operation, insignificant in 3 and not present in 4.

The Breakpoints Data Base has information on the achievement of surprise in the engagements. Figures D-8 and D-9 show a count of engagements by the side achieving surprise versus the side changing posture.

At the divisional level, achieving surprise does not appear to help the attacker. The defender did force an attacker posture change in the one case in which he achieved surprise, but no conclusions can be drawn from one case.

The pattern at the regimental level is more striking. The attacker forced a defender posture change in 100% (10 of 10) of the engagements in which he achieved surprise, although the tendency, when there was no surprise, was toward an attacker posture change (13 of 19 engagements).

In spite of its importance to the combat outcomes (as shown by the results above),this factor was judged inappropriate for the breakpoint model because surprise is generally the cause of conditions leading to a posture change, rather than a direct cause of the posture change itself. It is possible that seeing an opponent suddenly appear at an unexpected place or in unexpected numbers might cause a unit to retire without fighting, but in such a case, an engagement will not have taken place. Once an engagement starts, then surprise is translated into other factors that affect the outcome directly.

9. Enemy Occupation of Key Terrain

This factor was cited as the cause of a breakpoint in 6% of McQuie's cases. Neither Clark nor Adkins mentioned it specifically, although both listed factors which would include this as a special case.

For the discussion groups, key terrain usually meant higher ground with opportunities for observing the opponent. In every operation in which it was present (6 out of 8 cases), it was judged to be significant. This factor was retained for further consideration.

10. Unfavorable Status of Unit in Adjacent Sector

While enemy maneuver might be assumed to include this factor, it is treated here as a separate factor because both McQuie and Dupuy did so.(10) McQuie found it to be a cause of breaks in 13% of his cases; Dupuy used it as one of his criteria for a posture change.

This factor is another of the set of factors related to maneuver and the relative position of the forces on the battlefield. Since it seemed clear that the model must address tactical questions, this factor was retained for further consideration.

11. Enemy Maneuver—Flanking, Envelopment, Penetration

Of the several factors related to tactical maneuver, this one was mentioned most frequently in the literature and by the discussion groups. McQuie found it given as cause in 33% of his cases -- the most frequently cited cause of breakpoints.

The discussion groups found it to be present in 75% of the operations (6 of 8) and decisive in all of these 6.

In discussing this factor, the veterans used such phrases as "they cut us off" or "they were moving in behind us." In one case they explained that the momentum of the enemy's attack had carried it beyond their unit and that, had they continued to hold where they were, they would have been isolated and powerless to affect the outcome significantly.

This factor was retained for further consideration.

12. Unfavorable Advance Rate

From the viewpoint of the attacker, a low advance rate is unfavorable; from the viewpoint of the defender, a high advance rate is unfavorable. Dupuy chose this as one of his four factors leading to a posture change, but it did not appear on any other list.

This factor was not explicitly discussed by the discussion groups. While it is relatively easy to determine its value from historical records (when they exist), it is not easy for combatants to assess advance rates at the time, and, in fact, it is not something they are likely to note in a pre-breakpoint situation.

We were able to infer the veterans' judgments on this factor as significant in 2 cases; present, but insignificant, in 1 case; of unknown effect in 1 case; and not present in 4 cases.

However, the group discussions were not a reliable source for estimates of the significance of this factor. The data base offered more information. Figure D-10 shows the effect of the attacker's average advance rates on posture changes.

As expected, this table indicates that posture changes by the defender are associated with higher attacker advance rates than are attacker posture changes. This observation holds for both divisional and regimental-level engagements.

This is one of those factors closely related to maneuver and tactical position. Our judgment was that it should be a breakpoint model factor, although some of its effects would probably be included also in one or more of the other tactics-related factors.

13. Lack of Artillery/Air Support

The groups judged that they received inadequate artillery support in 63% of the operations (5 of 8). Of these 5, the factor was felt to be decisive in 1 operation, significant in 3, and insignificant in 1. Air support was lacking in the same percentage of cases (63%), but its lack was judged significant in only 1 operation; in the others, it was seen as insignificant in producing the posture change.

We judged this factor unsuitable for the model; supporting fire is more properly handled by the combat model; the consequences of the fire support would be input to the breakpoint model.

14. Heavy Enemy Artillery and Air Attacks

McQuie found this factor to be decisive in 2% of the cases he examined, but it is not mentioned as a separate factor in any other list.

The discussion groups remembered heavy artillery attacks in 5 of the operations. They judged them significant, but not decisive, in 60% of the operations in which they were present (3 of 5 cases).

Figures D-11 and D-12 show the average initial numbers of artillery pieces and the numbers of supporting air sorties.

These tables show data at different levels of reality: the air sorties represent support actually provided during the engagements; the artillery numbers represent capabilities, but do not indicate how they were used during the engagement.

This factor was judged unsuitable for the breakpoint model, since modeling air and artillery attacks is basically the responsibility of the ground combat model. While their effects -- in terms of their contributions to casualties and equipment losses -- will certainly play some role in the breakpoint model, to include air and artillery attacks as separate factors would indicate that they have a special significance beyond their destructive potential. While there is evidence that this may be the case (suppression effects, for example), these effects are the responsibility of the ground combat model if they are to be included at all.

15. Lack of Reserves

Adkins listed reserves as a factor to be considered, and McQuie found the lack of reserves to be a decisive factor in 12% of his cases. The discussion groups found a lack of reserves significant in 1 case; present, but insignificant, in 2; and not present in 5 of the operations.

There are no quantitative data on the numbers of reserves present and employed in the engagements in the data base. However, the cases have been coded to indicate whether one side had an advantage over its opponent in the

matter of reserves. Figures D-13 and D-14 link the advantage of reserves to posture change.

The effect on posture changes of having an advantage over an opponent in the matter of reserves is striking. At the divisional level, the attacker forced a defender posture change in 100% (14 of 14) of the engagements in which he held the advantage. When he did not have an advantage (either the defender or neither held it), the defender forced an attacker posture change in 67% (30 of 45) of the engagements.

The same pattern is seen in the regimental-level engagements. When the attacker had the advantage of reserves, the defender changed posture in 82% (9 of 11) of the engagements. The attacker changed posture in 75% (9 of 12) of the engagements in which the defender held the advantage. There appears to be a bias toward a defender posture change in the neutral cases, but there are only six cases.

It seems clear that reserves play an important role in avoiding a posture change. Therefore, this factor was not rejected at this point in the study.

16. Supply Shortage

Clark listed logistical support as a factor to be considered; McQuie found supply shortage to be critical in 2% of his cases.

The discussion groups evaluated the unit's logistics in terms of shortages in all areas except ammunition, which was considered separately. They found shortages to have been significant in 1 operation, present, but insignificant, in 2, and no shortages in 5.

There are no quantitative logistics data in the Breakpoints Data Base. The engagements were, however, coded to indicate when one side had an

advantage over its opponent in this area. Figures D-15 and D-16 show the effect of an advantage in logistics on posture changes.

At the divisional level, the attacker forced a defender posture change in 83% (5 of 6) of the engagements in which he had an advantage. When the defender had the advantage, the attacker was forced to change posture in 80% (4 of 5) engagements.

It seems reasonable that a factor representing the current supply situation, as well as some factor representing the unit's expectation of receiving supplies, should be included. Therefore, this factor was selected as suitable for the model.

17. Inadequate Weapons

Adequacy of weapons implies not only a sufficient number, but also weapons of the appropriate kind to counter the enemy's weapons. This factor was not on any of the lists, but the discussion groups found it very important. It is phrased here in general terms, but in the operations discussed by them, it always meant a lack of adequate antitank weapons. This factor was decisive in 2 cases; significant in 1; present, but insignificant, in 1; and not present in 4.

This is clearly an important factor; however, it was judged not appropriate for the breakpoint model. Handling the mix of weapons employed by the simulated forces is the task of the ground combat model. If the mix is favorable to one side or the other, then that situation will show up in some of the combat descriptors -- losses or movement rate, for example. The breakpoint will certainly be influenced by this factor, but through an indirect path.

18. Lack of Food; Hunger

Lack of food has not often been a critical factor for US forces. The groups judged it present in 4 of the operations, but it played an insignificant part in causing the posture change. In all of these cases the troops had been without food, or on very short rations, for only a few days at most.

This factor was judged inappropriate for the breakpoint model. It was planned that some logistics-related element would be included, but we judged that ammunition and fuel are more reliable indicators than food.

19. Low Ammunition

The discussion groups judged this factor to be present in 4 of the 8 operations, and found it decisive in 3 cases and significant in 1. This factor is retained, although lack of quantitative data will be a problem in using it.

20. Communications Failure

Communications is on almost everyone's list of critical factors. Clark reported.

> More or less drastic failure in communications marked all the breakpoints studied, usually preceding them and often contributive but apparently never the decisive factor.(11)

Communication breakdowns, or inadequate communications networks and equipment, were present in a majority of the operations according to the judgment of the discussion groups. In every case where a communication failure was present, it was judged to be not just an inconvenience, but significant or decisive to the breakpoint. Without good communications, commanders could not order actions to be taken and could not locate either their own units or

the enemy. Soldiers who were willing and able to follow orders were uncertain about what to do.

Unfortunately, there are no variables in the data base directly related to communications with which to test its effects on posture changes.

Because of Clark's results, the opinions of the veterans, and the general importance assigned to communications, we concluded that it should be considered for the breakpoint model.

21. Poor Reconnaissance

Clark lists reconnaissance as a factor to be considered. Her comments indicate that she thought a lack of adequate reconnaissance to be serious:

> From the engagements studied, it was obvious that a lack of reconnaissance prior to the engagement may seriously affect the outcome of battle because both terrain and enemy strength and positions are inadequately known.(12)

The discussion groups ju[illegible] poor reconnaissance to have been present in only 2 of the operations, but it was significant in 1 of those 2.

While this is undoubtedly an important, even critical, factor, we judged it inappropriate for the breakpoint model. It is one of those factors whose consequences lead to posture changes, but the factor itself is not directly related to them. Therefore, it was rejected for the model.

22. Intelligence Failure

The discussion groups judged this factor to have been present in only 2 of the operations, but it was found to be decisive in both.

There are no quantitative data related to this factor in the data base, but it is another of those areas where the engagements have been coded to

indicate which side might have held an advantage over its opponent. Figures D-17 and D-18 show the effects of this advantage on posture changes.

At the divisional level, there are no cases in which the attacker had an advantage in the intelligence area. All three engagements in which the defender had an advantage ended in an attacker posture change. This is in contrast to the nearly evenly divided cases when neither side had an advantage.

The trends are similar at the regimental level. In all five cases of an attacker advantage, there was a defender posture change. When the defender had an advantage, the attacker was forced to a posture change in 86% (6 of 7) of the engagements. As with the divisional engagements, there was a nearly even division (7 to 10) when neither side held an advantage.

Clearly, an intelligence advantage over an opponent is helpful in winning. This is, however, another factor which causes conditions leading to a posture change; it does not describe conditions directly preceding it. Intelligence was therefore rejected as a breakpoint model factor.

23. Precombat Fatigue

This factor was contributed by the discussion groups, who judged it to have been present, but insignificant, in half the operations and not present in the other half. It was clearly not a major factor in their opinion.

It is not mentioned explicitly by any other analyst. The closest reference is by Clark, who listed "length of rest period or service in an inactive sector just prior to the engagement."(13)

This factor was considered inappropriate for the breakpoint model. It may be played by the ground combat model, if desired, and its effects will then show up in the breakpoint model input.

24. Little Time in Line Before Engagement

Under the general category of "condition of troops at beginning of the engagement," Clark lists "nature of the unit's latest combat experience." (14) Her discussion does not make clear just what aspect of that experience she means. She may have been referring to the unit's morale or to its acquisition of combat expertise, although she included morale and combat experience as separate factors.

The discussion groups judged this factor to have been decisive in 1 operation; present, but insignificant, in 3; and not present in 4.

It was decided not to incorporate this factor, as a separate factor, in the breakpoint model. It combines aspects of combat experience, surprise, and morale, but it describes a preengagement condition rather than the situation immediately preceeding the posture change.

25. Poor Overall Level of Training/Lack of Combat Experience

These factors are discussed together because the only related data in the Breakpoints Data Base combine them. Figures D-19 and D-20 show the effects of having an advantage in the areas of training and experience.

While training and experience are frequently mentioned as important factors, it was not usual for one side to have the advantage in this area in the engagements in the Breakpoints Data Base. Even when it did, this advantage did not always lead to a win.

Thus, in the divisional-level engagements, having the advantage did not help the attacker, who won 43% (3 of 7) and lost 57% (4 of 7) of them. The defender was slightly better at turning this advantage into a win, doing so in 80% (4 of 5) of the engagements. However, there were too few cases to find any of this significant.

At the regimental level, the attacker forced a defender posture change in 83% (5 of 6) of the engagements in which he held an advantage. When there was no attacker advantage, the engagements split almost evenly between attacker and defender posture changes (11 to 10).

This factor is much like the tactical plan factor, in that it has no significant direct link to posture changes, but probably plays the role of enhancing some other more closely linked factor. We judged that this factor was inappropriate for the breakpoint model at present. It may be a candidate for a second-generation model later.

This judgment should not be interpreted as a conclusion that training and experience are unimportant to combat forces. It is, rather, a conclusion that they represent causality rather than description.

c. Poor Training for Specific Operation

Clark recognized the importance of training by including several factors related to it on her list. She listed "previous unit training for some special type of service" and, also, "previous unit training for any special type of situation involved in the pending engagement."(15) She cited the example of units involved in river crossings for which they had had "little or no training or practice."(16)

The discussion groups cited this factor in only 2 operations. As expected from the nature of the factor, these were unusual operations. Like Clark's example, one was a river crossing. The nature of the river posed special difficulties that could have been mastered only by training on a similar river.

