The Dupuy Institute

1497 Chain Bridge Road
Suite 100
McLean, Virginia 22101
Phone 703.356.1151
Fax 703.356.1152

Final Report

Capture Rate Study

Phases I and II

For Purchase Orders

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Prepared for:

Department of the Army
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6001 Goethals Road
Fort Belvoir, Virginia
22060-5230

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Introduction

The Enemy Prisoner of War/Civilian Internee (EPW/CI) Capture Rate Study is intended to develop estimations of capture rates for enemy prisoners of war and civilian internees (EPW/CI). The intent is that these rates be incorporated into the Headquarters Department of the Army (HQDA) Total Army Analysis (TAA) process.

Historically, capture rates have been influenced by a variety of factors including posture (offensive or defensive), theater of combat, intensity of combat, outcome of the engagement, terrain, weather, force ratios, distance advanced or retreated, degree and extent of encirclements, logistics, duration of the campaign, existence of retreat routes, morale and national characteristics. Usually, methods of calculating enemy prisoner of war (EPW/CI) capture rates have been based on extraction from and evaluation of existing historical data.

This final report addresses the first two phases of the project, covering the analysis developed from over 180 division-level engagements and over 60 army-level campaigns, all from World War II. The analysis developed from post-World War II data, including Small Scale Contingencies (SSCs) will be covered in Phase III.

This study does not address all of the issues relating to capture rates. Additional research should be done to determine the percent of EPW that are wounded, the number of civilian internees (including the number who need medical care), the number of refugees and non-interned civilians who might also provide a load upon military police and medical services, and the capture rates for units smaller than division (brigades, battalions and companies).

This study is almost entirely the work of two persons, Christopher A. Lawrence and Richard C. Anderson. Project management and the study plan were developed by Christopher A. Lawrence under guidance from Jeff Hall at the Center for Army Analysis (CAA). The Kursk engagements were researched by Chris Lawrence, while the Soviet EPW capture data was the result of research done by Dr. Fyodor Sverdlov (Col. USSR, Ret). The Italian and Ardennes Engagements were mostly the work of Richard C. Anderson, with some Ardennes Engagements done by Jay Karamales. Jay Karamales also programmed the databases. The Campaign Data was mostly the work of Richard Anderson, with some research done by Chris Lawrence. The final report was primarily written by Chris Lawrence with support and inputs from Richard Anderson. We also received help and support from Nicholas Krawciw, Paul Krawciw, Tatiana Lawrence, Dr. Brian McCue (Center for Naval Analyses), Stanley Miller (CAA) and Susan Rich. This report was then provided to Gene Visco, Dr. James Taylor (Naval Post-Graduate School) and Dr. Brian McCue for a peer review.

Chapter
2

Previous Studies

The EPW capture rates that were used by the US Army until the middle of the 1980s were from FM101-10-1, *Staff Officers Field Manual, Organization, Technical, and Logistical Data* dated July 1976. The 1941 edition of this manual laid out a set of undocumented rates that were probably derived from World War I data. The manual was partially updated in 1943 and 1944, based upon the limited additional US exposure to ground combat in World War II to that time. The Field Manual continued to change over time with the addition of Korean War data and other factors from limited wars after 1961. These changes to the capture rate were undocumented, but even as late as the mid-1980s, most of the rates remained the same as those found in the 1944 Field Manual. It is clear that a systematic review and revision of the capture rates using a consistent set of data was never made. The analytical basis of all these estimates is unknown and undocumented. Whether any of this analysis was conducted with any methodological rigor is unknown.

The weaknesses of the data in the Field Manual were addressed in an article in the December 1984 *Military Review* by Major Mark Beto titled "Soviet Prisoners of War in the AirLand Battle." Then in October 1985, the Soldier Support Center of the Combat Development Directorate (SSC/CDD) issued a study titled the *Enemy Prisoner of War (EPW)/Civilian Internee (CI) Rate Study.* The study was authorized on 7 March 1985 and was clearly a "short fuse" effort, with rates based upon "the best available" data. The effort selected a period on the Eastern Front from Oct 42—May 44 that was felt to best represent the potential situation in Europe in the 1980s. The data was gathered from two different secondary sources. The German strength data appears to have come from Victor Madej's *German Army Order of Battle, 1939-1945*, and the German capture rates came from a HERO Study (Historical Evaluation and Research Organization, TDI's predecessor), *German and Soviet Replacement Systems in World War II*.

In the case of the German capture rates, there were 8 time periods reported in the HERO study, each varying from 5 to 7 months, and together covering the entire war on the Eastern Front. The Soviet POWs captured in each of these eight periods varied from 75,000 to 3,400,000. The periods selected for the SSC/CDD capture rate study tended to concentrate on those cases where the Soviets were on the offense and lost the fewest numbers captured. For the purposes of answering the study question, this was not incorrect, but it was very limiting. Of course, it was understood by SSC/CDD study authors that the data was limited to German defensive actions (although they also included offensive data based upon a single five month German offensive period) and had only limited applicability for other scenarios. Civilian internees were not addressed. The data in this study is highly aggregated, and, inasmuch as the strengths and captures come from two different secondary sources, there is some question of data compatibility. However, at the level of aggregation of this study, this is probably not a significant point. The capture rates were derived from a force that was primarily on the defensive, and were aggregated from a front that had extended quiet periods and large quiet sectors. It is not surprising that the capture value derived was very low (.35 captures per day per 1,000 of own troops).

The next work to address the subject was the 1990 US Army Military Police School (USAMPS) Directorate of Combat Developments study based upon 8 campaigns. These included Grenada (1984), Panama (1989), the Falklands War (1982), the Yom Kippur War (Arab Israeli, 1973), the Suez Canal

Campaign (Arab-Israeli, 1956), the Six Day War (Arab-Israeli, 1967), the Gothic Line Offensive (Northern Italy 1944-45) and the Sevastopol Campaign (1942). This odd selection of three minor Latin American interventions, three Arab-Israeli Wars and two World War II campaigns produced a capture rate over 30 times higher than the Soldier Support Center study. This is not surprising considering the campaigns selected. Whether those that were chosen to be studied were representative of expected rates is open to question. Moreover, the size of the statistical sample is quite small.

The USAMPS study very clearly accuses the previous study of deliberately selecting a scenario to produce a rate lower than one previously drawn from the Field Manual. The USAMPS study implies that this was done at the direction of the Vice Chief of Staff of the Army and was for the purpose of developing lower capture rates so as to provide a reason to reduce EPW force structure. However, the USAMPS study also did some very strange things. The lengths of some of the conflicts were quite long, while the operations only had two or three days of ground combat. The Falklands Islands War was set at 74 days, Grenada (URGENT FURY) at 30 days, and Panama (JUST CAUSE) at 43 days. This resulted in some very odd daily capture rates that hardly represent the actual situation. The study also did not address civilian internees. As in the previous study, this study also relied heavily upon data produced by HERO or Trevor N. Dupuy, as it appears that the data used for over half the campaigns was drawn directly from Trevor N. Dupuy's *Encyclopedia of Military History*.

Both the USAMPS and Soldier Support Center studies appear to be slanted for the purpose of providing the answers desired by their respective sponsors. Both of these documents may be more accurately classified as white papers than as analysis.

The final effort to address the subject is also the most exhaustive study to date, the Potomac Systems Engineering (PSE) study done for the US Army Training and Doctrine Command (TRADOC). While this study was far wider in its range, covering 23 campaigns, it was still restricted to one-sided data, limited samples, gross levels of aggregation, and mostly secondary sources for its data. It did not address civilian internees. Its research was undocumented and could not be verified. For example, PSE used a Soviet captured in action (CIA) figure for Barbarossa different from the HERO study figure utilized in the Soldier Support Center study (3,000,000 vs. 3,400,000). The HERO data came from the intelligence reports of the German Army General Staff. The source of the PSE data is not indicated. PSE clearly drew five of its examples directly from the USAMPS study, not only using the same data, but even selecting the same periods for calculating the daily capture rates (30 days for Grenada, 43 for Panama and 74 for the Falklands). It is a mystery why the authors of the PSE study chose to take five examples from the USAMPS study without attribution but did not take the other three.

Somehow, from 23 points of data PSE was able to separate the results into four theaters and divide them into four stages in each theater. They defined their capture rates by gross geographical areas, which is a little strange. They ended up displaying the results of 23 points of data into 4 by 4 matrices (16 categories). This required interpolation of the data within each campaign and "expert judgment" to produce the factors presented by the matrices. This does not lead one to have much confidence in the scientific validity of any of the figures presented. In the end, this study was flawed in its conceptual approach although it was certainly the most ambitious of the studies done to date.

The capture rate produced by the 1985 SSC study was .35 captures per day per 1,000 of own troops. For the 1987 USAMPS study it was 10.9 captures per day per 1,000 of own troops. For the 1992 PSE study it ranged from 1.03 to 49.40 captures per day per 1,000 of own troops in "Europe" depending on what stage the campaign was in. The Dupuy Institute was uncomfortable with the analytical underpinnings and data accuracy for all of these studies and approached this subject from a different perspective. However, the studies were useful for showing the limits of what could be accomplished with gross aggregation and one-sided data.

Chapter
3

Study Plan

The Dupuy Institute study addresses the issue of the POW capture rates for division-level engagements and Army-level operations. No systematic effort was made to address civilian internees. The study also does not address capture rates for echelons of combat battalion-level or below.

The study was contractually broken into three separately funded phases. The major tasks in each phase were:

Phase I:

1. Assemble 60 division-level engagements from the Italian Campaign.

2. Assemble 60 division-level engagements from the Kursk Campaign.

3. Prepare a List of Candidate Engagements.

4. Prepare a Research Plan.

5. Revise the Land War Database (LWDB) to create an EPW database of division-level engagements.

6. Prepare a Database User's Guide.

Phase II:

1. Assemble 60 division-level engagements from the second Ardennes Campaign (Battle of the Bulge).

2. Assemble 60 army-level campaigns from World War II.

3. Conduct analysis of the division-level engagement database to produce EPW capture rates.

4. Create a Campaign Database (CaDB) for the army-level operations.

5. Conduct analysis of the army-level operations database to produce EPW capture rates.

6. Prepare a Final Report addressing WWII data.

Phase III:

1. Assemble 60 post-World War II division-level engagements.

2. Assemble 13 or more post-World War II army-level operations.

3. Assemble 50 post-World War II Small Scale Contingency (SSC) operations.

4. Create a Small Scale Contingency Operations (SSCO) Database for the SSCs.

5. Revise the Database User's Guide.

6. Conduct analysis of the post-World War II data.

7. Prepare Final Report addressing post-WWII data and integrating the World War II and post-WWII data.

Phases I and II were effectively a continuous effort. Phase I created a database of 120 division-level engagements from the Italian and Kursk Campaigns and Phase II created a database of 60 division-level engagements from the Ardennes Campaign and a separate database of 60 army-level operations. The analysis of the 180 division-level engagements from both Phase I & II was then completed, followed by the same analysis on the 60 Army-level Campaigns. This report addresses all the work done on Phase I and II and will serve as a baseline for the Phase III report.

Phases I & II concentrated on obtaining the best available data in statistically significant numbers. This meant looking at operations where there were well-defined reports in the archived unit records. As such, the study derived its initial analysis from World War II engagements. This was done because World War II is the most recent source for two-sided primary source data on modern warfare. All the World War II division-level engagements were derived from primary source data, usually the daily records of the units engaged, or from databases created by HERO (Historical Evaluation Research Organization), DMSI (Data Memory Systems Incorporated) or TDI (The Dupuy Institute). These databases were created mostly from primary-source records. Furthermore, even such primary-source records have required being supplemented by quantitative military judgment (i.e., the educated guesses by knowledgeable military historians of TDI). Without such quantitative military judgment, complete data records[1] are simply not available from even primary-source historical records. Thus, any primary data source for past combat cannot, by itself, generate all the data required for developing the databases reported here without help from the experienced eye of the military historian. The employees of TDI were actively involved in working-on or assembling the databases. Therefore, there is a corporate knowledge and confidence in these databases that would not be there if other sources were used. The three databases used (The Land Warfare Database, the Ardennes Campaign Simulation Database, and the Kursk Database) were all created directly for CAA or as a byproduct of work that was done for CAA.

To be able to achieve a large enough database to provide material that remained statistically significant, especially when broken down into categories for further analysis, it was essential to build on existing work. In that way, the maximum amount of data could be accurately assembled at a minimum cost. The use of these existing databases allowed TDI to do this. Without these databases, and the prior experience of working with them, TDI could not have developed 240 separate records composed of hard data to develop its analysis without considerable additional time and cost. In effect, the Center for Army Analysis (CAA) is beginning to reap the financial benefits of its continued steady support of an experienced historical research team.

[1] R. McQuie, "Military History and Mathematical Analysis," Military Review 50, No. 5, 8-17 (1970).

While the Land Warfare Database was an existing product that was expanded for use in the EPW Study, the Campaign Database (CaDB) was created specifically for this study and for use in future analysis. There were three reasons for a separate Campaign Database.

First, there was a concern that the sum of the captures by divisions would not equal the sum of the captures over the entire course of operations. It was suspected that this was due to elements being bypassed in combat or movement and therefore not always recorded. Also there was a concern over the quality of the data recorded at division level.

Second, there was a concern that the dynamics of multi-week campaigns might differ from those of multi-day battles, and that movement and maneuver might play a part in collecting EPWs that would otherwise not always be seen in division-level engagements.

Third, there was a concern that the rates applicable to one level of a command may not have the same value at higher or lower levels of command. For example, average casualty rates for battalions are significantly different from those usually seen for divisions or armies. As there is limited data assembled for battalion-level combat and collecting such data is difficult and potentially costly, this issue of scale could only easily be looked at between divisions and armies, and 1- to 7-day battles versus 8- to 60-day campaigns.

The 60 World War II campaigns were created mostly from primary source data with narrative continuity often derived from secondary sources. For the purposes of this study, a campaign was defined as an army-level operation ranging from 8 to 60 days (or shorter if the operation was completed before then).

The World War II data was analyzed to provide a baseline of EPW capture rates using the most reliable data. The need for a baseline built from hard data was essential before moving to Phase III. Phase III is intended to answer the same questions, but using post-World War II data. While post-World War II data is clearly the better material to use for any study of modern combat, there are potentially several significant problems. First, it is almost impossible to obtain good, reliable, two-sided primary source data from any of the post-WWII conflicts. Therefore, the data that is assembled may be a mixture of solid research, secondary sources of unknown validity, and a degree of estimation. The result is data that is very "fuzzy." As "fuzzy" data is not the best material to serve as an analytical basis, it was felt that CAA would be best served by an analysis developed from a solid foundation of data. The "fuzzy" post-WWII data could then be presented in comparison and contrast. This allows one to utilize data as needed based upon whether or not reliable older data is preferred or less reliable recent data is preferred, or whether a mixture based upon both is preferred. This decision is left to the end user.

This study differed from all previous studies in six major ways.

First and foremost, it was developed from two-sided data, meaning that both opponents' data was included in the record of each engagement or operation. To properly understand the dynamics of combat, TDI believes that both sides of the equation must be examined.

Second, as the analysis was developed from two-sided data, the measures of effectiveness (MOE) were different from all previous studies. The previous studies based capture rates upon the number of enemy troops captured compared to the capturing unit's strength (number of enemy troops captured per thousand of own troops in area of operation). As these studies were based upon one-sided data, this was the MOE forced on the analyst. As all of TDI's work on this project was based on two-sided data, the measure of effectiveness utilized was the number of enemy troops captured compared to the enemy's unit strength (number of enemy troops captured per thousand of enemy troops in area of operation). This MOE has a number of advantages, the most important being that it relates the number of captured to the number available to be captured.

The third major difference is that the study defined the size and range of the operations being used for the analysis. Instead of lumping together operations as disparate in size and scope as Grenada and Operation Barbarossa (the German invasion of the Soviet Union from 22 June 1941 to 7 December 1941), the TDI study combined operations together that were at least similar in scope and size by an order of magnitude.

The fourth major difference is that by limiting the engagement times to a reasonable period, the TDI study provided capture rates for a specific set of conditions at a specific time. Previous studies tended to focus on the capture rates over an entire campaign. This can result in strange figures in cases where the campaign ended with the complete surrender of one army to the other. The Dupuy Institute database divides the events into discrete periods so that a final capitulation does not bias the capture rates in all operations occurring prior to that date.

The fifth major difference is in the extent of data. All of the previous studies suffered from not having a statistically significant number of data points. For highly variable, social science data (which is what combat data tends to be), 30 to 60 cases usually are required to establish the statistical significance of the results. If an existing database is divided into several categories for purposes of analysis, then a database is needed that is large enough to provide a statistically significant number of samples in each category. By having 180 two-sided division-level engagements, this means that 360 points of data are available for analysis. This allows the data be divided into 6 or more subcategories for analysis, while still retaining a sufficient number of examples in each category. This allows for considerable confidence in the analytical results.

The sixth major difference is in the quality of the data. Almost all of the World War II data is drawn directly from the records of the units engaged. This is a much more rigorous and extensive data collection effort than that done for any of the previous EPW studies. While maintaining higher standards for this data, this study was done at a lower cost than some of the previous studies.

However, Phase III will be devoted entirely to post-World War II data. Post-World War II research presents major problems. In almost all cases, primary source archival data is not available for both sides, and in many cases the primary source archival data is not available for either side. Because of the wide range of wars and conflicts since World War II, the time involved in conducting in-depth research in each becomes prohibitive. As such, The Dupuy Institute will be forced to use secondary sources extensively. Furthermore, the selection of battles and campaigns will be driven by the availability of secondary sources. As such, the selection and quality of data may be less than ideal. However, it is felt that post-WWII engagements and campaigns need to be addressed. There is some concern that changes in doctrine and technology over time may influence capture rates. As such, data will be collected and analyzed for the post-World War II period. If there is a lack of confidence in the analysis that comes from that data, then an analyst still has the option of relying entirely on the well-researched two-sided data from World War II. In this way, we hope that all major concerns over data quality, data currency, and budget have been reasonably addressed in a balanced fashion.

If there have been changes in the EPW capture rates as a result of changes in doctrine or technology since World War II, this may indeed show up in the Phase III collection effort, and may serve as a baseline for measuring the impact of a Revolution in Military Affairs (RMA) on EPW capture rates. This analysis could be further extended by looking at engagements from the pre-World War II period.

The second major problem with post-WWII data is that there has been very limited detailed statistical material assembled on these wars. As a result, not only will the quality of data be less, but the number of engagements and operations that can be developed on a finite budget is more limited. When more analytical work is done in the post-WWII operations, then more material will be available. However, to date there is very little statistical data available. Therefore, assembling each engagement

or operations is time consuming. This reduces the number of operations that can be done within the given project budget.

Study Timeline

During the course of Phase I and II of the study the following major milestones occurred:

Phase I contract award: 22 May 1998

Phase II contract award: 25 September 1998

1. A detailed explanation of the proposed study plan was provided in the "List of Candidate Conflicts", submitted to US Army Concepts Analysis Agency (CAA) in July 1998.

2. The Database User's Guide was submitted to CAA in July 1998.

3. A conference held at CAA concerning this effort was held in early September 1998, and as a result further direction was given for the course of the project.

4. Research Plan was submitted to CAA on 7 October 1998

5. The Ardennes engagements (Phase II) were completed in February 1999

6. The Italian engagements were completed in March 1999

7. The preliminary analysis of the engagement data was presented to CAA on 2 June 1999. Approval was given to initiate Phase III and continue with the project as planned.

8. Campaign Database design (Phase II) was completed June 1999

9. The Kursk engagements were completed August 1999. This completed Phase I.

10. The 60 Campaigns were completed March 2000.

11. This Final Report was delivered March 2000. This completes Phase II.

Chapter
4

Research

It has been found convenient to subdivide the overall database of historical battles into four distinct subsets because of the wide range in the nature of the historical materials available for researching capture rates. These subsets were denoted as follows:

(1) the Italian (engagement-level) data,
(2) the Ardennes (engagement-level) data,
(3) the Kursk (engagement-level) data, and
(4) the World War II campaign-level data.

Substantially different research materials were available for researching each of these four subsets. Consequently, the research effort was substantially different for each of the four subsets and is described below for each of them.

A. The Italian Data

The Land Warfare Database was originally created in the 1980s under contract for CAA as a report on 601 battles from 1600 to 1973. It was submitted to CAA as part of the CHASE study. At its own expense, DMSI then computerized this database in Reflex and added four additional engagements in 1986, but without the battle narratives. In 1989, as part of the Breakpoints project, 27 additional engagements were added to the database. In 1995, TDI, at its own expense, changed the format of the database from Reflex to Access and added all the battle narratives to the database. This created a database of 632 engagements, of which 70 are from the Italian Campaign (September 1943—May 1945) in World War II. These 70 Italian Campaign battles are the basis for those found in the EPW Engagements Database. The format for the EPW Engagement Database is the same as that of the Land Warfare Database.

The original LWDB aggregated battle casualties and did not separately report KIA, WIA, MIA or CIA. The Dupuy Institute systematically researched US records of the units involved in the LWDB Italian Campaign battles and extracted from these reports the number of Germans captured. The opposing German division, corps and army records have also been researched for relevant data on allied POWs. US and German records are located in the US National Archives. As part of this process, additional data has been identified and some of the Italian campaign engagements have been modified from their original form. This work was performed by Richard Anderson, who also created the 27 additional engagements for the Breakpoints study.

There are 42 US-vs-German engagements and 28 UK-vs-German engagements. Additional research was conducted for a week during an unrelated business trip to Europe in January 1999 in the Public Records Office in Kew Gardens, London. This research was conducted by Chris Lawrence.

It was intended that at least 60 of the 70 Italian Campaign battles in the Land Warfare Database be utilized. Because our confidence is high for the data in these battles, and the research has already been completed, we ended up using all 70 of the battles, and creating several additional en-

gagements, resulting in a final database of 76 engagements. There are 18 engagements in 1944 in which the Germans did not report Allied captured. As these are all cases of successful Allied attacks, and the capture rates were probably low, or even zero, they were assigned a value of zero. This is the only significant interpolation of the data in the Italian engagements.

In the process of reviewing the Italian engagement records, TDI ended up modifying some of them. Some engagement records were changed as a result of identifying more complete sources and correcting some errors in the original work. Consequently, all of the Salerno engagements were corrected and British casualties for most of the engagements were recalculated.

Because some data accuracy problems were encountered in the original HERO data, this research effort turned out to be broader, more detailed, and more time consuming than originally expected. Therefore, TDI went through all the German Army and Corps records for the entire Italian Campaign and through many of the US Army records for the campaign.

For the Italian Campaign, The Dupuy Institute has on file by unit copies of the original records from which the data was extracted. A list of the 76 Italian Campaign battles is provided in Appendix I.

B. The Ardennes Data

The Ardennes engagements are derived from the Ardennes Campaign Simulation Database; he Ardennes research files; the supporting book *Hitler's Last Gamble*; and from Jay Karamales' detailed research efforts from the armor/anti-armor study performed for CAA and expanded in his two books, *Against the Panzers* and the as yet unpublished *Against the Panzers II*. Most of this work—some 51 engagements—was done by one of the coauthors of *Hitler's Last Gamble*, Richard Anderson. Mr. Karamales' work was used to create 14 engagements that he had already researched for his books.

Twelve of the Ardennes battles had already been created for the Land Warfare Database. Ten of these were done by Richard Anderson in 1989 for the Breakpoints Study. The only additional work required for these engagements was to research the number of captures. This was done from the US National Archives for both the US and German records.

The Ardennes Campaign engagements were limited mostly to December 1944. This is due to the data problems with the German records, where the quality of the data declines with the advent of the New Year. As this battle has been heavily documented and researched in secondary sources, we also made limited use of secondary sources, mostly for the narratives.

For the Ardennes engagements, The Dupuy Institute has on file by unit copies of the original records from which the data was extracted. A list of the 77 Ardennes Campaign battles is provided in Appendix II.

C. The Kursk Data

Because 5,000+ pages of German records were copied during the Kursk Database project, including all the daily operations staff reports, only limited additional research was required for the German side of the Kursk battle. After the initial data was assembled, there was some concern that the existing documents did not correctly account for the German EPW captures, especially for the 255th ID, which seemed to be devoid of data. TDI had noted in its Italian research that the German Corps Ic (G-2, or intelligence) staff usually kept good daily accounting of POWs. A separate unscheduled effort was made to collect from the archives all the data from the intelligence files of the 48th Panzer Corps and the 52nd Corps. This provided complete data for the 255th ID (which reported only 3 prisoners in the operational records, vice the 385 prisoners reported in the intelligence files). It also resulted in some

corrections to the prisoner counts for the 332nd ID, 3rd Panzer Division, and Grossdeutschland Panzer Grenadier Divisions.

For the Soviets, reports of captured Germans were kept in the intelligence reports of the Soviet units. As intelligence files were not copied during the Kursk project, Col. Sverdlov, the TDI consultant who headed the original research team, extracted the relevant data from the files of the 47 division-sized infantry and armor units involved in the battle.

For each engagement from the Battle of Kursk, a separate folder was created and is kept on file at The Dupuy Institute showing the calculations, notes and materials assembled for each battle. A list of the Kursk battles is provided in Appendix III.

D. The World War II Campaigns

For Phase II of the project, TDI was to assemble a database of 60 World War II campaigns. TDI created a separate database for the campaigns based upon the Land Warfare Database (LWDB). As such, many of the fields from the Land Warfare Database were used. Several new fields were added to address the sometimes widely fluctuating strengths that may be found in extended campaigns, and to provide more weapons detail. The resolution and factors sections of the LWDB were reduced and adjusted to fit the campaign parameters, and the measurement of factors affecting outcomes was changed to a numeric system. This new database was christened the Campaign Database (CaDB).

All the campaigns selected are from Kursk, Italy and the Western Desert. They were assembled mostly from primary source data. The intention for the Western European campaigns was to collect as complete a selection of material as possible, covering the whole length and breadth of the North African, Sicilian, and Italian Campaigns from beginning to end. The attraction of these campaigns was that there was good data for both sides and that they were small enough that a complete recording of operations in those theaters was possible. Assembling data for Northwest Europe would have been more difficult due to problems with the German records. German records were retired to the Potsdam Archives at six-month interval, in July and January of a calendar year. Thus, there are extensive records available through June 1944; then the quality and quantity of the records degrade considerably for the July—December 1944 period. Except for some high command documents, most of the records after 1944 were lost or destroyed in the capitulation of May 1945. In addition, the size of the Northwest European Campaign is a problem. At its peak, eight Allied armies were involved, as opposed to two in Italy. It would not have been possible to collect the entire operation in a series of 8- to 60-day army-level operations within the budget allotted.

A sampling of engagements was also drawn from the Eastern Front, all from the various operations around Kursk in July and August 1943. These engagements were chosen because TDI had partially collected some of the data. It was felt that some Eastern Front representation was needed for the database.

All campaigns are selected from the "European" theaters. This "Eurocentric" approach is due to the habit of the primary Axis antagonist in the Pacific Theater—the Japanese—of refusing to surrender, even in the most desperate of situations. This resulted in an exceedingly low number of captures. Similarly, there were also relatively few captured from the Allied side. This was partially because of the Japanese reputation for treatment of prisoners, and partially because most of the Allied campaigns after August of 1942 (except Burma and China) were overwhelming Allied victories, with disparate levels of support, firepower, numbers and outcome.

Due to cultural and situational factors, it is not expected that the campaigns from the Pacific Theater are very representative of modern warfare in general. However, let's examine some Japanese statistics from a reliable secondary source.[2]

Action	End Date	Total Committed	Total KIA	CIA	% CIA
Guadalcanal	Aug 42	800	785	15	1.88
Attu	May 43	2,350	2,321	29	1.23
Tarawa	Nov 43	2,571	2,563	8	0.31
Makin	Nov 43	300	299	1	0.33
Roi-Namur	Feb 44	3,472	3,421	51	1.47
Kwajalein	Feb 44	4,938	4,859	79	1.60
Saipan	Jul 44	30,000	29,079	921	3.07
Luzon	1945	287,000	279,703	7,297	2.54
SW Pacific	1945	600,000	581,000	19,000	3.17
Okinawa	Jun 45	99,401	92,000	7,401	7.45
Totals		**1,030,832**	**996,030**	**34,802**	
Average					**2.31**
Weighted Average					**3.38**

Notes on the data:

Guadalcanal — This is the Battle of the Tenaru River. Of the approximately 800 men committed, a few escaped. Of the 15 captured, 12 were wounded.

Saipan — Probably fewer than 30,000 soldiers and sailors in the garrison.

Luzon — Rough estimate of strength.

SW Pacific — Covers the entire campaign, including the Philippines. Rough estimate of strength and CIA.

Okinawa — Rough estimate of strength. Of the people that surrendered, around a third or more may have been Okinawans, and not ethnic Japanese.

The Japanese figures for civilian internees are also unusual. In the case of Saipan, the US interned 10,258 civilian but at least 1,000 civilians committed suicide at Marpi Point (some accounts record an exaggerated figure of 10,000). At Okinawa, there was a civilian population of 463,000 of which the Japanese evacuated 80,000 from the island before the invasion. As 320,762 civilians were interned according to US records, this points to an estimated 62,238 civilian deaths. Of those, about 39,000 were drafted into the army, with some 24,000 making up a home guard (militia).

Currently, there are no nations in the world that worship their emperor as a god or follow a warrior code similar to Bushido. The only major armed group whose members still occasionally commit suicide in lieu of surrendering is the Tamil Tigers of Sri Lanka. For a number of reasons, it is not expected that the US will conduct any military operations in that area. Therefore, it is not considered necessary to calculate capture rates for operations against armed forces that refuse to surrender.

[2] Richard B. Frank, *Downfall: The End of the Imperial Japanese Empire*, New York: Random House, 1999.

The campaigns lean heavily towards those areas where we have done previous work (Italy and Kursk), but the material from North Africa is new research done specifically for this project. Because of its size, duration, terrain, and climate, we attempted to complete all the campaigns from the Western Desert, but were unable to do so because of time and budget limitations. We also selected two army-level operations from the Sicilian Campaign to fill in the picture from Africa to Italy, even though the Axis data was limited. We attempted to address every significant Mediterranean Theater ground campaign that the US or UK participated in from after the fall of France until the invasion of Normandy, with the exception of Greece (1941 and 1944-45). We avoided the Greek campaign because of the involvement of four different nationalities (UK, Greece, Germany, and Italy). For two of these participants, we are not familiar with the quality of the primary or secondary data. The later Allied operation in Greece (1944-45) was also not included, more because it had the characteristics of a Small Scale Contingency Operation than conventional warfare. As such, it may be utilized in the Small Scale Contingency Operations Database in Phase III.