The second operation was a two-regiment withdrawal through a pass that provided cover on both sides for enemy troops who reached the area first and established a gauntlet of fire along the length of the pass.

The discussion groups found lack of specific training to be decisive in the first case and insignificant to the breakpoint in the second one.

This factor was judged not appropriate for the breakpoint model. The fact of poor training will undoubtedly affect the circumstances of the engagements, but it will be these circumstances that lead to a posture change, not the lack of training. For example, one effect of poor training can be a failure to use communications equipment effectively. However, it is the lack of communications, which can arise in numerous other ways, that is retained for consideration as a breakpoint model factor.

27. Inadequate Combined Arms Training

The discussion groups found this factor to have been present in only one operation, but there it was decisive.

This factor is not suitable for the breakpoint model. While training is important to combat outcomes, it is the results of training that will be input to the breakpoint model. (See the discussion above.)

28. Hasty Unit Commitment on New Ground

Clark discussed this factor under the general heading of "condition of troops at beginning of the engagement." She referred to it in the positive sense as "previous combat experience in the kind of terrain and climate in which the unit was being committed" and offered a further explanation: "A unit experienced in desert warfare in North Africa might, for instance, have difficulty in adjusting to its first experience in the Italian mountains"(17)

We judged this factor inappropriate for the breakpoint model, since any contribution to breakpoints is adequately covered by the factors of training and experience. This factor represents a nuance too fine to be handled at the current level of breakpoint modeling.

29. High Personnel Replacements

The number of new replacements in a unit at the start of the engagement is one of Clark's specific factors under her general heading "condition of troops."(18)

The discussion groups found that having high personnel replacements was a frequent situation (6 of 8 operations). However, this factor was decisive in only 1 operation and significant in 1. In the other cases, it was judged insignificant.

This factor was rejected for the breakpoint model. While it could be important to the performance of a combat unit, it is not clear that it belongs as a separate factor in the breakpoint model.

30. Troop Exhaustion During Combat

This factor was contributed by the discussion groups, who found it significant in 1 case; present, but insignificant in 3 cases; and not present in 4.

There are no data in the breakpoint data base relative to this factor. Figures D-21 and D-22 show duration of the engagement versus mission accomplishment, with the thought that fatigue might increase as the engagement is prolonged.

These tables do not show a relationship of any significance between the length of the engagement and posture changes. If the idea that fatigue is related to the duration of the engagements is accepted, then it would appear that fatigue is not an important factor for either side. This conclusion matches the opinions of the veterans, who found it significant in only 1 case out of the 4 in which it was present.

We concluded that fatigue should not be a factor in the breakpoint model. Certainly, this argument based on the engagement duration does no establish the lack of a relationship between fatigue and posture change (the assumption of a relationship between fatigue and duration could very likely be wrong). However, if there is an effect, it is an indirect one and should be played, if at all, in the ground combat model.

31. Poor Morale

Clark includes morale in her list of significant factors. Adkins combines a closely related idea with fatigue to list "fatigue and motivation."

Morale is another of the variables for which an advantage of one side over another is coded in the data base. Figures D-23 and D-24 show the effects of an advantage in morale on posture changes.

The divisional-level cases suggest that having an advantage over an opponent in the area of morale is not common (16 of 59 cases) and, when present, plays no great role in the outcome. When the attacker has an advantage, he forces a defender posture change in 63% (10 of 16) of these engagements. When neither side has the advantage, the defender has a slight edge, forcing an attacker posture change in 56% (24 of 43) of the cases.

Having an advantage in the area of morale is even less frequent in the regimental-level engagements (1 of 24).

Unlike such factors as experience and training, which refer to preengagement conditions and do not change significantly during an engagement, morale can be a volatile characteristic. It would seem almost certain that poor morale accompanies a posture change; establishing that it precedes the posture change and is a cause of it is harder.

This factor was retained for further consideration. While the data did not establish a strong relationship, and morale would be difficult to quantify, yet it is on almost everyone's list of factors to consider.

32. Low Mission Urgency

Both Clark and Adkins listed the mission as a critical factor. It appeared on Clark's list as "the imperative of the assigned mission." In discussing it, Clark commented:

> The degree of urgency of the mission assigned a unit may be assumed to influence its determination to carry out the order. If the order is to take an objective regardless of the cost or hold to the last man, this factor certainly must influence the implementing decisions of battalion and company officers who have to answer for any failure. . . . It seems possible that the nature of the order and the manner in which officers transmit it downwards may have sufficient influence to account for the willingness of some units to continue their mission at least for a time despite loss percentages at which other units break.(19)

Clark's discussion of this factor seems to indicate that she sees it as related to the leadership qualities of the commander.

The discussion groups found a high degree of mission urgency in 6 of the operations. It was clear to them that high mission urgency, even when expressed in such terms as "Hold at all costs!," does not prevent a breakpoint when other circumstances force one. However, in the single case in which the mission urgency was seen to be low, it was judged to be a significant factor leading to a posture change.

This factor was rejected for the model. While it has a strong intuitive appeal, there are no quantitative data to support it as a model component.

33. Poor Leadership

Leadership was on everyone's list of factors to be considered, but while the quality of leadership can be critical to combat outcomes on occasion, there is a wide range of leadership performance over which it apparently is not a determining factor.

Although most of the discussion groups criticized individual leaders, or categories of leaders -- especially young junior officers sent in as replacements -- they generally spoke highly of their leaders. Poor leadership was considered to be present in only 1 operation, where, however, it was judged to be one of a number of decisive factors. The leadership was rated good in 6 of the operations and not rated in 1.

Figures D-25 and D-26 show the effects of an advantage over the opponent in the quality of leadership, as entered in the data base. At the divisional level, there was only one case of an advantage in leadership. In this one case, it belonged to the defender, and the engagement ended in an attacker posture change. While this is the expected result, no conclusions can be based on one case.

There were a few more regimental-level engagements in which one side had a leadership advantage (8 of 29). In all but one of these, the effect is what would have been predicted -- the side having the advantage forced its opponent to a posture change.

We judged this factor inappropriate for the breakpoint model. This is another of those factors whose effects may be seen in the model input when it is present, although the factor itself is not included.

34. Poor Staff Work

This factor did not appear explicitly on any of the lists from the literature. Clark did list tactical plan and leadership, which could represent, respectively, the consequences and cause of this factor.

The discussion groups judged poor staff work to have been present in 2 of their operations. In 1, it was thought decisive and in the other, insignificant.

This factor is not appropriate for the breakpoint model, although when it is present, its consequences will undoubtedly appear in the input to the breakpoint model.

35. Troop Confusion Over Orders, Objectives

This factor was a contribution of the discussion groups. They recognized that any posture change is likely to be accompanied by confusion and, in citing this factor, they referred only to confusion that was reported to have been present well before the breakpoint occurred and, in one case, well before an attack began. They were, thus, careful to limit their discussion to confusion that could have brought about the posture change rather than confusion that was the result of it.

They judged that confusion, as they had defined it, was decisive in 2 operations, present but insignificant in 2, and not present in 3. For the eighth operation, they were uncertain about whether or not confusion had been present.

Although it is easy to visualize circumstances in which confusion leads to a posture change, this factor was judged inappropriate for the model. This is one of those factors that does not itself enter into the model, although its consequences do.

36. Poor, or No, Maps

This factor was contributed by the discussion groups, who judged it decisive in 1 operation; significant in 1 operation; present, but significant, in 2; and not present in 4.

Certainly, having proper maps is crucial to successful tactical planning and execution, but we judged that so fine a detail as having maps is inappropriate for the breakpoint model.

37. Poor Roadnet

This factor was found by the discussion groups to be significant in 2 cases, present but insignificant in 4, and not present in the remaining 2 operations.

The factor was judged inappropriate for the breakpoint model for two reasons: It is related to other factors (logistics, communications, movement rates) in which it plays a causal, rather than a descriptive, role; and it should be played, if at all, in the ground combat model, through which it will affect the input to the breakpoint model. That is, it is the effects of this factor, rather than the factor itself, that will enter into the breakpoint model.

38. Weather Change

McQuie cited a change in the weather as a cause of breaks in 2% of his cases. Clark discussed weather and terrain together.

The discussion groups found this factor present in only one operation, where it was insignificant to the breakpoint.

This factor was judged inappropriate for the model as a separate element. Any engagement in which weather contributes significantly to a posture change probably includes a failure of either leadership or morale.

39. Unfavorable Terrain

Clark covered terrain in two ways: as the unit's unfamilarity with the terrain and under the heading "unusual environmental stresses," as "inherently difficult terrain." She does not discuss terrain at length, but merely comments: "A unit which might be able to carry out its mission in fair weather and level terrain might be unable to continue under the added stresses of cold, rain, and mountainous country."(20)

In 5 of the 8 operations discussed by groups of veterans, the participants indicated that the terrain was unfavorable for carrying out their mission. In 1 case terrain was judged a decisive factor, in 3 others a significant factor, and in 1 case insignificant to the breakpoint. Thus it was judged decisive or significant in 80% of the cases in which it was present.

The factor of terrain is, without doubt, an important concern in planning and executing tactical operations. It would play a role in a ground combat model, but will not be a factor in the breakpoint model.

Notes

1. The analysis in this section, carried out early in the project, used the 24 newly researched engagements and 64 engagements from the LWDB. By the time of the model development phase, the data base had been reorganized as described in Section VI. While the entries in the figures shown in this section would be slightly different if the reorganized data base were used, the assessment of factors would not be significantly changed.
2. For sources cited, see the bibliography at the end of Appendix C.

3. The divisional-level engagements include both US-German and US-Japanese engagements. While numerical values of the various engagement parameters (casualty and movement rates, for example) are expected to differ significantly between these two groups of engagements, the conclusions regarding the identity of the factors for the breakpont model should not. For example, the initial attacker-defender personnel ratios for these engagements are shown below:

US Opponent	Posture Change by Attacker	Posture Change by Defender
Germans	1.9	2.7
Japanese	3.7	4.9
Combined	2.4	4.3

These numbers suggest that, regardless of the identity of the US opponent, the average attacker/defender personnel ratio is higher for those engagements ending in a defender posture change. Thus, even though the numbers are different, the trends are the same. For the tables in this appendix, the distinction between Japanese and German opponents will not be made.

4. Private communication from Dr. Daniel Willard, April 30, 1988.

5. The effects of perceptions may be investigated by sending false values to the breakpoint model. Thus, the analyst may ask a "what if" question of the type: "Although the force ratio is currently X, what would the model do if it were Y instead?" Of course, this treats a perception as fact and ignores such psychological questions as how a commander acts in the face of uncertainty. While there has been much work in the area of decision-making under uncertainty, treating posture change decisions from this viewpoint is well beyond the scope of this project; we are still trying to identify first-order effects.

6. This has led to the speculation that she may have been seeing casualties that resulted from, rather than caused, the break.

7. Clark, p. 34.

8. Of course, his concept of combat power ratio certainly depends in part on cumulative casualties.

9. Clark, p. 31.

10. Neither McQuie nor Dupuy used the words "unfavorable status of unit in adjacent sector." McQuie's factor was "adjacent unit withdrew." With the view that withdrawal certainly represents an "unfavorable status," his factor is discussed here. This was clearly what Dupuy had in mind in positing as a tentative criterion "the opponent is 10 km beyond the front line in an adjacent sector." Again, this factor seems the one most nearly related to this.

11. Clark, p. 33.

12. Clark, p. 32.

13. Clark, p. 29.

14. Clark, pp. 29-30.

15. Clark, p. 30.

16. Ibid.

17. Clark, pp. 29-30.

18. Ibid.

19. Clark, p. 31.

20. Clark, p. 30.

Table D-1. Average Initial Ratios (Attacker/Defender) vs Posture Changes in Divisional-Level Engagements

Ratio Type	Posture Change by			
	Attacker		Defender	
	Average	No.Cases	Average	No. Cases
Personnel	1.9	21	2.7	21
Armor	4.0	20	6.4	15
Artillery	3.2	30	8.7	29
Air sorties	4.7	10	20.5	4

Table D-2. Average Initial Ratios (Attacker/Defender) vs Posture Changes in Regimental-Level Engagements

Ratio Type	Posture Change by			
	Attacker		Defender	
	Average	No.Cases	Average	No. Cases
Personnel	3.3	13	1.9	16
Armor	3.8	10	2.1	13
Artillery	3.4	9	1.8	16
Air sorties	2.0	2	.3	6

Table D-3. Average Initial and Final Personnel Ratios vs Posture Changes (Attacker/Defender)

Engagement Level	Posture Change by			
	Attacker		Defender	
	Pers. Ratio (A/D)		Pers. Ratio (A/D)	
	Initial	Final	Initial	Final
Divisional	2.4	3.9	4.8	61.
Regimental	2.1	3.3	1.6	2.0

Table D-4. Average Weapon Losses (%/day) vs Posture Changes in Divisional-Level Engagements

Equipment Type	Posture Change by			
	Attacker		Defender	
	Avg %	No. Cases	Avg %	No. Cases
Attacker artillery losses	3.1	7	-*	-
Defender artillery losses	1.3	4	10.3	2
Attacker armor losses	5.7	17	1.8	18
Defender armor losses	18.4	5	15.3	4

* - indicates insufficient data for a computation

Table D-5. Average Weapon Losses (%/day) vs Posture Changes in Regimental-Level Engagements

Equipment Type	Posture Change by			
	Attacker		Defender	
	Avg %	No. Cases	Avg %	No. Cases
Attacker artillery losses	3.1	5	2.6	4
Defender artillery losses	10.	2	12.7	11
Attacker armor losses	7.9	11	15.5	13
Defender armor losses	7.	7	14.1	15

* - indicates insufficient data for a computation

Table D-6. Initial Defender Troops/Frontage Ratio vs Posture Changes in Divisional-Level Engagements