The research effort for the campaign database turned out to be more expansive than originally anticipated. It was originally felt that we could develop the Italian data from our existing research files and the North African data from secondary sources. When it became apparent that this was not going to result in high quality data nor be complete, TDI conducted an extensive additional research effort. This included a thorough review of all the German Panzer Army Africa, DAK, and 5th Panzer Army operations and intelligence staff files (by Richard Anderson). TDI also sent two researchers (Chris Lawrence and Richard Anderson) to England in September 1999 for a week to gather all the useful material from the 8th Army, Western Desert Force, and other relevant files, so as to have a complete record of British operations in Italy and North Africa. These two man-weeks of research in England turned out to be insufficient to resolve the complexity of the British records caused by the odd and shifting command arrangements in the Western Desert. As such, research was completed for 1940, 1941 and 1943, but not for 1942.

We also intended to add twelve operations from the Battle of Kursk. This is primarily to provide a little more data from the Eastern Front and to continue to engage our Russian research team. This included an extensive effort by Colonel Sverdlov's team, which was completed and delivered to us.

We originally targeted a total of 72 campaigns. We were unable to find sufficient data to complete some of these, and others we were unable to complete because of restrictions in budget and time. However, we were able to assemble complete, two-sided casualty and EPW capture data for 22 North African, 2 Sicilian, and 47 Italian Campaigns for a total of 71 operations. In addition, there are 31 North African and 12 Eastern Front operations where we have assembled casualty and capture data for at least one of the two sides. These can be completed at a later date.

For the campaigns, The Dupuy Institute has on file copies of the original records the data was extracted from. The list of 71 operations completed is provided in Appendix IV.

Chapter
5

Data Description

The analysis was conducted in two major steps. First, the engagements (some 202 of them) were analyzed separately from the campaigns. Furthermore, as the engagements clearly fell into three distinct theaters (Italian, Ardennes and Kursk), each theater was analyzed separately before the results were combined into a final set of figures.

Second, the campaign data was analyzed separately from the engagement data. These two data sets were then compared to each other.

A. Definitions for Purpose of Analysis

The analysis below is based upon definitions developed specifically for the analysis. These require some explanation.

Force Mix: Force mix is used to determine whether forces are primarily infantry, armor supported, or armor heavy. The definition is derived from the data. A primarily infantry force is defined as one with less than 2 main battle tanks per 1,000 men. An armor supported force is defined as having from 2 to 8 main battle tanks per 1,000 men. An armor heavy force is defined as having more than 8 main battle tanks per 1,000 men.

These definitions were derived so that an infantry division, even with limited armor support, would be considered "primarily infantry," while an infantry division with one or two battalions of tanks or self-propelled tank destroyers attached would be considered "armor supported." An armor division would be classified as "armor heavy." By setting a numerical value, this definition could be consistently applied to forces very different in size and composition. When applied to the units involved in the engagements, this definition proved to be a good working definition.

For purposes of the database, "Main Battle Tanks" are defined as armored fighting vehicles, including generally, the principal AFV of armored divisions, armed with large caliber guns, and with the primary mission of engaging and defeating the enemy's armor; all self-propelled antitank guns; and all armored assault guns.

Force Ratios: Force ratio is defined as the personnel strength of the attacker divided by the personnel strength of the defender. These strength figures are the sum, at the start of an engagement, of all personnel in the force subject to enemy fire, including generally combat and combat support troops but also service support troops if subject to enemy fire.

The LWDB also includes data on equipment, including light and main battle tanks and the number of field guns. As considerable material was gathered in the creation of the these files, The Dupuy Institute has for most of the engagements a detailed count of the weapons starting from tripod mounted machineguns and including all larger caliber weapons. It would have been possible to measure the force ratios based upon a scoring system of the weapons. This was not done for three reasons.

First, to assemble, count and score the weapons would have taken a considerable additional effort, perhaps as much as that spent upon any single phase of the enabling contracts. As such, counting and scoring could not be done within the budget that was available.

Second, a scoring system had to be selected that was "valid." To date, there is no method of validating a scoring system outside of the model in which it is used. Only one such scoring system has been validated within a model (Trevor N. Dupuy's Operational Lethality Indices). Other scoring systems exist based upon “face validity.” Furthermore, additional scoring systems based on killer-victim scoreboards have been developed.[3] Any analytical use of a scoring system would have to include a test of its reliability (predictive capability) (cf. Taylor [1999]). As such, any such effort would either require accepting a scoring system based upon faith or conducting an independent test of the validity of the scoring system. Accepting a system based upon faith does not necessarily improve the accuracy or confidence of the resulting analysis. Testing a scoring system is time consuming and would have required additional effort.

Finally, in many cases, a scoring system would not have significantly changed the strength ratios in the engagements. In many cases, the opposing forces are similar in armament and structure. It is not known if the force ratios for those where there was an asymmetrical organization of the opposing forces would have changed significantly in any consistent direction. It is possible that the changes in the force ratios from using a scoring system would have averaged out, resulting in no significant change in the analytical results.

As the force ratio was one of only four factors used to test the data with, it was decided that using a scoring system for weapons did not make economic sense at this juncture.

Outcome: As a result of an examination of the data, it became clear that the capture rates were being affected by the outcome of the engagement. The analysts then defined a series of engagement outcomes, and classified all of the engagements according to those definitions. Seven engagement outcomes were defined. They are:

Limited Action - An engagement characterized by limited activity by either side. In this case the category of attacker and defender may be arbitrary, but is usually determined by the side on the strategic or operational offensive during the period of the engagement.

Limited Attack - An engagement where the attackers offensive activity is characterized by patrols, raids or by attacks with limited objectives. Limited attacks include feints and secondary attacks that are part of larger battles.

Failed Attack - An engagement where the attacker attempts to mount a significant attack with the intention of dislodging the enemy, but does not make a significant advance and does not achieve its objective.

Attack Advances - An engagement where the attacker advances, but does not achieve a clear-cut penetration of the defender's position. Depending on the degree with which the attack achieved its objective, the attacker may or may not be the winner.

Defender Penetrated - An engagement where the attacker achieves a penetration of the defender's position. In this case the attacker is almost invariably the winner.

[3] J.G. Taylor, Lanchester Models of Warfare, Vol. I and II, Operations Research Society of America (ORSA), Alexandria, VA, 1983.

Defender Enveloped - An engagement where the attacker achieves a penetration or breakthrough of the defenders position and successfully envelops or surrounds major parts of the defending force.

Other - Any outcome that cannot be described by the other six categories.

Note that these categorizations were applied based upon a careful analysis of the course of the engagement and its result. They were not simply based upon "winners" and "losers" or the assigned mission accomplishment scores of the participants.

Of the 202 engagements in the EPW database, only 1 (Avellino) was classified as "Other."

B. The Italian Campaign Engagements

There are a total of 76 Italian Campaign engagements in the EPW database. For the purposes of the statistics and analysis below, all were used except for the engagement "Avellino." That engagement is truly an outlier, being the only engagement of battalion-level (600 people attacking 1200) and the only engagement where the outcome is classified as "Other," being a case where the attacker is attacking while surrounded. The remaining engagements were mostly division-level actions which fit the other six outcome definitions.

The engagements are from the following campaigns:

Salerno (9 Sep—30 Sep 1943)	15 engagements*
Volturno River (11 Oct—10 Nov 1943)	17 engagements
Garigliano River (11 Nov—20 Dec 1943)	3 engagements
First Cassino (Rapido River) (21 Jan--20 Feb 1944)	4 engagements
Anzio (22 Jan—22 Jun 1944)	13 engagements
Rome (11 May—30 Jun 1944)	23 engagements
Gothic Line (12 Jul 1944—10 April 1945)	1 engagement

*includes Avellino

Due to problems with gaps in the German data after June 30, 1944, only one engagement is from after that date.

These engagements cover a mix of German and US offensive actions. They included:

38 US offensive actions*
21 UK offensive actions
7 German offensive actions versus the US
10 German offensive actions versus the UK forces.

* Includes Avellino

The battles occurred in a mix of climatic and terrain conditions, including:

10 in cold climate conditions (although not in heavy snow coverage)
22 in rugged terrain
16 River crossing operations
3 Amphibious assaults

The battles were primarily division-level (see the definitions in Appendix V for how the level of combat was determined). There is 1 battalion-level battle (Avellino, which has 600 attackers versus 1200 defenders and is excluded from all calculations below), 7 brigade-level battles (the smallest of which is Monte Maggiore, which has 5,551 attackers versus 3,288 defenders) and two corps-level actions (the largest which is Fioccia, which has 37,114 attackers versus 19,613 defenders). Only the battalion-level action is excluded. The average strengths were:

Average Strength:	12,726
Average Attacker Strength:	16,945
Average Defender Strength:	8,506

The highest strength is 38,693 (British 1st and 5th ID (+) attacking at Tarto-Tiber). The lowest strength is 1,800 (elements of the German 15th PzGrD defending at Rapido South I & II). There were 14 engagements in which the defender had fewer than 5,000 men. There were no engagements in which the attacker had fewer than 5,000 men.

The force ratios for the sides varied widely. The average force ratio was 2.34 to 1, while the weighted force ratio (total attackers in all engagements divided by total defenders in all engagements) was 1.99 to 1. The highest force ratio was 6.31 to 1 (Monte Camino III). The lowest ratio was .72 to 1 (Altavilla).

The battles were mostly of two and three days in length. Thirteen battles were 1 day in duration, 30 battles were two days, 21 were for three days and 10 were for four days. The longest battle was 5 days in length (Il Giogio Pass). The average battle was 2.41 days in length.

The force mix varied widely. There were only three engagements in which both sides fielded primarily infantry forces. In 18 of the engagements, one side was primarily infantry. In 16 of the engagements, one side used armor heavy forces. In none of the engagements did both sides have armor heavy forces. In 39 of the engagements, both sides were armor supported.

The average attacker tank (MBT) strength per engagement was 77. The average defender tank strength per engagements was 40. The highest tank strength was 304. There were only a limited number of large armor actions. In only 10 of the engagements did the attacker have 150 or more tanks. The defender never had more than 139 tanks.

The battles selected were drawn mostly from existing engagements in the Land Warfare Database. As such, they record events that occurred during periods of intense combat. This means that none of the outcomes were "limited action" or "limited attack." Thirty outcomes were "failed attack," 32 outcomes were "attack advances," and 13 outcomes were penetrations. There were no "envelopments" and the excluded Avellino engagement is the only "Other".

Casualties ranged from a high of 1,721 (the attacker at Moletta River II) and 1,639 (the defender at Battapaglia) to a low of 9 (the attacker at Canal I). Average casualties were 429 for the attacker and 421 for the defender. As a percent of the force engaged, the highest casualties were 10.7%

per day (the defender at Velletri) and the lowest casualties were 0.3% per day (the attacker at Canal I). The average attacker percent loss per day was 1.35% versus 1.93% for the defender. The weighted daily averages, based upon total casualties divided by total strengths, were 1.05% for the attacker and 2.05% for the defender.

The highest reported number of Enemy Prisoners of War captured was 1136 (attacker at Anzio Breakout) and the lowest was 0 in 30 instances. However, in 18 of these instances, there were no reports of captures in the records. In all of these cases, we feel that if there were unrecorded captures, the number captured was probably zero or close to it. In these cases in which no captures are recorded, the forces were on the defensive.

The average number of EPWs captured by the attacker was 140 (60 per day), while the average number of EPWs captured by the defender was a robust 52 (22 per day). The highest percent captured was 8.86% of strength (the defender at Anzio Breakout) while the lowest percent was zero. The average percent of CIA lost by the attacker was 0.41% of strength, or 0.17% per day. The average CIA lost by the defender was 1.56% of strength, or 0.65% per day. If one looks at CIA as a percentage of the total casualties, this ranges from 100% to 0% of the losses, with the attacker losing an average of 13.58% of their casualties as CIA while the defender lost an average of 33.07% of their casualties as CIA! In seven cases, one side reported more captured than the other side reported total casualties. The percent captured in these cases is set at 100% (as opposed to some figure greater than 100%). These averages change somewhat if one uses a weighted average of total casualties versus total CIA. In this case the attacker lost an average of 12.24% of his casualties as CIA while the defender lost an average of 33.20% of his casualties as CIA.

C. The Ardennes Campaign Engagements

There are a total of 77 engagements in the EPW database that we consider to be part of the Ardennes Campaign engagements. 71 of them are from what is usually defined as the Ardennes Campaign, while another four are from the Westwall-Hürtgen Forest Campaign in Northwest Europe. These four engagements occurred just prior to the opening of the Ardennes Campaign and were geographically nearby. Of the remaining, one occurred on the Seine River in August 1944 and was part of the Pursuit Across France. The other is the Battle of Kasserine Pass from February 1943 in Tunisia. These two were included because the EPW data was readily available in the TDI research files. The Kasserine Pass engagement was included in this data set instead of with the Italian Campaign engagements so as to preserve the purity of that data set.

Not used from the LWDB for the EPW database were another 5 engagements from the Tunisian Campaign, 5 from the Pursuit Across France, 2 from the Westwall Campaign, and 5 from the Ardennes. These were not included because we simply did not have, or had not taken the time, to gather EPW data for them. The Land Warfare Database also contains one engagement from the France 1940 Campaign, 5 from the Campaign of El Alamein, 6 from Normandy, and 13 from the Lorraine Campaign.

For the purposes of the statistics and analysis below, all 71 of the "Ardennes" engagements were used. Six battalion-level and lower engagements were not. This was done to be consistent with the exclusion criteria used for the Italian Campaign Engagements. Although the excluded engagements were not necessarily statistical outliers, it was felt that they were simply at too low a level of aggregation to lump their statistics in with a database of corps, division and brigade-level battles.

The engagements excluded were Trois Ponts, Stavelot, Stoumont, and Dom Bütgenbach I, II, and III. These engagements were all on the northern flank of the Ardennes, from the 18th and 19th of December, and involved attacking elements of the 6th Panzer Army. The largest of them was Stoumont with 510 attackers versus 1,045 defenders. Their average strength was 316 for the attacker and 458 for the defender. In all six, the Germans were the attackers.

Almost all of these engagements occurred after June 30, 1944. This means that the German data is sometimes questionable. As such, this data set is in some respects not as reliable as the Italian Campaign engagements. Still, because of the extensive work done by TDI staff on the Ardennes Campaign Simulation Database, it was felt that this was the best data available and that there was little that could be done to improve upon this data.

These engagements cover a mix of German and US offensive actions. They included:

41 US offensive actions
36 German offensive actions*

*including the six engagements deleted from further analysis

The battles occurred in a mix of climatic and terrain conditions, including:

73 cold climate conditions (although not in heavy snow coverage)
49 in rugged terrain
6 river crossing operations
3 battles in an urban environment

These totals also include the six engagements deleted from further analysis.

The battles were primarily division-level. There were 5 battalion-level battles and 1 squad-level action (all of which were excluded from all calculations below), 14 brigade-level battles (the smallest of which is Dom Bütgenbach VI, which had 1500 attackers versus 800 defenders) and 7 corps-level actions (the largest of which is Bastogne I, which pitted 39,444 attackers against 22,755 defenders). The average strengths were:

Average Strength:	12,168
Average Attacker Strength:	15,024
Average Defender Strength:	9,311

The highest strength was 43,800 (German XLVII Panzer Corps attacking at Our River Center). The lowest strength was 308 (US K/110th/28th ID defending at Hosingen). Overall, there were more small engagements recorded in the Ardennes data than are in the Italian data. This is partially due to the tendency of the terrain to channel attacks, resulting in some major actions being relatively small but well recorded.

There were 19 engagements in wihch the defender had less than 5,000 men, and in four of those, the defender had less than 1,000 men. In eight of the 19 engagements the attacker also had less than 5,000 men.

The force ratios for the sides varied widely. The average force ratio was 2.79 to 1, while the weighted force ratio was 1.61 to 1. The highest force ratio was 36.36 to 1 (Hosingen). The lowest ratio is .34 to 1 (Malmédy).

Fifty-three of the battles were 1 day in length. Sixteen battles were two to four days in length. The longest battle was 6 days in length (Westwall). The average battle was 1.61 days in length.

The force mixes varied widely. In only six of the engagements were both sides primarily infantry forces. In a total of 31 engagements, at least one side was primarily infantry. In 26 of those engagements, it was the defender. In 22 of the engagements, at least one side had armor heavy forces. In 8 of those engagements, it was the defender. In two of those engagements, both sides had armor heavy forces. In 28 of the engagements, both sides were armor supported.

The average attacker tank (MBT) strength per engagement was 84. The average defender tank strength per engagements was 37. The highest tank strength was 335 (Seine). While the averages and range of armor were very similar to the Italian Campaign engagements, the Ardennes saw both more armor heavy actions as well as more pure infantry actions. In effect, the armor was less evenly spread, even though the total number of tanks recorded in the 71 battles are almost the same number as in the 75 Italian Campaign battles (5,987 vs 5,783 on the offense and 2,652 vs 2,973 on the defense). Still, in the Ardennes, there were not that many more major armor actions. Only in 13 of the engagements (vice 10 for the Italian Campaign data) did the attacker have 150 or more tanks. The defender never had more than 159 tanks (vice 139). The two armor heavy versus armor heavy engagements consisted of a large action at Celles in which 302 tanks opposed 116, and a lop-sided action at La Gleize in which 224 tanks opposed 34. There were only three engagements in which each side had 100 tanks or more, and a total of 8 engagements in which each side had more than 60 tanks. There were a total of 31 engagements in which each side had 30 or more tanks.

In comparison, the Italian data had no armor heavy to armor heavy engagements, but still had a similar number of large armor engagements. There were actually 4 Italian engagements in which each side had 100 or more tanks, and 8 engagements in which each sides had more than 60 tanks. There were a total of 39 Italian engagements in which each side had 30 or more tanks. The Italian figures are from a data set of four more engagements than the Ardennes data.

The difference between the Italian and Ardennes data sets are in the cases in which armor support was minimal to non-existent. In the Italian data, there were 4 instances in which the attacker had no tanks and 5 instances in which the defender had no tanks, and 2 additional instances in which the defender had fewer than 10 tanks. In the Ardennes data there were also 4 instances in which the attacker had no tanks and 1 case in which the attacker had less than 10. For the defender, there were 9 cases in which he had no tanks, and 10 additional cases in which the defender had less than 10.

This flies in the face of the general opinion that the Ardennes was an "armor heavy campaign" while the Italian Campaign was not. From the selection of engagements in the database, it appears that the amount and use of armor in the two data sets is similar.

The Ardennes battles selected were drawn from three sources. 12 were drawn from the existing LWDB engagements. 14 were created by Jay Karamales from his anti-armor studies. All of these engagements are classic studies of battles; that is, they are studies of combat that occurred and do not record what happened in the lulls between major engagements. However, of the 51 new engagements created by Richard Anderson for this project, 44 were included with the specific intent of recording an extended series of engagements on a daily basis. These engagements cover the operations of the divisions of the US III Corps from the beginning of the Third Army counteroffensive on 22 December 1944 to 31 December 1944, and the operations of the 101st Airborne Division at Bastogne from 19 to 27 December. As such, they also cover periods when the action was fairly quiet. As a result, the Ardennes Campaign data set includes 1 engagement with an outcome of "limited action," 7 that are "limited attack," 15 engagements that are ""failed attack," 27 engagements that resulted in "attack advances," 16 engagements that were "defender penetrated," and 5 engagements that are "defender enveloped." There were no engagements with an outcome of "Other".

The casualties for the defenders ranged from a high of 3,636 (Westwall), in a six-day engagement, or 2,028 (4th AD Attack IV) in a 1 day engagement, to a low of 15 (Höfen). For the attackers, the

casualties ranged from a high of 1,477 (Westwall) in a six-day engagement, or 639 in a 1 day engagement (Bastogne VI), to a low of 1 (4th AD Attack I).

Average casualties were 256 for the attacker and 548 for the defender. Average casualties per day were 160 for the attacker and 341 for the defender. This is somewhat different from the Italian Campaign engagements, in which the average casualties per day were 178 for the attacker (which is close to the Ardennes figures) and 174 for the defender (which is about one-half the Ardennes average).

As the Ardennes contained a wider range of engagements by size, this difference in size appears to have affected the percent casualty figures. As a percentage of the force engaged, the highest casualties were 85.71% per day (the defender at Honsfeld) and the lowest casualties were 0.01% per day (the attacker at 4th AD Attack I). However, looking at unit size, one finds that at Honsfeld there were only 525 defenders. For defenders with between 5,000 and 10,000 personnel, the highest percent losses were 20.60% (Our River Center) and for defenders with more than 10,000 personnel, the highest percent was 6.95% (80th ID Attack II). For the attackers a similar phenomenon based upon unit size is observed. For attacker strengths of less than 5,000, the highest loss was 26.67% of a force of 1,500 (Dom Bütgenbach VI). For forces between 5,000 and 10,000, the highest loss was 4.42% (Schmidt I) and for forces greater than 10,000, the highest loss was 4.10% (Bastogne VII).

The average attacker percent loss per day was 1.87%. The average defender percent loss per day was a rather large 7.16%. This figure is much higher than that found in the Italian data (1.35 and 1.93 respectively) and it appears to have been somewhat affected by the many engagements in which the defender had a battalion-size force. The weighted daily averages were 1.71% for the attacker and 5.89% for the defender. This was also much higher than the Italian Campaign (1.05 and 2.05 respectively). No compelling reasons could be found to explain this difference. However, it does not seem to have had an impact on the final calculation of EPW capture rates because they appear to have been far more affected by the engagement outcome.

The highest reported number of Enemy Prisoners of War captured was 3,435 (attacker at Schnee Eifel North II) and the lowest was 0 in 57 instances. In five of these instances, there were no captures reported. For those five cases, the number of EPWs captured was probably close to zero and for mathematical completeness, all of those cases were assigned a value of zero.

The average number of EPWs captured by the attacker was 283 (176 per day) while the average number of EPWs captured by the defender was 28 (18 per day). The highest percent captured was 97.73% of strength (the defender at Hosingen) while the lowest percent was again 0. The average percent of CIA lost by the attacker was 0.24% of strength, or 0.15% per day. The average CIA lost by the defender was 7.21% of strength, or 4.49% per day. If one looks at CIA as a percent of the total casualties, this ranges from 97.73% to 0% of the losses, with the attacker losing an average of 14.37% of their casualties as CIA while the defender lost an average of 33.69% of their casualties as CIA. These averages change somewhat if a weighted average of total casualties versus total CIA is used. In this case the attacker lost an average of 11.00% of his casualties as CIA while the defender lost an average of 51.59% of his casualties as CIA.

Because six engagements were excluded from this data, a brief comparison of the statistics of the included 71 engagements and the excluded 6 is given below:

	Included Engagements	Excluded Engagements
Number of Engagements	71	6
Average Attacker Strength	15,024	316
Average Defender Strength	9,311	458
Average Force Ratio	2.79	1.16
Weighted Force Ratio	1.61	0.69
Average Battle Length (days)	1.61	1
Average Attacker Tank Strength	84	15
Average Defender Tank Strength	37	2
Average Attacker Casualties	256	60
Average Defender Casualties	548	67
Average Attacker Casualties per Day	160	60
Average Defender Casualties per Day	341	67
Average Attacker Percent Loss per Day	1.87	34.77
Average Defender Percent Loss per Day	7.16	11.99
Weighted Attacker Percent Loss per Day	1.71	19.02
Weighted Defender Percent Loss per Day	5.89	14.64
Average Number of Attacker EPWs	283	51
Average Number of Attacker EPWs per Day	176	51
Average Number of Defender EPWs	28	0
Average Number of Defender EPWs per Day	18	0
Average Percent of Attacker CIA	0.24	2.08
Average Percent of Attacker CIA per day	0.15	2.08
Average Percent of Defender CIA	7.21	5.20
Average Percent of Defender CIA per Day	4.49	5.20
Average Percent Attacker Losses are CIA	14.37	2.08
Average Percent Defender Losses are CIA	33.69	21.47
Total Percent Attacker Losses are CIA	11	0.28
Total Percent Defender Losses are CIA	51.59	75.62

Overall, the similarities between the Italian and Ardennes Campaign engagements are more compelling than the differences.

	Italian	Ardennes
Number of Engagements	75	71
Average Attacker Strength	16,945	15,024
Average Defender Strength	8,506	9,311
Average Force Ratio	2.34	2.79
Weighted Force Ratio	1.99	1.61
Average Battle Length (days)	2.41	1.61
Average Attacker Tank Strength	77	84
Average Defender Tank Strength	40	37
Average Attacker Casualties	429	256
Average Defender Casualties	421	548
Average Attacker Casualties per Day	178	160
Average Defender Casualties per Day	174	341
Average Attacker Percent Loss per Day	1.35	1.87
Average Defender Percent Loss per Day	1.93	7.16
Weighted Attacker Percent Loss per Day	1.05	1.71
Weighted Defender Percent Loss per Day	2.05	5.89
Average Number of Attacker EPWs	140	283
Average Number of Attacker EPWs per Day	60	176
Average Number of Defender EPWs	52	28
Average Number of Defender EPWs per Day	22	18
Average Percent of Attacker CIA	0.41	0.24
Average Percent of Attacker CIA per Day	0.17	0.15
Average Percent of Defender CIA	1.56	7.21
Average Percent of Defender CIA per Day	0.65	4.49
Average Percent Attacker Losses are CIA	13.58	14.37
Average Percent Defender Losses are CIA	33.07	33.69
Total Percent Attacker Losses are CIA	12.24	11
Total Percent Defender Losses are CIA	33.2	51.59

The overall conclusion that may be drawn from examining the two data sets is that there is really no strong reason to analyze them separately, and they may be lumped together as one large data set of US and UK versus German actions.

D. The Battle of Kursk Engagements

There are 49 engagements from the Battle of Kursk in the EPW database. It was intended to include every engagement from the 4th Panzer Army's attack (which consisted of 1 infantry corps and 2 armor corps), which would have resulted in over 70 engagements. However, budget and schedule considerations forced us to forego analyzing the operations of one of the armor corps. Therefore, the Kursk engagements record all of the actions fought by the 52nd Army Corps and the 48th Panzer Corps between 4 and 18 July 1943.

The battles include 22 from the 52nd Corps operations and 27 from the 48th Pz Corps operations. They cover a mix of 31 German offensive actions and 18 Soviet offensive actions. The engagements occurred mostly in rolling terrain with 11 engagements in rolling open terrain and 27 in rolling mixed terrain. There are 11 engagements in rough terrain, which are mostly infantry actions. There are no river crossings and no battles in an urban environment. The weather was temperate throughout, although with plenty of rain and showers. The rain appeared to play a significant role in only one engagement, effectively stalling a German armor attack.

As all the engagements are division-sized or corps-sized, and none are excluded from the analysis. The average strengths were:

Average Strength:	24,651
Average Attacker Strength:	28,521
Average Defender Strength:	20,782

The highest strength was 67,829 (Soviet 1st Tank Army counterattack around Verkhopenye). The lowest strength was 1,191 (Soviet elements surrounded at Vorskla River). There was only 1 engagement where one side (the defender) had fewer than 5,000 men. There were 21 engagements where one side had more than 30,000 men. In 8 of these, both sides had more than 30,000 men.

The primary reason for the corps-size actions is due to the nature of the fighting itself. In the first few days, two or three German divisions were concentrated on one defending Soviet division. The 48th Pz Corps then effectively formed a combined combat group from 3rd Panzer Division, the Grossdeutschland Panzer Grenadier Division, with the 39th Panzer Rgt attached, and sometimes with all or part of the 332nd Infantry Division attached. These formations then attempted to conduct a series of encirclement operations on corps-size Soviet units in a number of confusing actions. Meanwhile the Soviets were supporting their Tank Corps (equivalent to an armor division) with two or more rifle divisions. In the largest of the engagements (Verkhopenye) the Soviet forces consisted of three full tank corps, plus two brigades of a mechanized corps, and 5 infantry divisions versus the two German armored divisions, with a regiment from the 332nd Infantry Division attached. Because of the disparate frontages and sizes of the opposing formations, breakdown of these engagements into smaller components could only be done with a considerable amount of interpolation as to what percent of what unit was facing whom, along with an appropriate set of judgment calls as to the percent of strengths, armor, artillery, and casualties that should be applied to each engagement. As this would have been creating detail beyond what was reported in the records (which was mostly at the division-level), it was decided that the most reasonable approach was to assemble the engagements at a level of aggregation that would allow for whole divisions to be included in each engagement. Therefore, we ended up with 21 corps-level actions, and average strengths for both the attacker and defender of about twice that of the Italian and Ardennes data sets.

The force ratios for the sides varied widely. The average force ratio was a rather low 1.67 to 1, while the weighted force ratio was 1.37 to 1. The highest force ratio was 11.77 to 1 (Vorskla Ravine), although this is far from typical. The next largest force ratio was 3.79 to 1. The lowest ratio was .51 to 1 (Kruglik-Kalinovka).

Most of the battles (36) were of one day duration. The longest battle was 7 days in length (Krasnopolye V). All of the battles that were more than one day in length were "limited action" or "limited attack." There were two engagements of less than a day (.3 days and .7 days), in which the German armor forces penetrated the Soviet 67th Gds Rifle Division, then turned west in exploitation and then engaged the 3rd Mechanized Corps which was defending a separate defensive position behind the initial defense line. The average battle was 1.39 days in length.

The force mix varied widely, with the engagements having either little armor support on either side or both sides having large numbers of tanks. Because of the large infantry elements in the German Panzer Divisions, especially the Panzer Grenadier Divisions, and because of the tendency for the Soviet Tank Corps to fight with one or more Rifle Divisions attached, in only 1 instance did either side actually have an engagement that exceeded the threshold of 8 tanks per thousand troops. There was 1

other instance of 7 tanks per 1,000 troops. The rest of the armor engagements occurred in an environment where there were less than 6 tanks per 1,000 troops. This was during the course of the largest armor battle in history.

In 20 engagements, both sides were primarily infantry forces. In 9 of the engagements, one side was armor supported, while the other side was primarily infantry. In 19 of the engagements, both sides were armor supported. There was 1 case of an armor heavy force attacking a primarily infantry force. During the course of these battles, the Germans committed a total of 2 panzer divisions, 1 panzergrenadier division (a large panzer division with extra armor and an extra regiment of infantry), and 1 independent tank regiment with 2 large battalions of Panther tanks. The Soviets committed 4 tank corps, 1 mechanized corps, 3 independent tank brigades, 5 independent tank regiments, and 3 self-propelled artillery regiments. On the Soviet side, this amounted to about half of the armor in the entire southern sector of the Battle of Kursk.