Defender Troops/Frontage (Men/Km)	Posture Change by Attacker	Posture Change by Defender	Totals
Ø - 999	9	14	23
1000 - 1999	13	11	24
2000 - 2999	4	3	7
3000 - 3999	2	Ø	2
4000 - 4999	1	1	2
GE 5000	1	Ø	1
Totals	30	29	59

Table D-7. Initial Defender Troops/Frontage Ratio vs Posture Changes in Regimental-Level Engagements

Defender Troops/Frontage (Men/Km)	Posture Change by Attacker	Posture Change by Defender	Totals
Ø - 999	8	10	18
1000 - 1999	4	4	8
2000 - 2999	1	Ø	1
GE 3000	Ø	2	2
Totals	13	16	29

Table D-8. Surprise vs Posture Changes in Divisional-Level Engagements

Surprise Achieved by	Posture Change by		Total Cases
	Attacker	Defender	
Attacker	5	5	10
Defender	1	0	1
Neither	24	24	48
Total Cases	30	29	59

Table D-9. Surprise vs Posture Changes in Regimental-Level Engagements

Surprise Achieved by	Posture Change by		Total Cases
	Attacker	Defender	
Attacker	0	10	10
Defender	0	0	0
Neither	13	6	19
Total cases	13	16	29

Table D-10. Average Movement Rates (Km/Day)

Engagement Level	Posture Change by	
	Attacker	Defender
Divisional	1.1	6.9
Regimental	.3	4.0

Table D-11. Average Artillery Pieces and Air Sorties vs Posture Changes in Divisional-Level Engagements

Force Type	Posture Change by	
	Attacker	Defender
Attacker artillery	143	87
Attacker air sorties	84	124
Defender artillery	81	45
Defender air sorties	77	2

Table D-12. Average Artillery Pieces and Air Sorties vs Posture Changes in Regimental-Level Engagements

Force Type	Posture Change by	
	Attacker	Defender
Attacker artillery	112	49
Attacker air sorties	9	29
Defender artillery	81	45
Defender air sorties	10	76

Table D-13. Reserves vs Posture Changes in Divisional-Level Engagements

Reserves Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	0	14	14
Defender advantage	3	1	4
Advantage to neither	27	14	41
Total Cases	30	29	59

Table D-14. Reserves vs Posture Changes in Regimental-Level Engagements

Reserves Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	2	9	11
Defender advantage	9	3	12
Advantage to neither	2	4	6
Total Cases	13	16	29

Table D-15. Logistics vs Posture Changes in Divisional-Level Engagements

Logistics Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	1	5	6
Defender advantage	4	1	5
Advantage to neither	25	23	48
Total Cases	30	29	59

Table D-16. Logistics vs Post re Changes in Regimental-Level Engagements*

Logistics Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	6	Ø	6
Defender advantage	1	2	
Advantage to neitner	6	14	20
Total Cases	13	16	29

* There may be difficulties with this data item in the regimental-level engagements.

Table D-17. Intelligence vs Posture Changes in Divisional-Level Engagements

Intelligence Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	Ø	Ø	Ø
Defender advantage	3	Ø	3
Advantage to neither	27	29	56
Total Cases	30	29	59

Table D-18. Intelligence vs Posture Changes in Regimental-Level Engagements

Intelligence Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	Ø	5	5
Defender advantage	6	1	7
Advantage to neither	7	10	17
Total Cases	13	16	29

Table D-19. Training/Experience vs Posture Changes in Divisional-Level Engagements

Training/ Experience Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	4	3	7
Defender advantage	4	1	5
Advantage to neither	22	25	47
Total Cases	30	29	59

Table D-20. Training/Experience vs Posture Changes in Regimental-Level Engagements

Training/ Experience Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	1	5	6
Defender advantage	1	1	2
Advantage to neither	11	10	21
Total Cases	13	16	29

Table D-21. Engagement Duration vs Posture Changes in Divisional-Level Engagements

Engagement Duration	Posture Change by		Total Cases
	Attacker	Defender	
2 days, or less	17	9	26
Longer than 2 days	13	20	33
Total Cases	30	29	59

Table D-22. Engagement Duration vs Posture Changes in Regimental-Level Engagements

Engagement Duration	Posture Change by		Total Cases
	Attacker	Defender	
2 days, or less	7	9	16
Longer than 2 days	6	7	13
Total Cases	13	16	29

Table D-23. Morale vs Posture Changes in Divisional-Level Engagements

Morale Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	6	10	16
Defender advantage	0	0	0
Advantage to neither	24	19	43
Total Cases	30	29	59

Table D-24. Morale vs Posture Changes in Regimental-Level Engagements

Morale Situation	Posture Change by		Total Cases
	Attacker	Defender	
Attacker advantage	0	1	1
Defender advantage	0	0	0
Advantage to neither	13	15	28
Total Cases	13	16	29

Table D-25. Leadership vs Posture Changes in Divisional-Level Engagements

Leadership Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	0	0	0
Defender advantage	1	0	1
Advantage to neither	29	29	58
Total Cases	30	29	59

Table D-26. Leadership vs Posture Changes in Regimental-Level Engagements

Leadership Situation	Posture Changes by		Total Cases
	Attacker	Defender	
Attacker advantage	0	2	2
Defender advantage	5	1	6
Advantage to neither	8	13	21
Total Cases	13	16	29

Figure D-27. Results of the Significance Tests

Factor Tested	Engagement Level		Test
	Regt	Div	
Artillery/air support	S	S	X
Mobility	N	S	P
Surprise	S	N	P
Reserves	S	S	X
Duration	N	S	X
Logistics	S	S	P
Intelligence	N	N	P
Training/experience	S	-	P
Morale	-	S	X
Leadership	S	-	X

Key: S = Significant (.Ø5 level)
N = Not significant
- = Too few cases for testing
X = Chi-square test
P = Fisher's exact test

Note: These tests were carried out on the tables in this appendix by Dr. Peter Shapiro, Arbor Inc., our statistical consultant for this project.

Appendix E

ESTIMATION OF THE PARAMETER VALUES FROM THE HISTORICAL DATA BASE

Purpose

This appendix describes methods for deriving values for the model parameters from historical data. For each of the two versions of the Breakpoint Model (the event version and the time-step version) two sets of parameter values are derived. One set of parameter values is appropriate for regimental-level engagements and one set for divisional-level engagements.

The Engagement Data

The names of the engagements are found in Figure II-3. Figures E-1 and E-2 show the following data items needed for the parameter computations:

Id	Engagement identification number
PC	Posture change type: A = Attack to defend D = Defend to retrograde movement
Eng Dur	Duration of the engagement (days)
Adv(Km/day)	Average attacker rate of advance (km/day)
Front Width	Width of the front (km)
Atk Pers	Initial number of attacker personnel
Def Pers	Initial number of defender personnel
Atk Cas	Average attacker casualty rate (percent of initial attacker personnel)
Def Cas	Average defender casualty rate (percent of initial defender personnel)

General Procedures for Parameter Estimation

Figures E-3 to E-20 display the sorted factor values from which the parameter values are derived. Each figure has the following four columns:

Id	Engagement identification number
PC	Posture change type: A = Attack to defend D = Defend to retrograde movement
Value	Value of the factor identified in the figure title.
Parameter	Estimate of the parameter value identified by the symbols A1, A2, B1, etc., shown in the flow diagrams. Capital

letters are used for the event version parameters, since these are the inputs to the model. Lower case letters are used in the time-step figures since these are the daily values from which the model parameters will be computed. (See the discussion below.)

For estimation of the time-step parameters, the engagement durations are added. The three long engagements (8, 11, and 12 days) are treated with the 6-day engagements.

The general procedure for the estimation of model parameters has the following steps for each factor:

1. Sort the engagements on the basis of the factor value.
2. Starting at the end of the sorted list favorable to an attacker posture change, go down (or up) the list to the first defender posture change.
3. The parameter value is the average of the values for the case of the defender posture change and the adjacent case of the attacker posture change.

To illustrate this procedure, a portion of Figure E-4 is reproduced below:

Id	PC	Value	
7	A	1.33	
10	A	1.39	
----------			1.41 = B1
15	D	1.43	
.	.	.	

The run of As is broken at engagement 15. The value of B1 is the average of 1.39 and 1.43, or 1.41.

Parameters for the defender are obtained in a similar way. To illustrate, the lower portion of Figure E-4 is shown below:

.	.	.	
4	A	4.22	
----------			5.56 = B2
18	D	6.90	
15	D	9.75	

The run of Ds is broken at engagement 4. The value of B2 is the average of 4.22 and 6.90, or 5.56.

In some cases, the runs of As and of Ds are broken at the same point. In this case, the value of the last A case and the value of the first D case are taken for the parameters. This situation is illustrated by the values for the change in personnel ratio in one-day engagements given in Figure E-14. A portion of this figure is shown below:

1	A	-0.04	
11	A	0.05	
6	A	0.18	= b1

16	D	0.24	= b2
19	D	0.91	

A third situation arises when the rules do not provide an unambiguous choice. A portion of the casualty ratios (from Figure E-7) is shown below:

18	D	0.25	
17	D	0.28	
----------			0.31 = E
6	A	0.34	
21	D	0.37	
----------			0.49 = E
7	A	0.61	
11	A	0.79	

Reading down from the top, the run of Ds is broken at engagement 6. Drawing the dividing line here leads to E = 0.31. However, the run of As which starts at the bottom is broken by engagement 21, leading to E = 0.49. Either value is legitimate according to the rules we established. The value E = 0.31 is used because it leads to one fewer errors in identifying the posture changes.

Finally, there are some cases in which an estimate of the parameter cannot be made. This occurs in the computation of parameter values for the time-step model when the already small number of cases is sorted by duration. For example, the personnel ratios for three-day engagements from Figure E-14 are shown below:

9	A	-0.02	no estimate
10	A	0.02	

Since there are no defender posture changes in this group of two engagements, we have no basis for estimating a parameter value.

The procedure described here leads to a first estimation of the model parameters that will not necessarily produce the fewest number of incorrect posture change identifications. For some factors, an anomalous engagement will interrupt the sequence of attacker (or defender) posture changes, so that a strict application of the rules would lead to a less successful parameter set.

For example, consider the following sequence of personnel ratio values taken from Figure E-9:

.	.	.	
36	D	4.07	
5	A	4.27	
---	---	---	4.55 = b2
45	D	4.82	
31	D	5.10	
57	D	5.24	
35	D	5.56	
16	D	5.82	
9	A	5.83	
11	A	6.12	
13	A	6.97	
---	---	---	7.19 = b2
58	D	7.41	
32	D	15.30	
37	D	16.62	
60	D	20.52	

(continued)

61	D	21.02	
52	D	29.39	
7	A	38.15	
----------			39.82 = b2
38	D	41.47	
50	D	45.84	
8	A	47.52	
----------			117.7 = b2
39	D	187	
34	D	444	
40	D	568	
33	D	595	

A strict application of the rules would produce a value of 117.7 for the parameter B2. However, an examination of the list shows the next breaks in the run of Ds occur at engagements 7, 13, and 5.

There are two competing objectives: any As included in the run of Ds increases the probability of making an error in the posture changes decided by this factor, but the power of the factor to reach a decision depends on the number of engagements within the parameter limits.

In this particular example, stopping at engagement 8 produces a probability of correct posture change identification of 1.0, but only four of the historical cases could be decided by this factor. If the dividing line is set at engagement 7, then the probability of being correct is .86 and the number of engagements within the parameter limit is 7. However, if the run of Ds is broken at engagement 13, the probability is still .86, but the number of cases is now 14. If we go further up the list to break the run of Ds at engagement 5, the number of cases increases to 22, but the probability drops to .77. The best balance between being able to decide and being able to decide correctly is not perfectly clear, but the parameter value of 7.19 appears to be a reasonable trade-off.

A workable rule is the following: when the choice of a parameter value is not clear, choose that value that maximizes the probability of making a

correct identification of the posture change, subject to the condition that at least 10% of the engagements lie within the chosen parameter value.

"Fine-tuning" of the parameter values made after a study of the model results might reduce the number of incorrect posture change identifications. This type of "fine-tuning" lies, however, more in the realm of art. Until more is known about the posture change conditions and until there are more historical cases in the data base, it seems better to retain parameter values derived by a set of rules which, although they cannot entirely eliminate the role of individual judgment, will, nevertheless, minimize it.

The Event Version of the Breakpoint Model

The event version uses five factors:

- Total Distance Advanced/Width of Front
- Final Personnel Ratio (Attacker/Defender)
- Total Attacker Casualties
- Total Defender Casualties
- Casualty Ratio (Attacker/Defender)

Figures E-3 through E-12 show the sorted values for these five factors for the regimental and divisional engagements. Estimates of the parameter values are made according to the procedures discussed above and are marked in each figure.

The Time-Step Version of the Breakpoint Model

The time-step version requires four factors:

- Cumulative Distance Advanced/Width of Front
- Change in Personnel Ratio (Attacker/Defender)

- Cumulative Attacker Casualties
- Cumulative Defender Casualties

While the general procedure for obtaining parameter values for the time-step version is similar to that for the event version, there are some differences. The most obvious, shown in Figures E-13 through E-20, is the sorting by the engagement duration as well as by the factor value, thus allowing model parameters to be derived for each duration. It might be preferable to use these parameters for the matching day of the simulated engagement -- that is, values computed from historical engagements lasting one day would be used on the first day of simulated combat; factors from engagements of two days' duration, for the second day of the simulated combat, and so on. There were, however, some durations having so few historical cases that reasonable parameter values could not be obtained. Therefore, pending a major new data collection effort, weighted averages of values for the individual durations were used for the factor checks on each day of simulated combat.

Computation of Parameters for the Regimental Engagements

Distance Advanced/Width of Front

Sorted values for this factor are given in Figure E-13 for the regimental engagements. Below is a summary of the values from which the weighted averages of the parameter values were computed.

Day	a1	a0*	a2	No. cases
1	0.10	..	1.67	11
2	0.63	0.63	1.50	4
3	..	..	..	.
4	2.00	0.67	4.00	3
Weighted averages		0.647	2.02	

* a0 = a1 / (Day - 1)

Change in Personnel Ratio

Sorted values for this factor are given in Figure E-14 for the regimental engagements. The values from which the weighted averages were computed are given below:

Day	b1	b0*	b2	No. cases
1	0.18	..	0.24	11
2	0.0	0.0	0.11	4
3	..	..	..	.
4	0.10	0.03	0.97	3
Weighted averages		0.013	.33	

* b0 = b1 / (Day - 1)

Casualties

Figures E-15 and E-16 show the sorted values of the total attacker and defender casualties, respectively. The values from which the weighted averages were computed are shown below:

Day	c	d	No. cases
1	3.72	15.12	11
2	3.28	6.45	4
3	..	..	.
4	7.60	17.39	3
Weighted averages	4.27	13.57	

Computation of Parameters for the Divisional Engagements

Distance Advanced/Width of Front

Sorted values for this factor are given in Figure E-17 for the divisional engagements. The values from which the weighted averages of the parameter values were computed are summarized below.

Day	a1	a0*	a2	No. cases
1	0.165	..	0.42	8
2	0.14	0.14	0.53	18
3	0.06	0.03	0.71	19
4	0.36	0.12	3.75	9
5	0.20	0.05	0.44	3
6	0.51	0.10	0.60	5
Weighted averages		0.089	1.04	

* a0 = a1 / (Day - 1)

Change in Personnel Ratio

The sorted values of this factor for the divisional engagements are given in Figure E-18. Values from which weighted averages are computed are shown below:

Day	b1	b0*	b2	No. cases
1	0.055	..	.135	8
2	0.005	0.005	0.05	18
3	0.06	0.03	5.64	19
4	0.68	0.227	33.10	9
5	..	..	..	.
6	-.04	-0.008	0.42	5
Weighted averages		0.052	7.05	

* b0 = b1 / (Day - 1)

Casualties

The sorted values of attacker casualties and defender casualties are given for the divisional engagements in Figures E-19 and E-20, respectively. The values from which the weighted averages are given below:

Day	c	d	No. cases
1	1.90	7.0	8
2	4.35	26.7	18
3	3.90	39.8	19
4	3.80	83.8	9
5	..	..	.
6	16.60	22.8	5
Weighted averages	4.83	36.6	

The parameter values derived as described here are summarized in Figures VI-6 and VI-9 in the main body of this report.

Significant Figures

Questions have been raised about the number of significant figures used in the numerical values of the model parameters. (See Figures VI-6 and VI-9.) These parameters, generally shown to three significant figures, are derived from historical data generally having two significant figures. This is consistent with the following procedural rules*:

- When rounding off an answer, keep one more figure than was present in the original data, and
- Never round at intermediate steps, only the final answer.

Even Wolf, who states the older rounding rules** (i.e., in adding or subtracting, keep the number of decimal places equal to the smallest number in the data set and in multiplying or dividing, keep the minimum number of significant figures), actually follows the newer rules in practice. For

*Robert R. Johnson, Elementary Statistics (Belmont, Calif.: Duxbury Press, Wadsworth, 1980), p. 30.

**Frank L. Wolf, Elements of Probability and Statistics (New York: McGraw Hill, 1962), p. 21.

example, he shows the product of 4 and .4 as 1.6 and the variance of a set of data, containing cases of one significant figure, as 8.25.***

Consider the Figure E-18, where the origins of the divisional-level parameters for the time-step version of the model are indicated. Generally, the parameter is an average of two data entries. Thus, for engagements lasting two days, the value of the parameter b2 is the average of .04 and .06, or .05. However, the value of b1 is the average of .00 and .01, or .005. Rounding up to .01 (or down to .00) does not convey clearly the idea that an average is taken, rather than either of the data values themselves.

One solution is to retain the significant figures in the discussion of the procedures for obtaining parameter values, but round the model parameter values themselves. The principal argument against doing so is again pedagogical. The reader may now easily associate each of the model parameters shown in Figures VI-6 and VI-9 with its computation in Appendix E. Since there is some precedent in the textbooks on statistics and data analysis for doing so, and since it aids an understanding of how the parameter values were obtained, the significant figures shown in Tables VI-6 and VI-9 will be retained.

It seems possible that some of the objection to the use of these significant figures arises from a confusion of the number of significant figures in a parameter with its implied range of applicability. There may be a subconscious feeling that assigning a value of 2.02 to a parameter indicates that the parameter is applicable on a much wider range of engagements than if its value were expressed as 2. This, of course, is not the case. We believe that the correct parameter values for the set of engagements currently in the Breakpoints Data Base are the values in Tables VI-6 and VI-9. Will these

---

***Ibid., p. 117.

values be the most appropriate for a different set of engagements? No definitive answer can be given until a new engagements set is examined, but we suspect the answer is no.

We expect the enduring portion of this project to be the idea that three general areas are critical in examining the termination of conflict engagements: (1) the tactical situation, (2) the relative combat power of each side, and (3) the losses of combat forces.

The particular factors chosen for the Breakpoint Model may last until the next major effort at combat data collection. For example, we expect that information on enemy activities in adjacent sectors will either replace the distance advanced as an indicator of tactics, or at least be an important addition to it.

The most perishable component of the model is the set of parameter values, which will not, we suspect, survive transplantation to a new engagement set.

Figure E-1. Data for the Regimental-Level Engagements

Id No	P C	Eng Dur (Day)	Adv (Km/ Day)	Front Width (Km)	Atk Pers (Men)	Def Pers (Men)	Atk Cas (%)	Def Cas (%)
1	A	1	0.0	4.0	2738	8380	13.4	0.6
2	A	1	0.7	1.0	8000	2200	5.1	0.6
3	A	1	1.0	1.0	7600	2200	8.8	0.6
4	A	1	0.5	1.0	7700	1800	2.1	0.7
5	A	1	0.8	1.0	7538	1800	7.6	0.7
6	A	1	4.0	3.0	8500	4600	4.4	13.0
7	A	4	0.9	1.7	6200	5025	2.6	4.2
8	A	2	0.2	2.0	4350	3450	1.9	1.4
9	A	3	0.5	1.2	4950	3700	2.4	1.8
10	A	3	0.3	3.0	9100	6600	3.3	3.6
11	A	1	0.8	2.0	8150	3700	8.6	10.8
12	A	2	0.0	1.8	6850	15350	27.0	1.1
13	A	1	0.0	3.6	[illegible]00	15777	31.7	1.5
14	A	2	1.0	3.2	7418	5000	0.8	0.7
15	D	4	1.0	1.0	4100	4100	1.2	22.6
16	D	1	16.0	22.0	6400	5333	0.3	17.2
17	D	2	3.0	4.0	7000	5303	1.4	5.0
18	D	4	1.1	1.0	8300	1400	1.1	4.5
19	D	1	5.0	2.5	3300	1357	3.0	29.5
20	D	1	0.3	1.5	5237	2500	0.9	96.0
21	D	5	0.2	1.2	9000	4836	7.3	20.0

Figure E-2. Data for the Divisional-Level Engagements

Id	F C	Eng Dur (Days)	Adv (Km/ Day)	Front Width (Km)	Atk Pers (Men)	Def Pers (Men)	Atk Cas (%)	Def Cas (%)
1	A	3	0.0	8.0	15637	19613	0.6	0.7
2	A	2	0.0	2.0	13400	7077	0.4	1.5
3	A	1	0.0	25.0	10300	22019	4.4	0.9
4	A	6	0.0	9.0	25497	27673	3.1	1.7
5	A	2	0.0	3.0	15986	4300	0.7	9.0
6	A	3	0.0	3.0	14594	5000	0.6	8.8
7	A	4	0.1	3.8	21247	3000	1.3	20.6
8	A	5	0.1	2.5	20973	4757	0.6	18.2
9	A	2	0.3	3.0	18660	4250	0.2	12.5
10	A	2	0.4	8.0	17404	6566	0.4	0.2
11	A	2	0.5	4.0	15840	3000	0.4	7.2
12	A	1	1.4	3.6	15224	5044	1.0	2.4
13	A	3	0.5	2.5	16091	3500	0.4	11.6
14	A	1	1.6	14.0	20683	12327	3.7	10.7
15	D	2	1.0	11.0	10348	6519	0.9	1.1
16	D	4	0.5	3.0	18777	4000	0.2	5.0
17	A	4	0.6	3.0	17300	6108	1.2	2.9
18	A	3	0.9	11.0	29711	15801	1.5	2.9
19	A	4	0.7	9.6	41974	20496	1.3	1.8
20	A	2	1.6	6.0	16600	6566	1.1	1.1
21	A	3	1.1	6.5	19047	10593	0.9	1.8
22	A	1	3.7	11.0	12447	8390	2.0	0.7
23	D	3	1.3	11.0	16232	6713	0.2	1.1
24	A	2	2.0	9.7	14733	12691	2.4	1.2
25	A	12	0.4	9.5	20493	20250	1.5	1.2
26	D	1	5.0	11.0	15871	6999	0.4	3.3
27	A	1	6.0	5.0	15646	8325	0.7	7.0
28	A	4	0.8	2.0	14600	4500	1.9	2.5
29	A	4	0.2	2.6	10000	4625	1.1	1.1
30	D	1	9.0	2.0	11000	4300	1.8	7.0
31	D	3	0.1	2.6	18111	4731	0.9	9.0
32	D	3	0.3	2.0	16002	2500	0.5	19.6
33	D	3	0.3	3.0	15808	2000	0.7	32.9
34	D	3	0.3	4.0	15205	2600	0.4	32.9
35	D	2	0.5	3.6	16043	3338	0.5	7.2
36	D	2	0.7	2.2	15109	5140	0.4	14.2
37	D	5	0.3	3.4	16291	2600	0.9	12.8
38	D	4	0.4	4.0	18388	2900	0.8	21.3
39	D	4	0.4	2.1	18095	3900	0.7	24.4
40	D	6	0.3	3.0	19047	3250	0.5	16.5
41	D	2	1.2	9.0	13095	4563	0.8	3.6
42	D	2	1.6	4.8	16870	6321	1.2	1.5
43	D	3	1.1	7.5	18702	9250	1.0	3.7
44	D	2	2.0	5.0	16458	7500	1.6	2.9
45	D	5	0.8	4.0	15721	3700	0.7	3.0
46	D	2	2.2	5.0	22641	13012	0.7	4.5
47	D	2	2.4	9.0	18476	7250	0.7	0.5
48	D	3	1.6	15.0	18030	6653	0.5	1.9
49	D	2	2.6	5.5	26607	10111	1.3	2.8
50	D	3	2.2	5.0	19082	2000	0.5	26.5
51	D	8	1.0	12.0	18228	7500	1.9	3.9
52	D	3	3.4	1.6	22888	1400	0.2	14.9
53	D	3	4.8	5.6	22974	12815	1.1	3.5
54	D	3	4.8	7.8	19971	11928	2.5	4.5
55	D	3	5.3	14.0	17925	6957	0.3	1.3
56	D	3	7.3	5.0	17232	6000	0.2	2.0
57	D	11	4.0	31.0	24098	5000	0.4	1.1
58	D	1	4.0	6.0	14300	2050	0.4	6.2
59	D	2	2.0	2.4	15730	5050	2.0	7.4
60	D	4	1.5	1.0	12800	4150	0.4	21.3
61	D	3	3.3	12.0	43800	5340	0.7	20.6
62	D	2	2.0	4.0	16000	5740	2.4	6.1

Figure E-3. Sorted Values for the Factor Distance Advanced/ Front Width for the Regimental Engagements (Parameters for the Event Version)

Id	PC	Value	
1	A	0.00	
12	A	0.00	
13	A	0.00	
8	A	0.15	0.175 = A1
20	D	0.20	
10	A	0.30	
11	A	0.40	
4	A	0.50	
14	A	0.63	
2	A	0.70	
16	D	0.73	
5	A	0.80	
21	D	0.83	
3	A	1.00	
9	A	1.25	
6	A	1.33	
17	D	1.50	
7	A	2.00	2.00 = A2
19	D	2.00	
15	D	4.00	
18	D	4.40	

Figure E-4. Sorted Values for the Factor Final Personnel Ratio (Attacker/Defender) for the Regimental Engagements (Parameters for the Event Version)

Id	PC	Value	
13	A	0.18	
12	A	0.21	
1	A	0.28	
8	A	1.25	
9	A	1.31	
7	A	1.33	
10	A	1.39	1.41 = B1
17	D	1.43	
16	D	1.44	
14	A	1.48	
6	A	2.03	
11	A	2.26	
3	A	3.17	
19	D	3.34	
2	A	3.47	
5	A	3.90	
4	A	4.22	5.56 = B2
18	D	6.90	
15	D	9.75	
20	D	51.9	
21	D	999.	