The average attacker tank (MBT) strength per engagement was 86. The average defender tank strength per engagements was 59. The highest tank strength was 437. There were 19 cases in which the attacker had no armor, and 23 cases in which the defender had no armor. In 13 of the engagements the attacker had 150 or more tanks. The defender also had large armor forces—the largest being 230 tanks—and had more than 150 tanks in 10 engagements. There were 10 engagements in which each side had more than 100 tanks, 15 engagements in which each side had more than 60 tanks, and a total of 21 engagements in which each side had more than 30 tanks.

Still, the force mix and size of the armor clashes are not significantly different from that found in the Italian and Ardennes data sets. Certainly none of the three data sets may be characterized as an "armor heavy" data set. A brief comparison shows:

	Italian	Ardennes	Kursk
Number of Engagements	75	71	49
Average Attacker Tanks	77	84	86
Average Defender Tanks	40	37	59
Peak tank strength	304	335	437
Both sides have more than:			
100 tanks	4	3	10
60 tanks	8	8	15
30 tanks	39	31	21

Still, this data is not entirely representative of the German force mix on the southern offensive at Kursk. There were two additional tank corps and one infantry corps involved in the southern offensive. If all this data is included, the Kursk figure would have changed some as a result of adding a higher percentage of armor engagements.

The Kursk engagements were not chosen in the same way as the other databases. Instead TDI started from the westernmost division-sized unit of the 4th Panzer Army and recorded every engagement of these units from July 4th through the 18th, and worked eastward until every unit in the 52nd Corps and the 48th Panzer Corps had been analyzed for that time period. This data set includes 4 German infantry divisions and 3 German panzer and panzer-grenadier divisions covering 94 division-days of combat. The Soviet forces included 13 Soviet rifle divisions and 5 Soviet tank and mechanized Corps covering some 181 division-days of combat.

As such, the database recorded every combat that occurred during an armored corps offensive, which then shifted to the defensive, and recorded every combat in a supporting infantry corps on the fringe of the offensive. This data set records events on quiet sectors as well as periods of intense combat. This resulted in 8 of the outcomes being "limited action" and 13 being "limited attack." Nine of the outcomes are "failed attack," 12 of the outcomes are "attack advances," 4 of the outcomes are "defender penetrated," and 3 of the outcomes are "defender enveloped."

Casualties varied from a high of 4,431 for the attacker (counterattack around Verkhopenye) and 4,012 for the defender (Tolstoye Woods) to a low of 1 (both attacker and defender at Soldatskoye I). The average casualties were 442 for the attacker, or 319 per day, and 596 for the defender, or 430 per day. As a percent of the force engaged, the highest casualties were 100% per day (Defender at Vorskla Ravine) and the lowest casualties were 0% per day (both sides at Soldatskoye I). The average attacker percent loss per day was 1.38% versus 4.38% for the defender. The weighted daily averages were 1.55% for the attacker and 2.87% for the defender.

The highest reported number of Enemy Prisoners of War captured was 2,585 (attacker at Berezovka) and the lowest was 0 in 13 instances. The average number of EPWs captured by the attacker was 236 (170 per day) while the average number of EPW captured by the defender was 22 (16 per day). The highest percent captured was 100% of strength (the defender at Vorskla Ravine) while the lowest percentage was zero. The average percentage of CIA lost by the attacker was 0.08% of strength or 0.06% per day. The average CIA lost by the defender was 2.79% of strength or 2.76% per day. If one looks at CIA as a percentage of the total casualties, this ranges from 100% to 0% of the losses, with the attacker losing an average of 6.10% of their casualties as CIA while the defender lost an average of 26.50% of their casualties as CIA! The weighted averages for these figures are 4.98 and 39.66 respectively.

The CIA figures were heavily influenced by human factors. As discussed below, the Soviets surrendered to the Germans in larger numbers regardless of the tactical situation. As the Germans were usually on the offensive and the Soviets were usually on the defensive, this heavily biases the CIA figures. See the discussion on human factors below.

E. The World War II Operations

The second part of the EPW database consists of 71 operations from World War II, filed in a separate computerized database. This database is similar to, but not the same as, the database used for the engagements. The operations chosen are from the following campaigns:

Campaign	Start Date	End Date	# Engagements
First North African	6/11/1940	2/7/1941	9
Second North African	2/8/1941	11/17/1941	9
Third North African	11/18/1941	7/1/1942	3
Fourth North African	7/2/1942	1/14/1943	1
Torch	11/8/1942	11/14/1942	0
Tunisian	11/15/1942	5/12/1943	0
Sicilian	7/10/1943	8/17/1943	2
Calabrian	9/3/1943	9/30/1943	1
Salerno	9/9/1943	9/30/1943	1
Naples	10/1/1943	10/10/1943	2
Volturno	10/11/1943	11/10/1943	1
Trigno	10/11/1943	11/20/1943	1
Garigliano	11/11/1943	1/20/1944	2
Sangro	11/21/1943	2/20/1944	3
Cassino	1/21/1944	3/31/1944	4
Anzio	1/22/1944	5/22/1944	7
Gustav Line	3/21/1944	5/10/1944	2
Rome	5/11/1944	6/30/1944	5
Gothic Line	7/1/1944	4/10/1945	14
Po Valley	4/11/1945	5/6/1945	4

The entire first year and a half of the campaign in North Africa is covered, as are the two years of operations in Sicily and Italy. In addition, there are 32 more operations that are partially entered, but incomplete due to a lack of data. These could be completed with some additional research effort and would yield an additional seven operations from the Third North African Campaign, five operations from the Fourth North African Campaigns, one to three operations from Operation Torch, and 19 operations from the Tunisian Campaign. If

these were completed, the database would then be a complete picture of all operations from Sidi Barrani to the Brenner Pass over the course of five full years.

Organization	# of Operations
Italian XXII Corps	1
Italian XXIII Corps	1
Italian 10th Army	7
Italian 6th Army (elements)	2
German Aufklärungsstab Rommel	1
German Afrika Korps	5
German Panzergruppe Afrika	7
German 1st Parachute Division (+)	1
German XIV Panzer Corps	8
German LI Mountain Corps	5
German LXXVI Panzer Corps	4
German 14th Army (elements)	2
German 10th Army	10
German 14th Army	17
9th Australian Division (+)	1
UK Cyrenaica Command	1
UK XIII Corps	3
UK Western Desert Force	10
UK Eighth Army	28
US VI Corps	8
US 5th Army	19
US Seventh Army	1

We defined our campaigns as an army-level operation of 8 to 60 days in length. Of the 71 operations recorded, all fit this definition for length, with the exception of "Graziani's Advance," which was only 6 days long, and the final two operations "German Capitulation in Italy (US)" and "German Capitulation in Italy (UK)," which were only 4 days in length. The length of the operations were based upon the commonly accepted definition for the campaign. However, in some cases, the campaigns were divided into subsets so as to keep the length under 60 days.

As for them being army-level, the operations were conducted by the organizations shown in the table at left.

Looking at the organizations, there were two divisions (both on the defense), effectively 47 corps (15 on the attack), and 95 armies in these operations. The divisions ranged in strength from 15,000 to 36,000. The corps ranged in strength from 24,000 to 105,044 when defending, and from 32,000 to 114,011 when attacking. The armies ranged in strength from 24,855 to 183,000 when defending, and from 71,870 to 378,106 when attacking. These are all starting strengths. The database also records end and average strengths. In five cases, the end strength of the defending corps and armies were below one thousand. The average starting strength of these operations were:

Average Starting Strength: 128,631

Average Attacker Strength: 176,485

Average Defender Strength: 80,689

The lowest strength for the attacker was 32,000 (Western Desert Force in the "Arrival of Rommel") and the highest strength was 378,106 (the US 5th Army attacking in the "Race to Rome"). The lowest strength was 15,000 (the German 1st Parachute Division (+) defending at "BAYTOWN") and the highest defending strength was 183,000 (elements of the Italian 6th Army at "HUSKY (US)"). There were 5 operations in which the attacker had less than 40,000 troops and a total of 9 operations in which the attacker had less than 60,000 troops. There were 12 operations in which the defender had 40,000 or fewer troops, and a total of 24 operations in which the defender had fewer than 60,000 troops.

Unlike the engagement data, in which seven battalion-level engagements were excluded from the analysis, none of these army-level operations were excluded from further analysis.

These operations cover a mix of German, Italian, UK and US offensives, including:

5 Italian offensive operations
6 German offensive operations
35 UK offensive operations
25 US offensive operations

All of the Italian and three of the German offensive operations were against a British defender.

The force ratios for the sides varied widely. The average force ratio was 2.65 to 1, while the weighted force ratio was 2.18 to 1. The highest force ratio was 12.38 to 1 (BAYTOWN). The lowest ratio was 0.58 to 1 in three cases (COMPASS, Arrival of Rommel, HUSKY (US)). Two of these were offensive operations against the Italians, both successful, and one was a "limited action" that covered a period when the British offensive in North Africa was halted and the Germans were arriving to reinforce the Italian forces. Overall, there were 11 operations in which the attacker was outnumbered. Five of these were "limited action" and one was a "limited attack" where neither side did much. Four of the remaining five were successful attacks. In three of those four cases, the Italians were defenders. The other case of a successful attack while outnumbered was the "Battle of Gazala," wherein Rommel achieved victory despite attacking at 0.78 to 1. In the case of the failed attack (Anzio), the Germans counterattacked against an Allied force while outnumbered 0.71 to 1.

The operations ranged from 4 to 51 days in length. Two operations were 4 days in duration, one operation was 6 days, eight were 9 to 10 days, one was 13 days, fourteen were 16 to 22 days, nineteen were 28 to 31 days, twenty-two were 36 to 44 days, and four operations were 50 to 51 days. The average operation was 28.87 days in length.

There were a wide variety of force mixes. As we were dealing with army-level operations, we cut the definition of infantry, armor supported, and armor heavy by half (i.e., less than 1 tank per thousand is infantry, from 1 to 4 tanks per thousand is armor supported, and more than 4 tanks per thousand is armor heavy). Using this definition resulted in only 1 operation in which both sides were primarily infantry, 20 operations in which one side was primarily infantry, 24 operations in which one side was armor heavy, and only one operation in which both sides were armor heavy. In 28 of the operations, both sides were armor supported.

Using the original definition, there was only one operation with armor heavy forces, 7 were primarily infantry operations, 33 were operations in which one side was armor supported and the other side was infantry, and 28 were operations in which each side was armor supported. It was felt that the original definition did not fit well for army-level aggregations.

The average attacker tank (MBT) strength per operation was 576. The average defender tank strength per operation was 171 (in 65 operations, as defender armor strength was not known in 6 cases). The highest tank strength was 1,420 (DIADEM, UK). There were a large number of operations with significant armor. In 36 of the operations the attacker had 500 or more tanks. In two of the operations, the defender also had more than 500 tanks. The defender did have more than 200 tanks in 23 of the operations and in all these cases, the attacker had at least 217 tanks.

There are some gaps in the data. In five cases, we are missing the total casualties for the attacker. In six cases, we are missing the total number of main battle tanks for the defender. In one case, the number of people captured by the defenders is not known, although the figure is certainly less than 500 troops.

As the operations covered entire campaigns (or parts of campaigns) from either the beginning to the end (as in Italy) or from the beginning of operations in June 1940 until the research budget was exhausted (June 1941 in North Africa), they represent all of the operations conducted during that time. This means that there was an entire range of outcomes. The only exceptions are "The Cauldron (Gazala)" and the "Second Battle of El Alamein," which were clearly two periods of intense combat.

Although isolated from the remainder of the operations, they were included because most of the data was easily available. Otherwise, the data selection is unbiased in the sense that everything that occurred during those operations is covered, as opposed to cherry-picking data from high points.

Fifteen of the outcomes were "limited action," nine were "limited attack," eight were "failed attack," twenty were "attack advances," thirteen were penetrations, and four were "Envelopments." There were also two "Others," which cover the final surrender of the German forces in Italy to the Allies (they are the two 4-day operations).

A comparison of the length of the campaign versus its outcome shows:

North Africa	Days
Limited Action	372
Limited Attack	36
Failed Attack	67
Attack Advances	34
Defender Penetrated	53
Defender Surrounded	61
Sicily and Italy	**Days**
Limited Action	182
Limited Attack	251
Failed Attack	130
Attack Advances	558
Defender Penetrated	298
Defender Surrounded	
Other	8
Total	**2,050**

As indicated, there were some 408 inactive days in North Africa compared to 215 active days (a roughly two to one ratio). The reverse was true of Sicily and Italy, where the number of inactive days were 433 and the number of active days were 864. Still, this comparison is not an accurate reflection of the frequency of combat, as what is being measured here is outcome. Within each operation there were days of both high and low activity. It does reflect the difficulty that both sides found in sustaining operations in the North African desert.

Casualties ranged from a high of 22,192 (the attacker at Gothic Line Assault (US)) and 136,325 (the defender at HUSKY (US)) to a low of 8 (the defender at Sidi Barrani II). There were 13 cases in which the defender lost 20,000 or more troops. In six of those cases, the defender was Italian. There is only one case in which the attacker lost more than 20,000. There were four cases in which the defender lost less than 100. In all of those cases, they were the British defending in "limited action" versus the Italians in North Africa.

Average casualties were 5,580 for the attacker (66 known cases) and 12,642 for the defender. As a percent of the force engaged, the highest casualties were 25% per day (the two cases of the defender at German Capitulation in Italy (US & UK), both 4-day operations) and the lowest casualties were 0% per day (the attacker at Italian Build-up II). The average attacker percent per day loss was 0.14% (66 cases) versus 1.35% for the defender. The weighted daily averages (based upon total casualties divided by total strengths divided by average number of days) were 0.11% for the attacker and 0.54% for the defender.

The highest reported number of EPWs captured was 122,204 (attacker at HUSKY(US)) and the lowest was 0 in 32 instances. The average number of EPWs captured by the attacker was 9,278 or 321 per day (70 cases) while the average number of EPW captured by the defender was 385 or 13 per day. The highest percentage captured was 100% of strength (the two cases of the defender at Capitulation in Italy (US & UK)), while the lowest percentage was zero. The average percent of CIA lost by the attacker was 0.26% of strength or 0.01% per day (70 cases). The average CIA lost by the defender was 13.29% of strength or 0.46% per day, 1.18% per day if one averages the percent per day loss for each operation. If one views CIA as a percent of the total casualties, this ranges from 100% to 0% of the losses, with 6.02% of the attacker casualties as CIA, while the defender lost an average of 38.75% of their casualties as CIA! In three cases, there were more EPW reported as captured by one side than there were total casualties reported by the other. In all but one case, this can be explained by differences in reporting periods in the records. The percent captured in these cases was set at 100% (as opposed to some figure greater than 100%). These averages change somewhat if a weighted average of total casualties versus total CIA is used. In this case, the attacker lost an average of 7.32% of the total casualties as CIA, while the defender lost an average of 73.39% of the total casualties as CIA. This latter figure was clearly driven by a number of large surrenders, including 113,303 at Po Valley

(US), 122,204 at HUSKY (US). In addition to the two final capitulations in Italy, there were several other German operations and five Italian operations with large-scale surrenders.

One of the main reasons for developing the Campaign Database was to compare the difference in capture rates between army-level operations and division-level engagements. This was undertaken due to concerns that the two were not directly comparable. This concern was magnified by previous studies that generated averages from a database that included operations as diverse as "Barbarossa" (the invasion of Russia) and "Just Cause" (Grenada), and treated them with equal weight and significance. One cannot apply the data from one level of aggregation to another level without understanding that the statistics for different levels of combat may differ.

The following is a comparison of the Italian campaign as viewed from the division level and the army level:

	Division-level Engagements	Army-level Engagements	Ratio, Division-level vs Army level
Allied Offensive Actions	59	44	
German Offensive Actions	17	3	
Average Attacker Strength	16,945	219,146	1 to 12.9
Average Defender Strength	8,506	83,178	1 to 9.8
Average Force Ratio	2.34 to 1	3.37 to 1	
Weighted Force Ratio	1.99 to 1	2.63 to 1	
Average Battle Length (Days)	2.41	28.70	1 to 11.9
Average Attacker Tank Strength	77	738	1 to 9.6
Average Defender Tank Strength	40	166	1 to 4.2
Average Attacker Casualties	429	6,259	1 to 14.6
Average Defender Casualties	421	10,547	1 to 25.1
Average Attacker Casualties per day	178	218	1 to 1.2
Average Defender Casualties per day	174	367	1 to 2.1
Average Attacker Percent Loss per day	1.35	0.14	1 to .1
Average Defender Percent Loss per day	1.93	1.46	1 to .8
Weighted Attacker Percent Loss per day	1.05	0.10	1 to .1
Weighted Defender Percent Loss per day	2.05	0.44	1 to .2
Average Number of Attacker EPWs	140	6,381	1 to 45.6
Average Number of Attacker EPWs per day	60	222	1 to 3.7
Average Number of Defender EPWs	52	314	1 to 6.0
Average Number of Defender EPWs per day	22	11	1 to .5
Average Percent of Attacker CIA	0.41	0.21	1 to .5
Average Percent of Attacker CIA per day	0.17	0.01	1 to .1
Average Percent of Defender CIA	1.56	9.93	1 to 6.4
Average Percent of Defender CIA per day	0.65	1.28	1 to 2.0
Average Percent Attacker Losses are CIA	13.58	4.68	1 to .3
Average Percent Defender Losses are CIA	33.07	35.75	1 to 1.1
Total Percent Attacker Losses are CIA	12.24	5.02	1 to .4
Total Percent Defender Losses are CIA	33.20	60.5	1 to 1.8

This comparison establishes several things. First, it clearly shows that the army-level operations in Italy are about ten times the size and duration of the division-level engagements. This is shown by the average attacker strength, the average defender strength, the average battle length, the average attacker tank strength, and the average attacker casualties. The average defender tank strength is only larger by a factor of 4 and the average defender casualties are some 25 times higher. There is a little bit of an apples-and-oranges comparison here, as the operations continue until 1945, while the engagements, with one exception, are from June 1944 or earlier. The force ratios for the operations and engagements are similar, as are—surprisingly enough—the average attacker and defender casualties per day. Furthermore, the average number of EPWs captured per day is also similar. Of course, what is different is the percentage of casualties per day, which is about one-fifth to one-tenth of that for the engagements. For the percent captured per day, the operations are less than one-tenth of that for the engagements for the attacker, while it is actually larger for the defender. This difference is mostly caused by the last four of the 47 operations, in which over 70% of the defender's total captured were suffered. The real difference is that 75 of the 76 division-level engagements occur as part of the first 29 operations, and only one engagement occurs as part of the last 18 operations. These last 18 operations account for 72% of the defender's casualties and 85% of the defender's captured, while only accounting for 41% of the attacker's casualties and 19% of the attackers captured. A more direct comparison between the 76 engagements and the 29 operations in which they occurred follows:

	Italian Division-level Engagements	Italian Army-level Operations	Ratio, Division-level to Army-level
Allied Offensive Actions	59	26	
German Offensive Actions	17	3	
Average Attacker Strength	16,945	184,949	1 to 10.9
Average Defender Strength	8,506	70,928	1 to 8.3
Average Force Ratio	2.34 to 1	3.25 to 1	
Weighted Force Ratio	1.99 to 1	2.61 to 1	
Average Battle Length (Days)	2.41	25.14	1 to 10.4
Average Attacker Tank Strength	77	562	1 to 7.3
Average Defender Tank Strength	40	157	1 to 3.9
Average Attacker Casualties	429	5,974	1 to 13.9
Average Defender Casualties	421	4,799	1 to 11.4
Average Attacker Casualties per day	178	238	1 to 1.3
Average Defender Casualties per day	174	191	1 to 1.1
Average Attacker Percent Loss per day	1.35	0.19	1 to .1
Average Defender Percent Loss per day	1.93	0.30	1 to .2
Weighted Attacker Percent Loss per day	1.05	0.13	1 to .1
Weighted Defender Percent Loss per day	2.05	0.25	1 to .1
Average Number of Attacker EPWs	140	1,559	1 to 11.1
Average Number of Attacker EPWs per day	60	62	1 to 1.0
Average Number of Defender EPWs	52	411	1 to 7.9
Average Number of Defender EPWs per day	22	16	1 to .7
Average Percent of Attacker CIA	0.41	0.30	1 to .7
Average Percent of Attacker CIA per day	0.17	0.02	1 to .1
Average Percent of Defender CIA	1.56	2.11	1 to 1.4
Average Percent of Defender CIA per day	0.65	0.11	1 to .2
Average Percent Attacker Losses are CIA	13.58	6.77	1 to .5
Average Percent Defender Losses are CIA	33.07	25.88	1 to .8
Total Percent Attacker Losses are CIA	12.24	6.88	1 to .6
Total Percent Defender Losses are CIA	33.20	32.49	1 to 1.0

This comparison supports the pattern detected. It again shows that the army-level operations in Italy are about ten times the size and duration of the division-level engagements. This is evinced in the average attacker strength, the average defender strength, the average battle length, average attacker casualties, average defender causalities, average number of attacker EPWs, and average num-

ber of defender EPWs. The average attacker tank strength is only larger by a factor of 7 and the average defender tank strength by a factor of 4. The previously high defender casualties and capture rates are now lowered, and their statistics fall into line with what was seen with the engagement data.

The force ratios for the operations and the engagements are similar, as are—surprisingly enough—the average attacker and defender casualties per day. Furthermore, the average number of EPW captured per day is also similar between the operations and the engagements, as is the average percent of attack CIA, the average percent of defender CIA, and the four various calculations of percent of losses that are CIA. What remains different is the percent of casualties per day and the percent captured per day, which is now consistently about one-fifth to one-tenth of the rate of the engagements for both attacker and defender. There are three major conclusions that can be drawn from analyzing this army-level data:

1. The casualty rates and capture rates for army-level operations are about one-fifth to one-tenth to those for division-level engagements.

2. It is clearly a huge methodological error to lump together the capture rates from large operations like "Barbarossa" with small operations like "Just Cause."

3. The engagement data from the Italian Campaign is a representative sample of battles from the campaign.

There are 24 other operations not included in the statistics above: 22 from the Western Desert and two from Sicily. If those 24 operations are compared with the 29 operations from Salerno to Rome, and with the 18 operations after Rome, one sees the following:

		Italian Campaign	
	African and Sicilian Campaign Operations	Salerno to Rome Operations	Rome to Surrender Operations
Allied Offensive Actions	16	26	18
Axis Offensive Actions	8	3	0
Average Attacker Strength	92,940	184,949	274,243
Average Defender Strength	75,814	70,928	102,914
Average Force Ratio	1.36 to 1	3.25 to 1	3.58 to 1
Weighted Force Ratio	1.23 to 1	2.61 to 1	2.66 to 1
Average Battle Length (Days)	29.21	25.14	34.44
Average Attacker Tank Strength	258	562	1,021
Average Defender Tank Strength	179	157	188
Average Attacker Casualties	3,900	5,974	6,718
Average Defender Casualties	16,745	4,799	19,807
Average Attacker Casualties per day	106	238	195
Average Defender Casualties per day	573	191	575
Average Attacker Percent Loss per day	0.14	0.19	0.07
Average Defender Percent Loss per day	1.38	0.30	3.33
Weighted Attacker Percent Loss per day	0.14	0.13	0.07
Weighted Defender Percent Loss per day	0.76	0.25	0.56
Average Number of Attacker EPWs	14,950	1,559	14,149
Average Number of Attacker EPWs per day	512	62	411
Average Number of Defender EPWs	531	411	157
Average Number of Defender EPWs per day	17	16	5
Average Percent of Attacker CIA	3.41	0.30	0.06
Average Percent of Attacker CIA per day	0.14	0.02	0
Average Percent of Defender CIA	24.63	2.11	20.97
Average Percent of Defender CIA per day	1.38	0.11	3.15
Average Percent Attacker Losses are CIA	9.51	6.77	1.31
Average Percent Defender Losses are CIA	44.63	25.88	51.66
Total Percent Attacker Losses are CIA	13.62	6.88	2.33
Total Percent Defender Losses are CIA	89.28	32.49	71.43

As can be seen, there are some differences between the statistics collected from the North African and Sicilian Campaigns and those from the two different portions of the Italian Campaign. Many of these differences are due to the presence of the Italian Army. If the 11 operations in which the Italian Army was the primary opponent are deleted (they still make up the majority of forces under German command in North Africa), then the following revised data is found:

North Africa and Sicily:	13 Included Operations
Allied Offensive Actions	10
German Offensive Actions	3
Average Attacker Strength	105,198
Average Defender Strength	80,916
Average Force Ratio	1.36 to 1
Weighted Force Ratio	1.30 to 1
Average Battle Length (Days)	29.31
Average Attacker Tank Strength	380
Average Defender Tank Strength	263
Average Attacker Casualties	4,573
Average Defender Casualties	7,063
Average Attacker Casualties per day	132
Average Defender Casualties per day	241
Average Attacker Percent Loss per day	0.16
Average Defender Percent Loss per day	0.46
Weighted Attacker Percent Loss per day	0.15
Weighted Defender Percent Loss per day	0.30
Average Number of Attacker EPWs	6,087
Average Number of Attacker EPWs per day	208
Average Number of Defender EPWs	866
Average Number of Defender EPWs per day	30
Average Percent of Attacker CIA	0.60
Average Percent of Attacker CIA per day	0.02
Average Percent of Defender CIA	6.94
Average Percent of Defender CIA per day	0.34
Average Percent Attacker Losses are CIA	12.92
Average Percent Defender Losses are CIA	39.94
Total Percent Attacker Losses are CIA	18.94
Total Percent Defender Losses are CIA	86.18

While this produces more "traditional" statistics, it still tends to better results for the attacker than the defender. This is probably related to terrain, the peculiarities of the desert war, and may be driven by the small number of cases. It must also be kept in mind that the majority of forces involved on the Axis side were Italians. This will be discussed further in the section on human factors.

The final point in this comparison of the engagements to the Campaign Database is the issue of operational tempo. With forces ten times larger and operations that are ten times longer, the campaigns show the count of the average daily casualties and average daily captures are similar to those found in the engagements. This naturally translates into daily casualty rates and daily capture rates being one-tenth of the engagements. What this means is that these armies of 6 to 20 divisions—when one takes into account the active and inactive sectors of their lines, and the quiet and active periods of their operations—are on the average maintaining one major division-level engagement per day. The operational tempo for an army-level operation is about one-tenth the operational tempo of a division-level operation.

F. The Enemy Prisoner of War Data

For this study, 202 engagements were assembled into a database compatible with the format used for the Land Warfare Database. As such, each record in the database has 121 fields. Only a small number of those fields were used for the above analysis. The complete EPW database, which includes narrative descriptions of the battles, was provided to CAA as part of this contract.

For the army-level operations, the 71 operations were assembled into a database compatible with the format used for the Campaign Database. As such, each record in the database has 130 fields. Again, only a small number of those fields were used for the above analysis. The completed parts of

the Campaign Database used for this study, which includes narrative descriptions of the operations, were provided to CAA as part of this contract.

As there is unfortunately no guarantee that in twenty years from now the disks will be readable, copyable, or even have maintained their electronic signature, it was decided to enclose the most pertinent data as part of this report.

TDI created four Microsoft Excel spreadsheets for analysis of the data. One displays the Italian Campaign engagements, one the Ardennes engagements, one the Kursk engagements, and one the Army-level Operations. These are attached to this report as Appendices VI through IX.

Chapter
6

Measuring Human Factors in Combat

Not all armed forces are the same. Their performance and capabilities in battle vary widely. The differences go far beyond the numbers, mix, and capabilities of the weapons brought onto the field of battle. There is an entire range of "force multipliers" that are related to the performance of human beings (and groups of human beings) on the battlefield. These force multipliers—what the Dupuy Institute refers to as "combat effectiveness"—include such factors as leadership, generalship, training, experience, morale, motivation, cohesion, intelligence (including interpretation), momentum, initiative, doctrine, the effects of surprise, logistical systems, organizational habits, and even cultural differences. Human factors are hard to measure. As such, the analytical community often ignores human factors.

For the Enemy Prisoner of War (EPW) study, it is impossible to ignore such issues as morale, motivation, and cohesion. These components of combat effectiveness have an effect on combat capability as well as on EPW capture rates. One would expect to see more personnel surrendering in a force with lower morale, motivation, and cohesion (less combat effectiveness) than one with higher morale, motivation, and cohesion (more combat effectiveness). For this study we are addressing combat effectiveness, as we believe that it is related to the EPW capture rates and that a proper estimation of EPW capture rates cannot be developed without taking combat effectiveness into account. Therefore, this study will digress briefly to discuss the measurable effects that we have been able to obtain from the data collected. These effects are measured by relative combat effectiveness, which includes morale, motivation, and unit cohesion.

As developed by Trevor N. Dupuy, performance differences in opposing combat forces may be looked at using three measurements, these being 1) mission accomplishment, 2) casualty effectiveness, and 3) spatial effectiveness.

Mission accomplishment is a measurement of who won or lost. This can be ascertained either by judgment or by whether or not the attacker advanced. The Dupuy Institute prefers to use judgment, as in some cases the attacker may make limited advances in attacks that are otherwise disastrous. This is not uncommon. In most cases, however, there is no difference between the results made from judgment and those made from a rigid rule based upon advanced rates.

Mission accomplishment can be further refined by scoring mission success. This was done in the EPW database by scoring both sides from 0 to 10. This was again done by judgment. As measuring mission accomplishment is not precise, it was decided not to use it for further analysis.

Casualty effectiveness is the ability of one side to cause an enemy casualties relative to its own losses. This is probably the best measure of combat effectiveness, although it has some weaknesses. First is that casualty reports are not always as precise as one would hope.

A second weakness is that not all nationalities classify or report their casualties in the same way. This is a particular problem in the reporting of wounded, and makes comparisons of total casualty figures a little difficult. Reporting total casualties means a summation of men killed in action (KIA),

wounded in action (WIA), and missing in action (MIA). It is what was used for casualty comparisons for this study, even though there was some concern over how the WIA are reported.