Figure F-5. Sorted Values for the Factor Total Attacker Casualties for the Regimental Engagements (Parameters for the Event Version)

Id	PC	Value	
16	D	0.31	
20	D	0.90	
14	A	1.60	
4	A	2.10	
17	D	2.80	
19	D	3.03	
8	A	3.75	
6	A	4.41	
18	D	4.46	
15	D	4.88	5.0 = C
2	A	5.10	
9	A	7.07	
5	A	7.63	
11	A	8.59	
3	A	8.76	
10	A	9.89	
7	A	10.3	
1	A	13.4	
13	A	31.7	
21	D	36.5	
12	A	54.0	

Figure E-6. Sorted Values for the Factor Total Defender Casualties for the Regimental Engagements (Parameters for the Event Version)

Id	PC	Value	
2	A	0.59	
3	A	0.59	
1	A	0.60	
4	A	0.72	
5	A	0.72	
14	A	1.40	
13	A	1.50	
12	A	2.20	
8	A	2.90	
9	A	5.41	
17	D	10.00	
11	A	10.81	
10	A	10.91	
6	A	13.04	
7	A	16.92	17.1 = D
16	D	17.20	
18	D	17.86	
19	D	29.43	
15	D	90.24	
20	D	96.00	
21	D	100	

Figure E-7. Sorted Values for the Factor Casualty Ratio (Attacker/Defender) for the Regimental Engagements (Parameters for the Event Version)

Id	PC	Value	
20	D	0.01	
16	D	0.02	
15	D	0.05	
19	D	0.10	
18	D	0.25	
17	D	0.28	0.31 = E
6	A	0.34	
21	D	0.37	(0.49 = E)
7	A	0.61	
11	A	0.79	
10	A	0.91	
14	A	1.14	
8	A	1.29	
9	A	1.31	
4	A	2.92	
2	A	8.63	
5	A	10.57	
3	A	14.82	
13	A	21.13	
1	A	22.45	
2	A	24.55	

Figure E-8. Sorted Values for the Factor Distance Advanced/ Front Width for the Divisional Engagements (Parameters for the Event Version)

Id	PC	Value	
1	A	0.00	
2	A	0.00	
3	A	0.00	
4	A	0.00	
5	A	0.00	
6	A	0.00	
10	A	0.10	
7	A	0.11	
14	A	0.11	0.115 = A1
31	D	0.12	
15	D	0.18	
8	A	0.20	
9	A	0.20	
30	D	0.22	
34	D	0.23	
18	A	0.25	
11	A	0.25	
41	D	0.27	
35	D	0.28	
19	A	0.29	
33	D	0.30	
29	A	0.31	
48	D	0.32	
22	A	0.34	
23	D	0.35	
12	A	0.39	
38	D	0.40	
24	A	0.41	
43	D	0.44	
37	D	0.44	
32	D	0.45	
26	D	0.45	
25	A	0.51	
21	A	0.51	
20	A	0.53	
47	D	0.53	
13	A	0.60	
40	D	0.60	
36	D	0.64	
42	D	0.67	
16	D	0.67	
51	D	0.67	
58	D	0.67	
39	D	0.76	
17	A	0.80	
44	D	0.80	
61	D	0.81	
46	D	0.88	
49	D	0.95	
45	D	1.00	
62	D	1.00	
55	D	1.14	
27	A	1.20	
50	D	1.32	
57	D	1.38	
28	A	1.50	1.59 = A2
59	D	1.67	
54	D	1.85	
53	D	2.57	
56	D	4.38	
60	D	6.00	
52	D	6.38	

Figure E-9. Sorted Values for the Factor Final Personnel Ratio (Attacker/Defender) for the Divisional Engagements (Parameters for the Event Version)

Id	PC	Value	
3	A	0.45	
1	A	0.80	
4	A	0.84	
25	A	0.97	
24	A	1.13	
22	A	1.46	1.53 = B1
15	D	1.59	
54	D	1.79	
14	A	1.81	
21	A	1.85	
46	D	1.89	
53	D	1.89	
2	A	1.94	
18	A	1.97	
27	A	2.01	
19	A	2.10	
29	A	2.16	
43	D	2.21	
44	D	2.25	
26	D	2.34	
23	D	2.49	
20	A	2.53	
47	D	2.54	
10	A	2.64	
55	D	2.66	
42	D	2.69	
30	D	2.70	
49	D	2.72	
48	D	2.83	
51	D	3.00	
62	D	3.02	
56	D	3.04	
41	D	3.04	
17	A	3.05	
12	A	3.06	
28	A	3.32	
59	D	3.52	
6	A	3.89	
36	D	4.07	
5	A	4.27	
45	D	4.82	
31	D	5.10	
57	D	5.24	
35	D	5.56	
16	D	5.82	
9	A	5.83	
11	A	6.12	
13	A	6.97	7.19 = B2
58	D	7.41	
32	D	15.3	
37	D	16.6	
60	D	20.5	
61	D	21.0	
52	D	29.3	
7	A	38.1	
38	D	41.4	
50	D	45.8	
8	A	47.5	
39	D	187	
34	D	444	
40	D	568	
33	D	595	

Figure E-10. Sorted Values for the Factor Total Attacker Casualties for the Divisional Engagements (Parameters for the Event Version)

Id	PC	Value	
58	D	0.4	
9	A	0.4	
26	D	0.4	
23	D	0.6	
52	D	0.6	
56	D	0.6	
27	A	0.7	
2	A	0.8	
10	A	0.8	
11	A	0.8	
16	D	0.8	
36	D	0.8	
55	D	0.9	
12	A	1.0	
35	D	1.0	
13	A	1.2	
34	D	1.2	
5	A	1.4	
46	D	1.4	
47	D	1.4	
32	D	1.5	
48	D	1.5	
50	D	1.5	
60	D	1.6	
41	D	1.6	
15	D	1.8	
30	D	1.8	
1	A	1.8	
6	A	1.8	
22	A	2.0	
33	D	2.1	
61	D	2.1	
20	A	2.2	
42	D	2.4	
49	D	2.6	
21	A	2.7	
31	D	2.7	
39	D	2.8	
43	D	2.9	
8	A	3.0	
40	D	3.0	
38	D	3.2	
44	D	3.2	
53	D	3.3	
45	D	3.5	
14	A	3.7	
59	D	3.9	
3	A	4.4	
29	A	4.4	
57	D	4.4	
18	A	4.5	
37	D	4.5	
17	A	4.8	
24	A	4.8	
62	D	4.8	
7	A	5.2	
19	A	5.2	
54	D	7.5	
28	A	7.7	
51	D	15.2	16.6 = C
25	A	18.0	
4	A	18.6	

Figure E-11. Sorted Values for the Factor Total Defender Casualties for the Divisional Engagements (Parameters for the Event Version)

Id	PC	Value	
10	A	0.4	
22	A	0.7	
3	A	0.9	
47	D	1.0	
1	A	2.1	
15	D	2.2	
20	A	2.2	
12	A	2.4	
24	A	2.4	
2	A	3.0	
42	D	3.0	
26	D	3.3	
23	D	3.3	
55	D	3.9	
29	A	4.3	
21	A	5.4	
49	D	5.6	
48	D	5.7	
44	D	5.8	
56	D	6.0	
58	D	6.2	
27	A	7.0	
30	D	7.0	
19	A	7.2	
41	D	7.2	
18	A	8.7	
46	D	9.0	
28	A	9.8	
4	A	10.2	
53	D	10.5	
14	A	10.7	
43	D	11.1	
17	A	11.6	
57	D	12.1	
62	D	12.2	
54	D	13.5	
11	A	14.4	
35	D	14.4	
25	A	14.4	
59	D	14.9	
45	D	15.0	
5	A	18.0	
16	D	20.0	
9	A	25.0	
6	A	26.4	
31	D	27.0	
36	D	28.4	
51	D	31.2	
13	A	34.8	39.8 = D
52	D	44.7	
32	D	58.8	
61	D	61.8	
37	D	64.0	
50	D	79.5	
7	A	82.4	
38	D	85.2	
60	D	85.2	
8	A	91.0	
39	D	97.6	
33	D	98.7	
34	D	98.7	
40	D	99.0	

Figure E-12. Sorted Values for the Factor Casualty Ratio (Attacker/Defender) for the Divisional Engagements (Parameters for the Event Version)

Id	PC	Value	
34	D	0.01	
52	D	0.01	
9	A	0.02	
60	D	0.02	
50	D	0.02	
33	D	0.02	
32	D	0.03	
36	D	0.03	
39	D	0.03	
40	D	0.03	
8	A	0.03	
61	D	0.03	
13	A	0.03	
38	D	0.04	
16	D	0.04	
11	A	0.06	
58	D	0.06	
7	A	0.06	
6	A	0.07	
35	D	0.07	
37	D	0.07	
5	A	0.08	
31	D	0.10	
27	A	0.10	
56	D	0.10	
26	D	0.12	
46	D	0.16	
23	D	0.18	
41	D	0.22	
55	D	0.23	
45	D	0.23	
43	D	0.26	
30	D	0.26	
59	D	0.26	
48	D	0.26	
2	A	0.27	
53	D	0.31	
14	A	0.35	
57	D	0.36	
62	D	0.40	0.405 = E
17	A	0.41	
12	A	0.42	
49	D	0.46	
51	D	0.49	
21	A	0.50	
18	A	0.52	
44	D	0.55	
54	D	0.56	
19	A	0.72	
28	A	0.79	
42	D	0.80	
15	D	0.82	
1	A	0.86	
20	A	1.00	
29	A	1.02	
25	A	1.25	
47	D	1.40	
4	A	1.82	
10	A	2.00	
24	A	2.00	
22	A	2.86	
3	A	4.89	

Figure E-15. Sorted Values for the Factor Total Distance Advanced/ Front Width for the Regimental Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
1	A	1	0.00	
13	A	1	0.00	0.10 = a1
20	D	1	0.20	
11	A	1	0.40	
4	A	1	0.50	
2	A	1	0.70	
16	D	1	0.73	
5	A	1	0.80	
3	A	1	1.00	
6	A	1	1.33	
19	D	1	2.00	1.67 = a2
12	A	2	0.00	
8	A	2	0.15	
14	A	2	0.63	= a1
17	D	2	1.50	= a2
10	A	3	0.30	no estimate
9	A	3	1.25	
7	A	4	2.00	= a1
15	D	4	4.00	= a2
18	D	4	4.40	
21	D	5	0.83	no estimate

Figure E-14. Sorted Values for the Factor Change in Personnel Ratio (Attacker/Defender) for the Regimental Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
5	A	1	-0.29	
3	A	1	-0.28	
2	A	1	-0.16	
13	A	1	-0.08	
4	A	1	-0.06	
1	A	1	-0.04	
11	A	1	0.05	
6	A	1	0.18	= b1
16	D	1	0.24	= b2
19	D	1	0.91	
20	D	1	49.80	
12	A	2	-0.24	
8	A	2	-0.01	
14	A	2	-0.00	= b1
17	D	2	0.11	= b2
9	A	3	-0.02	no estimate
10	A	3	0.02	
7	A	4	0.10	= b1
18	D	4	0.97	= b2
15	D	4	8.75	
21	D	5	999	no estimate

Figure E-15. Sorted Values for the Factor Total Attacker Casualties for the Regimental Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
16	D	1	0.3	
20	D	1	0.9	
4	A	1	2.1	
19	D	1	3.0	3.72 = c
6	A	1	4.4	
2	A	1	5.1	
5	A	1	7.6	
11	A	1	8.5	
3	A	1	8.7	
1	A	1	13.4	
13	A	1	31.7	
14	A	2	1.6	
17	D	2	2.8	3.28 = c
8	A	2	3.7	
12	A	2	54.0	
9	A	3	7.0	no estimate
10	A	3	9.8	
18	D	4	4.4	
15	D	4	4.8	7.60 = c
7	A	4	10.3	
21	D	5	36.50	

Figure E-16. Sorted Values for the Factor Total Defender Casualties for the Regimental Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
2	A	1	0.6	
3	A	1	0.6	
1	A	1	0.6	
4	A	1	0.7	
5	A	1	0.7	
13	A	1	1.5	
11	A	1	10.8	
6	A	1	13.0	15.1 = d
16	D	1	17.2	
19	D	1	29.5	
20	D	1	96.0	
14	A	2	1.4	
12	A	2	2.2	
8	A	2	2.9	6.45 = d
17	D	2	10.0	
9	A	3	5.4	no estimate
10	A	3	10.9	
7	A	4	16.9	17.4 = d
18	D	4	17.9	
15	D	4	90.2	
21	D	5	100.	

Figure E-17. Sorted Values for the Factor Distance Advanced/ Front Width for the Divisional Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
3	A	1	0.00	
14	A	1	0.11	0.165 = a1
30	D	1	0.22	
22	A	1	0.34	
12	A	1	0.39	0.42 = a2
26	D	1	0.45	
58	D	1	0.67	
27	A	1	1.20	
2	A	2	0.00	
5	A	2	0.00	
10	A	2	0.10	0.14 = a1
15	D	2	0.18	
9	A	2	0.20	
11	A	2	0.25	
41	D	2	0.27	
35	D	2	0.28	
24	A	2	0.41	
20	A	2	0.53	0.53 = a2
47	D	2	0.53	
36	D	2	0.64	
42	D	2	0.67	
44	D	2	0.80	
46	D	2	0.88	
49	D	2	0.95	
62	D	2	1.00	
59	D	2	1.67	
1	A	3	0.00	
6	A	3	0.00	0.06 = a1
31	D	3	0.12	
34	D	3	0.23	
18	A	3	0.25	
33	D	3	0.30	
48	D	3	0.32	
23	D	3	0.35	
43	D	3	0.44	
32	D	3	0.45	
21	A	3	0.51	
13	A	3	0.60	0.71 = a2
61	D	3	0.81	
55	D	3	1.14	
50	D	3	1.32	
54	D	3	1.85	
53	D	3	2.57	
56	D	3	4.38	
52	D	3	6.38	
7	A	4	0.11	
19	A	4	0.29	
29	A	4	0.31	0.36 = a1
38	D	4	0.40	
16	D	4	0.67	
39	D	4	0.76	
17	A	4	0.80	
28	A	4	1.50	3.75 = a2
60	D	4	6.00	
8	A	5	0.20	= a1
37	D	5	0.44	= a2
45	D	5	1.00	
4	A	6	0.00	
25	A	12	0.51	= a1
40	D	6	0.60	= a2
51	D	8	0.67	
57	D	11	1.38	

Figure E-18. Sorted Values for the Factor Change in Personnel Ratio (Attacker/Defender) for the Divisional Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
22	A	1	-0.02	
3	A	1	-0.02	
12	A	1	0.04	0.055 = b1
26	D	1	0.07	
27	A	1	0.13	
14	A	1	0.13	0.135 = b2
30	D	1	0.14	
58	D	1	0.44	
24	A	2	-0.03	
10	A	2	-0.01	
47	D	2	-0.01	
20	A	2	0.00	0.005 = b1
15	D	2	0.01	
42	D	2	0.02	
2	A	2	0.04	0.05 = b2
44	D	2	0.06	
49	D	2	0.08	
46	D	2	0.15	
41	D	2	0.17	
62	D	2	0.23	
59	D	2	0.40	
5	A	2	0.72	
35	D	2	0.75	
11	A	2	0.84	
36	D	2	1.13	
9	A	2	1.44	
1	A	3	0.00	
21	A	3	0.05	0.06 = b1
23	D	3	0.07	
55	D	3	0.08	
18	A	3	0.09	
54	D	3	0.12	
48	D	3	0.12	
53	D	3	0.14	
56	D	3	0.16	
43	D	3	0.19	
6	A	3	0.98	
31	D	3	1.27	
13	A	3	2.37	5.64 = b2
32	D	3	8.90	
61	D	3	12.82	
52	D	3	13.04	
50	D	3	36.30	
34	D	3	438	
33	D	3	587	
19	A	4	-0.01	
29	A	4	-0.00	
28	A	4	0.07	
17	A	4	0.22	0.68 = b1
16	D	4	1.13	
60	D	4	17.43	
7	A	4	30.02	33.1 = b2
38	D	4	35.1	
39	D	4	183	
45	D	5	0.5	
37	D	5	10.3	no estimate
8	A	5	43.1	
4	A	6	-0.09	
25	A	6	-0.04	= b1
57	D	6	0.42	= b2
51	D	6	0.57	
40	D	6	562	

Figure E-19. Sorted Values for the Factor Total Attacker Casualties for the Divisional Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
58	D	1	0.3	
26	D	1	0.4	
27	A	1	0.7	
12	A	1	1.0	
30	D	1	1.8	1.90 = c
22	A	1	2.0	
14	A	1	3.7	
3	A	1	4.4	
9	A	2	0.4	
2	A	2	0.8	
10	A	2	0.8	
11	A	2	0.8	
36	D	2	0.8	
35	D	2	1.0	
5	A	2	1.4	
46	D	2	1.4	
47	D	2	1.4	
41	D	2	1.6	
15	D	2	1.8	
20	A	2	2.2	
42	D	2	2.4	
49	D	2	2.6	
44	D	2	3.2	
59	D	2	3.9	4.35 = c
24	A	2	4.8	
62	D	2	4.8	
23	D	3	0.6	
52	D	3	0.6	
56	D	3	0.6	
55	D	3	0.9	
13	A	3	1.2	
34	D	3	1.2	
32	D	3	1.5	
48	D	3	1.5	
50	D	3	1.5	
1	A	3	1.8	
6	A	3	1.8	
33	D	3	2.1	
61	D	3	2.1	
21	A	3	2.7	
31	D	3	2.7	
43	D	3	2.8	
53	D	3	3.3	3.90 = c
18	A	3	4.5	
54	D	3	7.5	
16	D	4	0.8	
60	D	4	1.5	
39	D	4	2.8	
38	D	4	3.2	3.80 = c
29	A	4	4.4	
17	A	4	4.8	
7	A	4	5.2	
19	A	4	5.2	
28	A	4	7.7	
8	A	5	3.0	
45	D	5	3.5	no estimate
37	D	5	4.5	
40	D	6	3.0	
57	D	11	4.4	
51	D	8	15.2	16.6 = c
25	A	12	18.0	
4	A	6	18.6	

Figure E-20. Sorted Values for the Factor Total Defender Casualties for the Divisional Engagements (Parameters for the Time-Step Version)

Id	PC	Dur	Value	
22	A	1	0.7	
3	A	1	0.9	
12	A	1	2.4	
26	D	1	3.3	
58	D	1	6.2	
27	A	1	7.0	
30	D	1	7.0	= d
14	A	1	10.7	
10	A	2	0.4	
47	D	2	1.0	
15	D	2	2.2	
20	A	2	2.2	
24	A	2	2.4	
2	A	2	3.0	
42	D	2	3.0	
49	D	2	5.6	
44	D	2	5.8	
41	D	2	7.2	
46	D	2	9.0	
62	D	2	12.2	
11	A	2	14.4	
35	D	2	14.4	
59	D	2	14.8	
5	A	2	18.0	
9	A	2	25.0	26.7 = d
36	D	2	28.4	
1	A	3	2.1	
23	D	3	3.3	
55	D	3	3.9	
21	A	3	5.4	
48	D	3	5.7	
56	D	3	6.0	
18	A	3	8.7	
53	D	3	10.5	
43	D	3	11.1	
54	D	3	13.5	
6	A	3	24.4	
31	D	3	27.0	
13	A	3	34.8	39.8 = d
52	D	3	44.7	
32	D	3	58.8	
61	D	3	61.8	
50	D	3	79.5	
33	D	3	98.7	
34	D	3	98.7	
29	A	4	4.3	
19	A	4	4.8	
28	A	4	9.8	
17	A	4	11.6	
16	D	4	20.0	
7	A	4	82.4	83.8 = d
38	D	4	85.2	
60	D	4	85.2	
39	D	4	97.6	
45	D	5	15.0	
37	D	5	64.0	no estimate
8	A	5	91.0	
4	A	6	10.2	
57	D	11	12.1	
25	A	12	14.4	22.8 = d
51	D	8	31.2	
40	D	6	99	

Appendix F

ANALYSIS OF BREAKPOINT MODEL RESULTS INCONSISTENT WITH HISTORICAL EXPERIENCE

Introduction

Considerable confidence in the Breakpoint Model is generated by the high proportion of engagements in which the model predictions are consistent with what happened in the actual historical experience. As explained on pp. VI-2, the model has two versions: an event version and a time-step version. Figure F-1 summarizes correct calls and errors for each of these two versions, for each of the two sets of engagements: those at the regiment level and those at the division level.

Looking at the results in the most critical possible light, there were 59 engagements in which the results were correct for both model versions, 9 in which they were incorrect for both versions, and 15 in which the results were correct in one model version and incorrect in the other. Thus it could be said that there were 24 engagements (29%) in which the results were inconsistent or partly inconsistent with history, with 71% fully consistent, 11% completely inconsistent, and 18% partly inconsistent. Or, in other words, there were 89% in which the results were consistent with history for one or both of the model versions.

It is obviously desirable, however, to achieve the closest possible correlation between actual battlefield results and the model predictions, except in those instances in which the historical results are so abnormal as to provide statistical "outliers" which the model should not represent. Accordingly, an examination has been made of each of the instances of inconsistency for two purposes:

1. To determine if these instances of inconsistency were due to historical cases so abnormal that the results probably could not (and perhaps should not) be matched by a model designed to handle "normal" situations, and

2. To seek to identify factors that, if they could be adequately represented, would make a later version of the model still more realistic and efficient.

In the following pages, each of the engagements which was not correctly predicted by the model is analyzed in an effort to identify those factors not present in the model that may have been responsible for the forced posture change. To provide a meaningful context for this analysis, Figure F-2 shows average figures for the data categories reflected in the model, for all 21 regimental and 62 divisional engagements in the Breakpoints Data Base.

Regiment-Level Engagements

15. Schnee Eifel Center, 16-19 December 1944 (8000)*

Posture Change: Historical: Defender
Model: Attacker: Event version only; by final personnel ratio
Attacker: German 293d Volks Grenadier Regiment, 18th Volks Grenadier Division
Defender: US 423d Infantry Regiment, 106th Infantry Division
Data: duration: 4 days; adv rate: 1.0 km/day; front: 1 km; atkr str: 4,100; dfdr str: 4,100; atkr cas rate: 1.22%/day; dfdr cas rate: 22.56%/day

The 18th Volks Grenadier Division, of the LXVI Corps of the German Fifth Panzer Army, was generally opposite the US 106th Infantry Division at the outset of the German Ardennes Offensive, 16 December 1944. The 106th Division had gone into the line only a few days earlier and was without any previous combat experience. Using the old "3-1 rule of thumb," the 18th Volks Grenadier Division had only one-third of the strength normally thought to be necessary for a successful attack against fortified defensive positions like those of the 106th Division. By imaginative use of the resources available, and exercising economy of forces across most of his very extensive front, the 18th Volks Grenadier Division commander succeeded in enveloping the right flank of the 106th Division, and, in cooperation with the 62d Volks Grenadier Division, encircled about two-thirds of that division, forcing the surrender of most of the encircled units. A key element in the German plan was for the 293d Volks Grenadier Regiment to contain the US 423d Infantry by an aggressive secondary attack. The 293d Volks Grenadier Regiment was successful, advancing about 1 kilometer per day for four days, until the surrender of the American defenders. (Of course, the success of the 293d Volks Grenadier Regiment was only one of a number of causes -- notably, the successful envelopment of the 106th Division's left flank -- which led to that surrender.) Offsetting the relative German numerical weakness was an artillery superiority of nearly 4:1, the impact of complete surprise, and the superior relative combat effectiveness of the German forces, which the model cannot represent.

17. Kasserine Pass, 19-20 February 1943 (6040)

Posture Change: Historical: Defender
Model: Attacker: Event version only; by final personnel ratio
Attacker: German Afrika Corps elements
Defender: US 26th Regimental Combat Team (-)
Data: duration: 2.0 days; adv rate: 3.0 km/day; front: 4.0 km; atkr str.: 7,000; dfdr str: 5,303; atkr cas rate: 1.4%/day; dfdr cas rate: 5.0%/day

---

* Numbers in parentheses are Land Warfare Data Base (LWDB) numbers; those below 6030 are permanent numbers; those higher are temporary numbers.

After failing in an effort to seize the pass by a coup de main, the Germans undertook a methodical attack and drove the Americans off the commanding terrain on both flanks, forcing the defenders to withdraw in considerable disorder. The principal reason for the event version's failure to predict a defender posture change was the model's inability to represent (1) the substantial attacker armor superiority and (2) the German relative combat effectiveness superiority.

21. Tarawa-Betio, 20-24 November 1943 (5170)

Posture Change: Historical: Defender
Model: Attacker: Event version; by attacker casualties
Time-step version: by distance/front
Attacker: US 2d Marine Division
Defender: Japanese Gilbert Islands Garrison
Data: duration: 5 days; adv rate: 0.2 km/day; front: 1.2 km; atkr str: 9,000; dfdr str: 4,836; atkr cas rate: 7.30%/day; dfdr cas rate: 20%/day

In this amphibious assault the 2d Marine Division had less than a two-to-one superiority over the defending Japanese. The Breakpoint Model predicted an attacker failure, but in fact, in a desperate five-day struggle, the 2d Marine Division overran the Japanese defenses.

The reason for the failure of the model to predict the historical outcome is its inability to represent the effects of the massive naval gunfire and air preassault bombardment; the continuing naval gunfire, close air support, and armor support that the Marines received after they got ashore; and the relative combat effectiveness superiority of the Americans. There must also be some question as to the relevance of the model, as it is, to the special circumstances of amphibious operations.

Division-Level Engagements

7. Kakazu and Tombstone Ridges, 9-12 April 1945 (5400)

Posture Change: Historical: Attacker
Model: Defender: Event version only; by final personnel ratio
Attacker: US 96th Infantry Division
Defender: Japanese 12th Independent Infantry Battalion
Data: duration: 4 days; adv rate: 0.1 km/day; front: 3.8 km; atkr str: 21,247; dfdr str: 3,000; atkr cas rate: 1.3%/day; dfdr cas rate: 20.6%/day

Despite a 7:1 numerical superiority, and an even greater artillery superiority, plus overwhelming air support, the American attack was halted by a combination of tenacious and skillful Japanese defense, very difficult terrain, and very bad weather. The overwhelming attacker superiority led to the prediction of a defender posture change by the event version of the model;

the model is unable to reflect difficult terrain, bad weather, and the characteristics of the Japanese national military culture in World War II.

8. Attack on the Shuri Line's Eastern Flank II, 14-18 May 1945 (5440)

Posture Change: Historical: Attacker
Model: Defender: Event version only; by final personnel ratio
Attacker: US 96th Infantry Division
Defender: Japanese 24th Infantry Division elements
Data: duration: 5 days; adv rate: 0.1 km/day; front: 2.5 km; atkr str: 20,973; dfdr str: 4,757; atkr cas rate: 0.6%/day; dfdr cas rate: 18.2%/day

The 96th Division, with a numerical superiority of 4.4:1.0, plus overwhelming armor, artillery, and close air support superiority, should have been expected to drive the Japanese defenders from their positions. However, after five days of attacks, the exhausted Americans halted the attacks, having made only insignificant gains. The principal reasons for the failure of the time-step version of the model to predict an attacker posture change are apparently the model's inability to represent the effects of (1) terrain, (2) defensive posture, and (3) national military characteristics.

9. Initial Attack on Yuza-Dake/Yaeju Escarpment, 10-11 June 1945 (5470)

Posture Change: Historical: Attacker
Model: Defender: Event version; by defender casualties
Time-step version; by change in personnel ratio
Attacker: US 96th Infantry Division
Defender: Japanese 24th Infantry Division elements
Data: duration: 2 days; adv rate: 0.3 km/day; front: 3.0 km; atkr str: 18,660; dfdr str: 4,250; atkr cas rate: 0.2%/day; dfdr cas rate: 12.5%/day

In this two-day battle the US 96th Division had a 4.4:1.0 numerical superiority, a 15.6:1.0 artillery superiority, and 117 tanks to none. While the numerical preponderance is slightly less than in most other Okinawa battles, the imbalance in armor and in artillery is greater than average. The principal reason why the Americans were unable to make better progress was the very difficult terrain, fanatically defended by the Japanese.