There are some alternative metrics. One could compare total killed on both sides. This will generate odd comparisons if one side has a lot of MIA resulting in a low number (under-reporting) of KIA. One could also compare total losses, which is total KIA and MIA. This metric may be useful, but it too has some problems. In the situation in which a defender is overrun, a certain percentage of what would normally be WIA becomes CIA. As such, the attacker casualties include KIA and MIA, while the defender casualties include KIA, MIA and those WIA that could not get out of the way (which are recorded as MIA). This inflates the defender's losses relative to the attacker when they are overrun. As such, it was decided to stay with total casualties as a measurement, as it was felt to produce a more consistent results across a wide range of engagements.

The third weakness is that casualty effectiveness is not always the best measure of mission effectiveness.

Spatial effectiveness is a third way of measuring combat effectiveness. Spatial effectiveness is the measurement (usually in kilometers per day) of the ability to advance. This is probably the weakest metric and as such is not used in this study. There is clearly a combat effectiveness difference between armies when it comes to their ability to maneuver and exploit opportunities. Still, there are problems with this metric. Opposed advance rates are often surprisingly difficult to measure. Furthermore, they are often driven by the availability of gaps in the enemy lines. It is heavily influenced by factors like terrain and degree of motorization. Sometimes advance rates are limited by the desire of an attacker to advance or by where his objectives are. In some cases, they are limited by the depth of the terrain (for example, battles in the Pacific Atolls in WWII).

Finally, when using any of these measurements the analyst must also consider the conditions of combat. These include not only any inherent advantages of being on the defense, but also terrain, weather, and a host of other factors. Furthermore, the analyst must consider the mix of weapons and the capabilities of the weapons of each side. Obviously, a heavy armor force well supported by artillery will have a greater effective combat power than an unsupported mass of infantry. Lastly, the effects of air power need to be considered. To address these three factors (conditions, weapons, air power) would require an analytical structure, most likely a combat model, that is well beyond the scope and budget of this project. Therefore, these factors were not considered except in the most basic forms.

With these considerations in mind, the Dupuy Institute then attempted a first order measurement of the effectiveness of forces by different nationalities. This was accomplished by attempting to find a simple measurement of mission effectiveness and casualty effectiveness.

A. The Italian Campaign Engagements Comparisons

One of the advantages of studying the Italian Campaign is that it involved combat between forces of different backgrounds and nationalities. In the Italian Campaign there were a number of situations that could be helpful in an analysis of human factors. First and foremost, there were two similarly organized and armed forces (US and UK) fighting side by side, and in some cases cross-attached to each other, against essentially the same opponent in similar terrain and climate conditions. This allows for a measurement to be made between US and UK forces for capture rates. There are 45 US battles and 31 UK battles in the database. This analysis could be extended further to include various Commonwealth units and other Allies, including Indians, South Africans, Canadians, New Zealanders, Brazilians, French, French Moroccans, and others.

In the case of mission effectiveness, we only looked at whether the attack succeeded or failed (draws are considered failures). Of the 37 US attacks, 22 were successes and 15 were failures (59

percent success). The force ratios for the successes ranged from 1.67 to 4.25 (average of 2.50). The force ratios for the failures ranged from .72 to 4.28 (average of 2.52).

In the case of the British, there were 21 offensive actions, of which 14 were successes and 7 were failures (67 percent success). The force ratios for the successes ranged from 1.21 to 6.31 (average of 2.54). The force ratios for the failures ranged from 1.17 to 3.21 (average of 1.95).

In the case of the Germans there were 17 attacks (7 versus US), of which only 5 were successful (29 percent success). The analysis groups these attacks together regardless of whether they were against the US or British forces, insomuch as there are not enough cases to draw any type of reliable conclusion from the divided data. The force ratios for the successes ranged from 1.53 to 5.12 (average of 2.21). The force ratios for the failures ranged from .73 to 5.87 (average of 1.87). In no case did any of the three nationalities succeed while attacking outnumbered.

Looking at force ratios alone, there does not seem to be a strong indication of any significant performance differentials between the US and UK forces. As the number of cases of Germans attacking was low (17 examples), one is hesitant to draw conclusions from it. But the data does seem to indicate a possible German combat advantage in the range of 10 to 20% as they were able to succeed with a lower average force ratio. If such an advantage existed, it would probably have a very limited impact on the EPW figures.

Another way of trying to measure the performance difference between armed forces is to look at casualty effectiveness.

There are 22 examples in the database from Italy in which the US attacked successfully. In these cases, the Americans caused from 20 to 1,617 losses on the Germans (an average of 538 per engagement) while suffering themselves from 80 to 1,524 losses (an average of 463 per engagement). In 10 of the cases the attacker suffered fewer losses that the defender. These figures point to a 16% combat advantage over the Germans. This difference may be merely a product of the small sample size (22 cases) and the highly variable data.

This data is further influenced by 11 of the attacks being penetrations. It is readily apparent from the data that in a penetration the casualty ratio tilts in favor of the attacker. In the 11 US attacks that resulted in penetration, the total US casualties are 5,019 while the total German casualties are 7,992, a 59% casualty effectiveness advantage for the US. In the case of the successful attacks that did not penetrate, the total US casualties are 5,169 (average US losses per attack of 470 vice 456 for penetrating attacks) while the German losses are 3,852 (an average of 350). These figures point to a casualty effectiveness advantage of 34% on the part of the Germans. Furthermore, in 9 of the 11 examples where the US penetrated, the attacker loss was less than the defender loss. In only one example where the attacker did not penetrate, did he suffer fewer losses than the defender. Of course, the ability to penetrate the enemy may also be a measure of combat effectiveness.

In their 15 unsuccessful attacks, the US caused from 13 to 1,617 losses on the Germans (an average of 427), while suffering themselves from 65 to 1,304 losses (an average of 413). There were seven cases where the attacker loss was less than the defender. This data is heavily influenced by one very lopsided exchange (Altavilla) where the US suffered 250 casualties while the opposing side suffered 1,617. If this battle is not considered, the average German loss is 342 while the average US loss is 425. This would point to a 24% casualty effectiveness advantage for the Germans, which is similar to what is shown for those 11 US attacks that advanced. This difference in effectiveness may be wholly explainable by the difference in reporting systems and the advantage of the defense.

In the case of the British the casualty effectiveness for their attacks was somewhat different. In the 14 cases in which they successfully attacked, they caused from 35 to 850 losses to the Germans (an average of 188) while suffering themselves from 9 to 1,180 losses (an average of 337). In five of the cases, they suffered fewer casualties than the defender. There were no penetrating attacks. This points to a 79% casualty effectiveness advantage on the part of the Germans. If this small data sample (14 cases) is representative, then this strongly indicates a performance difference between the Germans and the British and implies a difference between the US and the British.

In their 7 unsuccessful attacks the British caused from 20 to 478 losses on the Germans (an average of 178), while suffering themselves from 14 to 1,213 losses (an average of 252). The totals in this case point to a 42% casualty effectiveness advantage on the part of the Germans.

While the purpose of this report is not to denigrate the performance of our allies in World War II, for analytical purposes it is important to understand that there may have been a performance difference. Therefore, we will do a quick and dirty comparison between the US and UK combat performances when it comes to casualty effectiveness. Keep in mind, though, that there was no significant difference when we measured their performance using mission effectiveness.

One can combine the results from engagements in which the outcome was "attack advances" or "failed attack" for each nationality, as there was not a significant difference in the average casualties of the two outcomes, nor was there a large difference between the attacker and defender casualty ratios. Excluding Altavilla, which clearly would tilt the figures to the US favor, there were 25 cases in which the US suffered a total of 11,113 casualties (average of 445 per engagement) versus 8,637 German casualties (average of 345 per engagement). There were 7 cases (28%) in which the US suffered fewer losses that the defender. These figures point to a 29% casualty effectiveness advantage on the part of the Germans.

If all of the US data is used, including penetrations (all 37 cases), the figures are 16,382 US casualties (average of 443) versus 18,246 German casualties (average of 493). There were 16 cases (43%) in which the US suffered fewer losses than the defender. Because they included breakthroughs, these figures were not used for the conclusions below.

In the case of the 21 UK engagements, the UK suffered 6,479 casualties (average of 309 per engagement) while the Germans suffered 3,877 (average of 185 per engagement). There were 8 cases (38%) in which the UK suffered fewer casualties than the defender. In 5 of these cases, casualties for both sides were quite low (less than 100 for either side). In none of the US cases were the casualties so low. These figures point to a 67% casualty effective advantage on the part of the Germans.

Directly comparing the US and UK figures show a tendency for the US to take higher casualties (445 vs 309) by 44% and a tendency to cause higher casualties (345 vs 185) by 86%. If these samples are representative of the Italian Campaign and the army performances in general (UK, UK and German), then this would point to a 29% casualty effectiveness advantage of the US over the UK.

There is no overwhelming reason to consider the 46 battles used for this comparison to be representative of the Italian Campaign as a whole. Similarly, there is no overwhelming reason to consider them not to be representative. The casualty reporting systems in both armies were similar and the two armies tend to generate similar killed to wounded ratios. Therefore, the differences in performance can be explained by a biased selection of the battles, by random differences due to a statistically insignificant number of battles, by differences in the battle conditions between the two sections of the front, by a difference in the opposing German forces in the two sectors of the front, or by the absence or presence of air power. This clearly needs to be studied further, but for now there is some reason to believe that there was a performance difference between the US and UK forces.

In contrast, we have only 17 examples of the Germans attacking. There were only 5 cases of successful German attacks (one was a penetration). These attacks caused 54 to 1,081 losses to the Allies (an average of 727) and from 34 to 1,612 losses to the Germans themselves (an average of 851). There were 3 cases in which the attacker lost less than the defender. These casualty figures indicate a 17% casualty effectiveness advantage over the Germans by the Allies.

For their 12 unsuccessful attacks, the Germans caused 54 to 1,639 losses (an average of 482) while themselves suffering 68 to 1,129 losses (an average of 419). There were 6 cases in which they suffered fewer casualties than the defender. These casualty figures would point to a 15% casualty effectiveness advantage on the part of the Germans!

If one considers all 17 German attacks together, not including the one penetrating attack, the result is 16 attacks causing 8,698 Allied losses (an average of 544) and 9,005 German casualties (an average of 563). There were 8 cases (50%) in which the attacker suffered fewer casualties than the defender. In only one of those cases did both sides take fewer than 100 casualties. This implies almost no casualty effectiveness difference between the Germans and the Allies when the Germans were attacking (4%). As "defense is the stronger form of combat," this could lead one to conclude that the Germans had some combat effectiveness advantage.

If the one penetrating attack is included in the data, then the Germans caused 9,419 casualties to the Allies (an average of 554) while suffering 9,282 of their own (an average of 546). There were 9 cases in which the attacker suffered fewer casualties than the defender. The performance difference would be around 1%.

Unfortunately, when trying to compare the US and UK on defense, the number of examples are quite small. There were only 7 examples of the US in defense and 10 of the UK. Still, in light of the above discussion on performance differences, it was felt worthwhile to examine these cases as well. In the seven US cases, the Germans caused 2,036 casualties (an average of 291) while they suffered 3,538 losses (an average of 505). There were two engagements in which the Germans lost fewer than the defender, and only one attack was successful. These figures indicate a casualty effectiveness difference of 74% in favor of the US. These engagements contain one instance in which the Germans attacked while outnumbered.

In the 10 UK cases, the Germans caused 3,747 casualties (an average of 312) while they suffered 1,487 casualties (an average of 124). This is a significant performance difference, as the Germans caused a similar number of casualties per engagement (312 vice 291) while suffering a fraction of what they suffered when attacking the US forces (124 vice 505). This is a difference in casualty effectiveness of 4.37 between the UK and US. There were 7 engagements in which the Germans lost less than the defender, and among those 7 were three successful attacks and one penetration. These engagements also included five instances in which the Germans attacked while outnumbered.

While the two data sets are extremely small and not quite equivalent, they clearly support the earlier contention that there was a performance difference between the US and UK and between the Allies and the Germans.

Other than calculating averages, the Dupuy Institute did not conduct statistical analysis of this data. As the largest data set is 22 and the smallest is 5, and the data is highly variable, it was not felt that much could be learned from such analysis. Furthermore, even if one does achieve a statistical fit, the most important question—whether this is a unbiased sample (meaning does it really represent the data)—cannot be answered by statistics. TDI does feel that the data points in a very definite direction. TDI is hesitant to make a judgment as to whether this data is typical of the Italian Campaign battles, but has no reason to believe that it is not. TDI feels that more engagements need to be assembled to address this issue.

In addition, the conditions of combat, weapons, and air power should be addressed. No attempt was made to examine these conditions except to separate attacker from defender. In many respects, this separation also somewhat addressed the effects of terrain, as terrain usually favors the defender. As all the forces were in the same theater there were no drastic differences in climate and weather, although it certainly differed from engagement to engagement. In many cases, the engagements in question featured the US and UK fighting side by side. This occurred in the engagements at Salerno and Anzio. In some cases the US and UK divisions were fighting different elements of the same German division. In those cases, many of the conditions of combat would be similar. Overall, there was no sense that the mix of terrain, weather, opponent, etc. biased the outcome of one side over the other.

It is also not a case of one particularly good or bad organization influencing the outcome. The 76 battles include 7 different US divisions, 5 different British divisions, and 11 different German divisions. The greatest number of battles fought by any formation is the German 3rd Panzer Grenadier Division, which fought in 18 battles. The greatest number of battles fought by an Allied formation is by the UK 56th Infantry Division, which fought in 11 battles. All of the battles involving UK units occurred while they were under command of the US 5th Army. As such, the British were fighting near the US units to which they are being compared, and often opposed the same enemy formations.

The mix, number, and type of weapons between the US and UK forces was similar. The divisions were similar in size and weapon assortment. The German divisions were also similar in organization to the US and UK divisions. The technology and quality of the weapons were similar among all three armies. While force mix (armor versus infantry) certainly favored one side or the other in individual battles, there is no reason to believe that there were any significant advantages to any army from its mix and type of weapons.

Air power was not considered in this analysis. It certainly should be. Both the US and UK had a considerable air presence, and while they had air superiority over most of the battlefield, the Germans did have some air support. As such, the advantage in air power was certainly with the Allies. There is no reason to believe that it favored the US over the UK.

Besides lack of air support, the Germans probably suffered from having some logistical limitations as to the availability of artillery ammunition and early in the campaign, shortages of non-divisional (corps and army) artillery assets.

The tentative conclusion from these comparisons is that the German and the US forces were roughly equivalent in combat capability. This ignores the favorable impact on the US of its air support and the negative impact on the Germans of their logistical restrictions. Furthermore, the Germans often counted wounded differently, which could result in less wounded being reporting. This could easily make the overall reported German casualties 20% lower than a US or UK unit would report that had suffered the number and type of losses. Given that, it would appear that the combat effectiveness of the US forces was roughly equal or slightly inferior to the Germans (by possibly as much as 20%).

The combat performance of the UK forces relative to the US forces was clearly inferior, probably by around 20 or 30%. This makes the UK forces definitely inferior to the German forces, by as much as 50%. For purposes of determining EPW rates, these differences are only noted. These different figures are within the same order of magnitude.

B. Ardennes Campaign Engagements Comparisons

All of the Ardennes engagements involve the US Army versus the German Army. There were certainly situations in which UK and other Allied forces fought alongside the American forces, but none

of these cases was used. As such, one can only look at whether there is a measurable performance difference between the US and German armies.

In the case of the German Army in the Ardennes, it was less consistent in morale, motivation, and unit cohesion than it had been in Italy. To many German soldiers, it was evident that Germany was losing the war. This certainly had some effect on the motivation of some units. Furthermore, many of the infantry units had been raised from the extremes of the manpower pool, consisting of the very young and the very old. Many of these units (mostly Volksgrenadier units) had also undergone only minimal training. Finally, there were a number of SS units which, while perhaps not more competent at warfare than German Army units, were more politically motivated, and as such they may have had a higher morale in the face of a very difficult situation. Some of SS and Army units were veteran formations of years of combat on the Eastern Front. The Ardennes offensive included some of the most experienced units in the German army, while other units were newly raised. This further magnified the performance differences between individual units. Finally, the Germans were making an even greater use of foreign nationals (Hiwis) at this time.

In the case of the Ardennes data, there were 7 battles with SS armor units, 15 battles with other German Army armored units, 30 battles with Volksgrenadier units and 19 battles with other units (regular infantry and parachute formations).

Regarding mission effectiveness, we looked at whether the attack succeeded or failed (draws were considered failures). Of the 41 US attacks, 28 were successes and 13 were failures (68 percent success). The force ratios for the successes ranged from 1.15 to 7.83 (average of 2.24). The force ratios for the failures ranged from 1.23 to 2.24 (average of 1.57).

In the case of the Germans there were 30 attacks, of which 11 were successful and 19 failed (37 percent success). The force ratios for the successes ranged from 1.05 to 36.36 (average of 7.22). The force ratios for the failures ranged from .34 to 12.80 (average of 1.85). The German data clearly had some outliers. In the attack, the highest force ratio was 36.36 while the second highest was 9.14. Excluding the highest ratio, the average is 3.92. In the case of the Germans attacks that failed, the highest force ratio was 12.80, while the second highest was 2.40. Excluding the highest force ratio, the average is 1.17.

As with the Italian data, there were no cases in which any unit succeeded while attacking outnumbered (a total of 146 cases). In contrast, there were 27 cases in the Italian Campaign and 25 cases in Ardennes where the attacker failed although he outnumbered the defender.

The table on the following page shows a comparison of US and German data from the Italian and Ardennes campaigns.

Looking at US attacks, it does appear that the US Army performed better in the attack in the Ardennes engagements than it did in the Italian engagements. For example, the average ratio for a successful attack in the Ardennes was 2.24 vice 2.50 for Italy, while the average ratio for a failed attack was 1.57 in the Ardennes and 2.52 in Italy.

While the US clearly had air supremacy in the Ardennes Campaign, they certainly had air superiority through most of the Italian Campaign as well. As there is no other clear pattern of differences (technological, terrain, etc.) in the two sets of engagements, this would indicate either an improvement in the US Army in the last half of 1944 compared to the US Army in Italy in late 1943 and the first half of 1944, or a decline in the overall performance of the German Army, or both.

Unfortunately, there are only 17 examples of German attacks in the Italian data, including only 7 examples of the Germans attacking the US and 10 examples of the Germans attacking the UK. As it

	Ardennes	Italy
US Successful Attack		
Number of Cases	28	22
Percent Success	68%	59%
Lowest Ratio	1.15	1.67
Highest Ratio	7.83	4.25
Average	2.24	2.50
US Failed Attack		
Number of Cases	13	15
Lowest Ratio	1.23	0.72
Highest Ratio	2.24	4.28
Average	1.57	2.52
German Successful Attack		
Number of Cases	11	5
Percent Success	37%	29%
Lowest Ratio	1.05	1.53
Highest Ratio	9.14	5.12
Average	3.92	2.21
German Failed Attack		
Number of Cases	19	12
Lowest Ratio	0.34	0.73
Highest Ratio	2.40	5.87
Average	1.17	1.87

appears that the performance of UK forces involved was worse than the US performance, this biases the data somewhat.

The data for the Germans on the attack is more difficult to interpret. In the Ardennes the Germans outnumbered the defenders by 3.92 to 1, compared to 2.21 to 1 in Italy. The Ardennes figure may not be indicative of the change in force ratios required by the Germans to win, as many of the German attacks in the Ardennes data set are from the early days of the offensive, when three armies attacked a single corps in an effort to breach the US lines. As a result, the statistics are skewed. In the case of the failed German attacks, one sees the reverse. In the Ardennes the Germans failed on an average ratio of 1.17 to 1, while the average ratio of the failures in Italy is higher at 1.87. No conclusions can be drawn from this small sample.

In the 28 cases in the Ardennes data in which the US attacked successfully, the Americans caused from 18 to 3,616 losses to the Germans (an average of 541 per engagement) while suffering themselves from 1 to 1,477 losses (an average of 207 per engagement). In 23 of the cases the attacker suffered fewer losses than the defender.

This data is heavily influenced by the number of successful penetrations and envelopments in the Ardennes. The US staged 13 attacks that penetrated and 1 attack in which the defender was enveloped. This is the same percentage (50%) of penetrations and envelopments as in the Italian data. In the 14 US attacks that penetrated or enveloped, the total US casualties were 2,963 (average of 212 per engagement) while the total German casualties were 8,484 (average of 606). This was a much better performance than in Italy, where the average US casualties were 456 per engagement while the average German casualties were 727.

In the case of successful attacks that did not penetrate or envelop, the total US casualties were 2,839 (average of 203 US losses per attack vice 212 for a penetrating attack) while the German losses were 6,662 (average of 476 losses per attack vice 606 for a penetrating attack).

This indicates a performance difference relative to the US versus the German Army in the Ardennes when compared to Italy. Overall, in the Ardennes the US caused 2.61 casualties for every one it received during a successful attack. In Italy the ratio was 1.16 to 1. When penetrating, the ratio was 2.86 to 1 versus 1.59 to 1 for Italy. When not penetrating, the exchange ratio was still a significant 2.34 to 1 vice 0.74 to 1 in Italy. Overall, this suggests a shift in casualty effectiveness by a factor of two between Italy and the Ardennes.

When one looks at the unsuccessful US attacks, the same pattern appears. In the 13 unsuccessful attacks, the US caused from 29 to 2,028 losses to the Germans (an average of 502 losses per engagement), while suffering themselves from 6 to 1,096 losses (an average of 223 per engagement).

There were 8 cases in which the attacker lost less than the defender. This data is heavily influenced by one very lopsided battle (4th AD Attack IV) in which the US suffered 125 casualties while the opposing side lost 2,028. Excluding this battle, the average German loss was 375 while the average US loss was 231. The other oddity about this data is that they were not all "Failed Attacks." Four of the engagements were considered "Attack Advances" even though they scored as a draw or defender win, and five of the engagements were "limited attack." Still, the data shows a significant difference in result from the Italian Campaign engagements. While the Germans and US lost about the same casualties in the Italian Campaign data, in the Ardennes the German losses were more than twice the US losses. In both sets of data, one outlier is excluded. With those outliers excluded, the Italian data show the Germans losing 0.80 men for every loss the US suffered, while the Ardennes data shows the Germans losing 1.62 men for every loss the US suffered. With or without the outliers, the casualty effectiveness of the US forces in Ardennes is again twice that of Italy.

Combining all the "attack advances," "failed attack," and "limited attack" engagements into one category, and excluding the one outlier, results in 26 cases in which the US suffered a total of 5,616 casualties (average of 216 per engagement) versus 11,161 German casualties (average of 429 per engagement). There were 20 cases (77%) in which the US suffered fewer losses than the defender. These figures point to a 99% casualty effectiveness advantage on the part of the US. To compare this directly with the Italian data:

	Ardennes	Italy
Number of Cases	26	25
Average US loss	216	445
Average German loss	429	345
% US suffered less	77	28

This means that US casualty effectiveness increased from .78 German losses per US loss to 1.99 German losses per US loss, a casualty effectiveness improvement of 155%.

Grouping the data from all the successful US attacks produced similar figures. The total across all 41 US attacks was 8704 casualties (average of 212) versus 21673 German casualties (average of 529. There were 31 cases (76%) in which the US suffered fewer losses than the defender. These figures indicate a 150% casualty effectiveness advantage on the part of the US. To compare this directly with the Italian data:

	Ardennes	Italy
Number of Cases	41	37
Average US loss	212	443
Average German loss	529	493
% US suffered less	77	43

These aggregate figures show that US casualty effectiveness increased from 1.11 German losses per US loss to 2.50 German losses per US loss, a casualty effectiveness improvement of 125%.

Unfortunately, the Ardennes data may be biased. It includes 35 engagements drawn from the US III Corps attack on the German southern flank. In this case, the initial US attack benefited from surprise, and the German opposition was dispersed and out of position. As such, it was an unusually successful offensive and in fact may not be a typical example. A mixture of other US attacks in the Ardennes would need to be analyzed if one was to have confidence in this data.

While the data for the German attacks in Italy is less satisfactory due to the small number of examples, and due to only 7 of the cases featuring the US as defender, they still need to be looked at to see if differences of the same order of magnitude are detected when the Germans are attacking and the US is defending.

There are 30 examples in the Ardennes data of German attacks, 11 successful and 19 unsuccessful. Of the 11 successful attacks (as rated by the accomplishment scores) two were "failed attacks," two were "attack advances," three were "penetrations," and four were "defender enveloped." These attacks caused 89 to 3535 losses to the US (an average of 1,185) while suffering from 4 to 1237 losses themselves (an average of 428). There were 8 cases in which the attacker lost less than the defender.

For the 19 unsuccessful attacks, there were 1 "limited action," two "limited attacks," nine "failed attacks," and seven "attack advances." These attacks caused from 15 to 888 casualties to the US (average of 222) while the Americans suffered from 4 to 824 casualties themselves (an average of 253). There were 7 cases in which the attacker lost less than the defender.

Comparing this data to the Italian data is a little more difficult. In the case of the successful attacks the Italian data has only 5 cases, of which only one was a penetration, while the 7 of the 11 Ardennes data attacks were penetrations. Comparing only the 4 “attack advances” results from the Ardennes data to the 4 from the Italian data is probably irrelevant as the number of examples is too small. Therefore, nothing can be concluded from this data.

In the case of the unsuccessful attacks, in the Ardennes engagements the Germans caused 0.88 casualties for every one they suffered while in the Italian engagements the Germans caused 1.15 casualties for every one they suffered. Assuming all other factors are equal, this implies a degradation in casualty effectiveness of the German forces of some 31% from Italy to the Ardennes.

The table below compares the performance of the US and German forces in Ardennes versus Italy.

	Ardennes	Italy
US Successful Attack		
Number of Cases	28	22
Average US losses	207	463
Average German losses	541	538
Times US losses lower	23	10
No. of Type 5+ Attacks	14	11
Average US losses - Type 5+	212	456
Average German losses - Type 5+	606	727
Average US losses - Type 4	203	470
Average German losses - Type 4	476	350
US Failed Attack		
Number of Cases	13	15
Average US losses	223	413
Average German losses	502	427
Times US losses lower	8	7
Average US loss less outlier	231	425
Average German loss less outlier	375	342
German Successful Attack		
Number of Cases	11	5
Average German loses	428	851
Average US losses	1185	727
Times German losses lower	8	3
German Failed Attack		
Number of Cases	19	12
Average German losses	253	419
Average US losses	222	482
Times German losses lower	7	6

Based upon the data from the US attacks, one can possibly conclude that the relative performance difference between the two armies had changed by as much as a factor of two. This conclusion may be drawn from a data set that is biased. The data from the German attacks does not support that contention, although it does seem to indicate some possible change. The change could also be caused by three other factors: better US air and artillery support, declining German morale after the offensive fails, or random variations or biased data.

To address the first point, only 13 of the US attacks in the Ardennes occurred in good weather where they had extensive air support and good artillery observation. Most of the German attacks occurred in bad weather where the US had little air support, and the Germans did not have any effective air support throughout the Ardennes Campaign. Still this does not explain the difference in the results from the US

attacks in Italy and in the Ardennes. Many of the US attacks in Italy were also conducted with air support and in favorable weather. Without looking extensively at the air support for each individual attack, which is well beyond the budget of this contract, this issue cannot be definitively answered. There were improvements in US close air support doctrine and tactics from early 1944 to late 1944. However, any such improvements would not account for what appears to be a two-to-one increase in casualty effectiveness. Command of the air is certainly a factor in explaining the different outcomes in the US attacks in the Ardennes and the German attacks in the Ardennes.

Most of the US attacks in the data set come from the period after the first five days of the Ardennes Campaign when the German offensive had failed, the weather had cleared (although only for four days), and the Germans were under attack on the ground and sometimes from the air as well. The perceived decline in German defensive capability may have been due to declining morale and motivation stemming from either the situation on the ground or from aerial bombardment. To make such a determination as to cause would require more research.

Finally, one can not rule out the possibility that the data is simply biased or the results are within the random variation of the data. As the data selected was not a true random sampling, the data selection could have resulted in a bias in the data in one direction or the other. The data does not seem abnormal to TDI and the engagements were not selected to any specific criteria. As such, it is not expected that the data would not show a strong bias.

Of course, all this data exhibits quite wide statistical variability. For example, the standard deviation of the 28 successful attacks for the attacker (average losses of 207) is 304.22. For the defender (average losses of 541) the standard deviation is 701.15. What this means is that if the data collected is truly unbiased and is truly representative of the population of combats in Ardennes as a whole, then the 80% confidence interval for the average attacker losses is between 131 to 283, while the 80% confidence interval for the average defender losses is between 366 to 715.

The choice of measures selected fundamentally biases the numbers in favor of multi-day engagements and weights the averages in favor of large engagements. There are two other metrics that could have been used for these comparisons: losses per day and percent losses per day. Losses per day was not chosen as a metric because the issue was comparative losses between two sides. The measurement of percent losses per day could have been selected but it was felt this would have given equal weight to small actions and large actions. A measurement weighted by size seemed to be of more value. The advantage of percent losses (or percent losses per day) is that it ties the measurement to the number of people in the engagement. As the Ardennes and Italian databases are similar in the average size of an engagement, is was felt that the two databases could be compared directly.

Overall, one must concede that there is a possibility that the relative performance between the US and German forces in the Ardennes was different (in favor of the US) than in Italy. These differences may explain some of the capture rate differences between the two data sets.

C. The Battle of Kursk Engagements Comparisons

The most salient point of the Kursk data is to show the significance of nationality upon capture rates. These differences appear in both the casualty rates and in the capture rates. These differences are so apparent that we can simply dispense with the detailed analysis as provided above for the Italian and Ardennes data. A look at the force ratios for the Soviet and German attacks, compared to the casualty exchange ratios for these attacks clearly show the combat effectiveness differences at Kursk. Looking separately at low odds (low force ratios) attacks is also illustrative.

	Average Force Ratio	Average Loss Ratio
All Soviet Attacks (18)	1.42 to 1	5.63 to 1
Soviet Low-odds Attacks (12) .51 - 1.34 to 1	1.00 to 1	4.83 to 1
All German Attacks (31)	1.66 to 1	.30 to 1
German Low-odds Attacks (21) .63 - 1.42 to 1	.93 to 1	.41 to 1

This shows a very significant casualty effectiveness advantage on the part of the Germans. When the Soviets attacked, they lost an average of 5.63 men for every German lost. When the Germans attacked, they lost .30 men for every Soviet lost, or inflicted 3.33 casualties for every 1 they lost. The difference between the effectiveness of the Germans when attacking versus defending is probably explained by the advantages of defense, terrain, etc. When the "odds are even," which is roughly approximated by the low odds attacks, the Soviets attacked at an average odds of 1 to 1, yet lost almost 5 men for every 1 the Germans lost. The Germans attacked at less than 1 to 1, and caused almost 2.5 losses per 1 of their own lost.