11. Shuri Envelopment, Phase II, 26-27 May 1945 (5320)

Posture Change: Historical: Attacker
Model: Defender: Event version; by defender casualties
Time-step version; by change in personnel ratio
Attacker: US 7th Infantry Division
Defender: Japanese 24th Infantry Division elements

Data: duration: 2 days; adv rate: 0.5 km/day; front: 4.0 km; atkr str: 15,840; dfdr str: 3,000; atkr cas rate: 0.4%/day; dfdr cas rate: 7.2%/day

The US 7th Infantry Division had a manpower superiority of about 5:1 and an artillery superiority of about 7:1. Thus an attacker success, or a defender posture change, would have been expected. However, the commander of the Japanese 24th Division, recognizing that -- because of earlier American successes -- his fortified positions, even though on terrain favorable to defense, were untenable, conducted a slow but successful withdrawal to a new defensive position. By the evening of the second day the 24th Division had completed its withdrawal, and broke contact. The 7th Division occupied the abandoned positions, and ceased further advance for more than 24 hours. Since the Japanese had withdrawn successfully, and since the 7th Division ceased its attacks, we have elected to consider this as an involuntary attacker posture change. This is certainly debatable, and thus it is difficult to argue that the Breakpoint Model, in predicting a defender posture change, was necessarily in error.

12. Singling-Bining, 6 December 1944 (4820)

Posture Change: Historical: Attacker
Model: Defender: Event version only; by distance/front
Attacker: US 4th Armored Division
Defender: German 25th Panzer Grenadier Division
Data: duration: 1 day; adv rate: 1.4 km/day; front: 3.6 km; atkr str: 15,224; dfdr str: 5,044; atkr cas rate: 1.0%/day; dfdr cas rate: 2.4%/day

The US 4th Armored Division in a one-day battle with a force barely one-third its own strength, was repulsed from Singling, but was able to occupy nearby Bining. Since the exhausted 4th Armored Division called off its attack against Singling, and was relieved from the line the following day, we have elected to show this drawn battle as an attacker posture change. We believe that this was a proper assessment of the results of a largely unsuccessful attack. It is perhaps significant, however, that the time-step version of the Breakpoint Model predicts that this should have been a defender posture change. Had it not been for the exhausted condition of the 4th Armored Division, that is the way the battle probably would have turned out.

13. Hill 95-I, 6-8 June 1945 (5340)

Posture Change: Historical: Attacker
Model: Defender: Event version; by final personnel ratio
Time-step version: by defender casualties
Attacker: US 7th Infantry Division
Defender: Japanese 44th Independent Mixed Brigade
Data: duration: 3 days; adv rate: 0.5 km/day; front: 2.5 km; atkr str: 16,091; dfdr str: 3,500; atkr cas rate: 0.4%/day; dfdr cas rate: 11.6%/day

Although the 7th Infantry Division had nearly a 5:1 numerical superiority, nearly 100 close air support sorties, and more than a ten-to-one artillery superiority, the desperate Japanese defense of fortified positions in rugged terrain limited the American advance to about one kilometer in a three-day period. On the third day the 7th Division attack was called off, in order to prepare for a renewed assault the following day. There were two interacting reasons for the lack of success by the much superior American force. In the first place, the Japanese willingly sacrificed lives in a desperate battle to hold extremely strong fortifications on very defensible terrain. In the second place the American commander was not willing to continue his own much more modest losses with tactics which had not achieved the results he had hoped for. So he called off the attack, and developed a new plan, which was successful on following days.

14. Velletri, 26 May 1944 (4470)

Posture Change: Historical: Attacker
Model: Defender: Event version only; by casualty ratio
Attacker: US 1st Armored Division
Defender: German 362d Infantry Division
Data: duration: 1 day; adv rate: 1.6 km/day; front: 14 km; atkr str: 20,683; dfdr str: 12,327; atkr cas rate: 3.7%/day; dfdr cas rate: 10.7%/day

This was the fourth day of the breakout from the Anzio Beachhead. US intelligence reported that the 362d Infantry Division had been "broken" in the three previous days; thus the 1st Armored Division did not expect serious resistance. Instead, in one of the bloodiest division engagements of the war in Italy, the Americans were surprised as the 362d took advantage of deceptively flat, but deeply indented terrain (not adequately represented on maps), and strong defensive positions, to repulse the American attack (which was further disrupted by a serious command failure at the combat command level). The principal reason for the event version's failure appears to have been its inability to represent surprise, terrain, and relative combat effectiveness.

15. Bourgaltroff, 14-15 November 1944 (4740)

Posture Change: Historical: Defender
Model: Attacker: Event version; by casualty ratio
Time-step version; by change in personnel ratio
Attacker: US 4th Armored Division
Defender: German 11th Panzer Division (-)
Data: duration: 2 days; adv rate: 1 km/day; front: 11 km; atkr str: 10,348; dfdr str: 6,519; atkr cas rate: 0.9%/day; dfdr cas rate: 1.1%/day

By armored force maneuver, taking advantage of their numerical tank superiority, the attackers forced the defenders to withdraw to new positions in Bourgaltroff. Although the Americans had little better than a 2:1 superi-

ority in personnel and artillery, they had nearly a 6:1 superiority in armor. It was undoubtedly this armor superiority, which the model cannot reflect, which caused it incorrectly to forecast an attacker posture change.

23. Burbach-Durstel, 27-29 November 1944 (4780)

Posture Change: Historical: Defender
Model: Attacker: Time-step version only; by change in personnel ratio
Attacker: US 4th Armored Division
Defender: German Panzer Lehr Division
Data: duration: 3 days; adv rate: 1.3 km/day; front: 11 km; atkr str: 16,232; dfdr str: 6,713; atkr cas rate: 0.2%/day; dfdr cas rate: 1.1%/day

In desultory combat (the result of near-exhaustion of both sides in incessant combat in atrocious weather), the Americans took advantage of their almost 5:1 tank numerical superiority to maneuver the Germans out of several fortified villages between Durstel and Sarre-Union. This armor superiority was undoubtedly the reason for the attacker's historical success, instead of the attacker posture change predicted by the model.

27. Chartres, 16 August 1944 (4620)

Posture Change: Historical: Attacker
Model: Defender: Event version; by distance/front
Time-step version; by distance/front
Attacker: US 7th Armored Division
Defender: German First Army elements
Data: duration: 1 day; adv rate: 6.0 km/day; front: 5.0 km; atkr str: 15,646; dfdr str: 8,325; atkr cas rate: 0.7%/day: dfdr cas rate: 7.0%/day

The 7th Armored Division, advancing southeastward toward Paris shortly after the breakout from the Normandy Beachhead, encountered serious resistance in Chartres from a makeshift force of several German formations. With a numerical advantage of almost 2:1, a comparable artillery advantage, and more than 300 tanks against 15, a decisive American success was predictable, and in fact the Breakpoint Model did predict a defender posture change. However, the Germans successfully repulsed the American attack. It was not until American reinforcements arrived that the Germans were driven from the city two days later. There are two probable reasons for the failure of the Breakpoint Model to predict the attacker posture change: (1) The model is not sufficiently discriminating to be able to deal with the effect of an urban environment, skillfully defended, upon an armored force; (2) the model cannot reflect the relative combat effectiveness superiority of the German defenders. It should be noted that the model made its decision in both versions on the basis of the attacker's rapid advance. The advance was indeed rapid until the Americans reached Chartres itself and encountered the strong advantages an urban environment gives to a determined defender.

30. Schnee Eifel South, 16 December 1944 (8010)

Posture Change: Historical: Defender
Model: Attacker: Time-step only; by attacker casualties
Attacker: German 62d Volks Grenadier Division
Defender: US 424th Infantry Regiment, 106th Infantry Division
Data: duration: 1 day; adv rate: 2.0 km/day; front: 9.0 km; atkr str: 11,000; dfdr str: 4,300; atkr cas rate: 1.8%/day; dfdr cas rate: 7.0%/day

Just to the south of the 18th Volks Grenadier Division, the 62d Volks Grenadier Division, exploiting the penetration initiated by the 18th Volks Grenadier Division, attacked the northern flank and rear of the 424th Infantry Regiment of the 106th Infantry Division. According to the Breakpoint Model, the 424th should have been able to repulse the attack of the 62d Volks Grenadier Division. In fact, however, the 424th was thrown back 2 kilometers, after suffering nearly 7% casualties in one day. The discrepancy between the historical results and the model prediction is probably due to the unreadiness, and relatively low combat effectiveness, of the American defenders, combined with the effects of complete surprise.

31. Tomb Hill - Ouki, 19-21 April 1945 (5230)

Posture Change: Historical: Defender
Model: Attacker: Time-step version only; by distance/front
Attacker: US 7th Infantry Division
Defender: Japanese 11th Independent Battalion
Data: duration: 3 days; adv rate: 0.1 km/day; front: 2.6 km; atkr str: 18,111; dfdr str: 4,731; atkr cas rate: 0.9%/day; dfdr cas rate: 9.0%/day

The US force preponderance was 3.8:1.0 and the artillery preponderance was 6.9:1.0, somewhat less than the preponderances in most other Okinawa battles. However, there was an armor imbalance of 151 American tanks to no Japanese tanks, and 123 air support sorties to none. These are undoubtedly the principal reasons why the American attackers drove the Japanese from their defensive positions, forcing a defender posture change. Also contributing was the relative combat effectiveness superiority of the Americans. The model called the engagement incorrectly on the basis of the low advance rate -- unusually low for a successful attacker. This was a hard-fought, close engagement in which the attackers seized and held one of their objectives (Tomb Hill), but took the other (the village of Ouki) only to lose it again.

41. Monte Grande (Rome), 17-19 May 1944 (4390)

Posture Change: Historical: Defender
Model: Attacker: Time-step version only; by attacker casualties
Attacker: US 88th Infantry Division

Defender: German 94th Infantry Division
Data: duration: 2 days; adv rate: 1.2 km/day; front: 9 km; atkr str: 13,095; dfdr str: 4,563; atkr cas rate: 0.8%/day; dfdr cas rate: 3.6%/day

The US 88th Division (minus one regiment) was continuing an offensive that had just broken through the German Gustav Line. Although the attacker's numerical superiority was less than 3:1, its artillery superiority was more than 3:1, and it enjoyed almost a 6:1 superiority in armor support. In addition, this was one of the best US divisions of World War II, enjoying combat effectiveness superiority over its German opponents in this engagement. Thus the attacker success, despite the model prediction, was due to factors the model cannot represent: superiority in artillery, armor, and combat effectiveness.

42. Santa Maria Oliveto, 4-5 November 1943 (4140)

Posture Change: Historical: Defender
Model: Attacker: Event; By casualty ratio
Time-step; By change in personnel ratio
Attacker: US 34th Infantry Division
Defender: German 3d Panzer Grenadier Division
Data: duration: 2 days; adv rate: 1.6 km/day; front: 4.8 km; atkr str; 16,870; dfdr str: 6,371; atkr cas rate: 1.2%/day; dfdr cas rate: 1.5%/day

The US 34th Infantry Division was successful in a two-day assault crossing of the Volturno River against the German 3d Panzer Grenadier Division, while the Breakpoint Model predicted an attacker failure. The 34th Division had substantial armor support in this battle, and it also seems likely that the Germans, having adopted a delaying strategy, decided not to make the additional effort and sacrifice that a successful defense would have required.

44. Castellonorato, 14-15 May 1944 (4360)

Posture Change: Historical: Defender
Model: Attacker: Event version only; by casualty ratio
Attacker: US 85th Infantry Division
Defender: German 94th Infantry Division (-)
Data: duration: 2 days; adv rate: 2.0 km/day; front: 5.0 km; atkr str 16,485; dfdr str: 7,500; atkr cas rate: 1.6%/day; dfdr cas rate: 2.9%/day

This attack, which resulted in the capture of the fortified mountain village of Castellonorato, breached the Gustav Line and -- in combination with similar success by the adjacent 88th Infantry Division -- forced a general German withdrawal. Although the 85th Division had little better than a 2:1 superiority over the defenders, it had nearly a 6:1 superiority in armor, and enjoyed substantial close air support. It was these aspects of superiority, which the model cannot represent, which resulted in an attacker success.

47. Triflisco, 13-14 October 1943 (4080)

Posture Change: Historical: Defender
Model: Attacker: Event version; by casualty ratio
Time-step version; by change in personnel ratio
Attacker: US 3d Infantry Division
Defender: German Hermann Goering Parachute Panzer Division
Data: duration: 2 days; adv rate: 2.4 km/day; front: 9.0 km; atkr str: 18,476; dfdr str: 7,250; atkr cas rate: 0.7%/day; dfdr cas rate: 0.5%/day

This was a successful two-day assault crossing of the Volturno River by the US 3d Infantry Division, opposed by the German Hermann Goering Parachute Panzer Division. The model predicts a defender success, and an attacker posture change. In fact, it is doubtful that the 3d Infantry Division would have been successful against a very formidable German opponent, despite a nearly 2.5:1.0 numerical superiority, had it not been for the successful achievement of surprise by the attackers. Also contributing were substantial imbalances in favor of the attacker in armor and air support.