If the Italian data is analyzed the same way, one will notice a similar tendency, although much more subtle.

Italian Campaign Data	Average Force Ratio	Average Loss Ratio
All US Attacks (37)	2.52 to 1	3.01 to 1
US Low-odds Attacks (3) .72 - 1.31 to 1	1.04 to 1	.26 to 1
All UK Attacks (21)	2.34 to 1	1.71 to 1
UK low-odds Attacks (4) 1.17 - 1.41 to 1	1.30 to 1	2.11 to 1
All German Attacks (17)	1.88 to 1	.97 to 1
German Low-odds Attacks (7) .73 - 1.48 to 1	.89 to 1	.68 to 1

In this case, when the US was the attacker, they lost 3 men for every 1 the defending Germans lost. The UK lost about 2 men in the attack for every German loss. When the Germans attacked they lost about 1 for 1. This was true even when the average force ratio of the US & UK attacks were higher than the German attacks. There were not enough low-odds attacks to perform a meaningful comparison between them.

Significantly, this pattern does not carry through to the Ardennes data.

Ardennes Campaign Data	Average Force Ratio	Average Loss Ratio
All US Attacks (41)	2.03 to 1	.24 to 1
US Low-odds Attacks (12) 1.15 - 1.48 to 1	1.31 to 1	.65 to 1
All German Attacks (30)	3.33 to 1	.70 to 1
German Low-odds Attacks (13) .34 - 1.37 to 1	.80 to 1	.38 to 1

In the case of the Ardennes data, when the US attacked the Germans lost about 4 men to each American lost. When the Germans attacked, the Americans lost about 1.5 men to each German lost.

If this data is taken at face value, it would argue for a casualty effectiveness of the Germans over the Soviets by a factor of around 4 to 1, over the US and UK in Italy by a factor of around 2 to 1, and the US having a casualty effectiveness advantage over the Germans in the Ardennes of around 2 to 1. This implies a significant shift in capability of the US Army, or decline of the German army by Ardennes.

For several reasons, these numbers are not completely accepted. The calculation of the averages of combat effectiveness becomes somewhat convoluted. The opposite of a force ratio of 5 to 1 is .2 to 1. If one takes a simple average of these two numbers, the average force ratio is 2.6 to 1, whereas the actual average is 1.0 to 1. Therefore the "averages" are calculated by summing the force ratios greater than 1 and adding 1 for every force ratio below 1, then dividing that by the sum of the inverse of

the force ratios below 1 and adding 1 for every force ratio above 1. For example, if the data set consists of two 5-to-1 attacks and a 1-to-5 attack, the average force ratio is 11/7ths or 1.57 to 1.

In the case of the Kursk data, and to a lesser extent with the Italian data, most of the force ratios tend to be low and the casualty exchange ratios are not widely divergent. In the case of the Ardennes data, we have battles at 40 to 1 odds and several cases in which the casualty exchange ratios are around 25 to 1. These lopsided exchanges heavily influence the mathematics, but they are on both sides. A more useful comparison may be to look at the total casualties.

In the cases below, the force ratio is the sum of the strength of all the cases, compared to the sum of the strength of the opposing forces, while the losses are the total losses for each side, compared to the losses of the opposing side.

Kursk Campaign Data	Total Force Ratio	Total Loss Ratio
All Soviet Attacks (18)	1.43 to 1	6.04 to 1
Soviet Low-odds Attacks (12) .51 - 1.34 to 1	1.02 to 1	3.92 to 1
All German Attacks (31)	1.34 to 1	.30 to 1
German Low-odds Attacks (21) .63 - 1.42 to 1	.99 to 1	.27 to 1

Notice that using the "weighted averages" did not change the numbers much. These figures still support the contention that there is a casualty effectiveness difference between the Germans and the Soviets of around 4 to 1.

Italian Campaign Data	Total Force Ratio	Total Loss Ratio
All US Attacks (37)	2.18 to 1	.89 to 1
US Low-odds Attacks (3) .72 - 1.31 to 1	1.15 to 1	.27 to 1
All UK Attacks (21)	2.07 to 1	1.33 to 1
UK low-odds Attacks (4) 1.17 - 1.41 to 1	1.30 to 1	2.31 to 1
All German Attacks (17)	1.59 to 1	.99 to 1
German Low-odds Attacks (7) .73 - 1.48 to 1	.85 to 1	.57 to 1

The Italian data, based upon weighted averages, shows a different picture. Most significant is the casualty effectiveness of the US attacks. The shift from 3.01 to 1 down to .89 to 1 is caused by a number of smaller engagements having very lopsided exchange ratios. For example, the casualty ratios for the 4 Rapido River operations were 31.38, 12.46, 51.23, and 44.23. These smaller engagements (less than 10,000 attackers) clearly skewed the statistics. In fact there is only one other engagement which has a casualty exchange rate greater than 10.

Using these weighted statistics, one cannot discern any difference in casualty effectiveness between the US and the Germans. The US had a 1.12 to 1 favorable kill ratio when they attacked (average force ratio of 2.18 to 1), while the Germans had effectively a 1 to 1 kill ratio with lower average odds (1.59 to 1). This supports the earlier contention that there was no difference or that it favored the Germans by 20 to 30 percent. In these figures, the British make a slightly worse showing than the US, with a casualty effectiveness ratio some 50% worse than the US.

With little difference between US and German relative casualty effectiveness, this leads us to consider whether there had been a relative shift between the US and German armies by the time of the Ardennes Campaign.

Ardennes Campaign Data	Total Force Ratio	Total Loss Ratio
All US Attacks (41)	1.69 to 1	.40 to 1
US Low-odds Attacks (12) 1.15 - 1.48 to 1	1.29 to 1	.69 to 1
All German Attacks (30)	1.52 to 1	.55 to 1
German Low-odds Attacks (13) .34 - 1.37 to 1	.85 to 1	.38 to 1

The use of weighted averages does not change the Ardennes data much. The most significant change is in the overall US casualty effectiveness, which is lower, while the Germans improve. This moves the overall casualty effectiveness of the two forces closer to each other, with the US having the edge in overall attacks, while the Germans have the edge in low odds attacks. This indicates that there was, at best, a limited change in relative performance between the US and German forces from Italy to the Ardennes.

Continuing only with Kursk for the moment: if the above figures on Kursk do not clearly make the case that there was a performance difference between the German and Soviet forces at Kursk, then we need to look at some of the other casualty measurements.

For Kursk, we do have some very different casualty figures for the Soviets versus the Germans. A summary of the total casualty statistics is in order:

	German	Soviet	Ratio
Total Casualties	10,233	40,644	1 to 3.97
When attacking	7,963	13,703	1 to 1.72
When defending	2,270	26,941	1 to 11.87
Total Bloody Casualties	9,936	27,046	1 to 2.72
Total KIA	**1,523**	**8,008**	**1 to 5.26**
WIA to KIA Ratio	5.52 to 1	2.38 to 1	
When attacking	5.63 to 1	2.90 to 1	
When defending	5.16 to 1	2.06 to 1	
Total MIA	**297**	**13,598**	**1 to 45.78**
When attacking	190	1,909	1 to 10.05
When defending	107	11,689	1 to 109.24
Total CIA	**227**	**12,436**	**1 to 54.78**
Percent of MIA is CIA	76.43	91.45	
Total Deserters	4	599	1 to 149.75
Percent of CIA deserters	1.76	4.82	

This data is from 49 engagements, in which the Germans were considered attackers in 31 cases and the Soviets were the attackers in 18 cases. Converting the gross casualty figures into casualty by engagement results in the following table:

	German	Soviet	Ratio
Average Casualties	209	829	1 to 3.97
When attacking	257	761	1 to 2.96
When defending	126	869	1 to 6.90

This again clearly makes the point, if it has not already been made *ad nauseam*, that the Germans enjoyed a relative performance advantage in both the attack and the defense. This advantage was clearly not related to posture, but appears regardless of posture.

Another fact to note in the above table is that for both sides the wounded-to-killed ratio is higher for the attacker than the defender. This is as expected, and reflects both the higher MIA for the defender and that there is a difference in the ratio of KIA/WIA simply because someone is on the de-

fense versus the attack. This difference in the wounded-to-killed ratio between attacker and defender has shown up in other TDI work, but to date TDI has not published a paper on the subject nor conducted definitive research on the subject.

The significant figure is the large number of MIAs for the Soviets. These MIAs are confirmed by the large number of Soviet CIAs reported by the Germans. There is clearly a correlation between MIA and CIA, although we do have a number of cases in which the MIAs are less than the CIAs reported by the other side.

The deserter figure is the most interesting. There is probably also a correlation between the number of deserters and the number of CIA. A force with a higher number of deserters will probably have a correspondingly higher number of CIA. It is felt that such measurement of deserters and AWOL is probably a reflection of the general state of a unit's morale and cohesion. The Soviets' high desertion rate reflected their low morale and cohesion, and is therefore reflected in their higher capture rate.

Also at Kursk, the measurement of mission effectiveness is clearly very different. In the 31 German attacks, 19 were successful (61%). Of the 18 Soviet attacks, only 3 were successful (17%). The average force ratio for a German attack, however, was much lower than in the Italian or Ardennes data, being only 1.34 to 1. The average force ratio of the Soviet attacks was effectively the same as the Germans, being 1.43 to 1. Still, numbers matter. There were only 2 cases in which the Germans were successful while attacking outnumbered. In fact these were the only 2 such cases out of the 195 attacks reviewed, of which 31 were at odds of 1 to 1 or less. In contrast, there was only 1 case (odds 1.09 to 1) in which the Germans failed when attacking while outnumbering the Soviets. In the other 11 failed German attacks, the defenders matched or outnumbered them. The Soviets, on the other hand, failed 11 times in the attack even though they outnumbered the defenders.

In the case of Kursk, the terrain was generally rolling with mixed cover. As such, it was easier terrain in which to attack, and less difficult than the usual terrain in the Italian and Ardennes engagements. Technology and weapons for the two sides were similar, although one could certainly make the argument that the Soviets were the technologically superior force. The mix, number, and types of weapons in the two forces were different. The Soviets had many more guns on the battlefield, but they tended to be of smaller caliber. The Germans clearly outnumbered the Soviets in field artillery and large caliber guns. The German Air Force, although it was numerically outnumbered, was soon able to establish a stronger presence over the battlefield than the Soviets, and therefore air power factors favored the Germans. Still, this establishment of air superiority was achieved by a force that was outnumbered and downed enemy airplanes at a rate of greater than 5 for every 1 they lost! The ground formations involved tended to be typical of their armies, or in many cases were some of the better-equipped and most experienced forces of their respective armies. Most of the divisions on both sides had seen extensive combat, and most had had a period of about two months to prepare for the upcoming battle. Both sides were initially well supplied and supported, although some Soviet units suffered logistical problems as the battle developed.

The conclusion from the Kursk comparison is that the Germans had a clear advantage in combat capability that showed itself in both offensive and defensive casualty effectiveness and mission effectiveness. The difference appears to be a factor of 3.

D. The Campaign Database Comparisons

The campaign data confirms three of the four major points determined from the engagement data:

- that there was a difference in Allied versus German performance;

- that this difference appears to have changed over time;
- that there was a difference between US and UK performance; and
- that some armed forces (in this case the Italians) performed noticeably worse than the norms as established by Germany, the US, and the UK.

Let's look at some comparative statistics.

For measuring the difference in Allied versus German performance and whether it changes over time, we will look at two data sets—the operations data from Salerno to Rome, and the operations data after Rome and up to the German surrender. Eliminating the German offensives from the data, we have a simple comparison of Allies on attack versus Germans on the defense. The data shows:

Italian Campaign	Salerno to Rome Operations	Rome to Surender Operations
Allied Offensive Actions	**26**	**14**
Average Attacker Strength	194,020	284,153
Average Defender Strength	69,090	107,173
Average Force Ratio	3.48 to 1	3.14 to 1
Weighted Force Ratio	2.81 to 1	2.65 to 1
Average Battle Length (Days)	26.92	40.57
Average Attacker Tank Strength	582	1,019
Average Defender Tank Strength	134	208
Average Attacker Casualties	6,125	7,613
Average Defender Casualties	4,744	10,339
Average Attacker Casualties per day	227	188
Average Defender Casualties per day	176	255
Average Attacker Percent Loss per day	0.16	0.06
Average Defender Percent Loss per day	0.27	0.32
Weighted Attacker Percent Loss per day	0.12	0.07
Weighted Defender Percent Loss per day	0.26	0.24
Average Number of Attacker EPWs	1,552	3,293
Average Number of Attacker EPWs per day	58	81
Average Number of Defender EPWs	380	202
Average Number of Defender EPWs per day	14	5
Average Percent of Attacker CIA	0.24	0.07
Average Percent of Attacker CIA per day	0.02	0
Average Percent of Defender CIA	2.13	4.39
Average Percent of Defender CIA per day	0.10	0.10
Average Percent Attacker Losses are CIA	5.73	1.68
Average Percent Defender Losses are CIA	25.36	38.37
Total Percent Attacker Losses are CIA	6.20	2.65
Total Percent Defender Losses are CIA	32.72	31.85
Average Daily Advance Rate	1.85 km	.43 km
Average Outcome Value	3.23	3.57
Average Casualty Ratio	1.72	0.95
Weighted Casualty Ratio	1.29	0.74

In the case of the 26 early Italian Campaign operations, they include 4 "limited actions," 5 "limited attacks," 2 "failed attacks," 11 "attack advances," and 4 "defenders penetrated." The attacker won

in 15 of the operations, 6 were judged to be draws, and the defender won in 5 of the cases. Five of the nine "limited actions" and "limited attacks" were conducted by the UK. Both "failed attacks" were conducted by the US, and three of the four penetrations were by the US.

In the case of the 14 late Italian Campaign operations, there were 1 "limited action," 3 "limited attacks," 1 "failed attack," 5 "attack advances," and 4 "defenders penetrated." The attacker won in 9 of the operations and 5 were judged to be draws. One of the four "limited actions" and "limited attacks" were conducted by the UK, as were two of the four "defenders penetrated." The "failed attack" was an American operation.

What the early Italian data shows is that while outnumbering the defender around 3 to 1, the attacker suffered 30 to 50 percent more casualties. In contrast the later Italian data, which covers a similar number of operational days (568 versus 700), shows slightly lower forces ratios, a slightly higher armor ratio, and a much more favorable casualty exchange ratio (the attacker caused a total of 1.36 casualties for every one they lost, versus losing 1.29 casualties for every one they caused earlier). The average advance rates for the later Italian data is lower and the average mission accomplishment score is higher.

The first question—whether or not the Germans were better than the Allies—is clearly addressed in the early Italian data, where the Germans are seen inflicting higher casualties on the Allies even though they were heavily outnumbered. While some of this may be explained by the advantage of the defense and other factors, this does not seem to be able to explain the entire difference. The later Italian Campaign data is a little harder to judge in this regard, as the weighted average force ratios are 2.65 to 1 while the casualty exchange ratios are 1 to 1.36. Since the percent of defender losses that are CIA does not increase in the later data (in fact it decreases), the difference does not appear to be caused by declining morale (assumed to be displayed by the increase in captured). The average percent captured per day remains the same for the defender, although significantly, it decreases for the attacker. Therefore, this difference in perceived performance is caused by either operational differences, or by actual changes in the competency of the Allies relative to the Axis.

The second question—whether the difference in the relative combat performance of the two sides changed over time—appears to be solidly answered in the affirmative. The degree of change in casualty effectiveness appears to be about 70%. This is estimated by the change in casualty effectiveness (1.29 to 1 versus 1 to 1.36), and assumes that all other factors balanced out.

The third question is whether there was a performance difference between the US and the UK. This seems to be contraindicated by the operations data, as shown in the table at the top of the following page.

Italian Campaign	US Operations	UK Operations
Allied Offensive Actions	**24**	**20**
Average Attacker Strength	218,467	236,884
Average Defender Strength	87,078	77,946
Average Force Ratio	3.00 to 1	4.15 to 1
Weighted Force Ratio	2.51 to 1	3.04 to 1
Average Battle Length (Days)	29.5	30.6
Average Attacker Tank Strength	754	771
Average Defender Tank Strength	184	115
Average Attacker Casualties	7,425	5,097
Average Defender Casualties	12,002	9,591
Average Attacker Casualties per day	252	167
Average Defender Casualties per day	407	313
Average Attacker Percent Loss per day	0.16	0.06
Average Defender Percent Loss per day	1.51	1.53
Weighted Attacker Percent Loss per day	0.12	0.07
Weighted Defender Percent Loss per day	0.47	0.40
Average Number of Attacker EPWs	7,781	5,415
Average Number of Attacker EPWs per day	264	177
Average Number of Defender EPWs	417	136
Average Number of Defender EPWs per day	14	4
Average Percent of Attacker CIA	0.26	0.05
Average Percent of Attacker CIA per day	0.02	0
Average Percent of Defender CIA	11.20	8.19
Average Percent of Defender CIA per day	1.35	1.35
Average Percent Attacker Losses are CIA	4.80	2.86
Average Percent Defender Losses are CIA	38.77	32.94
Total Percent Attacker Losses are CIA	5.62	2.67
Total Percent Defender Losses are CIA	64.83	56.46
Average Daily Advance Rate	1.44 km	2.09 km
Average Outcome Value	3.58	3.60
Average Casualty Ratio	1.27	1.39
Weighted Casualty Ratio	1.62	1.88

One needs to leave out the last two operations for both the US and UK (Po Valley Breakthrough and the German Capitulation). These operations were responsible for 133,110 German casualties out of 288,055 (46%) for the US and 78,675 German casualties out of 191,813 (41%) for the UK.

Italian Campaign	US Operations	UK Operations
Allied Offensive Actions	**22**	**18**
Average Attacker Strength	219,334	233,183
Average Defender Strength	88,923	74,470
Average Force Ratio	2.68 to 1	4.20 to 1
Weighted Force Ratio	2.47 to 1	3.13 to 1
Average Battle Length (Days)	31	32.56
Average Attacker Tank Strength	733	737
Average Defender Tank Strength	193	105
Average Attacker Casualties	7,823	5,206
Average Defender Casualties	7,043	6,285
Average Attacker Casualties per day	252	160
Average Defender Casualties per day	227	193
Average Attacker Percent Loss per day	0.17	0.06
Average Defender Percent Loss per day	0.30	0.27
Weighted Attacker Percent Loss per day	0.12	0.07
Weighted Defender Percent Loss per day	0.26	0.26
Average Number of Attacker EPWs	2,491	1,758
Average Number of Attacker EPWs per day	80	54
Average Number of Defender EPWs	455	151
Average Number of Defender EPWs per day	15	5
Average Percent of Attacker CIA	0.29	0.05
Average Percent of Attacker CIA per day	0.02	0
Average Percent of Defender CIA	3.19	2.58
Average Percent of Defender CIA per day	0.13	0.07
Average Percent Attacker Losses are CIA	5.24	3.18
Average Percent Defender Losses are CIA	33.25	25.84
Total Percent Attacker Losses are CIA	5.82	2.90
Total Percent Defender Losses are CIA	35.37	27.97
Average Daily Advance Rate	1.05 km	1.71 km
Average Outcome Value	3.36	3.33
Average Casualty Ratio	1.38	1.53
Weighted Casualty Ratio	1.11	0.83

This data does not indicate that there was a relative combat performance difference between the US and UK. While this data does conveniently display the US and UK forces that were fighting side-by-side, in the same theater, in the same time frame, and in the same level of aggregation, this still is not a very clean comparison. The US forces often had British and Commonwealth troops (among other units) attached to them. Furthermore, the British Eighth Army included Australians, New Zealanders, Canadians, Poles, South Africans, Indians, and others. At any one time, as many as fifteen different Allied nationalities served under the US and UK commands in Italy, including French Moroccan troops and a Brazilian division. Therefore Italian Campaign army-level operation data does not produce a direct comparison between US and UK forces.

What this data shows is that there was a difference in the mode of fighting between the US and UK (or perhaps between the west coast versus the east coast of Italy). The US attacked at lower odds, against stronger armored forces, and both suffered and inflicted higher casualties per day. In contrast, the British had a more favorable casualty exchange ratio. The US caused 0.90 casualties for every 1 that it suffered, while the UK caused 1.21 casualties for every 1 that it suffered. This implies a 30% casualty effectiveness performance difference in favor of the UK, and is opposite to the patterns

shown with the division-level data. Furthermore, the UK maintained a higher average advance rate. This last figure is almost certainly due to the inclusion of the Anzio engagements in the US data and BAYTOWN in the UK data, and not much weight should be given to it.

One could postulate six likely reasons why the army-level data in fact shows the opposite pattern from that found in the division-level data. First, the British divisions measured with the division-level data may not have been typical of British performance. This may be true, as most of the British data comes from the 46th and 56th Infantry Divisions. Trevor Dupuy's studies indicated that these divisions performed particularly poorly. Second, as the US and UK operations often included other Allied units, this may not be a valid comparison of US and UK relative performance. Third, the opposing Germans forces on the west coast may have been better. Fourth, the inclusion of the Anzio and Salerno data in the US column, even though they included strong British forces, heavily influences the results. Furthermore, the successes at Anzio and Salerno were particularly marginal. Fifth, the US engaged in a number of difficult operations that biased the average casualty rates (Salerno, Anzio, First Cassino). Sixth, this could be simply a result of the random variations in the data.

Therefore, the army-level data does not support the previous conclusions that there was a performance difference between the US and UK, although there still appears to be difference in the way they performed, or in their intensity of combat. These subjects need to be explored further using some of the divisions from the UK Eighth Army in Italy versus the US divisions. Furthermore, the low average capture rates per day for the attacker indicates that the Eighth Army had high morale.

Just for comparison, in the three cases in which the Germans are attacking the US, they caused an average of 1.13 US casualties for every 1 they lost, even though the average aggregate force ratio was only 1.22 to 1, and the Germans only had an aggregate armor advantage of 1.13 to 1.

The final point, that some armies perform noticeably poorer than the norms, cannot be more sharply illustrated than with the Italian Army data. There are eleven campaigns in which the Italians were the primary opponent. In five of those they were on the offensive, and in six they were on the defensive. The data from those operations show:

Italian Army Operations	Offensive Operations	Defensive Operations
Actions	**5**	**6**
Average Attacker Strength	104,500	56,749
Average Defender Strength	65,809	73,099
Average Force Ratio	1.91 to 1	0.89 to 1
Weighted Force Ratio	1.59 to 1	0.78 to 1
Average Battle Length (Days)	36.2	23.17
Average Attacker Tank Strength	55	163
Average Defender Tank Strength	104	59
Average Attacker Casualties	1,750	3,384
Average Defender Casualties	56	51,631
Average Attacker Casualties per day	19	146
Average Defender Casualties per day	2	2,229
Average Attacker Percent Loss per Day	0.03	0.14
Average Defender Percent Loss per Day	0	4.55
Weighted Attacker Percent Loss per Day	0.05	0.26
Weighted Defender Percent Loss per Day	0	3.05
Average Number of Attacker EPWs	2	46,612
Average Number of Attacker EPWs per day	0	2,012
Average Number of Defender EPWs	72	101
Average Number of Defender EPWs per day	2	4
Average Percent of Attacker CIA	0.07	0.12
Average Percent of Attacker CIA per day	0	0
Average Percent of Defender CIA	0	73.32
Average Percent of Defender CIA per day	0	4.32
Average Percent Attacker Losses are CIA	9.84	1.90
Average Percent Defender Losses are CIA	1.82	90.44
Total Percent Attacker Losses are CIA	4.11	2.98
Total Percent Defender Losses are CIA	3.57	90.28
Average Daily Advance Rate	3.50 km	13.23 km
Average Outcome Value	1.60	5.33
Average Casualty Ratio	14.04	0.08
Weighted Casualty Ratio	31.25	0.07

The data here provides a very clear picture. Even when the many extenuating circumstances are considered, the performance of the Italian Army was still abysmal and certainly worse than that of the Soviet Army. In the offensive, the Italians managed to lose 31.25 casualties for every one they inflicted. They performed much better when defending, losing only 15.25 people for every one they inflict. In the defense, over 90% of the Italian force ended up surrendering, making the percent surrendering per day come out to 4% or greater.

E. Desertion and Unit Cohesion

Because Germany had already been at war for four years, the German Army in Italy was not always a homogeneous or well trained, cohesive force. Many of the units initially available were formed from reserve divisions to replace combat divisions lost at Stalingrad and in Tunisia. In general, their levels of training and cohesion were probably not always up to the standards found earlier in the war. The constant attrition of the Italian Campaign and the lack of replacements combined to degrade German unit cohesion and performance. Furthermore, Germans units often included "Volksdeutsch" (people of German heritage from outside Germany) and "Hiwis" (other foreign nationals, often captured dur-

ing actions of the Eastern Front, who had volunteered to serve in German construction, rear area, and sometimes combat units). Nevertheless, most German units in Italy had a core of experienced officers and NCOs. Most of the US units had no combat experience when they arrived in Italy. Most of the UK units were experienced.

The records of the German Tenth Army provide some insight to the problem of desertion in Italy. The monthly activity reports of the Army Ic/AO[4] are available for December 1943 to May 1944 (the report for April is missing but some of the data is repeated in the May report). These reports detail the number of AWOL personnel (*unerlaubter Entfernung/Fahnenflucht*) and deserters (*Überlaufer*), their ethnic origins, units, and fates.

The Tenth Army reported a total of 1,179 AWOL and deserters from September 1943 to May 1944. The monthly missing in action (MIA) for the Tenth Army is also shown (internal evidence in the reports show that the MIA accounting by the Tenth Army did not include AWOLs and deserters), and by month of occurrence these are:

	AWOL/DST	MIA	TOTAL
Sep-43	8	1,539	1,547
Oct-43	57	1,485	1,542
Nov-43	121	2,371	2,492
Dec-43	300	2,920	3,220
Jan-44	209	2,129	2,338
Feb-44	207	1,126	1,333
Mar-44	71	569	640
Apr-44	184	114	298
May-44	22	6,484	6,506
Total	**1,179**	**18,737**	**19,916**

Note: The German MIA figure for May 1944 given here is found by subtracting the cumulative figures for April from those in a late report from June. The Allied DIADEM offensive shattered the Tenth Army, disrupting the staff. Internal evidence strongly indicates that MIAs for the month were under-reported. A close examination of the German records shows that the Tenth Army MIA loss for the month was at least 8,050 (see the Defender Source notes for the two DIADEM engagements in the EPW Campaign Database.

By the end of May 1944, of 1,129 cases (50 cases in September and October 1943 were not detailed), 454 were judged to be deserters, 78 had surrendered or been captured, and 597 AWOLs were still at large. Of the 1,129 cases, 662 were *Reichsdeutsche* (native Germans or Austrians), 371 were *Volksdeutsche* (native German speakers of foreign birth), and 96 were Russian, Croatian, or other non-German volunteers. Although these ethnic Germans and non-Germans account for only one-third of the sample above, they certainly did not make up one-third of the German army. They may in fact have been a major problem, as was reported by the 3rd Panzer Grenadier Division's IIb (adjutant for enlisted personnel) for 16 September to 15 December 1943: "...of 561 Ethnic Germans assigned to the division, 79 were MIA of which 27 were considered deserters ...of 273 Germans [reported missing], only 2 were deserters."

Therefore, 4.8% of the "Ethnic Germans" deserted! Comparing the desertion rates, of the "Ethnic Germans" 27 of 79 MIA were deserters, or some 34.2% of the missing. For native Germans, only 2 of the 273 missing were deserters, or some .7% of the missing. This is a 47 to 1 difference in perceived desertion rate.

A slightly more detailed examination of the casualty experience of the German XIV Panzer Corps in March 1944 may be of interest, and is presented in the next table. Also noted are the captures reported by the US Fifth Army for the divisions of the corps.

[4] Abwehr Officer—the counterintelligence officer who was responsible for dealing with the problem of desertion and unauthorized absence in the army.

Division	KIA	SWIA	LWIA	MIA	AWOL	DST	POW
5th MtnD	96	300	117	12	8	6	13
44th ID	61	296	64	10	12	17	13
15th PzGD	89	322	75	103	9	3	83
94th ID	53	148	54	2	5	1	10
90th PzGD	23	39	44	0	5	0	0
71st ID	89	254	105	35	11	7	1
1st ParaD	378	1186	44	202	3	3	201
TOTAL	**789**	**2545**	**503**	**364**	**53**	**37**	**321**

Note that the hardest hit division (42.32% of the total corps loss), the 1st Parachute Division of Monte Cassino fame, suffered minimal loss from desertion (0.16% of its total loss). Desertion accounted for 0.86% of the total corps loss.

The Allies observed this difference in unit cohesion of the various nationalities. In particular they noted that the majority of the deserters they captured were non-Germans. Appendix "A" to the IV Corps G-2 Report No. 209, "PW Breakdown, Recapitulation for the Month of December," reports the following figures from a summation of 8 allied divisions and 21 miscellaneous units:

Captured			
Off.	**EM**	**Deserter**	**Non-deserter**
0	104	78	26
		75%	25%
German	**Non-German**		
46	58		
44.20%	55.80%		

To put these figures in perspective, the German units in Italy usually had non-German elements. These often made up 5 to 10% of the strength of a German division, normally serving as combat support or in the division rear. They often made up the majority of personnel in the non-divisional construction and engineering troops, but these were often well to the rear. Yet, these non-German forces accounted for more than half the deserters the Allies picked up. Furthermore, if the 3rd Panzer Division report is typical, then the vast majority of the deserters the Allies recorded as "German" were probably *Volksdeutsche* as well.

The Germans were also aware that experience and unit cohesion made a difference in the number of missing in action. There was a commentary on casualty figures by the German Tenth Army Ia (effectively the G-3) for the period 1 September to 10 October 1943, which encompassed Salerno among other actions. He reported:

> "These figures include the losses from the battle of Salerno and from Termoli. Such combat operations will occur again and again within a monthly time span. Therefore a weekly average loss of ca. 1300 men can be regarded as normal. The high number of missing can be only partially traced to Salerno and Termoli. The main reason lies in the inexperience and the inadequate training of the young replacements. When his CO is killed, the young soldier is completely helpless in the face of a better trained enemy. The number of sick is primarily due to malaria."

In contrast, the Allied armies' loss to desertion across the lines was probably minimal. However, the available data suggests that AWOLs and deserters hiding in Allied rear areas was a major problem. The British Eighth Army Personnel Branch History provides various reports of AWOLs and deserters. The cases reported to trial for the period 1 Jan 44 to 30 Sep 44 included 411 AWOL and 878

desertions. For Oct 44 to May 45, there were 3,190 AWOL and 1133 deserters reported, although how many were brought to trial is not known. Looking at Allied desertion from the German side, the Tenth Army data is somewhat fragmentary. At least 7,193 Allied prisoners were accounted for, but the number of Allied deserters was not recorded. However, the subordinated German XIV Panzer Corps reports are very complete, giving a total of 5,320 Allied prisoners for the same period (September 1943 to May 1944). Of these, it appears that as few as 17 were considered to be deserters (0.32%). The German Fourteenth Army reported 9,211 Allied prisoners from 22 January 1944 through December 1944. Of these, only 3 (0.03%) were confirmed as deserters, one of whom was an American. It appears that he was the only United States prisoner captured in Italy that was recorded by the Germans as a deserter.

F. Conclusions

1. The Germans and the US were roughly equivalent in combat effectiveness, with the US being within 20 to 30 percent of the Germans (possibly lower). This appears to have been especially true in Italy, although they may have had the same combat effectiveness in the Ardennes. The overall impact of US versus German combat effectiveness is not significant enough to bias further analysis.

2. The Germans and the UK were within the same order of magnitude of combat effectiveness, with the UK perhaps being somewhat inferior (by 20 to 50 percent). While this may have had some impact on the results of the battles, it was not a significant enough difference to bias further analysis, especially considering the small number of German versus UK engagements.

3. Therefore, all the data from the Italian and Ardennes engagements, whether US, UK, or German, can be used interchangeably to determine EPW rates.

4. There is a significant difference between the German and Soviet combat effectiveness, by a rough factor of 3. This heavily biases the analysis. Therefore, the Eastern Front data must be considered separately from the Western Front data.

5. Italian combat effectiveness appears to be poorer than Soviet combat effectiveness.

6. Human factors are a major determinant of desertion and capture rates. Further analysis based upon a more in-depth study of human factors is needed.

7. There is most likely a correlation between desertion rates (and possibly AWOL rates) and capture rates. It may be possible to develop a method to correlate desertion and AWOL rates with capture rates.

8. There is most likely a correlation between desertion rates (and possibly AWOL rates) and unit combat effectiveness. It may be possible to develop a method to correlate desertion and AWOL rates with combat effectiveness.

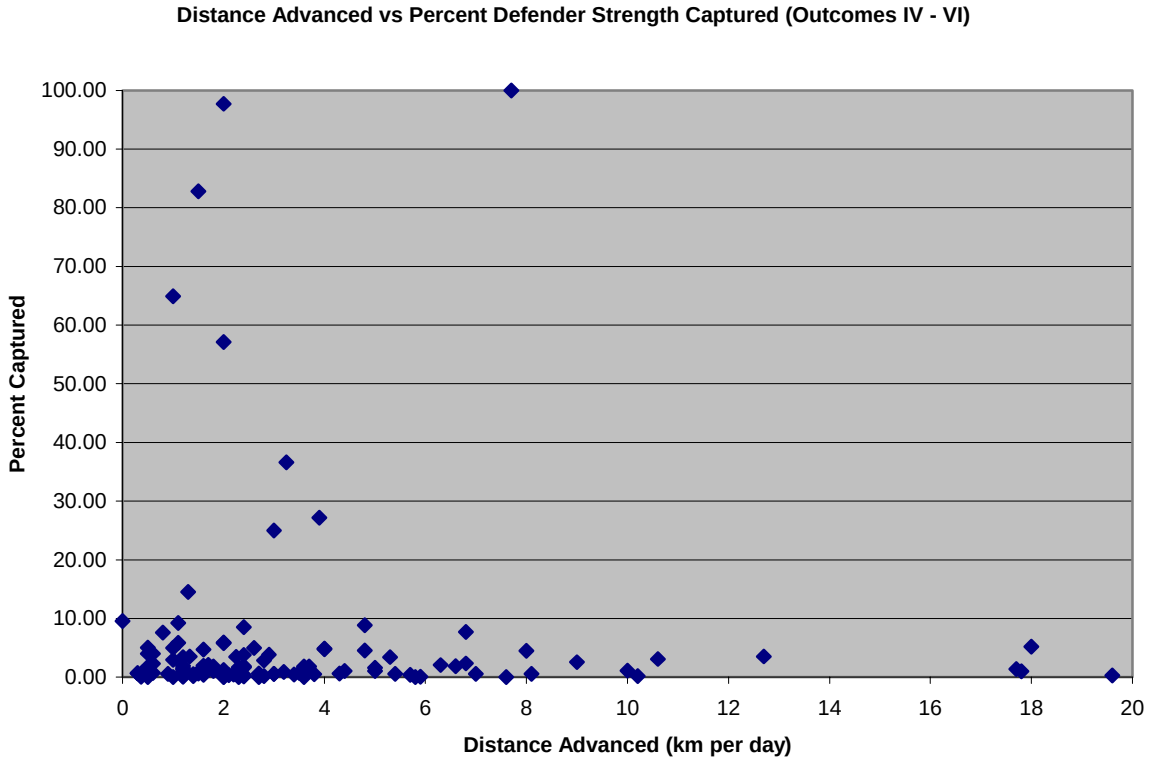
Therefore, for the purposes of the analysis of capture rates, US, UK, and Western Front German data was considered as part of a single statistical set. The Soviet data and the Eastern Front German data had to be considered separately as the impact of human factors heavily influenced the capture rate.

Chapter
7

Other Factors

The analysis presented in this chapter is based upon Posture (Attacker or Defender), outcome of the engagement, force mix (armor heavy, armor supported or infantry), and combat effectiveness (Soviet or otherwise). There are a number of factors tested that either had no measurable impact on EPW Capture Rates or simply could not be properly measured given the time and budget available. These include advance rates, force ratios, artillery, air, terrain and weather. These are discussed below.

A. Testing Advance Rates



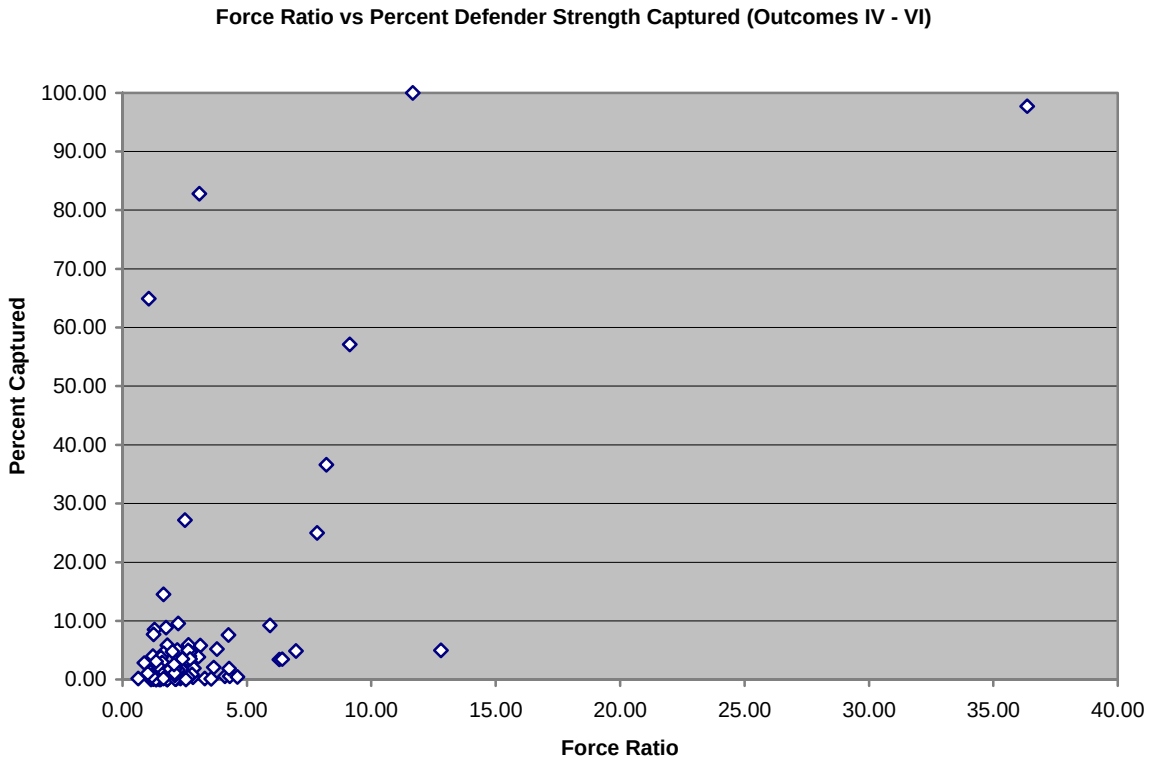
In the original conception of this project, it was felt that there might be some correlation between the rate advanced by a unit in combat, and the percent of the opposing force captured. A direct correlation between advance rates and capture rates was not expected; however, such a correlation might be seen within one of the outcome categories (for example "Attack Advances"). TDI therefore conducted the following tests:

ADVANCE RATE vs

- Percent of Defender Strength Captured
- Percent of Attacker Strength Captured
- Percent of Defender Strength Captured (Outcome IV)
- Percent of Defender Strength Captured (Outcome V)
- Percent of Defender Strength Captured (Outcome VI)
- Percent of Defender Strength Captured (Outcomes IV - VI)

TDI could see no demonstrated correlation. On the previous page is the scattergram for the last test listed, Advance Rates vs Percent of Defender Strength Captured (Outcomes IV through VI). As one can see, the highest capture rates occurred in situations where the daily advance rates were usually less than 5 kilometers. Advance rates greater than 10 kilometers per day did not result in capture rates above 10%.

B. Testing Force Ratios



Over the years, the modeling and OR community has attempted to directly correlate force ratios with any number of factors, without much success. This is because combat is simply too complex for such a simplistic formulation. Still, TDI tested force ratios versus capture rates. The following were tested:

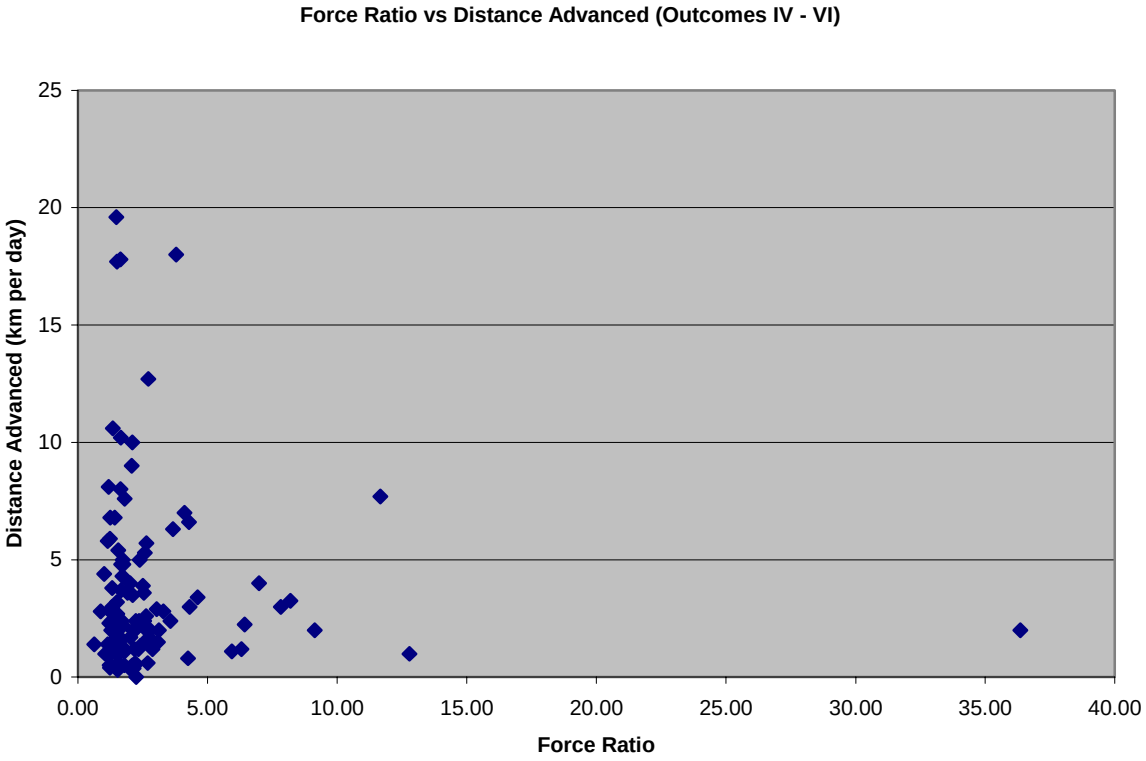
FORCE RATIO vs

- Percent of Attacker Strength Captured
- Percent of Defender Strength Captured
- Percent of Defender Strength Captured (Outcome IV)

- Percent of Defender Strength Captured (Outcome V)
- Percent of Defender Strength Captured (Outcome VI)
- Percent of Defender Strength Captured (Outcomes V & VI)
- Percent of Defender Strength Captured (Outcomes IV - VI)

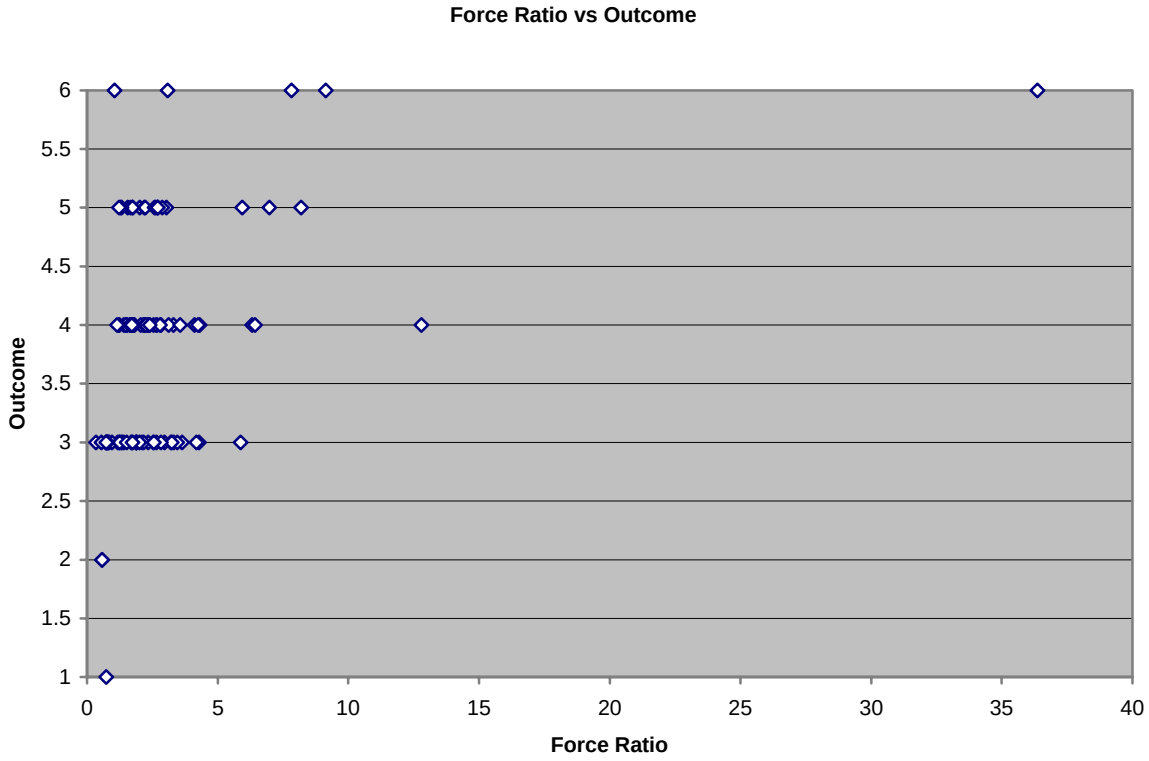
Again, TDI could see no demonstrated correlation, although this was expected. On the previous page is the scattergram for the last test listed, Force Ratio vs Percent of Defender Strength Captured (Outcomes IV through VI). As one can see, force ratios above 5 to 1 often, but not always, resulted in high capture rates. Still, some fairly low force ratios also resulted in high capture rates.

C. Force Ratios versus Advance Rates



Finally, as the data was available, we also tested force ratios versus advance rates. As expected, there was no direct correlation, which the work of Trevor N. Dupuy and Robert Helmbold has also shown. These tests were performed for outcome IV engagements and for outcomes IV - VI (see graph). As can be seen from this example, in all but one case in which there was an advance of five kilometers or more per day, the force ratio was less than 5 to 1, and in many cases, less than 2 to 1.

D. Force Ratios versus Outcome



It appears that where force ratios have an impact on combat is in helping to determine the outcome of the engagement. This is clearly demonstrated with the following graph. This graph clearly shows that for outcome 3 (failed attack), low odds attacks (less than 1 to 1) tend to fail. One notes that there are few successful attacks (outcomes 4, 5 or 6) where the attacker is outnumbered. It also shows that once the odds get above 4 to 1, attacks usually succeed. Beyond that, the degree of success of an attack is not directly related to force ratio, with the average or typical attack being about the same for outcome 4 engagements and outcome 5 engagements.

As a result, there is an indirect and limited relationship between force ratio and capture rates. However, as force ratio is only one of the factors to determine outcome, and outcome is only one of the factors that determine capture rates, then this relationship is difficult to measure.

E. Unit Size versus Capture Rate

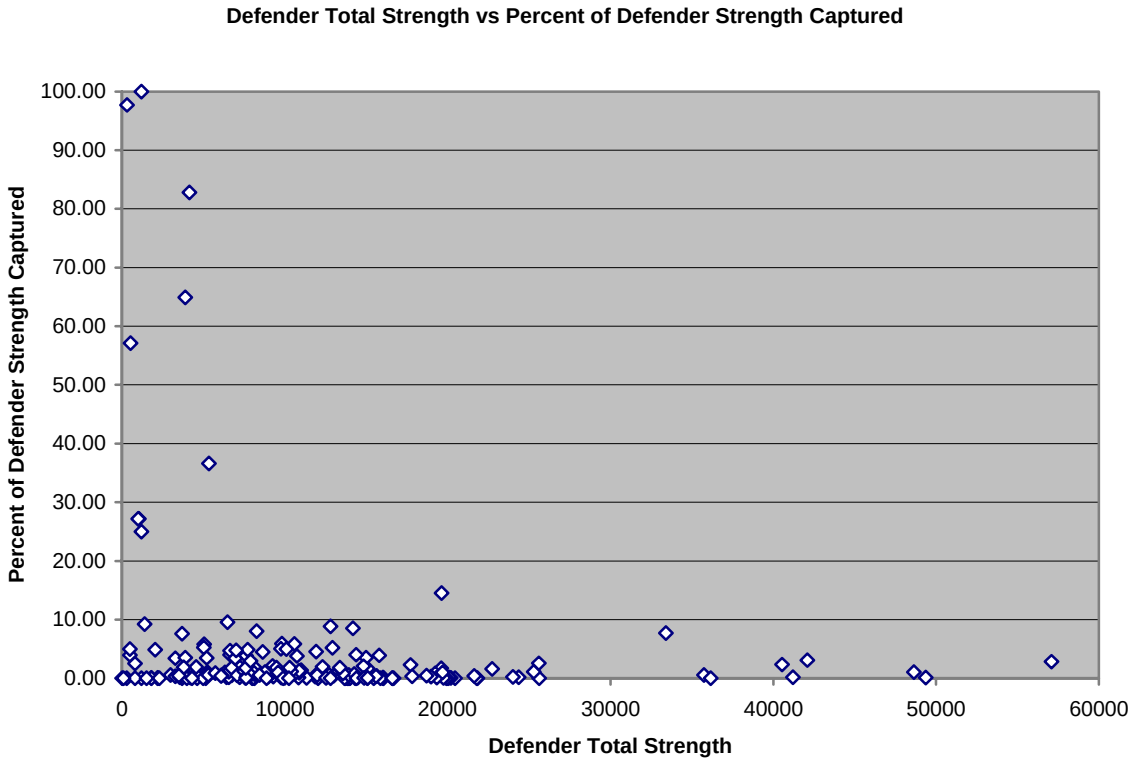
There is some correlation between unit size and capture rates in the same sense that there is a correlation between unit size and casualty rates. Quite simply, smaller units, on the average, suffer higher casualty rates. This effect is well documented (again, reference the work of Trevor N. Dupuy). This was the basis for excluding the battalion-level engagements. TDI chose not to exclude those engagements where one side was particularly small, so that would we have a significant number of engagements which had lopsided force ratios. However, there is still some tendency for the small engagements to bias the capture rates. This is definitely a problem for the Ardennes data, much less so for the Italian data, and not an issue at all for the Kursk data. If anything, there is a reverse problem with the Kursk data in that almost half the engagements are corps size operations. TDI has created for its use a working definition of the size of an engagement (see Appendix V). In accordance with those definitions, the data sets fit as follows:

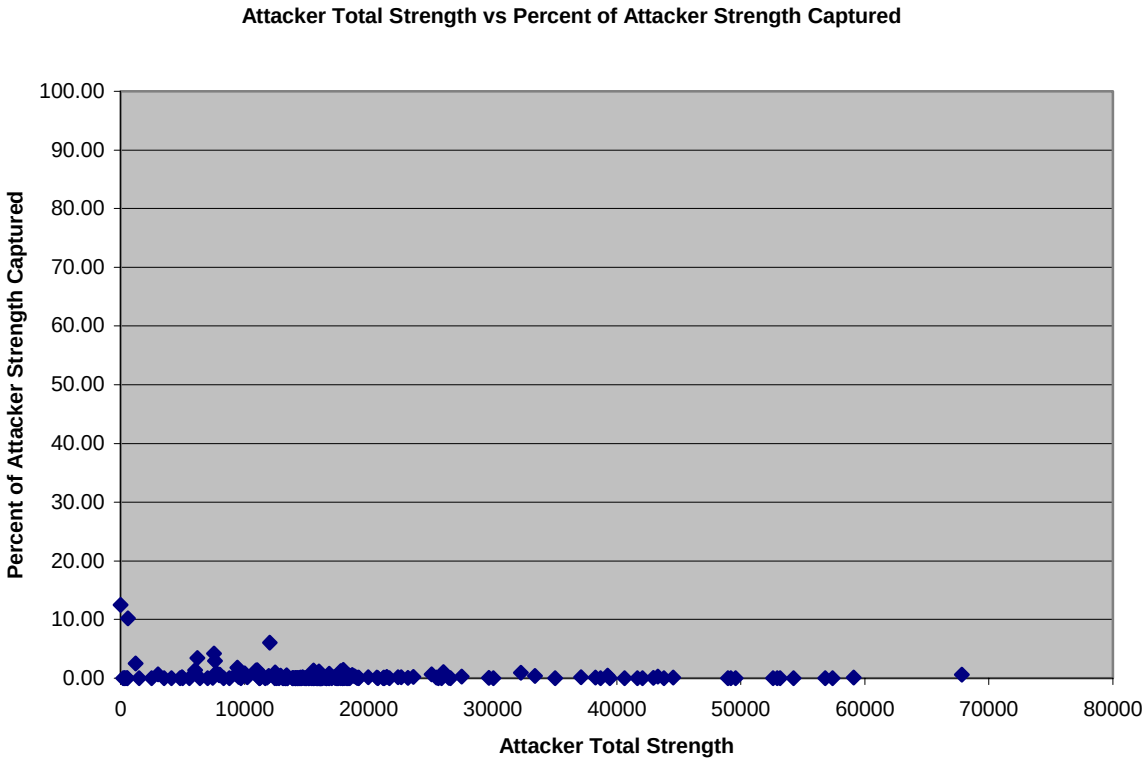
Number of Cases				
	Italian	**Ardennes**	**Kursk**	**Total**
Corps-level	2	7	21	**30**
Division-level	66	50	28	**144**
Brigade-level	7	14		**21**
Battalion-level	1	5		**6**
Company-level				
Squad-level		1		1
Total	**76**	**77**	**49**	**202**

The definition of the level of combat is based upon the attacker strength. This still results in forces of small size in some of these engagements. The next chart examines the range of sizes:

Number of Cases								
	Italian		**Ardennes**		**Kursk**		**Total**	
Strength	**Att**	**Def**	**Att**	**Def**	**Att**	**Def**	**Att**	**Def**
60,000 - 67,829					1		1	
50,000 - 59,999					7	1	7	1
40,000 - 49,999			2		8	5	10	5
30,000 - 39,999	2		4		3	3	9	3
20,000 - 29,999	14		3	8	3	5	20	13
15,000 - 19,999	34	7	21	3	15	16	70	26
10,000 - 14,999	15	16	26	18	10	16	51	50
7,500 - 9,999	7	19	3	15	2	2	12	36
5,000 - 7,499	3	19	4	8			7	27
2,500 - 4,999		10	6	9			6	19
1,000 - 2,499		4	2	6		1	2	11
308 - 999				4				4
Total	**75**	**75**	**71**	**71**	**49**	**49**	**195**	**195**
Average Strength	16,945	8,506	15,024	9,311	28,521	20,782	19,154	11,884

The actual correlation between EPW capture rate and unit size is shown in the following graphs.

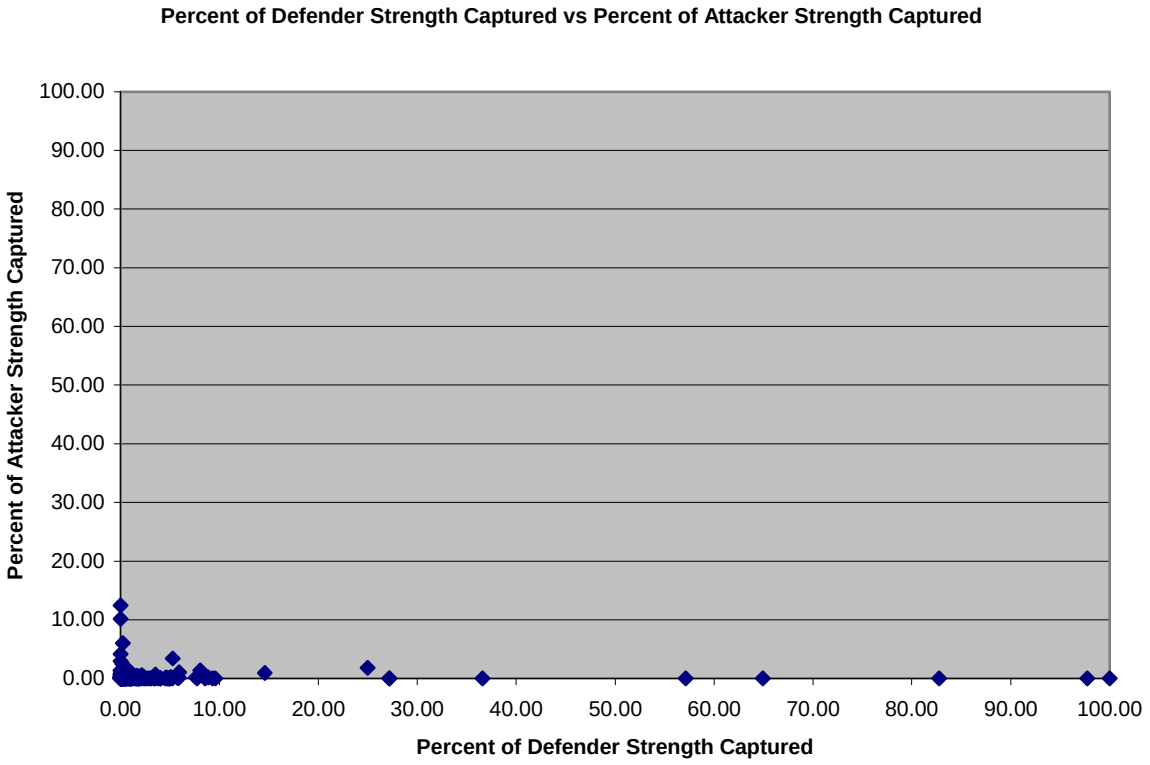

Defender Total Strength vs Percent of Defender Strength Captured
Percent of Defender Strength Captured
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
10000
20000
30000
40000
50000
60000
Defender Total Strength


Attacker Total Strength vs Percent of Attacker Strength Captured
Percent of Attacker Strength Captured
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0
10000
20000
30000
40000
50000
60000
70000
80000
Attacker Total Strength

These charts include all 202 points of data, including the otherwise excluded seven battalion-level engagements.

As can be seen, there may be some argument that the brigade-sized engagements and corps-sized engagements should be analyzed separately. This would produce limited results, as there are an significant number of cases for either, although it would help to make the division-level engagements a little purer.

F. Attacker versus Defender Captured



There is a clear inverse correlation between the percent of attacker strength captured versus the percent of defender strength captured. This inverse correlation is shown in our measurement of capture rates by outcome. As a result, TDI chose to keep the data for attacker and defender separate throughout the analysis. This separation is the basis for the determination that the capture rate is definitely differentiated by posture (whether attacker or defender). The graph showing this inverse relationship is below. Again, all 202 data points are used.

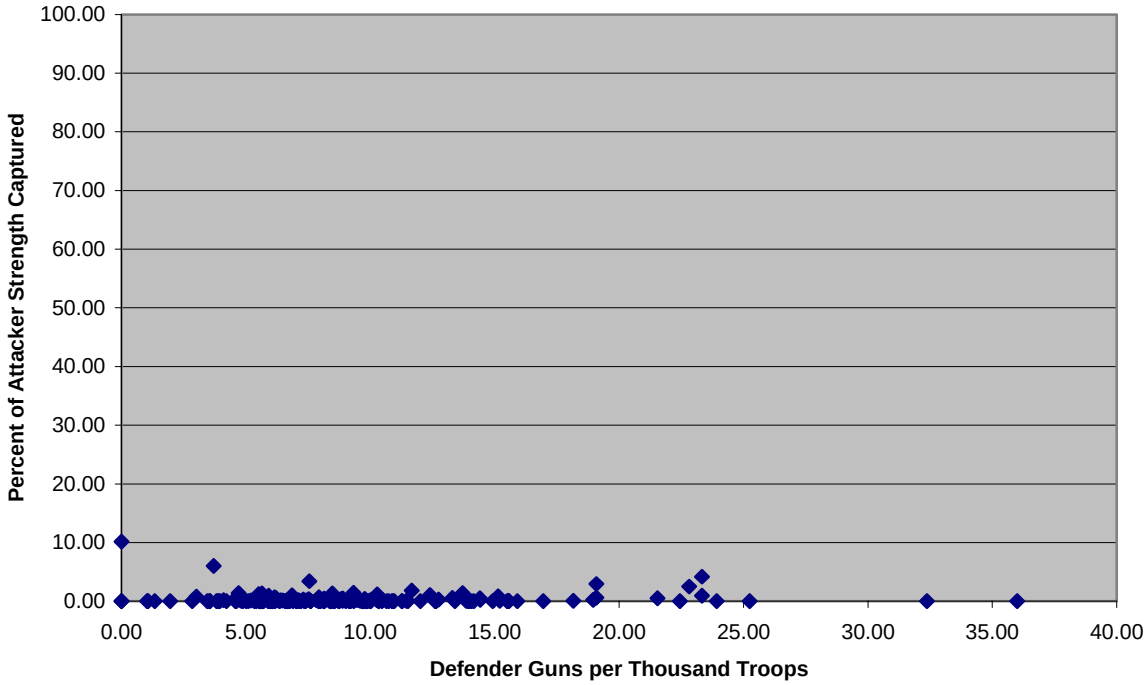
G. Artillery

The Dupuy Institute did not attempt to determine whether artillery had an impact on the capture rate. While we had good gun count figures, including a breakdown by types available, to be able to use the artillery figures to compare to capture rates would have required making two additional determinations. First, there would have to be a method for measuring the effectiveness of the different types of artillery guns and their usefulness in different roles. This is a particular problem with the Kursk engagements, where over half of the Russian artillery was the dual-purpose 76mm guns and the majority of their "field artillery" was the rather short-ranged 120mm mortars and 140mm rockets. Using simple gun counts would misrepresent the picture, while gun counts of field artillery alone, would misrepresent the picture in the opposite direction.

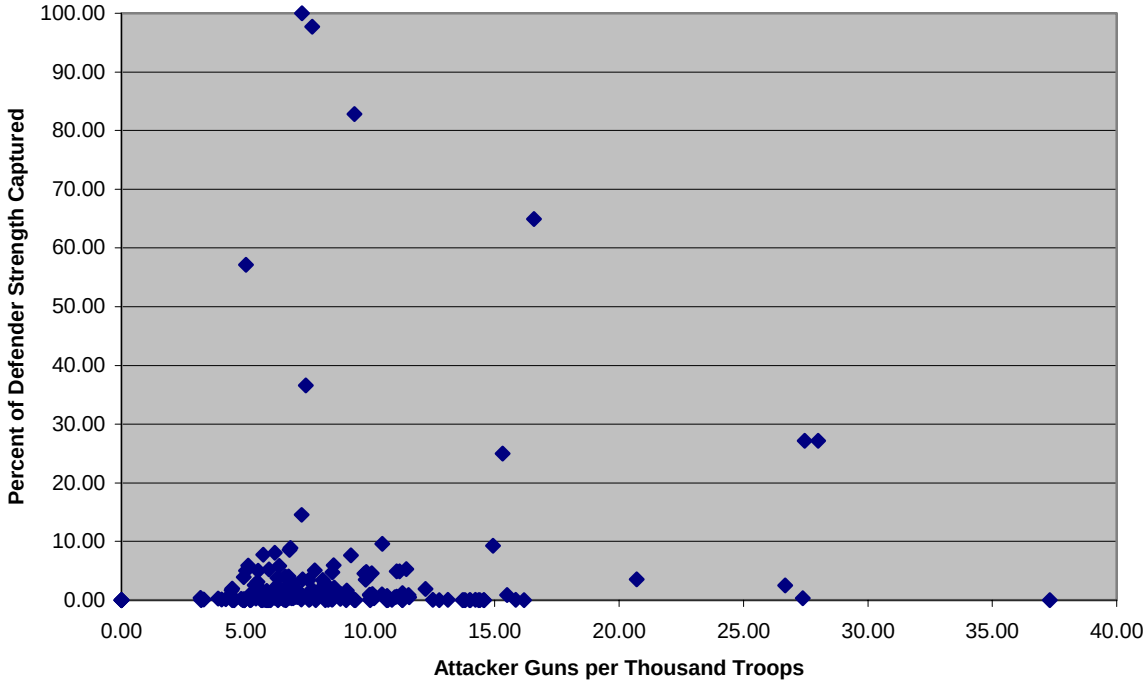
Second, the effectiveness of artillery is heavily influenced by the ammunition availability. In the case of the Germans versus the Soviets, and the US versus the Germans, one side had considerably more ammunition available and fired each gun more often. This requires examining the ammunition expenditure for each side. Furthermore, one must research whether any extensive bombardments occurred before the battles and the nature and extent of them. While this data does exist, and is in fact partially compiled for the Kursk and Ardennes engagements, it is still time consuming to assemble and analyze.

Intuitively, the analysts at TDI felt that there might be a small correlation between artillery and capture rates. Faced with the time and difficultly of analyzing this, it was decided not to look at this issue in depth. Still, as TDI did have a total gun count figure in the database, a quick comparison of guns counts to the percent of opposing forces captured did not encourage one to want to look at this issue in more depth. In the case of the comparison of attacker guns per thousand troops to the percent of the defender strength captured, it was clear that there was not a direct correlation. This data consists of 202 points, although two are not on this chart as they had more than 40 guns per 1000 troops (and less than 5% of defender troops captured). The comparison of the defender's guns versus the attacker's captured shows the same lack of correlation, with there being 5 cases in which the defender had more than 40 guns per 1000 troops, and were therefore excluded from the graphs on the next page.

Defender Guns per Thousand Troops vs Percent of Attacker Strength Captured



Attacker Guns per Thousand Troops vs Percent of Defender Strength Captured



H. Air Support

The Dupuy Institute did not attempt to determine whether air power had an impact on the capture rate. This is probably the single largest shortcoming of this study. There is a suspicion at the Institute that there may be some correlation, but it is not certain how strong a correlation may exist. There were several problems with adding air power to the existing engagements. Primarily, the air data for the Germans is sometimes maddeningly incomplete. In the case of the Kursk engagements, the German air liaison reports provide only daily sortie counts for the entire VIII Air Corps and do not indicate to where on the battlefield these missions flew. At any given time, there were as many as 17 different division-sized engagements they could have supported.

The next problem with any study of air support is to determine exactly who is being supporting. Because an airplane can transit a division combat area in less than 10 seconds, it is sometimes difficult to determine who is being supported by whom. Furthermore, many ostensible ground support sorties are not in fact involved in the direct support of ground operations. Some aircraft provide escort, some are on general air superiority missions or armed reconnaissance and may or may not be providing support in the areas over which they are flying, and some are on interdiction missions on the fringes of the battlefield and are not providing direct ground support. The number of planes that provide direct ground support during an engagement is often a fraction of the total number of planes operating over the battlefield. These can only be identified by a careful review of the mission and sortie reports, which no longer exist for much of the German Air Force.

Both of these problems can be partially offset by using intelligence and operations reports that count enemy aircraft sorties. While these are the opposing force's reports and are not always correct, they tend to be fairly accurate in the count of attacks on their own forces. So long as these reports are cross-checked against the air records of the originating force, they can be used with some confidence.

Aircraft also do many things to support the ground battle that do not include direct support. This includes pre-battle bombardment and interdiction. Any significant efforts in this regard would also need to be identified and evaluated.

Overall, it became clear that to assemble a valid measurement of the effects of air support would require a research effort on the air battles that would parallel the ground work in scope. This would be a significant additional effort and could not be accomplished within the budget limitations of this study. It is something that can be addressed and needs to be done.

I. Other

Finally, there is a host of other factors, such as terrain and weather, that were not addressed. It was felt that if these factors did have an effect on EPW capture rates, it was small enough that it would be difficult to identify and measure from this very noisy historical data. As such, it may not be possible to measure these effects with the current data set. However, with an expanded data set, this may be an area for future study.

J. Mission Effectiveness Score

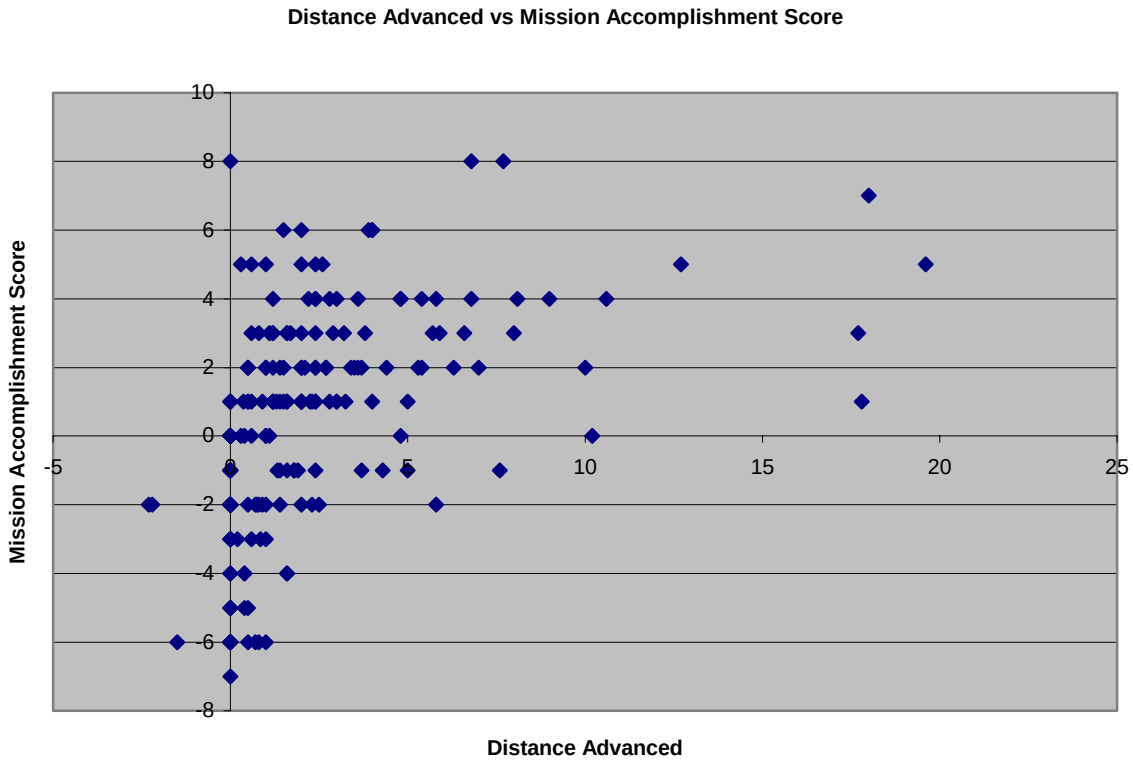
The Dupuy Institute chose not to use the mission effectiveness score as a factor in determining EPW rates due to our concerns about using an assigned score. This score rates both the attacker and the defender from 0 to 10, the higher mission effectiveness score the better. A single mission effectiveness score can be developed by subtracting the attacker score from the defender score. A positive number indicates an attacker success, and a negative number indicates a defender success. Looking at average mission effectiveness scores compared to outcome, shows the following:

	I	II	III	IV	V	VI
Italian			-3.37	1.69	3.54	
Ardennes	0	-0.57	-2.93	0.56	3.19	4
Kursk	0.13	0.15	-2.67	2.33	4.75	6.67

A similar comparison can be made with distance advanced and outcome (and distance advanced and mission effectiveness score). The average distance advanced by outcome is shown below:

	I	II	III	IV	V	VI
Italian			0.74	1.76	2.52	
Ardennes	0	0.36	0.45	3.71	5	1.9
Kursk	0.08	1.31	-0.58	5.18	11.43	5.77

Below is a graph showing the relationship between distance advanced and mission effectiveness score. In this case, we used the "net mission effectiveness" score, where the defender's score was subtracted from the attacker's score. The higher the score, the higher the degree of adjudged attacker success. Scores below zero indicate defender's success, with the lower score (higher absolute value) indicating more defender success. Again, we used all 202 data points. As can be seen, mission success scores below -2 had almost no advance. Otherwise advance rates and adjudged mission effectiveness scores were not closely related. This indicates that advance rates should be used with caution as a measurement of mission success.



It was determined that, because of the assigned nature of the mission effectiveness score, that it was not going to be used for further analysis. It may be a valid choice of measurement for future analysis.

Chapter
8

The Analysis

The following were determined to have had an effect on capture rates:

- Posture (whether attacking or defending)
- Outcome of the engagement
- Force Mix (armor ratios)
- Combat Effectiveness (being Soviet)

The analysis below will first examine the effect of being the attacker or defender and the outcome of the engagement. Then we will examine force mix, measured in terms of the number of tanks per thousand troops. Combat effectiveness has already been discussed in its relation to the Ardennes and Italian data, but its effect on the Kursk data will be specifically addressed.

A. The Impact of Outcome and Posture on Capture Rates

Having described the data, and looked at the issues that were either not significant or irresolvable, it is now time to see what the data can tell us about capture rates. First let's look at each of the data sets: Italy, Ardennes and Kursk.

There are seven tables following. Table 1 covers the 75 engagements (less Avellino) from the Italian Campaign, divided into the six outcome categories and posture (whether attacker and defender). Table 2 is the same data for the 71 Ardennes engagements and Table 3 is the same data for the 49 Kursk engagements. The next two tables (Tables 4 and 5) show the Kursk data separated into German attacks versus Soviet attacks. The next, rather busy Table 6 is simply Tables 1, 2 & 3 combined into one. Finally, there is a summary table (Table 7) that produces final figures based upon all three data sets.

The Italian Campaign engagements data shows a consistent pattern. As the outcome becomes more successful for the attacker, his casualties, measured as a percent of strength per day, declines, while the defender's casualties increase. The average CIA, measured as a percent of strength per day, goes from effective parity in the "failed attack" results for both the attacker and defender, to having the rate decrease to almost nothing as the attacker succeeds. In contrast, the defender rate increases as the attacker succeeds. The percent of losses that are captured in action also shows the same pattern. While all this is not unexpected, it is very nice that it fits so well into the expected pattern.

The Ardennes data follows a similar pattern. As there are some "Limited Action" and "Limited Attack" engagements, these demonstrate a different pattern, but the data from the Ardennes closely

matches that from the Italian Campaign, with two major exceptions. The first is that the casualty rates for failed attacks are much higher, although the capture rates are similar. Part of this difference is caused by the smaller forces involved. Seven of the 14 brigade-sized engagements in the Ardennes database are failed attacks. These smaller engagements, which make up some 20% of the Ardennes engagements, constitute almost half of the failed attacks. The average attacker strength for the 15 failed attacks is 9,845 compared to the database average of 15,024. The average defender strength for these engagements is 8,798 versus the database average of 9,311. This is a case where the biased selection of the data influenced the results. Still this is not the entire reason for the difference, as the Italian "failed attack" data also has a number of small and low odds attacks.

The other main difference is that defender casualties are simply higher. For example, in the Italian data, the defender suffered 1.90% losses in "attack advances" results while in the Ardennes the defender lost 3.63%. For "defender penetrated" results, the difference is 3.08% versus 8.80%. The percent captures per day also differs accordingly. This difference, which is also reflected in the "failed attack" results, is caused by a mixture of the selection of engagements, more intense fighting, larger number of small engagements, and the nature of the operations themselves.

The Kursk data also shows the same pattern, but again has higher casualty rates than Italy. The casualty rates at Kursk tended to be closer to that of the Ardennes, but some of this is driven by the high loss rates for the Soviets. The one figure that is odd for Kursk is the defender's casualties per day for "failed attack." This is almost entirely due to most of the failed attacks being Soviet attacks against German positions, resulting in fairly high losses for the attacks, and low losses for the defender. Table 3, when separated into German attacks and Soviet attacks, shows very different results. These are provided in Tables 4 and 5.

Unfortunately, there probably needs to be about 100 Kursk engagements to work from to really establish the point. But if one looks at the German attacks, one sees attacker figures that seem to be in line with the Italian and Ardennes data. The defender's losses are high. When one looks at the Soviet attacks, one sees a very different pattern. While measuring the statistical significance of this small number of cases (maximum of 9 in any category) may be academic, the contrast and consistent pattern tends to make a very strong case.

Table 6 shows Tables 1, 2, and 3 grouped together into one for comparison and contrast, and the final table (Table 7) shows the summation of all 195 points of data into one. As different as these three operations were, when the engagements are divided into outcome, the results are surprisingly similar. The mixing of different campaigns, different size units, and different nationalities muddies the results a little, but the sheer number of cases helps establish a very clear and consistent pattern.

ITALIAN CAMPAIGN (75 cases)
Table 1

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	0	0	30	32	13	0
Attacker % casualties per day	–	–	1.67	1.21	0.96	–
Defender % casualties per day	–	–	1.47	1.9	3.08	–
Attacker % CIA per day	–	–	0.49	0.15	0.16	–
Defender % CIA per day	–	–	0.23	0.65	1.35	–
Attacker, % of losses that are CIA	–	–	18.39	11.89	6.63	–
Defender, % of losses that are CIA	–	–	16.55	41.86	49.55	–

ARDENNES CAMPAIGN (71 cases)
Table 2

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	1	7	15	27	16	5
Attacker % casualties per day	0.03	0.86	5.56	0.9	0.71	1.47
Defender % casualties per day	0.45	1.21	5.85	3.63	8.8	34.6
Attacker % CIA per day	0.1	0.02	0.51	0.08	0	0.09
Defender % CIA per day	0.02	0.31	0.72	1.29	4.33	26.58
Attacker, % of losses that are CIA	100	6.17	19.06	10.9	0	4.33
Defender, % of losses that are CIA	4.49	24.61	9.65	33.46	47.96	79.95

BATTLE OF KURSK (49 cases)
Table 3

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	8	13	9	12	4	3
Attacker % casualties per day	0.27	0.77	3.04	1.86	0.91	0.75
Defender % casualties per day	0.17	0.58	1.04	4.27	7.59	38.32
Attacker % CIA per day	0.04	0.05	0.1	0.09	0	0.01
Defender % CIA per day	0.04	0.2	0.06	0.83	2.86	36.85
Attacker, % of losses that are CIA	7.23	11.38	4.17	4.25	0.47	0.93
Defender, % of losses that are CIA	30.32	23.83	6.62	25.21	36.54	79.28

BATTLE OF KURSK, Germans Attacking (31 cases)
Table 4

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	7	7	1	9	4	3
Attacker % casualties per day	0.16	0.73	0.83	1.3	0.91	0.75
Defender % casualties per day	0.13	0.84	1.74	5.35	7.59	38.32
Attacker % CIA per day	0	0	0.01	0.01	0	0.01
Defender % CIA per day	0.04	0.37	0.24	1.09	2.86	36.85
Attacker, % of losses that are CIA	3.5	1.09	0.79	1.52	0.47	0.93
Defender, % of losses that are CIA	34	42.22	13.64	30.95	36.54	79.28

BATTLE OF KURSK, Soviets Attacking (18 cases)
Table 5

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	1	6	8	3		
Attacker % casualties per day	1.01	0.81	3.32	3.54		
Defender % casualties per day	0.4	0.28	0.95	1.03		
Attacker % CIA per day	0.34	0.1	0.12	0.31		
Defender % CIA per day	0.02	0.01	0.04	0.06		
Attacker, % of losses that are CIA	33.33	23.38	4.6	12.45		
Defender, % of losses that are CIA	4.55	2.37	5.74	8		

SUMMARY (Italian vs Ardennes vs Kursk)
Table 6

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements						
Italian	0	0	30	32	13	0
Ardennes	1	7	15	27	16	5
Kursk	8	13	9	12	4	3
Attacker % casualties per day						
Italian			1.67	1.21	0.96	
Ardennes	0.03	0.86	5.56	0.9	0.71	1.47
Kursk	0.27	0.77	3.04	1.86	0.91	0.75
Defender % casualties per day						
Italian			1.47	1.9	3.08	
Ardennes	0.45	1.21	5.85	3.63	8.8	34.6
Kursk	0.17	0.58	1.04	4.27	7.59	38.32
Attacker % CIA per day						
Italian			0.49	0.15	0.06	
Ardennes	0.1	0.02	0.51	0.08		0.09
Kursk	0.04	0.05	0.1	0.09		0.01
Defender % CIA per day						
Italian			0.23	0.65	1.35	
Ardennes	0.02	0.31	0.72	1.29	4.33	26.58
Kursk	0.04	0.2	0.06	0.83	2.86	36.85
Attacker, % of losses that are CIA						
Italian			18.39	11.89	6.63	
Ardennes	100	6.17	19.06	10.9		4.33
Kursk	7.23	11.38	4.17	4.25	0.47	0.93
Defender, % of losses that are CIA						
Italian			16.55	41.86	49.55	
Ardennes	4.49	24.61	9.65	33.46	47.96	79.95
Kursk	30.32	23.83	6.62	25.21	36.54	79.28

SUMMATION (Compiled Data)
Table 7

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	9	20	54	71	33	8
Attacker % casualties per day	0.24	0.8	2.98	1.2	0.83	1.2
Defender % casualties per day	0.2	0.8	2.62	2.96	6.4	36
Attacker % CIA per day	0.05	0.04	0.43	0.11	0.02	0.06
Defender % CIA per day	0.04	0.24	0.34	0.92	2.98	30.43
Attacker, % of losses that are CIA	17.54	9.56	16.21	10.22	2.67	3.06
Defender, % of losses that are CIA	27.45	24.1	12.98	35.85	47.2	79.7

B. Conclusions from this Comparison

The outcome of an engagement is clearly a significant determiner of the EPW rate. The pattern of the relationships is the same for all three campaigns, discounting the problems caused by the performance of the Soviet Army. While the EPW rates are sensitive to unit size, it does not significantly bias the above data. Posture is significant, and EPW capture rates must be separated by attacker and defender. Therefore, one can conclude:

For the attacker:

1. The CIA rates for "limited action" and "limited attack" tend to be low for the attacker (.04 – .05% per day), with "limited attack" resulting in around 5% of the casualties being CIA (3.63 % if one excludes the Soviet attack) and the percent CIA in "limited action" being about the same (3.50%, excluding the 1 Soviet attack and the 1 Ardennes attack at 100%). Overall, the attacker CIA figures for both "limited attack" and "limited action" could be averaged at .01% per day if the 7 Soviet attacks are excluded, or at .04% if all the data is used. If the Soviet attacks are excluded, along with the one Ardennes engagement in which 100% of the losses were CIA, then we have 3.59% of the casualties taken as CIA. If all of the data is used, then 12.03% of the total casualties are taken as CIA.

2. The CIA rates for "failed attack" produce the highest capture rates for the attacker, resulting in 0.43% of the attacker's strength CIA with 16.21% of the casualties being captured in action. If the Soviet attacks are removed these figures do not significantly change, being only 8 points out of 54, and they are in fact lower than the average.

> Capture rates for "failed attack" are at least 10 times higher than for "limited action" and "limited attack."

3. The CIA rate declines noticeably for the attacker as the attack becomes more successful. For successful attacks this rate is 0.11% CIA per day with 10.22% percent of the total casualties being CIA. Soviet attacks, consisting of only 3 points out of 71, do not significantly affect these figures and do not vary widely from these averages.

> Capture rates for "attack advances" are one-fourth the rate of "failed attack."

4. The CIA rates for penetrations declines to almost nothing for the attacker, at .02% per day, with 2.67% of the total casualties being CIA. This is very close to the figures for "limited action" and "limited attack" if the Soviet attacks are excluded.

> Capture rates for "defender penetrated" are one-twentieth of "failed attack."

5. The CIA rate for envelopments rises slightly when compared to penetrations, as do casualties. While this is not surprising, it may be due to the low number of cases (8). Still the difference is small, with .06% per day being CIA and 3.06% of total casualties being captured. This is in the same ballpark as outcomes I, II and V ("limited action," "limited attack," and "defender penetrated").

For the defender:

1. The CIA rates for the defender for "limited action" is close to that for the attacker, at .04%. This is not surprising, as the primary difference between the attacker and defender in a "limited action" is definitional. The defender does record a rather hefty 27.45% of total casualties as CIA. These figures are clearly influenced by the 7 cases of the Soviets being on the defense out of a total of 9 examples. The remaining two examples produce an average figure of .02 per day and 4.52% of the total casualties as CIA. This figure is believed to be more representative of combat between forces of good morale and is very much in line with the attacker's figures.

> Defender's CIA rate in "limited actions" are about the same as the attacker's CIA rate.

2. The CIA rate for the defender in a "limited attack" is higher than that of the attacker, at .24% per day with 24.10% of the total casualties as CIA. Again, this figure would appear to be heavily influenced by the 7 cases in which the Soviets were on the defense, but the figures produced are similar to, and slightly lower than, the 7 cases in the Ardennes data. Removal of the 7 cases produces figures of .17% per day and 14.35% of the casualties.

> Regardless, the percent defender's CIA in "limited attack" are greater than the attacker's percent by 3 or 4 times.

3. The CIA rate for the defender for "failed attack" is the only case in which the defender performed better than the attacker, with .34% per day CIA and 12.98% of the total casualties as CIA. The one case of the Soviets successfully defending produced similar figures.

> Defender's CIA rate in "failed attack" are somewhat higher than for "limited attack."

4. The CIA rate for the defender for "attack advances" is the start of the trend for increasingly worse statistics for the poor defender. They suffer .92% per day CIA and 35.85% of total losses as CIA. This is significantly different from the attacker CIA rate, which is one-eighth of the defender rate. The Soviet defensive cases are in line with the other data.

> Defender's CIA rate for "attack advances" are three times higher than for "failed attack, as are the percent of losses captured.

5. The CIA rate for the defender for "defender penetrated" is a hefty 2.98% per day of strength, with 47.20% of the total losses as CIA. This is more than 100 times the attacker's CIA loss rate. The Soviet defensive cases are in line with the other data.

> Defender's CIA rate for "defender penetrated" is three times higher than for "attack advances."

6. The CIA rate for the defender for "enveloped" is 30.43% per day with, 79.70 percent of the total casualties as CIA. This is as expected. The only reason the CIA daily rate is not higher is that several of the enveloping engagements lasted more than one day. The defender's CIA rate is some 500 times greater than the attacker's. The Soviet defensive cases are in line with the other data.

> Defender's CIA for "envelopment" is 10 times higher than for "penetrations."

C. Force Mix (Tanks)

Another element (besides posture and outcome) that clearly has an impact on capture rates is the force mix. Force mix is measured by the presence of main battle tanks on the battlefield. Therefore, the presence of armor on the battlefield does have an impact on EPW rates.

As discussed above, armor is measured in this study as the number of main battle tanks per 1,000 of troops. We then analyzed the results by looking at the total number captured and at the percent of enemy strength captured. As a reminder, the definitions are:

Infantry	2 or less main battle tanks per 1,000 troops
Armor Supported	from 2 to 8 main battle tanks per 1,000 troops
Armor Heavy	8 or more main battle tanks per 1,000 troops

The average number captured shows a clear pattern across all of the data sets and across all force mixes. Note that as there are two sides to the engagement, the number of data points is 390.

TOTAL NUMBER CAPTURED	Average Cases	Number Captured
Italian Engagements		
Armor Heavy	16	160
Armor Supported	108	98
Infantry	26	49
Ardennes Engagements		
Armor Heavy	24	274
Armor Supported	81	147
Infantry	37	40
Kursk Engagements		
Armor Heavy	1	306
Armor Supported	47	238
Infantry	50	35

The pattern here is very clear. The Italian Campaign engagements are unique in that there are exactly the same number of examples of attackers and defenders for each force mix category. For the other two campaigns these numbers vary. When the figures are broken into attacker and defender this produces some very clear differences. These differences are not surprising, considering the we had already established that posture (attacker/defender) is a major factor in the capture rate. What is significant is that posture, when considered alone, appears to influence capture rate by a factor of 100 times or greater, while posture, when considered in combination with the force mix, shows much less of a spread between the attacker and defender.

TOTAL NUMBER CAPTURED Attacker and Defender		Average Cases	Number Captured
Italian Engagements			
Armor Heavy	Attacker	8	216
	Defender	8	103
Armor Supported	Attacker	54	146
	Defender	54	49
Infantry	Attacker	13	64
	Defender	13	34
Ardennes Engagements			
Armor Heavy	Attacker	16	490
	Defender	8	58
Armor Supported	Attacker	44	262
	Defender	37	32
Infantry	Attacker	11	65
	Defender	26	14
Kursk Engagements			
Armor Heavy	Attacker	1	306
	Defender	0	0
Armor Supported	Attacker	22	442
	Defender	25	34
Infantry	Attacker	26	60
	Defender	24	10

Again, the pattern here is clear. The difference between being the attacker or defender ranges from a factor of approximately 2 to 13. Changing the force mix from infantry to armor-supported results in an increase in average captures by 1.4 to 3.4 times for the defender and from 2.3 to 7.4 times for the attacker. Changing the force mix from armor supported to armor heavy increases the average captures by 1.8 to 2.1 times for the defender and from 1.5 to 1.9 times for the attacker. The change from infantry to armor heavy ranges from 3.0 to 4.1 for the defender and from 3.4 to 7.5 for the attacker. This tends to show that the impact of force mix on combat is about half the impact of posture. Some summary statistics are shown in the following table.

Armor Heavy	Attacker	25	395
	Defender	16	81
Armor Supported	Attacker	120	243
	Defender	116	40
Infantry	Attacker	50	62
	Defender	63	17

In aggregate, the difference in average captures by posture ranges from 3.6 to 6.1 (with an overall weighted average of 6, an average of 216 for the attacker versus 36 for the defender). The difference by force mix from infantry to armor supported is 2.4 for the defender and 3.9 for the attacker. The difference by force mix from armor supported to armor heavy is 2.0 for the defender and 1.6 for the attacker. The overall shift from infantry to armor heavy in average capture rates is 4.8 for the defender and 6.4 for the attacker. These figures imply that the impact of force mix on combat is roughly equal to, or slightly less than, the impact of posture on combat.

As the measurement used for most of the analyses in this report is percent captured per day, the table below addresses the same comparisons based upon the percent captured per day.

Percent of Enemy CIA		Cases of Enemy CIA	Average Daily %
Italian Engagements			
Armor Heavy	Attacker	8	0.87
	Defender	8	0.44
Armor Supported	Attacker	54	0.63
	Defender	54	0.27
Infantry	Attacker	13	0.35
	Defender	13	0.16
Ardennes Engagements			
Armor Heavy	Attacker	16	7.3
	Defender	8	0.2
Armor Supported	Attacker	44	2.85
	Defender	37	0.17
Infantry	Attacker	11	0.73
	Defender	26	0.1
Kursk Engagements			
Armor Heavy	Attacker	1	2.06
	Defender	0	0
Armor Supported	Attacker	22	1.44
	Defender	25	0.07
Infantry	Attacker	26	3.91
	less outlier	25	0.07
	Defender	24	0.05

Recasting the CIA figures as percent CIA per day changes the statistics, but not the pattern. In the case of the Italian Campaign engagements, the difference between attacker and defender is a factor of 2.0 to 2.3. The difference between force mix, from infantry to armor support and from armor supported to armor heavy, is 1.7 and 1.6 for the defender and 1.8 and 1.4 for the attacker. There is an overall shift from infantry to armor heavy of 2.8 times for the defender and 2.5 times for the attacker.

The Ardennes figures are not as tight, with the difference between attacker and defender being by a factor of 7.3 times to 36.5 times. The difference between force mix, from infantry to armor supported and armor supported to armor heavy is 1.7 and 1.2 for the defender and 3.9 and 2.6 for the attacker, with an overall shift from infantry to armor heavy of 2 for the defender and 10 for the attacker.

The Kursk figures show a very strange pattern. This is caused by the difference between German and Soviet capture rates and the existence of one outlier (Vorskla Ravine). If this outlier is left out, we end up with something that is more typical: the difference between attacker and defender is from 1.4 to 20.6; the difference between force mix, from infantry to armor supported for the defender is 1.4, and from infantry to armor support and armor supported to armor heavy for the attacker being 20.6 and 1.4, for an overall shift from infantry to armor supported of 29.4 times

Considering the wide performance disparities between the armies, a further subdivision of the Kursk figures into German and Soviet cases is probably worth looking at.

Battle of Kursk: German Cases			
Armor Heavy	Attacker	1	2.06
	Defender	0	
Armor Supported	Attacker	16	1.96
	Defender	9	0.19
Infantry	Attacker	14	7.26
	less outlier	13	0.11
	Defender	9	0.12

Battle of Kursk: Soviet Cases			
Armor Heavy	Attacker	0	
	Defender	0	
Armor Supported	Attacker	6	0.06
	Defender	16	0.01
Infantry	Attacker	12	0.01
	Defender	15	.00 (.003)

When the Kursk engagements are separated into German and Soviet segments, the same patterns emerge. Again, in the case of the German infantry attacks, there is one outlier (Vorskla Ravine) which was a German mopping-up operation that rounded up over 1000 POWs, resulting in 100% of the Soviets being captured. This operation is excluded from the calculations.

Still, even with the differences between the Soviet and German capture rates, we can summarize the statistics, in this case leaving out the Vorskla Ravine. This results in the following:

Kursk Capture Rates		Cases of Enemy CIA	Average Daily %
Armor Heavy	Attacker	25	5.03
	Defender	16	0.32
Armor Supported	Attacker	120	1.59
	Defender	116	0.2
Infantry	Attacker	49	0.29
	Defender	63	0.09

The difference between defense and offense ranges by a factor of 3.2 to 15.7, while the difference from infantry to armor supported is by a factor of 2.2 for the defender and 5.5 for the attacker, and from armor supported to armor heavy by a factor of 1.6 for the defender and 3.16 for the attacker. The overall shift caused by force mix is 3.6 times for the defender and 17.3 for the attacker.

The final issue to be addressed is the impact of the force mix on the combat outcome. There is a concern that as a matter of course, heavier armored forces will be more successful and therefore they are naturally going to capture more POWs. Hence what we could be measuring is not the effect of force mix on capture rates, but the effect of force mix on combat outcome. This does not appear to be the case. The "Success Distribution" table (Table 9) below should demonstrate this:

SUCCESS DISTRIBUTION Table 8	I	II	III	IV	V	VI
ITALY						
Attacker						
Armor Heavy	-	-	2	3	3	-
Armor Supported	-	-	22	22	10	-
Infantry	-	-	6	7	-	-
Defender						
Armor Heavy	-	-	7	1	-	-
Armor Supported	-	-	18	23	13	-
Infantry	-	-	5	8	-	-
ARDENNES						
Attacker						
Armor Heavy	-	-	4	4	5	3
Armor Supported	1	7	7	18	9	2
Infantry	-	-	4	5	2	-
Defender						
Armor Heavy	-	-	2	2	2	2
Armor Supported	1	2	8	17	9	-
Infantry	-	5	5	8	5	3
KURSK						
Attacker						
Armor Heavy	-	-	-	1	-	-
Armor Supported	-	3	6	7	4	2
Infantry	8	10	3	4	-	1
Defender						
Armor Heavy	-	-	-	-	-	-
Armor Supported	-	5	6	8	4	2
Infantry	8	8	3	4	-	1

If the force mix had had a major impact on the outcome, the expected result would be a higher percentage of the attacker engagements in categories IV, V, and VI being armor than those in category III. Conversely, one would also expect to see a higher percentage of the defender's engagements in categories IV, V, and VI to be infantry than those in category III.

In the case of the Italian engagements there is clearly a higher percentage of armor engagements among the attackers in outcome V than in III, and no infantry engagements, but the reverse pattern for the defender does not appear. In the Ardennes no pattern appears, with the force mixes for outcome III and V effectively the same for both the attacker and defender. For Kursk there is also no pattern, except that armor appears matched to armor, and infantry to infantry. At Kursk this was very noticeable, but in fact occurred across all the engagements. Where one side had armor, the other side often also had armor. A simple cross comparison of the engagements will make that trend clear:

Italy				
		Defender		
		Armor Heavy	Armor Supported	Infantry
Attacker	Armor Heavy		7	1
	Armor Supported	6	39	9
	Infantry	2	8	3

Ardennes				
		Defender		
		Armor Heavy	Armor Supported	Infantry
Attacker	Armor Heavy	2	7	7
	Armor Supported	3	28	13
	Infantry	3	2	6

Kursk				
		Defender		
		Armor Heavy	Armor Supported	Infantry
Attacker	Armor Heavy			1
	Armor Supported		19	3
	Infantry		6	20

Summation				
		Defender		
		Armor Heavy	Armor Supported	Infantry
Attacker	Armor Heavy	2	14	9
	Armor Supported	9	86	24
	Infantry	5	16	29

The tendency was for similar force mixes to be opposite each other. This occurred in 117 out of 195 cases (60%). The number of cases of truly disparate force mixes (armor heavy versus infantry or vice versa) was only 14. This partially explains why we do not see a major impact from force mixes on battle outcome. The summation chart for battle outcomes of the Italian, Ardennes, and Kursk campaigns is provided here:

Summation (Table 9)						
Attacker	**I**	**II**	**III**	**IV**	**V**	**VI**
Armor Heavy			6	8	8	3
Armor Supported	1	10	35	47	23	4
Infantry	8	10	13	16	2	1
Defender	**I**	**II**	**III**	**IV**	**V**	**VI**
Armor Heavy			9	3	2	2
Armor Supported	1	7	32	48	26	2
Infantry	8	13	13	20	5	4

The results are fairly intuitive. Heavy armor forces are not involved in "limited action" or "limited attack." There is a slight indication that armor heavy forces helped on the defense in outcome III (failed attack). While the mix of forces for outcome IV (attack advances) is much the same, the force mix for the defender for outcome IV has less armor heavy forces than for outcome III. Outcome V shows a definite bias for the attacker away from infantry forces and towards armor forces, while outcome VI definitely shows that bias on the part of the attacker and the reverse bias on the part of the defender. Still, considering the number of cases, and that there is not much difference between outcomes III and IV, one must conclude that there is not a significant relationship between force mix and outcome, although heavy armor forces seem to make the result more significant. As such, the actual rates used for the results from outcome V and VI may be biased by the fact that in those cases force mix also helps make an attack more successful.

Conclusions:

The following conclusions can be reached concerning the impact of force mix on EPW capture rates:

1. Force mix has a significant impact on EPW rates.

2. This effect appears to be consistent, and is present both when comparing infantry forces to armor supported forces, and when comparing armor supported forces to armor heavy forces.

3. The effect of force mix on EPW rates appears to be mostly independent of the effect of force mix on winning and losing.

4. The difference between armor heavy and infantry is by a factor of 5.75 times (figured as an arithmetic mean of the 41 armor heavy forces compared to the 113 infantry forces), or a factor of 6.4 for the attacker, and 4.8 for the defender. As percent per day CIA, the overall difference is by a factor of 17.7, with a factor of 17.3 for the attacker and 3.6 for the defender. Again, as a general rule of thumb, the percent losses for the force opposing an attacking armor heavy force will be 10 times higher than the force opposing an infantry force, with the actual losses (in numbers) being about 5 times higher.

5. The impact of force mix on capture rates is more significant for the attacker than for the defender. The effect on the attacker of the defender's force mix ranges from factor of 2 (the Ardennes data) to around 4.8. As a general rule of thumb, the percent losses for the force opposing an defending armor heavy force will be about 4 times higher than force opposing an infantry force, with the actual losses (in numbers) being in the same range.

6. The capture rate is definitely different for attackers and defenders, with the attacker netting an average of 6.5 times as many EPW as the defender (figured as an arithmetic mean of all 195 engagements). As a percent of strength, for outcome IV, the difference between attacker and defender is by a factor of 8.4. As a weighted average across outcomes I through VI, the difference between the attacker and the defender, as percent CIA per day, is 0.17% for the attacker and 2.21% for the defender, or by a factor of 13. As a general rule of thumb, the percent losses for the defender will be 10 times higher than the attacker, and the actual losses (in numbers) being about 5 times higher.

7. Winning is important in determining the capture rate.

- The difference in capture rates from outcome III to outcome IV is by a factor of 10.6 times, as measured by percent CIA (from .43 % on the attack to .11 %, and from .34% on the defense to .92%)

- The difference in capture rates from outcome III to outcome V is 188.6 times, as measured by percent CIA.

As a rule of thumb, the percent loss for the attacker that wins will be around 4 times less (or even lower) than if he loses, while the percent loss for a defender that loses will be 3 times or more higher than if he wins. Between these two sides, this can result in a shift by a factor of 10 for winning or losing, and by more than a factor of 100 if the attacker penetrates or encircles.

8. Therefore posture, winning, and force mix of the attacker are all factors of roughly equal weight in determining capture rates. Force mix of the defender is less important (less than half the value). In the case of winning, outcome can become the most significant factor if the win includes a penetration or envelopment.

D. Impact of Morale (Being Soviet)

There is a definite impact on capture rates caused by a force having lower morale, unit cohesion, motivation, and combat effectiveness. This difference shows up most clearly in the Kursk data, so this data was used to measure this difference. It becomes, in effect, the "Consequence of Being Soviet" but one can interpolate the impact on capture rates of any force with lower morale, combat effectiveness, motivation, or unit cohesion. The Soviet Army at Kursk in 1943 had two years of combat experience, had finished a very successful series of campaigns beginning at Stalingrad, and had equipment as good as or better than that of their opponent. There is reason to believe that their performance was not nearly as poor as an army's can be. A look at the campaign data seems to indicate that the Italian Army's performance in 1940-43 was much worse. So while these figures can be used for a force with poor morale, it still probably does not represent the situation that one would encounter with an untrained and demoralized armed force similar to the Iraqi Army in the Gulf War. In those cases, capture rates would be expected to be much higher. Still, the Kursk data does provide a basis for producing estimates based on the premise that not all armies are the same.

First, we compare the German data versus the Soviet data. The Soviet performance when attacking the Germans shows the Soviets suffering an average of 3.54 times higher percent daily losses than the Germans. In the cases in which they were defending, the Soviets suffered 1.82 times the German percent daily losses. If one leaves out the extreme cases in both calculations, which happen to be the "limited action" engagements, one is left with average Soviet percent daily loss rates when attacking of 2.61 times and when defending 3.34 times those of the Germans. Regardless of which data one uses, one comes up with a performance differential when the attacker and defender cases are averaged of around 2.5 to 3 (2.68 or 2.98). This is in line with the figures previously discussed on Kursk.

A similar comparison of percent captured in action results in the Soviets on the attack having from 10 to 30+ times as many captured (as measured as a percent of total force) and on the defense approximately 10 times as many captured (9.90). If one looks at the percent of losses that were captured in action, the Soviets had more than 10 times that of the Germans (11.25) when attacking, while their percent losses CIA when they were both defending is again multiples higher at approximately 8 (7.88) for the Soviets.

This indicates that a casualty effectiveness advantage factor of 3 tended to result in about 10 times as many captures. Not only did the relative performance advantage seem to increase the Soviet casualties, it also seemed to reduce the German casualties relative to the averages developed from the aggregate 195 engagements. This relationship between casualty effectiveness and capture rates may be geometric.

The next table is a composite "German table" from the Kursk data showing both their attack and defense data, and for comparison, the composite data from the 195 engagements. This clearly shows that the German capture rates at Kursk were well below the average. The percent of losses captured was well below average. There are three main reasons for this. First is the difference in relative combat effectiveness between the two forces. Second, the Germans clearly still had high morale, motivation, and unit cohesion. Third, it was well understood that a German was probably not going to survive Soviet captivity, reducing his willingness to be captured. Still, the data shows that the average casualties by outcome for these engagements is similar, although somewhat lower, to the average for the database. The capture rate for the Germans in the attack is almost non-existent, while the capture rate for the defense does show a pattern toward worsening as the attack succeeds. The percent of losses that are CIA seem to stay around 1% when attacking, although rising to 5% when defending, and even up to 8% or higher. Unfortunately, we have no cases of the Germans being penetrated or enveloped.

The Soviet data shows a very different pattern, with average casualties as both the attacker and defender higher than the average. The percent captures per day tend to be in line with the average data, while the percent of casualties that are captures also tends to be in line with the average data for the attacker and defender.

What this all shows is that while there is a clear difference, the difference tends to show up, at least in this data, as a mitigating or reducing effect on the higher morale force. Therefore, for purposes of trying to account for a significant morale difference between opposing forces, the very tentative conclusions should be:

1. If there is a relative casualty effectiveness disparity between two armies on the order of magnitude of 3, then there will be a disparity in the capture rates by an order of magnitude of 10, and this may well be reflected by decreasing the capture rates of the side with the higher morale.

2. It is clear that considerably more engagements need to be developed and analyzed to strengthen, or disprove this hypothesis. Regardless of the "shakiness" of the data, the impact of human factors on EPW capture rates cannot be ignored.

Battle of Kursk						
	No Attack	**Limited**	**Failed**	**Success**	**Penetrated**	**Envelopment**
	I	**II**	**III**	**IV**	**V**	**VI**
Number of engagements						
Germans attacking	7	7	1	9	4	3
Soviets attacking	1	6	8	3	0	0
Attacker % casualties per day						
Germans attacking	0.16	0.73	0.83	1.30	0.91	0.75
Soviets attacking	1.01	0.81	3.32	3.54		
Defender % casualties per day						
Germans defending	0.40	0.28	0.95	1.03		
Soviet defending	0.13	0.84	1.74	5.35	7.59	38.32
Attacker % CIA per day						
Germans attacking	0.00	0.00	0.01	0.01	0.00	0.01
Soviets attacking	0.34	0.10	0.12	0.31		
Defender % CIA per day						
Germans defending	0.02	0.01	0.04	0.06		
Soviets defending	0.04	0.37	0.24	1.09	2.86	36.85
Attacker % of losses that were CIA						
Germans attacking	3.50	1.09	0.79	1.52	0.47	0.93
Soviets attacking	33.33	23.38	4.60	12.45		
Defender % of losses that are CIA						
Germans defending	4.55	2.37	5.74	8.00		
Soviets defending	34.00	42.22	13.64	30.95	36.54	79.28

Summation vs the Germans at Kursk	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	9	20	54	71	33	8
Germans attacking at Kursk	7	7	1	9	4	3
Germans defending at Kursk	1	6	8	3	0	0
Attacker % casualties per day	.24	.80	2.98	1.2	0.83	1.20
Germans at Kursk	0.16	0.73	0.83	1.30	0.91	0.75
Defender % casualties per day	0.20	0.80	2.62	2.96	6.40	36.00
Germans at Kursk	0.40	0.28	0.95	1.03		
Attacker % CIA per day	0.05	0.04	0.43	0.11	0.02	0.06
Germans at Kursk	0.00	0.00	0.01	0.01	0.00	0.01
Defender % CIA per day	0.04	0.24	0.34	0.92	2.98	30.43
Germans at Kursk	0.02	0.01	0.04	0.06		
Attacker % of losses that were CIA	17.54	9.56	16.21	10.22	2.67	3.06
Germans at Kursk	3.50	1.09	0.79	1.52	0.47	0.93
Defender % of losses that are CIA	27.45	24.10	12.98	35.85	47.20	79.70
Germans at Kursk	4.55	2.37	5.74	8.00		

Summation vs the Soviets at Kursk	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Number of engagements	9	20	54	71	33	8
Soviets attacking at Kursk	1	6	8	3	0	0
Soviets defending at Kursk	7	7	1	9	4	3
Attacker % casualties per day	.24	.80	2.98	1.2	0.83	1.20
Soviets at Kursk	1.01	0.81	3.32	3.54		
Defender % casualties per day	0.20	0.80	2.62	2.96	6.40	36.00
Soviets at Kursk	0.13	0.84	1.74	5.35	7.59	38.32
Attacker % CIA per day	0.05	0.04	0.43	0.11	0.02	0.06
Soviets at Kursk	0.34	0.10	0.12	0.31		
Defender % CIA per day	0.04	0.24	0.34	0.92	2.98	30.43
Soviets at Kursk	0.04	0.37	0.24	1.09	2.86	36.85
Attacker % of losses that were CIA	17.54	9.56	16.21	10.22	2.67	3.06
Soviets at Kursk	33.33	23.38	4.60	12.45		
Defender % of losses that are CIA	27.45	24.10	12.98	35.85	47.20	79.70
Soviets at Kursk	34.00	42.22	13.64	30.95	36.54	79.28

Chapter
9

Study Conclusions

To summarize the conclusions of the study in four simple points:

- **Outcome is a Significant Determinant of EPW Rates**
  - Effect is by a factor of 10 or greater, and can rise to a factor of 100 or greater with penetrations and envelopments.
- **Being Attacker or Defender is a Significant Determinant of EPW Rates**
  - Effect is by a factor of 10 or greater
- **Force Mix is a Significant Determinant of EPW Rates**
  - Effect is by a factor of 10 or greater for the attacker
  - Effect is by a factor of around 4 for the defender
- **Morale (Being Soviet) is a Significant Determinant of EPW Rates**
  - Effect is by a factor of around 10
  - Historically, there have been armies much worse than the Soviet Army in 1943.

It appears we have the basis for a multiple regression model with four major independent variables (including "being Soviet")

The final recommended figures to be used, not considering the effects of force mix or unit morale, are in Table 10. These are the same figures as the composite figures given in Table 7 for “failed attack,” “attack advances,” “defender penetrated,” and “defender enveloped.” They differ from composite figures in the “limited action” and “limited attack” columns.

For the attacker in a “limited action” and “limited attack,” 7 Soviet attacks and 1 outlying Ardennes engagement were excluded from the data. The rest of the data set was combined to produce one result (there were 21 remaining data points). These results were applied to both categories. The Soviet attack data was excluded, as it was obviously producing casualty rates that were well above the norm seen for the other data. As they made up almost all of the “limited action” engagements, this left insufficient data to draw a conclusion. Therefore the data for the two categories was combined.

For the defender in a “limited action,” all 7 Soviet defending engagements were excluded from the data. This left 2 data points. As they appeared to match well with the data in the other categories, the average of these two points was used.

For the defender in a “limited attack,” all 7 Soviet defending engagements were excluded from the data. There were 13 surviving data points used to create these figures.

For the remaining categories, the data was used as is. In these cases, the Soviet casualty data was more in line with the other experiences, and they did not make up the majority of the cases. Therefore it was felt that it was best to use all available data if there was no compelling reason not to use it. The provided Tables 4, 5, 6, and 7 contain all the data necessary to create a different recommended rates table based upon different assumptions if an analyst so desires.

While TDI is satisfied with its recommended rates based upon posture (attacker/defender) and six engagement outcomes, and is comfortable that there was clearly a measurable impact on capture rates based upon force mix (tanks)and morale (being Soviet), we found that creating the next logical step—a matrix of recommended rates incorporating posture, outcome, and force mix—to be difficult to achieve.

Two attempts were made to expand the recommended rates table to include the three force mixes. One attempt consisted of cross-referencing the "% CIA per day" with summation tables for the "% of Enemy CIA" by force mix and posture. While it was mathematically possible to generate consistent figures, there was no confidence that they were correct. For example, the "defender % CIA per day" when facing an Armor Heavy force came out as 89.77%. There were only three examples of this scenario in the database, and they had daily capture rate values of 57.14%, 6.25% and 20.69% for an average of 28.03%. While multiplying the rates in each cell by the impact of force mix did produce a consistent set of figures, when these figures were tested to actual data they did not match.

The other option was to assemble the data from the actual database. This would create a 6 by 3 matrix, based on 6 outcomes and 3 force mixes, built from 195 points of data that are not distributed evenly. As a result, 13 of the 18 cells have 10 or less data points for the attacker. An attempt to assemble such data resulted in the percent capture rate for outcome V (defender penetrated) with armor heavy forces being 2.24% of the defender per day. This is below the average for outcome V (2.98%) and is only based on eight cases. Furthermore, the armor supported figure (meaning for forces with less armor) is higher (3.52%) based upon 19 cases and leaving out the four Kursk examples (which would push it up to 9.26%). The matrix created from actual data resulted in inconsistent figures, and there was a lack of confidence in the data in the majority of the cells. It was clear that we had reached the limit of what we could prove without further data.

To further expand such a table by the 49 examples of German/Soviet data so as to produce a final table based upon higher morale forces and lower morale forces was reaching even further beyond the robustness of the data and was not attempted.

Even the presented "Recommended Capture Rate" chart is based upon 9 data points for outcome I, 20 for outcome II, and only 8 for outcome VI. The table is based upon 54 cases for outcome III, 71 for outcome IV and 33 for outcome V. Still, these are the recommended capture rates for this study:

Table 10
Recommended Rates

	No Attack I	Limited II	Failed III	Success IV	Penetrated V	Envelopment VI
Attacker % CIA per day	0.01	0.01	0.43	0.11	0.02	0.06
Defender % CIA per day	0.02	0.17	0.34	0.92	2.98	30.43
Attacker, % of losses that are CIA	3.59	3.59	16.21	10.22	2.67	3.06

Chapter
10

Fitting the Results to CAA's Campaign Simulation Models

While the contracting agency for this study has specific model definitions and requirements that need to be filled, TDI felt that it was essential to produce a valid analytical definition for the outcome of the study as opposed to trying to force the data to fit various model definitions. This was done for two reasons. Most important, the data shows certain characteristics that can be measured using a proper set of outcome definitions. This produces answers that the TDI analysts believe are intellectually valid. To force feed the data into definitions that are not directly relevant would have harmed the validity of the answers.

Second, it is clear that the results of these studies can often be used as a source of reference for over 40 years. Models change over time, and their modeling definitions also change. Therefore, it was felt that for the sake of future analysis and developing a proper understanding of combat, it was more important to use the best definitions for the study, and leave it to the model operators to fit it to the requirements of their particular models. The study data may then also indicate where the model definitions need to be changed.

Seven outcomes are used: "limited action," "limited attack," failed attack," "attack advances," "defender penetrated," "defender enveloped," and "other." No capture rates are generated for the "other" definition; it was only needed as a classification for anything that didn't conveniently fit into the other six definitions.

These definitions do not directly match the categories used in CAA's models. CAA's categories are "postures" as opposed to "outcomes." As such, the categories are based upon the circumstances prior to the combat, while the study categories are based upon the results of such combat. Still, the two data sets can be matched to each other.

The CEM "postures" are, in fact, actually engagement types. CEM determines the type of engagement by considering

(1) the missions of the opposing forces, and
(2) type of defensive position (where appropriate).

The following figure indicates how this is done.

	Red Mission	Attack	Defend		Delay
Blue Mission	Position Type	Red —	Red Prepared	Red Hasty	Red —
Attack	Blue —	Meeting Engagement	Blue Attack of Prepared Position	Blue Attack of Hasty Position	Blue Advance
Defend	Blue Prepared	Red Attack of Prepared Position	Static	Static	Static
	Blue Hasty	Red Attack of Hasty Position	Static	Static	Static
Delay	Blue —	Red Advance	Static	Static	Static

The above figure indicates the following engagement types for CEM:

(1) meeting engagement,
(2) attack of prepared position,
(3) attack of hasty defense (hasty position),
(4) delay,
(5) static (neither side attacks).

In actuality, CEM considers around 13 different engagement types, among them being the following:

(1) meeting engagement,
(2) attack of fortified position,
(3) attack of prepared position,
(4) attack of hasty defense,
(5) delay,
(6) withdrawal,
(7) retirement (disorganized),
(8) static.

Combat outcomes (e.g., casualties and rates of advance) are played as being a function of these engagement types.[5]

Effectively, our analysis is based upon 12 categories (six outcomes times two postures) while CAA uses 5. Therefore, to create capture rates based upon CAA's model definitions, then one needs to determine the percent of each case that should be applied to each definition. In this case, it was decided to use the percentages of each case from the data that was used to generate the capture figures. For attack or defender, the "defender enveloped" result was not used since the model rarely is used to play encirclements. For the reserve posture, it was assumed that 90% of the time the units are well to the rear and not in any situation that would generate captures. Based upon this, the following rates were developed:

[5] Reference : R.E. Johnson, "Concepts Evaluation Model VI (CEM VI), Volume I – Technical Description," CAA-D-85-1, US Army Concepts Analysis Agency (CAA), Bethesda, MD, January 1985 (revised October 1987).

CAA Model Category	Rate	Note
Static	0.067	.310 of "limited action" + .690 of the "limited attack" rates, .500 of the attacker figure and .500 of the defender figure.
Defend	0.669	.432 of "failed attack" + .568 of "attacker advances" rates.
Delay	1.573	.683 of "attacker advances" + .317 of "defender penetrated" rates.
Attack	0.201	.342 of "failed attack" + .449 of "attacker advances" + .209 of "defender penetrated."
Reserve	0.002	.100 of "limited action" (defender) and .900 of zero.

The rates are percent of own strength captured by the opposing side each day. The figure ".002" means 1/500th of a percent, or one capture per 50,000 troops per day. Data should only be applied for division-level combat.

It is TDI's recommendation that CAA develop its capture rates based upon the outcome of the action, not the "posture" as they define it. TDI also recommends that a more complete set of postures be developed for CAA's models that is more in line with historical activity and different methods of attacking.

Chapter
11

Future Development

The study of combat is a scientific process that relies on the further development, refinement, research, and analysis of data so as to build up a sufficient body of well researched data from which reliable conclusions can be drawn. Each project that adds to the existing body of knowledge allows for new projects and developments that previously could not be done. In the case of the EPW study, analysis could be further expanded and refined to include:

1. Expand the Land Warfare Database by developing additional battles from other theaters to incorporate the full range of conventional warfare operational environments. From WWII, this would include:

   • Tunisian and Western Desert for desert warfare;
   • Operation "Mars", the Battle of Moscow, the relief of Stalingrad, and operations in Finland for winter warfare;
   • Operations in Burma, New Guinea and the Philippines for jungle warfare;
   • A selection of amphibious warfare operations;
   • A selection of mountain operations;
   • A selection of urban warfare operations.

   River crossings will naturally fall out of this selection. We will also need to consider whether to look at airborne and airmobile operations.

2. Develop comparable data for conflicts before WWII in order to identify any changes due to the revolution in warfare.

3. Expand research in Army-level campaigns from WWII to include a wide range of operations.

   • Arctic
   • Jungle
   • Amphibious
   • Mountain
   • Urban
   • Major Insurgencies
   • Minor Insurgencies

4. Research and analyze a series of Army-level campaigns from pre-WWII operations.

5. Research Vietnam for good modern two-sided data for conventional and unconventional combat. The Dupuy Institute may be able to gather two-sided data from these operations.

6. Expand the analysis to cover civilian internees and refugees.

This expansion of the databases will allow one to test and develop a set of battle data that will establish historically-based capture rates for conventional warfare engagements across a wide range of environments and conditions. Furthermore, it will allow analysis of other issues besides EPW capture rates, across a wide range of conditions. Studying World War I, World War II, and post-World War II operations will provide a means for projecting whether future capture rates will change and in what direction. This analysis can certainly be extended beyond capture rates so as to be able to look at the effects of evolution and revolutions in warfare.

Chapter
12

Final Comments

The immediate purpose of this project was to develop an estimation of capture rates for enemy prisoners of war. Concurrently, but without interfering with that mission, TDI also attempted to create a set of database tools for use with other Army analysis and modeling efforts. As such, more data was collected for each engagement and operation than was needed to answer the question put before us. This was intentional, for there is a need across the industry to build a basic foundation of knowledge that can be used for future studies. The Land Warfare Database (LWDB), CaDB (Campaign Database) and the SSCODB (Small Scale Contingency Operations Database) provide this.

TDI's long-term goal is to create a series of scientifically and rigorously researched databases that consider warfare at all levels and conditions in order to allow extensive analysis of this data by others and to allow the scientific development of combat-modeling concepts and theories of combat.

TDI has already begun this with the two day-by-day, division-level campaign databases, the Ardennes Campaign Simulation Database (ACSDB) and the Kursk Database (KDB). Furthermore, we have created a series of databases to address all levels of combat, from wars through campaigns, battles, engagements, and down to actions (see Appendix V for a detailed explanation of the "levels of combat").

At the highest level of aggregation, TDI built the Warfare, Armed Conflict and Contingency Operations (WACCO) Database, which attempts to cover every major conflict that resulted in more than 20 dead from 1898 to the present. It currently contains some 780 entries.

The Small Scale Contingency Operations Database (SSCODB), the Modern Contingency Operation Database (MCODB), and the old Casualty Estimates in Contingency Operations (CEC) study provide the material to attempt to address Small Scale Contingencies (SSCs) and Operations Other Than War (OOTW). The SSCODB is expected to include 60+ operations when completed, while the MCODB consists of 92 operations (one-sided data only).

The Campaign Database (CaDB) covers Army-level operations from 8 to 60 days in duration. It currently has a total of 115 operations, with 71 operations completed.

The Land Warfare Database (LWDB) covers battles and division-level engagements from 1600 to 1991. It has 774 completed entries.

The Battalion-Level Operations Database covers battalion-level actions from 1918 to 1989. It has over 70 entries.

With the exception of the MCODB, all the databases are two-sided data and most are researched primarily from the unit records of the participants.