48. Terracina, 22-24 May 1944 (4410)

Posture Change: Historical: Defender
Model: Attacker: Time-step only; by change in personnel ratio
Attacker: US 85th Infantry Division
Defender: German 94th Infantry Division
Data: duration: 3 days; adv rate: 1.6 km/day; front: 15.0 km; atkr str: 18,030; dfdr str: 6,653; atkr cas rate: 0.5%/day; dfdr cas rate: 1.9%/day

In this engagement the US 85th Division successfully attacked against elements of the German 94th Infantry and the 15th and 29th Panzer Grenadier Divisions, driving the defending Germans from defensive positions in and around Terracina in a three-day battle. The Germans had been badly battered in their withdrawal from the Volturno River, and were defending Terracina primarily to prevent the Americans from cutting off German units near the coast. A superficial survey of the input data does not reveal whether or not the Allied 2.7:1.0 numerical superiority would have been sufficient for an American success. However, the time-step version of the Breakpoint Model predicts a defender (or German) success, and an attacker posture change. The principal reason why this did not occur was apparently the fact that the Germans were not defending intensely, and were operationally in a delay posture. In addition, the Americans had nearly a 4:1 superiority in artillery.

49. Valmontone, 1-2 June 1944 (4550)

Posture Change: Historical: Defender
Model: Attacker: Time-step version only; by change in personnel ratio
Attacker: US 3d Infantry Division (+)
Defender: German Hermann Goering Parachute Panzer Division
Data: duration: 2 days; adv rate: 2.6 km/day; front: 5.5 km; atkr str: 26,607; dfdr str: 10,111; atkr cas rate: 1.3%/day; dfdr cas rate: 2.8%/day

The attack of the US 3d Infantry Division, with supporting armor, smashed the last major German defensive efforts to the south and east of Rome. Although the opposing German units were of high quality, in the previous days they had endured a terrible pummeling from the air and on the ground. While the attackers' strength superiority was about 2.6:1.0, their armor superiority was slightly more than 4:1, and they received massive close air support, while the defenders had no air support. The principal reason for the historical attacker success, despite the prediction of one version of the model, is the model's inability to represent the American armor and air superiority.

51. St. Lo, 11-18 July 1944 (4580)

Posture Change: Historical: Defender
Model: Attacker: Event version; by casualty ratio
Time-step version; by attacker casualties
Attacker: US 29th Infantry Division
Defender: German 352d Infantry Division elements and 3d Parachute Division elements
Data: duration: 8 days; adv rate: 1.0 km/day; front: 12.0 km; atkr str: 18,228; dfdr str: 7,500; atkr cas rate: 1.9%/day; dfdr cas rate: 3.9%/day

In mid-July 1944, the US 29th Infantry Division was given the mission of seizing the important road center of St. Lo, in north central Normandy, to gain a favorable position for the anticipated attempt to break out of the Normandy Beachhead, planned later in the month. The 29th Division had a 2.43:1.0 numerical superiority, a 4.7:1.0 superiority in armor, a 1.4:1.0 superiority in artillery, and 33 air sorties to 3 German air sorties. Given the fortified nature of the German defenses, it was far from certain that these margins of superiority would be enough for the 29th Division to accomplish its objective. The Breakpoint Model predicts that it will not, but in fact the 29th Division, after eight days of very tough fighting, finally did seize St. Lo. The principal reason for the discrepancy between the model prediction and the historical facts is probably that the 29th Division was one of the best US combat divisions in Europe, and the model is unable to be responsive to qualitative factors. Other likely contributors to the inconsistency were the substantial American preponderance in armor and the air support the Americans received.

54. Cisterna, 23-25 May 1944 (4450)

Posture Change: Historical: Defender
Model: Attacker: Event version only; by casualty ratio
Attacker: US 3d Infantry Division (+)
Defender: German 362d Infantry Division
Data: duration: 3 days; adv rate: 4.8 km/day; front: 7.8 km; atkr str: 19,971; dfdr str: 11,928; atkr cas rate: 2.5%/day; dfdr cas rate: 4.5%/day

In this attack, the US 3d Infantry Division (in combination with the 1st Armored Division to its right) was making the main effort of the US breakout from Anzio. Although the attackers' numerical superiority was only 1.67:1.0, they had the advantage of substantial surprise, more than a 2:1 superiority in armor, and 150 close air support sorties to none for the Germans. The principal reasons for the attacker success, which was not predicted by one version of the model, were (1) surprise, and (2) massive air support, advantages which the model cannot represent.

57. Sedjenane-Bizerte, 23 April-6 May 1943 (3930)

Posture Change: Historical: Defender
Model: Attacker: Time-step version only; by change in personnel ratio
Attacker: US 9th Infantry Division (+)
Defender: German von Manteuffel Division
Data: duration: 11 days; adv rate: 4.0 km/day; front: 32 km; atkr str: 24,098; dfdr str: 5,000; atkr cas rate: 0.4%/day; dfdr cas rate: 1.1%/day

Despite the advantage of a numerical superiority of nearly 5:1, it took the US 9th Infantry Division nearly 11 days to overcome desperate German resistance west of Bizerte, in Tunisia. One factor which the model cannot handle, and which was undoubtedly a major reason for the ultimate American success in this hard-fought battle, was the fact that the US 9th Division was unquestionably among the five best American divisions in the European-North African Theater in World War II. Also contributing were the tremendous attacker preponderance in armor and air support, as well as a significant artillery superiority.

Summary

Most of the inconsistencies between model results and historical results can be explained by the presence in the engagements of seven factors not represented in the model. Figure F-3 summarizes this analysis. From one to four of these factors were present in 23 of 24 cases in which one or both versions of the model did not reach a conclusion consistent with history. The other engagement (Shuri Envelopment II [11;5320]) was one in which the historians coding the engagement into the data base adjudged an attacker posture change, but in which the model finding of a defender posture change was not unreasonable.

The seven factors, and the frequency of their applicability to the 23 engagements, are the following:

1. Physical obstacles favoring defense: terrain, fortifications, urban environment -- 6
2. Surprise -- 5
3. Armor imbalance -- 12
4. Artillery inbalance -- 5
5. Air support imbalance -- 8
6. Relative combat effectiveness -- 10
7. Differences in national military characteristics -- 4

The meaning of most of these factors is self-explanatory, but two may require some further discussion. It should be stressed that relative combat effectiveness, as used here, means the relative effectiveness of the opposing units when physical resources and circumstances (effects of weapons, terrain, weather, and so forth) are equal. Combat effectiveness in this sense includes the effects of troop quality, training, combat experience, leadership, and other such human factors.

Differences in national military characteristics is a factor that comes into play when there are extreme differences between opposing sides as to what is accepted and expected military behavior. Engagements between US and Japanese forces in World War II show strikingly higher defender casualties for Japanese defenders (and Japanese attackers), and these figures are strikingly high when compared with both German and US casualty figures for European engagements. It seems clear that these disparities are the product of a Japanese military culture that regarded surrender as unthinkable and placed a relatively very high value on unyielding defense and death in battle for the protection of national values. One or both versions of the model incorrectly called four cases involving Japanese defenders, on the basis of high defender casualties, or a high attacker/defender personnel ratio. Here we see the play of the national military culture; Japanese commanders accepted casualties that would have been completely unacceptable to German or US commanders, and willingly continued fighting when the strength odds would have been considered hopeless by German or US commanders.

Inspection of the list of factors and the frequency with which they were applicable calls attention to armor imbalance. This factor was present in half the incorrectly called cases, and it is readily quantifiable. It might be considered as a candidate for inclusion in a future version of the model.

Figure F - 1. SUMMARY OF POSTURE CHANGE IDENTIFICATIONS

Engagement Level	Model Version								Total Cases
	Event				Time-Step				
	Correct Cases		Errors		Correct Cases		Errors		
	No.	%	No.	%	No.	%	No.	%	
Regimental	18	86	3	14	20	95	1	5	21
Divisional	48	77	14	23	46	74	16	26	62
Overall	66	80	17	20	66	80	17	20	83

Figure F-2. Statistical Summary of Breakpoints Data Base Engagements

Regimental engagements:
(From attacker's standpoint)

Germans Attacking US:	8
US Attacking Germans:	9
Japanese Attacking US:	2
US Attacking Japanese:	2
Total:	21

Overall Average Statistics:

	No. of Engagements	Duration (days)	Advance (km/day)	Front Width (kms)	Attacker Strength	Defender Strength	Attkr Cas (%/day)	Dfndr Cas (%/day)
Total:	21	2.0	1.8	3.0	6,497	4,962	6.40	11.30
Germans Attack US:	8	1.9	3.9 (2.2)*	5.1 (2.7)*	6,746	4,474	2.88	12.95 (9.35)**
US Attack Germans:	9	2.0	0.6	1.5	6,375	3,328	4.93	1.68
Japanese Attack US:	2	1.5	0.0	2.7	5,425	15,564	29.35	1.30
US Attack Japanese:	2	3.0	0.25	1.35	7,119	3,668	4.1	58.0

*If 1 engagement, Sidi Bou Zid I, is not considered
**If 3 disastrous Ardennes engagements are not considered

Figure F-2. Statistical Summary of Breakpoints Data Base Engagements (Continued)

Divisional Engagements
(From attacker's standpoint)

Germans attacking US: 13
US attacking Germans: 29

US attacking Japanese: 20

Total 62

Overall Average Statistics:

	No. of Engagements	Duration (days)	Advance (km/day)	Front Width (kms)	Attacker Strength	Defender Strength	Attkr Cas (%/day)	Dfndr Cas (%/day)
Total:	62	3.2	1.6	6.7	18,152	7,298	1.04	7.73
Germans Attack US:	13	2.5	1.4	7.7	18,952	10,634	1.72	5.72 (2.95)*
US Attack Germans:	29	3.2	2.3	8.8	18,167	8,477	1.06	2.71
US Attack Japanese:	20	3.3	0.6	3.1	17,612	3,418	0.57	16.32

*If two disastrous Ardennes engagements are not considered.

Figure F-3. SUMMARY ANALYSIS: REASONS FOR INCONSISTENCIES OF HISTORICAL RESULTS AND BREAKPOINT MODEL PREDICTIONS

Study Number	LWDB Number	Engagement Names	Historical Posture Change	Model Posture Change	Model Prediction Errors: Event Version: Distance Adv/ Width of Front	Final Personnel Ratio	Attacker Casualties	Defender Casualties	Casualty Ratio	Model Prediction Errors: Time-Step Version: Distance Adv/ Width of Front	Change in Personnel Ratio	Attacker Casualties	Defender Casualties	Factors Not Represented by Model: Obstacles*	Surprise	Armor Imbalance	Artillery Imbalance	Air Support Imbalance	Combat Effectiveness	National Military Character.
Regiment-Level Engagements																				
15	8000	Schnee Eifel Center	D	A		X									X		X		X	
17	6040	Kasserine Pass	D	A		X										X			X	
21	5170	Tarawa-Betio	D	A			X			X						X	X	X	X	
Division-Level Engagements																				
7	5400	Kakazu & Tombstone	A	D										X						X
8	5440	Atk, Shuri Line East	A	D										X						X
9	5470	Atk, Yuza-Dake/Yaeju	A	D				X			[illegible]			X						X
11	5320	Shuri Envelopment II	A	D				X			[illegible]									
12	4820	Singling-Bining	A	D	X														X	X
13	5340	Hill 95-I	A	D									X	X						
14	4470	Velletri	A	D					X					X	X				X	
15	4740	Bourgaltroff	D	A							X					X				
23	4780	Burbach-Durstel	D	A							X					X				
27	4620	Chartres	A	D	X									X					X	
30	8010	Schnee Eifel South	D	A								X			X				X	
31	5230	Tomb Hill-Ouki	D	A												X		X		
41	4390	Monte Grande (Rome)	D	A								X				X	X		X	
42	4140	S. Maria Oliveto	D	A					X		X					X				
44	4360	Castellonorato	D	A					X							X		X		
47	4080	Triflisco	D	A					X		X				X	X		X		
48	4410	Terracina	D	A							X						X			
49	4550	Valmontone	D	A							X					X		X		
51	4580	St. Lo	D	A					X			X				X		X	X	
54	4450	Cisterna	D	A											X			X		
57	3930	Sedjenane-Bizerte	D	A							X					X	X	X	X	

* Terrain, Fortifications, Urban Environment.

ADA201405

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date: Jun 30, 1986

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY N/A SINCE UNCLASSIFIED	3. DISTRIBUTION/AVAILABILITY OF REPORT DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A SINCE UNCLASSIFIED	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) HERO Rpt. #3430.5	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION DATA MEMORY SYSTEMS, INC. 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION US ARMY CONCEPTS ANALYSIS AGENCY
6c. ADDRESS (City, State, and ZIP Code) 10392 Democracy Lane Fairfax, VA 22030-5216	7b ADDRESS (City, State, and ZIP Code) Bethesda, MD 20814-2797
8a. NAME OF FUNDING/SPONSORING ORGANIZATION US ARMY CONCEPTS ANALYSIS AGENCY 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-87-C-0807
8c. ADDRESS (City, State, and ZIP Code) Bethesda, MD 20814-2797	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
FORCED CHANGES OF COMBAT POSTURE

12. PERSONAL AUTHOR(S)
Fain, Janice B.; Anderson, Richard C.; Dupuy, Trevor N.; Hammerman, Gay M.; Hawkins, Charles F

13a TYPE OF REPORT	13b TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 871001 TO 880230	880930	250

16. SUPPLEMENTARY NOTATION

17 COSATI CODES		
FIELD	GROUP	SUB-GROUP

18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
breakpoint, combat model, combat posture change, model development, historical combat engagements, combat narratives. (kp)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
This study is an examination of forced posture changes by combat units. From information gathered from the literature, historical research, and focused discussion groups of veterans, a list of factors associated with such changes of combat posture was compiled. A model of forced posture changes suitable for incorporation into a ground combat model was developed. Two sets of model parameters were derived from historical data. One set is suitable for use in divisional-level engagements and one set for use at the regimental level. The average success rate of correct posture change identification in the historical engagements is 80%.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE