Volume 1, Number 4 February 1997

THE INTERNATIONAL TNDM NEWSLETTER

Verification, Validation, and Accreditation (VVA)

Also in this issue:

- Military History and Validation of Combat Models
- 76 & 112 Battalion–Level Battles
- Casualties, Time, Winners and Losers Using BLODB
- How to Run TNDM from Windows 3.1 and Win95

INTRODUCTION

In tribute to what Trevor Dupuy pioneered and in an effort to pursue what he wanted to achieve, TDI continues to amass historical data and strives to refine the combat variables which go into the TNDM. In this fourth issue of our newsletter Christopher Lawrence, Dave Bongard, Richard Anderson, and Jay Karamales continue to provide information on these efforts.

As you, our readers, survey the pages of this issue, you may be curious about the total scope of work of TDI. The paragraphs below outline what is missing in applied military history and what TDI is doing to shore up that deficiency. In other words, here is *our core capability*:

1. TDI provides independent, objective, historically–based analyses of modern military campaigns. Operations research, as developed during and right after World War II, was based on recorded, detailed data from battles. It is now nearly extinct. It has been supplanted by weapons and systems effects and performance analyses totally devoid of human factors considerations. As a result the Services, particularly the Army, have only partial answers for the development of operational concepts, battle doctrine, weapons requirements, and organizations. Similarly, because they were not historically validated, the Service models and simulations are skewed. Striving for only measured weapons effects and technical systems capabilities, they miss (or significantly distort) the impact of leadership, training, organization, and psychological factors (such as fear of death) on military units in contact.

2. Over the years, TDI, a successor organization to the Historical Evaluation and Research Organization (HERO), both founded by the late Colonel Trevor N. Dupuy, has compiled a large database from modern military campaigns and battles. Using Colonel Dupuy's methodologies and some new techniques, TDI has developed the following capabilities:

a. Comparison of fighting capabilities of opposing forces (systemic strengths and weaknesses) based on:

(1) Command and organizational arrangements, leadership, force structure, intelligence, and logistics;

(2) Training, cultural and psychological profiles, and flow of information;

(3) Doctrinal flexibility or constraints in utilizing new weapons and technologies.

b. Validation of models or simulations and of scenarios for field exercises. Validation is a process, based on historical data and trends, that assists in determining whether a scenario, model, or simulation is an accurate representation of the real world. TDI has the capability to do this independently or to provide primary source historical data for agency in–house validations.

c. Estimating casualties for combat or other operations.

d. Providing lessons learned from studies of cause and effect chains among responsible players at the political, theater, operational, and tactical levels.

e. Analysis of group behavior (impact of various combat activities on units) and other human factors (historically–based aggregate measure of leadership, training, morale, organizational capacity, and cultural characteristics) in modern battles.

f. Studies, based on historic trends and experiential data, of the specific impact on combat caused by new technology and the improvement in weapons. This enables projections of ways in which future wars should be fought and understanding of what elements constitute "force multipliers."

3. The capabilities listed above merge operations research with historical trends, actual combat data, and real world perspectives creating applied military history in its most useful sense.

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IN HONOR OF THE MEMORY OF THE LATE

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Col., USA, Rtd.

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From the Editor...

This issue is a hodgepodge of articles. A few months ago, I carefully laid out plans for all the future issues, starting with this issue, to be organized around definite themes. The previous issue was also intended to be slightly thematic, except that I had to reduce the number of graphs (meaning the number of articles) so as to get the issue out sometime in 1996. This issue was intended to be built around the Dupuy Air Campaign Model (DACM), but several things occurred that worked against this plan. First, I was left with a collection of articles intended for the last newsletter ("article overflow") that I wanted to print. Second, and more significantly, an informal memo I wrote in 1994 suddenly got widely distributed within the US Army combat modeling community. This memo was intended for my future thematic issue on model validation (carefully planned to be the October 1997 issue), but the memo and issue are current now, so the thematic issue plans are temporarily reshuffled and we are going to talk about model validation in this issue.

Model validation has been discussed in the industry for over 20 years. In this decade, there was been some progress towards validation of models in the US Army, but from my point of view, not nearly enough. My experience with validation is as a "hands–on" expert. I was the program manager for two validation databases, the Ardennes Campaign Simulation Data Base (ACSDB) and the Kursk Data Base (KDB). In addition, I have directed the creation of the Battalion-Level Operations Database (BLODB). The real worker on that is Dave Bongard. I have then used that database to start a validation of the TNDM for battalion–level combat. This means that I have been involved in some way with three validation efforts, so I feel as qualified as anyone to discuss validation issues.

Enclosed in this issue is a letter from Paul Berenson of the US Army Training and Doctrine Command (TRADOC) to the "whole world" asking if validation is being done. This came about because of a phone conversation we had in December 1996 in which I stated in passing that "of course, none of these models has been validated." Dr. Berenson asked me if I had something I could send him on that, and indeed I did have a two old memos that I had written two years earlier to Dr. Brian McCue when he was at the Office of Technology Assessment (OTA) and to Trevor Dupuy. I then attached a cover letter to it and faxed it to him. After reading them, he asked me if it was okay to send them out, and I said it was. In January, I realized that they had been sent to the "whole world."

Upon re-reading them, I would have to say that the tone is a little harsher than I would like to take in a public letter, but then they were written as private letters. Hopefully no one was offended by the tone. Regardless of how sweet and sugary I might rewrite them, the basic ideas presented would be the same.

In my first memo, I state that I had no comment on the subject of accreditation. This is no longer the case. I have therefore enclosed an article on accreditation to clarify my position, or perhaps just my understanding, of this issue. I have also included an article on validation addressing the problems of validating models to other models, test data, or range data. This is in direct response to a statement in Dr. Berenson's memo. I have enclosed the late Trevor N. Dupuy's paper on validation that he presented at a MORS mini-symposium. We did not edit this paper, and it is included as is. I actually find he overstates the "fuzziness" of historical combat data. With proper research and selection of the battles, it isn't very fuzzy at all. I can certainly get figures like strengths and casualties to within 20%.

Also enclosed in this issue is the work we are doing on the battalion-level validation. The original data for the 74 battalion–level combats were assembled by Dave Bongard from secondary sources. I, as much as anyone, am aware that we should use primary source wherever possible, but since primary source research is expensive, and no one has budgeted for us to do this, we either had to use secondary sources or do nothing. I chose to do something.

After Mr. Bongard had assembled the battles, I put them in a database format so I could look at and test the data. Initially I just wanted to see if the data that we were getting from the battalion–level battles behaved significantly different than what we had gotten from division–level data. I got a little carried away with these tests and the four articles in

(cont.)

this newsletter are the result. Hopefully there is much of interest there. A note of warning: the data on some of the engagements have not been finalized, and for the validation some of the data have been corrected. I do not believe this makes any significant difference in my analysis of the data.

In the meantime, Mr. Bongard ran these engagements through the TNDM to see how they would come out. In the process, we added two more engagements, as we had situations in Tenaru River and Bir Gifgafa in which the defender made a significant counterattack with reinforcements during the battle. Instead of running it as one battle, Dave chose to break it into two separate engagements. This resulted in our having 76 engagements. I am now comparing the results of these 76 runs with the historical outcomes. Our conclusions will be printed in the next issue.

We have therefore included a revised listing of the 76 battles used in the validation effort. This is an update from the list in Volume 1, Number 2 of this newsletter. Also, as we suspect that we will be making some changes to the TNDM as a result of this validation effort, we have started preparing a second collection of 112 battalion–level engagements with which to recheck our revised model. This list is also included in the newsletter. You will note a number of obscure and unusual engagements. I believe if you test something, you should test it like you are trying to make it fail, so we let Mr. Bongard pick any engagements he desired. I may regret this.

For the Programmer's Cubicle, we have an article from José about using the TNDM in Windows 3.1 and Windows 95. Only those who have version 1.86 of the TNDM can access it in Windows 95. We have looked at making the model run with a Windows–type interface, but that change is a little more difficult.

For "Who is TDI" we have uncovered some background on Richard Anderson, who provided the article in the last issue on the Butterfly Effect. Again, pictures of historians are rare, but if you look at the cover of this issue you will see a picture of one of his workstations.

The next issue will contain the article on our initial attempts to create a model of the Air Campaign. We will be publishing the results of our validation of the TNDM as a battalion–level model.

The sixth issue will focus on the modeling of tanks and armored warfare. This will include the article on the use of mines and fortifications at Kursk. We also have a set of tables prepared by Richard Anderson on the effects of artillery on tanks. They are quite startling. Also, we hope to have a cover article by Jay Karamales from his tank/antitank studies. His new book *Against the Panzers* is now a featured selection for the Military Book Club.

The first issue of the second year of publication will include an article written by Trevor N. Dupuy that was never before published called "Technology and the Human Factors in War".

I am still awaiting articles from outside TDI and eagerly check my mailbox in hope of finding one. I also haven't yet seen any well–considered criticism of the model. I will publish any that I see. I am also looking for any suggestions for improvement.

That is all for now. If you have any questions, please contact me. Addresses and phone numbers are in the masthead.

DEPARTMENT OF THE ARMY
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REPLY TO ATTENTION OF

ATCG-S

21 Jan 97

MEMORANDUM FOR

Mike Bauman, Director, TRADOC Analysis Center
Edgar Vandiver III, Director, USA Concepts Analysis Agency
John McCarthy, Director, US Army Materiel Systems Analysis Activity

SUBJECT: Validation

Enclosure states that "Validation of models is not being done, regardless of what the regulations say." If the statement is true, it seriously limits the applications of such models.

The enclosure discusses why this statement is made, so I won't repeat the supporting rationale. You may be aware of the arguments in the enclosure.

I understood that validation was required for all models, as it should be. If validation through comparisons with properly validated models, or combat, NTC, or test data is not being done, how do we ensure that users are aware of the limitations of the models, and how it is appropriate to use each model? The argument that models are implicitly validated by widespread use isn't valid.

Do we need to change the policy governing model validation? Should we ask MORS to review the status of validations, and make recommendations for improvement?

Would appreciate a response.

Paul

Enclosure

PAUL J. BERENSON
Scientific Advisor to the CG

DISTRIBUTION:
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Mr Hollis
Dr Davis
Dr Fallin
Mr Fisette
Mr Hartman
Mr Riente
Mr Fox
Mr LaRocque
Mr Resnick

8 December 1996

To: Dr. Paul Berenson, TRADOC
From: Chris Lawrence
Subject: Validation

Dear Dr. Berenson,

Back in the middle of 1994, I was involved in the issues of Validation, Verification and Assurance (VVA), partially because of my work with the Congressional Office of Technology Assessment (OTA) and partially because of my role as the creator of two historical validation databases. Although my opinions have changed slightly (but only slightly) on the subject, I will forward to you the material I generated at that time. They include:

1. Letter to Dr. Brian McCue (OTA) dated 22 June 1994 of 5 pages.
2. Internal memorandum to Trevor Dupuy dated 28 July 1994 of 2 pages addressing some of his disagreements with my letter to Dr. Brian McCue.

According to what I know, only the following validations have been done:

1. Atlas (using 1940 Campaign in the West)
2. Vector (using undocumented turning runs)
3. QJM (by HERO using WWII and middle-east data)
4. Dr. Janice Fain's model (using HERO data)
5. CEM (by CAA using Ardennes Data Base)
6. SIMNET/JANUS (by IDA using 73 Easting data)
7. By Dr. Ralph Tom using exercises
8. FTLM (by Martin-Marietta/Oak Ridge)
9. TWISP (Korean data)

I am being polite in calling some of these validations. The only two validations I put a lot of credence in is the QJM validation in the 1970's and the CEM validation using Ardennes data that was completed last year. The Atlas validation of the France 1940 campaign is rumored to have resulted in the France winning and the analysts concluded that history has no relevance for modern combat. I don't know how valid this rumor is. The Vector validation used undocumented tuning runs to make sure the data fit according to Dr. James Taylor of the Naval Post–Graduate school. He has the documentation on that. The SIMNET/JANUS test is very strange because in the battle they choose, one side could not see or hit the other side. This results in the battle being a one–sided live fire exercise. Even then, my conclusion from reading the report was that the model was not validated, but indeed was sorely in error on such basic items as SSPKs and ammunition expenditure. FTLM has not been validated at all, but was simply a verification that was decreed to be a validation in the introduction of the report, even though the body of the report says otherwise. I forget who and what is the background on TWISP, but of course, one cannot get accurate Korean War data for the opposing side. I need to research this one better. Dr. Janice Fain also did some validation effort on a combat model she was working on some time in the 70s and also Dr. Ralph Tom's validated his model of man–to–man combat in defending a nuclear storage facility by conducting a series of field exercises.

I did bounce this list by Paul Davis of RAND several months ago, and his was not able to add any other validations to the list. I know that certain major models have never been validated. This includes JTLS (Joint Theater Level Simulation), that is used down in your neck of the woods by the Joint Warfare Center. You may want to wander over there and check this out for yourself. Validation of models is not being done, regardless of what the regulations say. This requirement will not be followed until such time as it is enforced by a policeman with a very big stick.

If you have any more questions, please call me at (703) 356-1151.

Sincerely,
Christopher A. Lawrence
Executive Director

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22 June 1994

Dear Brian,

Thank you for the opportunity to attend the OTA review committee. I found the discussions on VVA to be particularly interesting. I found it frustrating that the panelists, who in some cases had clearly divergent views on the subject, neither stressed these views or debated the different points. There was actually nothing I would have liked to do more than leap into these discussions. As it would have been inappropriate for me to so, I remained quiet. But, over time, my thinking on the subject of VVA and the scientific process of combat modeling have clearly crystallized into a strong opinion that I would like to take this opportunity to express in writing for the first time.

Verification, Validation and Assurance (VVA):

1. VVA = QA. (Validation, verification and assurance equals quality assurance). In any production facility working on a government deliverable (say for example, General Dynamics Convair Division working on the cruise missiles), QA is an independent discipline with a very specific function. There are people specially trained for it, they are in a department under a separate vice-president, quite independent from the production and program personnel, and usually have some authority to review, approve, or reject the products being produced by the rest of the company. This QA function in large facilities is further supplemented hy an in-house DCAS representative who is also a QA spe-

cialist representing the government. One estimate I heard was that QA usually made up 15 of the cost of an engineering project.

The Verification part of VVA is simply that QA step, which currently does not systematically exist for modeling. Verification should be planned as a on-going effort in any major modeling project, should be done by personnel independent of the project, and should have adequate money set aside to conduct the verification. While there is no need to place a hard and fast budget figure for VVA nor certify VVA engineers, the Defense Department needs to establish the habit (culture?) of conducting an independent verification is for every major modeling effort. The requirement to do this and certain minimum goals or standards should be clearly spelled out in internal DOD regulations. As there is no use in having a rule without an enforcer, some office should be assigned responsibility to make sure that VVA is conducted for every major modeling effort.

2. Validation needs to be done for all major models that are used in any predictive mode. This certainly includes JANUS, CEM, JTLS etc. Models used to develop "intellectual insights" do not need to be validated, but should not be used for any other purpose. I cannot think of a single model that is used simply to develop "intellectual insight." Certainly any model that will be predicting war outcomes, or forecasting ammunition expenditures needs to be validated.

3. Validation must be done by or with the help of an independent organization. This organization's independence is more important for validation than it is for verification. During a verification effort, at least the "verifier" and the project personnel will usually have a common goal of making sure the work was done correctly. In a validation effort, there may be no common ground and widely different perceptions of what is correct.

4. For models forecasting combat results (casualties, ammunition expenditures, or whatever), they must be able to be validated to history in addition to any other validation tests that may be appropriate.

Amid all the discussions of high tech weapons, what is often overlooked is that most of the weapons currently used are either updated WWII type weapons, or linear descendants of such. The organizations employing those weapons are structurally and doctrinally linear descendants of the WWII US Army organizations, and the personnel using them are similar (and in some case direct descendants) of the people who used them in WWII. When doing a simulation of modern combat, the majority of the elements employed are similar and directly descendent from those elements used in WWII. As such, any model for future combat, if the high tech weapons are stripped out, should be an entirely adequate model of WWII combat. If such a model cannot model WWII combat with is low-tech weapons, then one must question its ability to model any combat. While being able to model the past does not prove that it can model the future, not being able to model the past raises serious question whether the model can model anything.

The other main objection I hear to using historical data for validation is that combat is stochastic and that a battle represents just one point on the curve of possibilities. This is a semantic argument that is not looking deep enough into the subject.

Let us assume for a moment that the actions of any one person is unpredictable. If these people behave with any patterns, any norms or any societal conditioning, then there will be norms and patterns of behavior that will appear across most groups of people. Combat is conducted with groups of these people. If I have 10,000 people in a unit, these groups of people should behave in some definable patterns. Even if the patterns are weak, the sheer size of the samples should provide a bell-curve of possible results, and a range of expected results. If I have 10,000 of these unpredictable people engage 1,000 opposing unpredictable people, the difference in the ratios should alone produce a result that is different than pure chance.

If I give these people a little training, a little target practice, organize them in units, provide them with a doctrine, then their unpredictability declines considerably. If fact, I would expect that while I still could not predict the actions of individuals, nor those of their commanders, if a placed them in combat against 10,000 untrained unpredictable people, I would more often than not get an expected result.

While one cannot rule out the role of the individual in combat, especially as a commander, and while one cannot rule out the occasionally significant and unpredictable events, on most days with most units, you can expect a predictable result from combat. With large numbers of individuals, combat is deterministic with stochastic elements. This is considerably different than considering combat stochastic.

As you know, I have been in charge of assembling one data base of the Ardennes Campaign for the US Army Concepts Analysis Agency and am currently program manager for the second campaign data base to be assembled for them on the Battle of Kursk. In your viewgraphs presented today, you summarized the stochastic argument against validation as "N=l." As best as I can understand the argument (and in all honestly, I neither understand nor appreciate this argument), there is no value in validating a model to a historical campaign because there is only one known outcome out of many possible ones. I can only project from this argument that the person would only find a historical validation useful if we validated the model to a statistically significant sample of hundreds of campaigns.

But, an engagement consists of large numbers of men involved on each side. This aggregated data (the engagement) is repeated multiple times in a division in a day. This probably makes the division versus division battles somewhat deterministic. In the campaign data bases I have assembled, the division has been the basic unit that is "tracked" in the data base. In the case of the Ardennes Campaign Simulation Data Base, there are 79 divisions involved

ing combat over 30 days. Assuming that one division faces its equivalent to two-sided combat, then the data base has around 2,200 division days of combat to build the "probability curve" out of. This creates a number far larger than "N=l". For the Kursk data base, I estimate when it is complete there will be another 1,000 division days to work from, in addition to a large number of independent regiments and brigades. There are also other historical data bases to draw from besides these two. So in addition to validating the model to the data base, you also validate it to the individual combats, the aggregated combats and the means and modes of selected combats under selected conditions. In the case of the two campaigns, they were both fairly one sided. I would be surprised if any model would have the Germans roaring across the Meuse and on towards Brussels or the Germans slicing through the mass of Soviet units and penetrating to Oboyan, let alone all the way to Kursk. In both of these campaigns, the "N=l" result that came about was pretty much what you would expect given the starting forces.

5. Finally, probably the best way to execute effective VVA is to establish a separate agency within DOD (or each service) in charge of assisting in VVA efforts for all major models in the armed forces (or its individual service). This agency should be manned with people knowledgeable in the field and should be organizationally separate from any command producing or relying on models.

One of the problems involved in validating any model is that considerable time is required to learn the model, and some time is required to run it. As the experts are the people who designed it, and often they are the only ones knowledgeable to run it, than all VVA efforts should be a cooperative effort using a mixed staff of people from the VVA agency and the actual modelers who designed it. Needless to say, the report or analysis of the validation effort should be produced by the VVA Agency, vice the operating agency.

I doubt anything less than this will produce effective validation. The issue of validation has been discussed in the industry now for at least 20 years. To date, I only know of two validation efforts (both US Army). One appears seriously flawed and the other one I do not have the ability to validate (even though it used the Ardennes Data Base that I helped to assemble). Neither were done by an independent agency from the model's regular user. There is a point that to get anything done, one must quit discussing the details of how it should be done, and simply assign someone to do it, and give them the authority and resources to go forward.

6. I have no comments on the subject of assurance.

THE SCIENTIFIC METHOD AND MODELING:

1. The fundamental problem with the models being built for the purpose of forecasting is that no one has ever systematically assembled and analyzed the data on combat. Therefore, we don't know what really happens and what is really true. Even "sciences" as soft as economics have a "Law of Supply and Demand" (although it is certainly not a "law"). Military science does not know for certain if morale is to material as three is to one. Although most serious students realize this is probably true, it has neither been proven nor measured. The same for "defense is the stronger form of combat", the effects of suppression, the causes of breakpoints, the degradation effects of the combat environment, etc. None of the basic pieces that make up a model have been systematically proven or measured.

2. The models therefore are not built upon any established, accepted and provable pieces of data. In effect, all models are simply somebody's assumptions, guesses and judgements, that have been quantified and buried in computer code.

3. There is no lack of data to work from. It is complex, hard to assemble, and time-consuming to assemble and analyze (read "expensive"). But data does exist on combat, combat operations and the effects of combat, and exists in large amounts, although not always in the form that the user desires.

4. Combat data is difficult to analyze. It has a wide range of variability, has stochastic elements to it, has a very high number of significant independent variables, and those "independent" variables often cross correlate with each other. It is a very complex problem, probably more difficult to solve than sending a man to the moon.

5. To develop a base from which to build combat models from requires some form of understood norms, hypotheses and theories established and supported by data. To attempt to build a model without such a base is nothing less than quantifying opinion.

6. To build such a base requires "pure research" or "pure science". In the practical world, these means that some agency needs to fund one or more groups to assemble the large amount of data required to analyze this complex problem. This data needs to then be analyzed by one or more groups (the same or different groups) to identify patterns and norms. They may even be able to support such notions as "moral is to material as 2.76 is to 1".

7. To conduct such research required a steady multi-year funding effort among one or more research groups for the purpose of having them discover anything that is discoverable from this data. This large effort would eventually over time and repeated testing, determine what is knowable. What is then knowable could be incorporated in the model designs, reducing the judgement and increasing the quality.

Sincerely,
Chris Lawrence

28 July 1994

To: Trevor
From: Chris
Subject: VVA

1. Thanks for taking a look over my write-up. I will probably have one on John Kettelle's paper, which I found very interesting, in a couple of more days.

2. To clarify a point, I do not feel that validation is more important than verification. I just realize that the resistance to validation in the community will be much higher than the resistance to verification. In fact, I suspect most organizations will set up a verification program, label it "VVA" and claim that they have taken care of all validation, verification and assurance.

3. There is considerable resistance to validation within the community. I have encountered it in CAA and heard similar arguments put forward at the OTA meeting. While there may be some intellectual validity to their arguments (although I have yet to see any), and they may sincerely believe in what they say, the result of their arguments is to torpedo any validation efforts.

4. There are already software quality assurance (QA) procedures, software documentation standards, and software configuration management standards. These, if properly implemented, make it possible to do the verification of the software within the models. Any really good software QA process should also determine whether or not the software does what it was written to do. This is the essence of verification. The problems of verification can be solved by using established industry QA procedures. I suspect, as many of these models are made by "paper shops" and FFRDC's, they are not used to operating under a formal QA system the same way as hardware manufacturers are, and therefore this is not being done.

5. If an organization has a good internal, aggressive, independent QA organization, then verification should not be a problem. It is in the long term interest of the program managers, model designers, and the QA people to conduct the verification properly. Of course, it may not be in their short-term interest (schedule and budget!). But validation must be conducted by an outside and independent agency, for if the model is really bad, it is not in interest of the using or designing organization to confirm this.

6. So, it is not that I consider validation more important, but it is just that the only way to get a proper validation program going will be to create an independent agency for such. Socrates' "gadfly" as it is. An independent agency to do verification is not necessary, although it would be helpful. The real danger is that these organizations will set up verification efforts disguised as VVA and effectively bury the very necessary validation efforts that should be done.

7. As for Brian, I would recommend that you write him. I believe Dr. McCue is already aware of my opinions. I think I discussed it with him several years ago. I suspect he also knows your position. Finally, I suspect that his position is not far from ours, if he is not already in agreement. The real question for him is whether an OTA report is the proper forum to raise this issue. My recommendation to him would be to add an appendix to the OTA report (perhaps to Linda Voss' paper) detailing the reasons, recommendations, and how a truly independent VVA agency would be established. If OTA wishes to pursue such an recommendation, than it would probably be useful to obtain support and signatures from other people within the community.

8. If an OTA report is not the proper forum, than perhaps you should prepare an independent "report" for Congress, obtaining support and signatures from other major names in the community.

9. I'll probably provide a copy of this memo to Brian and Linda Voss.

Military History and Validation of Combat Models

A Presentation at MORS Mini–Symposium on Validation, 16 Oct 1990

by Trevor N. Dupuy

In the operations research community there is some confusion as to the respective meanings of the words "validation" and "verification." My definition of validation is as follows:

"To confirm or prove that the output or outputs of a model are consistent with the real-world functioning or operation of the process, procedure, or activity which the model is intended to represent or replicate."

In this paper the word "validation" with respect to combat models is assumed to mean assurance that a model realistically and reliably represents the real world of combat. Or, in other words, given a set of inputs which reflect the anticipated forces and weapons in a combat encounter between two opponents under a given set of circumstances, the model is validated if we can demonstrate that its outputs are likely to represent what would actually happen in a real-world encounter between these forces under those circumstances.

Thus, in this paper, the word "validation" has nothing to do with the correctness of computer code, or the apparent internal consistency or logic of relationships of model components, or with the soundness of the mathematical relationships or algorithms, or with satisfying the military judgment or experience of one individual.

True validation of combat models is not possible without testing them against modern historical combat experience. And so, in my opinion, a model is validated only when it will consistently replicate a number of military history battle outcomes in terms of: (a) Success-failure; (b) Attrition rates; and (c) Advance rates.

"Why," you may ask, "use imprecise, doubtful, and outdated history to validate a modern, scientific process? Field tests, experiments, and field exercises can provide data that is often instrumented, and certainly more reliable than any historical data."

I recognize that military history is imprecise; it is only an approximate, often biased and/or distorted, and frequently inconsistent reflection of what actually happened on historical battlefields. Records are contradictory. I also recognize that there is an element of chance or randomness in hurnan combat which can produce different results in otherwise apparently identical circumstances. I further recognize that history is retrospective, telling us only what has happened in the past. It cannot predict, if only because combat in the future will be fought with different weapons and equipment than were used in historical combat.

Despite these undoubted problems, military history provides more, and more accurate, information about the real world of combat, and how human beings behave and perform under varying circumstances of combat, than is possible to derive or compile from any other source. Despite some discrepancies, patterns are unmistakable and consistent. There is always a logical explanation for any individual deviations from the patterns. Historical examples that are inconsistent, or that are counter-intuitive, must be viewed with suspicion as possibly being poor or false history.

Of course absolute prediction of a future event is practically impossible, although not necessarily so theoretically. Any speculations which we make from tests or experiments must have some basis in terms of projections from past experience.

Training or demonstration exercises, proving ground tests, field experiments, all lack the one most pervasive and most important component of combat: Fear in a lethal environment. There is no way in peacetime, or non-battlefield, exercises, tests, or experiments to be sure that the results are consistent with what would have been the behavior or performance of individuals or units or formations facing hostile firepower on a real battlefield.

We know from the writings of the ancients (for instance Sun Tze—pronounced Sun Dzuh—and Thuycidides) that have survived to this day that human nature has not changed since the dawn of history. The human factor the way in which humans respond to stimuli or circumstnces is the most important basis for speculation and prediction. What about the "scientific" approach of those who insist that we can have no confidence in the accuracy or reliability of historical data, that it is therefore unscientific, and therefore that it should be ignored? These people insist that only "scientific" data should be used in modeling.

In fact, every model is based upon fundamental assumptions that are intuitive and unprovable. The first step in the creation of a model is a step away from scientific reality in seeking a basis for an unreal representation of a real phenomenon. I have shown that the unreality is perpetuated when we use other imitations of reality as the basis for representing reality. History is less than perfect, but to ignore it, and to use only data that is bound to be wrong, assures that we will not be able to represent human behavior in real combat.

At the risk of repetition, and even of protesting too much, let me assure you that I am well aware of the shortcomings of military history:

The record which is available to us, which is history, only approximately reflects what actually happened. It is incomplete. It is often biased, it is often distorted. Even when it is accurate, it may be reflecting chance rather than normal processes. It is neither precise nor consistent. But, it provides more, and more accurate, information on the real world of battle than is available from the most thoroughly documented field exercises, proving ground tests, or laboratory or field experiments.

Military history is imperfect. At best it reflects the actions and interactions of unpredictable human beings. We must always realize that a single historical example can be misleading for either of two reasons: (1) The data may be inaccurate, or (2) The data may be accurate, but untypical.

Nevertheless, histoy is indispensable. I repeat that the most pervasive characteristic of combat is fear in a lethal environment. For all of its imperfections, military history and only military history represents what happens under the environmental condition of fear.

Unfortunately, and somewhat unfairly, the reported findings of S.L.A. Marshall about human behavior in combat, which he reported in *Men Against Fire*, have been recently discounted by revisonist historians who assert that he never could have physically performed the research on which the book's findings were supposedly based. This has raised doubts about Marshall's assertion that 85% of infantry soldiers didn't fire their weapons in combat in World War II. That dramatic and surprising assertion was first challenged in a New Zealand study which found, on the basis of painstaking interviews, that most New Zealanders fired their weapons in combat. Thus, either Americans were different from New Zealanders, or Marshall was wrong. And now American historians have demonstrated that Marshall had had neither the time nor the opportunity to conduct his battlefield interviews which he claimed were the basis for his findings.

I knew Marshall, moderately well. I was fully as aware of his weaknesses as of his strengths. He was not a historian. I deplored the imprecision and lack of documentation in *Men Against Fire*. But the revisionist historians have underestimated the shrewd journalistic assessment capability of "SLAM" Marshall. His observations may not have been scientifically precise, but they were generally sound, and his assessment has been shared by many American infantry officers whose judgements I also respect. As to the New Zealand study, how many people will, after the war, admit that they didn't fire their weapons?

Perhaps most important, however, in judging the assessments of SLAM Marshall, is a recent study by a highly-respected British operations research analyst, David Rowland. Using impeccable OR methods Rowland has demonstrated that Marshall's assessment of the inefficient performance, or non-performance, of most soldiers in combat was essentially correct. An unclassified version of Rowland s study, "Assessments of Combat Degradation" appeared in the June 1986 issue of the *Royal United Services Institution Journal*.

Rowland was led to his investigations by the fact that soldier performance in field training exercises, using the British version of MILES technology, was not consistent with historical experience. Even after allowances for degradation from theoretical proving ground capability of weapons, defensive rifle fire almost invariably stopped any attack in these field trials. But history showed that attacks were often in fact, usually successfu1. He therefore began a study in which he made both imaginative and scientific use of historical data from over 100 small unit battles in the Boer War and the two World Wars. He demonstrated that when troops are under fire in actual combat, there is an additional degradation of performance by a factor ranging between 10 and 7. A degradation virtually of an order of magnitude! And this, mind you, on top of a comparable built-in degradation to allow for the difference between field conditions and proving ground conditions.

Not only does Rowland's study corroborate SLAM Marshall's observations, it showed conclusively that field exercises, training competitions and demonstrations, give results so different from real battlefield performance as to render them useless for validation purposes.

Which brings us back to military history. For all of the imprecision, internal contradictions, and inaccuracies inherent in historical data, at worst the deviations are generally far less than a factor of 2.0. This is at least four times more reliable than field test or exercise results.

I do not believe that history can ever repeat itself. The conditions of an event at one time can never be precisely duplicated later. But, bolstered by the Rowland study, I am confident that history paraphrases itself.

If large bodies of historical data are compiled, the patterns are clear and unmistakable, even if slightly fuzzy around the edges. Behavior in accordance with this pattern is therefore typical. As we have already agreed, sometimes behavior can be different from the pattern, but we know that it is untypical, and we can then seek for the reason, which invariably can be discovered.

This permits what I call an actuarial approach to data analysis. We can never predict precisely what will happen under any circumstances. But the actuarial approach, with ample data, provides confidence that the patterns reveal what is to happen under those circumstances, even if the actual results in individual instances vary to some extent from this "norm" (to use the Soviet military historical expression.).

It is relatively easy to take into account the differences in performance resulting from new weapons and equipment. The characteristics of the historical weapons and the current (or projected) weapons can be readily compared, and adjustments made accordingly in the validation procedure.

In the early 1960s an effort was made at SHAPE Headquarters to test the ATLAS Model against World War II data for the German invasion of Western Europe in May, 1940. The first excursion had the Allies ending up on the Rhine River. This was apparently quite reasonable: the Allies substantially outnumbered the Germans, they had more tanks, and their tanks were better. However, despite these

Allied advantages, the actual events in 1940 had not matched what ATLAS was now predicting. So the analysts did a little "fine tuning," (a splendid term for fudging). After the so-called adjustments, they tried again, and ran another excursion. This time the model had the Allies ending up in Berlin. The analysts (may the Lord forgive them!) were quite satisfied with the ability of ATLAS to represent modern combat. (Or at least they said so.) Their official conclusion was that the historical example was worthless, since weapons and equipment had changed so much in the preceding 20 years!

As I demonstrated in my book, *Options of Command*, the problem was that the model was unable to represent the German strategy, or to reflect the relative combat effectiveness of the opponents. The analysts should have reached a different conclusion. ATLAS had failed validation because a model that cannot with reasonable faithfulness and consistency replicate historical combat experience, certainly will be unable validly to reflect current or future combat.

How then, do we account for what I have said about the fuzziness of patterns, and the fact that individual historical examples may not fit the patterns? I will give you my rules of thumb:

a. The battle outcome should reflect historical success-failure experience about four times out of five.

b. For attrition rates, the model average of five historical scenarios should be consistent with the historical average within a factor of about 1.5.

c. For the advance rates, the model average of five historical scenarios should be consistent with the historical average within a factor of about 1.5.

Just as the heavens are the laboratory of the astronomer, so military history is the laboratory of the soldier and the military operations research analyst. The scientific basis for both astronomy and military science is the recording of the movements and relationships of bodies, and then analysis of those movements. (In the one case the bodies are heavenly, in the other they are very terrestrial.)

I repeat: Military history is the laboratory of the soldier. Failure of the analyst to use this laboratory will doom him to live with the scientific equivalent of Ptolomean astronomy, whereas he could use the evidence available in his laboratory to progress to the military science equivalent of Copernican astronomy.

The Problems of Validating Models to Other Models or to Test Data

by Christopher A. Lawrence

In his letter, Dr. Berenson refers to "...validation through comparisons with properly validated models, or combat, NTC or test data..." Obviously the best thing to validate a model to is current combat data. For many reasons, this is often not possible or practical. Therefore, people have looked at validating models by other methods. These other methods have problems that are often overlooked or not fully appreciated. They include validating to a properly validated model, NTC, or test data. Dr. Berenson very correctly states that the "argument that models are implicitly validated by widespread use isn't valid." I had heard rumors that people have seriously proposed this idea in MORS meetings. I assume the idea has died a natural and deserved death.

Let me preface my comments with the statement that my intersection with the modeling community is only in the area of force–on–force models. Much of what I say may not be relevant for other types of models.

Validating a model to another model makes little sense except as an expedient to save time and money. If I have validated the "properly validated model" to data, then why not just use that same data to validate the next model? An intermediary is not needed and could only serve to confuse the issue. We can probably assume that no combat model will ever validate perfectly. It will never match combat data point by point. This means there will be a certain amount of random error compared to the real world, and most likely there will be areas in which the model will tend to under–predict and areas in which the model will tend to over–predict. But if it is in the ball park, then it is validated. But when you validate one model to another, it may make errors in the same direction as those your baseline model is making, indicating a higher degree of fit to the real world data than actually exists. It may also make errors in the opposite direction. In the case where the validated model was over–predicting and the model to be validated was under–predicting (or vice versa), both models could be in the ball park, but the validation would show the second model significantly in error to the first.

Furthermore, some models certainly make counterbalancing errors, where the over–prediction in one error is countered by the under–prediction in another, resulting in a good final output. A good validation effort needs to be more than a simply pass/fail test. If the model to be validated to is being compared to other parts of the other model (say a tactical model is being compared to the tactical part of a model that does tactical and operational combat), then this can also cause problems with the veracity of the validation.

Finally, of course, if the model you are trying to validate is differing from the data being validated to, the problem can always be with the validation data. If you are validating to another model, then you are left with no choice but to go back to the original data anyway.

I personally know of no models that have been validated to other models. I would be interested in knowing of anyone who has done this, why they did this, and why they didn't use the original validation data.

While validation of a combat model to National Training Center (NTC) data may look reasonable on the surface, is not always the best. Training is not combat. In combat, the primary goal of many of the soldiers is to survive the experience. In training, surviving the experience is not an issue. Quite simply, you do not lose much if you "die" during a training exercise. This is very different from the real world. In combat, people will be far more cautious, for more concerned that they are covered and concealed, far less willing to advance, hastier in some actions, in some cases panicky. Training exercises will have higher rates of fire, more accurate fire, faster movement, quicker combat resolution and many other differences from real combat. As discussed in the work of David Rowland, these differences can be by a factor as much as 7 to 10 times to what would occur in a true combat environment. As such, any model validated to a training exercise is likely to produce casualties and advance rates that are simply too high by an order of magnitude.

I do know of one validation to a "training" exercise. Dr. Ralph Toms, formerly of Lawrence Livermore Laboratory, was developing a model of man–to–man combat to determine the minimum and optimum number of people to defend a storage facility. The number of defenders was 20 people or less. To validate his model, he actually took a recently evacuated facility that still had its standard guard team, and had it assaulted multiple times by a small special forces team. As a result of this validation exercise, he revised the model to serve as a better tool for his analysis. An interesting outcome of this validation is that the model as designed moved everyone about twice as fast as they did in the real world. This was because people within a model don't loiter, peek around corners, stop and adjust the straps on their packs, or slow to a walk when not moving in the open.

For the intended use of the model, which was to compare different defensive arrangements of storage facilities, this a good validation for the limited purposes for which the model is to be used. If one started to mutate this model into some form of small unit combat model, then it would have to be validated to some combat data. Ideally, this model should have been validated to combat data, but it would be extremely difficult to get the second–by–second combat data

that would be needed for such a model. But it could be tested to a well–documented commando operation at a more macro–level, like the raid on St. Nazaire, looking at the raid in 15 minute snapshots.

One interesting aspect of the validation is that by using field exercises, he was able to do multiple iterations of the "battle" to compare to the multiple iterations of the model. Of course, as a field exercise is still only a model of a battle, then you are basically still comparing a model to a model, albeit with a model that is clearly closer to the real world of combat.

Validating a combat model to test data has all the problems of validating a model to a training exercise, plus some. At least in a training exercise some of Clausewitz's friction in warfare appears (although not all). In a test environment, most of the friction in warfare will disappear. Unless the model is being used for some limited weapons comparison purposes, you are now validating a model against data that is only peripherally connected to the real world of combat.

Models designed from test data have even a greater potential for error from real world casualty rates. This means that for the model to be used for forecasting (and yes, Virginia, many models are used for forecasting), some type of severe dampening effect has to be designed into the model. I gather that many of the US Army models designed from AMSAA data have embedded this dampening effect somewhere in their code or design. How this dampening effect was derived, from what studies it came, and how it has been quantitatively measured, remain a mystery to me. I gather it is based on "expert" judgement.

Since receiving Paul Berenson's letter, two other validations methods have been brought to my attention. One is validation to expert judgement. My first thought is that if the experts could produce such great judgement, then why not just ask the experts to start with, and dispense with the models. It would certainly save a lot of money. But again, if one were using the models for training, and the goal and the use of the model was to create a realistic training environment, then an expert (meaning a combat veteran) would certainly be the person that could provide confirmation that it "feels right." Beyond that use, I am a little mystified as to when you would ever want to use "expert" judgement for validation. The other danger of expert validation is that the experts are simply brought in to sprinkle holy water on the effort without getting into the actual details of the model. Validation by expert judgement doesn't sound much different than "...models are implicitly validated by widespread use..."

The final and most intriguing validation methodology is the rumor I've heard that the SOTACA model was validated to the commercial wargame *Desert Fox*.

"Model Creep" and Model Accreditation

by Christopher A. Lawrence

In 1994, when I was preparing my memo on validation, I had never been involved in an accreditation issue, so I had no understanding nor interest in the subject. This has changed as a result of our using the TNDM for the Bosnia study.

As part of our forecast of potential US casualties in Bosnia, we modeled a deployment scenario and estimated the casualties based upon this scenario. This effort was headed by John Kettelle. Some of the scenarios that we were considering were up to brigade–level attacks on US positions. For our combat resolution, we used the TNDM. The TNDM had been used for battalion–level and company–level combat before, but this was the first time I had been involved in its use for such. After a discussion with Richard Anderson, I began to worry that we were using the model beyond it designed parameters. This led me to look into the use of the TNDM as a battalion–level model.

The TNDM was designed to model battalion– and company–level combat, but it was never tested or validated for such. In effect, it could do it, but we had no basis for knowing if it could do it right. The model had been validated to divisional–level combat and its use at a much lower level of combat had never been systematically tested (although it was not entirely untested). Fundamentally, this is the accreditation issue.

The danger here is "model creep," which is something like mission creep. A group of smart people design a model for a specific purpose, assemble data for that effort, test it, maybe even validate it, use it, and eventually get comfortable with it. They then start finding other subjects that the model can address until the model starts being used for something other than what it was originally designed for. As this can occur over a period of time, and often long after the original designers have moved onto greener pastures, the model may be creeping out of its validated use without the real awareness of the users. I can honestly state that this was what we were starting to do with the TNDM. I know that this has occurred elsewhere.

I believe the official definition of accreditation is "an official determination by management that an M&S is acceptable for a specific purpose." In the real world, especially in the commercial part of the real world, a significant part of the manager's job is to sell the organization's next job. As you must sell to eat, and usually eating takes priority over more mundane issues like the intellectual validity of your work, then "model creep" can become a major issue.

I particularly worry about it in the context of distributed interactive systems. The industry is starting to cobble together complex simulations using unrelated component parts to do new and better things. While these unrelated parts may indeed all be validated (although this is not always the case), the sum total of this effort, and the new purposes for which it is used for, also need to validated.

The 76 Battalion–Level Engagements

by Dave Bongard

The concept of "battalion–level engagement" has been employed relatively loosely here. As far as this list is concerned, a battalion–level engagement involves a force of no more than one reinforced battalion on one side, and a roughly comparable force on the other (ranging from a minimum of one company (+/-) to a maximum of one brigade/regiment). Broadly speaking, this produces manpower totals of 150 to 6,000.

The winning side or force is in italic boldface. An engagement with no indicated winner is a draw.

World War I

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Adv	Sc
Yvonne-Odette	4/13/18	StGr Grethe	3072	71	I&L/9 IRgt	650	71	3.5	0.00	T
Cantigny	5/28/18	***28th Irgt***	8679	300	II/272 IR	725	386	2	1.60	T
Hill 142	6/6/18	***5 Mar Rgt (-)***	2913	383	II/273 IR (+)	2458	471	8	0.90	T
West Wd I	6/6/18	3/5 Mar (-)	1740	361	***I/461 IR***	1121	54	6	0.00	T
Bourschs I	6/6/18	6 Mar Rgt (-)	2753	343	II/461 IR	1352	186	6	1.00	T
West Wd II	6/11/18	***2/5 Mar (+)***	3349	279	I/461 IR (+)	1798	541	12	1.60	T
N Wood I	6/12/18	***3/5 Mar (+)***	1740	167	II/110 GrR	1952	293	12	0.80	T
Bourschs II	6/13/18	109 IR (-/+)	3690	138	***3/5 Mar (+)***	2629	107	3	0.00	T
N Wood II	6/21/18	1/7 IR	1697	192	***III/347 IR (+)***	1428	18	4.5	0.00	T
N Wood III	6/23/18	3/5 Mar (+)	1256	133	***I/347 IR***	1565	19	4	0.00	T
N Wood IV	6/25/18	***3/5 Mar (+)***	4453	273	I/347 IR	1546	437	11	0.70	T
St. Amand F	7/18/18	***2/28 IR (+)***	1150	120	II/396 IRgt	400	400	2	2.00	T
Beaurpre F	7/18/18	***2/23 IR (+)***	4480	125	III/219 IR	565	181	4	2.50	T
Chaudun	7/18/18	***3/18 IR (+)***	1611	130	II/109 BGrR (+)	800	500	12	3.50	T
Berzy le Sec	7/21/18	***28 IR (-/+)***	4000	210	109 IR (-/+)	325	116	3.75	3.50	T
Bouzancy Rdg	7/21/18	***18 IR (-/+)***	5300	350	II/52 JgrR	554	276	4	1.50	T
Medeah Far	10/3/18	***2/9 IRgt***	1921	247	I/235 ResIR	155	83	2	3.10	T
Essen Hook	10/3/18	***1/5 Mar (+)***	1420	140	2/KolnLSAbt	216	120	5	0.10	T
Exermont-M	10/4/18	***18 IR (+)***	5336	352	elm 3 GdIR (+)	3270	193	14	2.10	T
Mayache R	10/4/18	***26 IR (+)***	5427	376	II/170 IR (+)	1899	114	14	1.30	T
La Neuville	10/4/18	***28 IR (+)***	5365	340	I/111 IR (+)	1940	61	12	1.60	T
Remilly-Aillicourt	11/6/18	***1/16 IR***	1210	25	6 ResJgrBn (+)	296	30	12	1.00	T
Hill 252	11/7/18	***16 IR (-/+)***	1989	110	14 Res ID (-)	1655	182	8	2.90	T

World War II

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Adv	Sc
Wake II	12/23/41	***SNLF (+)***	1500	120	det 1 MDBn	430	85	7	1.25	T
Makin Raid	8/17/42	***2 MarRdrBn (-***	221	40	1 co (-)	90	83	4	2.50	T
Tenaru R I	8/25/42	Ichiki Force	910	250	***2/1st Mar***	920	60	9	0.00	T
Tenaru R 2	8/25/42	***1&2/1st Mar***	1823	48	Ichiki Force	664	541	8.5	3.60	T
Edson's Rdg	9/13/42	Kawaguchi Frc	3500	600	1 MarRBn (+)	920	263	12	2.00	T
Chouigui Pass	11/26/42	190 Pz Bn	465	30	***1/1/1 AD***	188	24	6	0.00	T
Mte Maggio	12/2/43	***36 Inf Div (-)***	5551	40	15 PGD & 29 PzD	3288	15	48	2.40	Q
Engebi Is	2/18/44	***22 MarRgt (-)***	4125	303	1st AmBde (-)	1276	1240	24	2.80	T
Eniwetok	2/19/44	***106 IRgt (-/+)***	2605	202	1st AmBde (-)	1350	449	23	1.10	T
Lausdell XRds	12/17/44	KG Müller	3300	550	1/9 Inf (+)	600	400	5.75	0.75	T
Assenois	12/26/44	***CCB/4 AD***	1800	80	FusAbt 26 (+)	650	470	5	8.50	T
VER7BWx	2/8/45	***7 BW/51 ID***	850	33	1 co/84 ID	150	12	6	1.00	T
VER57Gx	2/8/45	***5/7 Gordons***	740	35	1.5 cos/84 ID	200	12	6	1.70	T
VER1BWx	2/8/45	***1 Black Watc***	740	22	1.5 cos/84 ID	220	18	12	2.75	T
VER1HLx	2/8/45	***1 HLI/53 ID***	740	14	1 F Co/84 ID	150	15	12	5.70	T
VER4RWx	2/8/45	***4 R Welch Fu***	740	20	1 F Co/84 ID	150	10	12	4.00	T
VER1OBx	2/8/45	***1 Ox&Bucks***	740	11	1 F Co/84 ID	150	12	12	9.00	T
VER1GHx	2/8/45	***1 GH/15 ID***	740	21	1 F Co/84 ID	150	12	6	12.90	T
VER9Cx	2/8/45	***9 Cameronian***	722	41	2 F Cos/84 ID	154	12	6	12.25	T
VER2ASx	2/8/45	***2 A&S Hlndrs***	740	46	2.5 F Cos/84 ID	370	26	12	5.30	T
VERXHLx	2/8/45	***10 HLI***	740	42	2.5 F Cos/84 ID	370	25	12	9.20	T
VERRDMx	2/8/45	***RdM/2d C ID***	740	20	1 F Co/84 ID	130	12	12	5.40	T
VERCHx	2/8/45	***Cal Hlndrs***	740	88	3 F cos/84 ID	400	58	12	4.80	T

see notes, next page

Post-1945

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Adv	Sc
Tu-Vu	12/9/51	***312 VMD (-/+)***	7000	1200	2 Mor cos (+)	420	250	12	2.80	T
Ninh Binh	6/29/54	***elms GM.2***	850	26	VM bn TF	475	283	6	3.00	Q+
Cau Lanh	8/28/63	***AR/CIDG TF***	500	3	VC company (-)	60	36	8	1.50	Q+
Cai Nuoc	9/10/63	***VC 306 IBn***	500	16	ARVN co TF	150	60	1	1.25	Q+
ZDB050	9/10/63	***Sct/42 IR***	100	1	VC company	120	49	1	1.00	Q+
Mapu	4/27/66	Indo. Bn	200	53	***B/2/Para***	75	7	2	0.00	Q+
Long Tan	8/18/66	VC force	1500	700	***6 RoyAusRgt (+)***	900	39	6	0.00	Q+
Hill 450	11/10/66	***2/502 IBn***	850	51	NVA 5/95 IRgt	214	142	12	2.50	Q+
PrekKlok 1	2/28/67	VC Bn TF	500	292	***B/1/6th Inf***	164	53	4	0.00	Q+
PrekKlok 2	3/10/67	VC 272 IR (-)	1000	354	***2/2 (+), 1 ID***	1600	41	3	0.00	Q+
Buell II	3/10/67	NVA 273 IR	2800	553	***3/22 (-), 25 ID***	400	27	3	0.00	Q+
ApBauBang 2	3/19/67	VC 2726 IR	900	403	***A/3/5 Cav***	150	66	8	0.00	Q+
Bir Gifgafa 1	6/8/67	***Eg 4 ArmdD***	3500	150	Is Tal Div	2000	50	2	1.50	Q
Bir Gifgafa 2	6/8/87	***elm Tal Div***	3030	10	Eg 4 Armd Div	3350	300	1	3.00	Q
Lo Giang 1	2/2/68	NVA co TF	350	136	***B/1/6th Inf***	120	32	1	0.00	Q+
Lo Giang 2	2/3/68	***1/6 Amcl ID***	500	47	NVA bn TF	800	403	4	2.50	Q+
Nui Ba Den	8/18/68	VC force	400	32	***elm 25 ID***	180	28	2	0.00	Q+
Mt Hermon I	10/8/73	Is Gol. Bde	2697	50	***Syr Para Bde***	1583	100	20	0.00	Q
Goose Green	5/28/82	***2/Para Rgt***	548	51	12 IRgt (+)	1324	200	15	10.50	T
Mt Harriet	6/11/82	***42 RMCdo***	660	12	4th IR (-)	400	325	8	3.50	T
Two Sisters	6/11/82	***45 RMCdo***	711	14	B, Svc/4th IR	400	53	4	3.00	T
Mt Longdon	6/11/82	***3/Para Rgt***	560	70	B/7 IRgt (+)	300	200	9	2.80	T
Tumbledown	6/13/82	***2/Scots Gds***	696	52	5th Mar Bn (+)	900	100	11.25	3.50	T
Wireless R	6/13/82	***2/Para Rgt***	660	14	7th Inf R (-)	650	60	8	3.50	T
Salinas	10/25/83	***US Rangers***	600	20	Cubans/GARM	754	220	12	4.00	T
Pearls AF	10/25/83	***USMC BLT***	500	2	Gren Militia	35	5	4.5	3.60	T
Lomba	3/10/87	***61 Mcz Bn***	1199	9	FAPLA 47 Bde	2264	120	24	0.50	T
Cuatir River	1/13/88	***RSA 20 Bde***	2706	23	FAPLA 21 Bde	2329	150	26	2.00	T
Lipanda	2/14/88	***4 SAI Rgt***	1213	2	FAPLA 59 Bde	2263	300	6	16.00	T
TF Bayonet	12/20/89	***5 Mcz Div TF***	3620	70	Panama NG	2300	94	45	3.00	T

Tu-Vu is described in some detail in Fall's *Street Without Joy* (pp. 51–53). The remaining Indochina/SE Asia engagements listed here are drawn from a QJM–based analysis of low–intensity operations (HERO Report 124, Feb, 1988).

The engagements listed here comprise 23 from World War I, 23 from World Was II, and 30 post–1945 battles, for a grand total of 76 engagements.

The coding for source and validation status, on the extreme right of each engagement line, is as follows. A "Q" (3 total) indicates an engagement which was part of the original QJM database, while a "Q+" (14 total) mark engagements which were analyzed as part of the QJM low–intensity combat study in 1988, and have recently been re–run with the TNDM. Finally, a "T" marks an engagement analyzed solely with the TNDM (57 total).

The 112 Battalion–Level Engagements

by Dave Bongard

The engagements listed below are "candidates" for TNDM analysis for validation of the TNDM for battalion-level actions.

This list (so far) provides 17 engagements from World War I, 7 interwar engagements, 20 from World war II, and 69 post-1945. The "Nicaraguan" engagements from the late 1920s involve 1–3 companies on each side, including both Marines and Nicaraguan government forces for the "good guys."

World War I era

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Front	Advance
Nuatja, T	8/27/14	Anglo-Fr	750	73	Schutzpolizei	150	6	4	1.2	0.0
Nsanakang K	8/31/14	Kam Schutzpn	400	35	Brit WA Regt	236	144	3	1.0	1.0
Sandfontein	9/26/14	SWA Schutzpn	550	60	SA/UK trps	305	62	10	2.4	0.0
Tanga 1	11/3/14	Force B (-)	3000	300	Schutzpn	450	25	12	1.6	1.0
Longido	11/3/14	Kraut Schutzpn	680	12	Rhodesian trps	1500	52	10	3.0	4.0
Tanga 2	11/4/14	Force B	7700	517	Schutzpn	1150	123	12	2.4	0.0
Yasimi	1/18/15	SchTr elms	2000		BEA gar trps	1000	200	10	3.5	2.0
Bare, K.	3/3/15	GC Regt (+)	800	148	Kam Schutzpn	500	104	5	1.6	br
Trekkopjes	4/26/15	SWA Schutzpn	710	41	UK/SA Force	650	42	5	1.2	0.0
Bayo, K.	11/4/15	UK bde (-)	1100	65	Kam Schutzpn	430	40	49	2.2	1.2
Salaita Hill	2/23/16	SA Bde	5820	452	SchTr elms	1270	53	10	6.0	0.0
Lokisale	4/5/16	SA Mtd Bde	1200	70	Feldkompanie 28	180	150	5	1.2	2.0
Makinda	6/24/16	UK bde (-)	850	46	Kraut gruppe	500	87	1.5	3.5	1.6
Narungombe	7/19/17	KAR & GCR	1600	120	8x Feldkompanie	2000	106	11	4.5	0.4
Mahiwa	11/17/17	Beves' col.	4900	2700	5x Feldkompanie	1500	517	37	7.0	0.0
The Rovuma	11/25/17	Schutztrpn	1200	20	Portugese Askari	1000	620	3	3.0	3.0
Nhamacurra	7/1/18	Schutztrpn	2000	45	Angol-Portugese	1600	650	5	3.0	3.0

1919–1939

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Front	Advance
Ocotal	7/16/27	Sandino forces	500	100	Hatfield Cmd	77	7	19	0.50	0.5
Quilali 1	12/21/27	Sandino forces	350	20	Livingston Col	157	28	5	0.50	0.0
Quilali 2	12/21/27	Sandino forces	200	12	Richal Col	60	10	40	0.25	0.0
Nva Segovia	2/27/28	Sandino Gp	20	15	USMC patrol	50	13	1.5	0.25	0.0
Pingarron	2/27/37	AL bn/XV InfBn	550	300	Nat 4 Bde	2000	400	20	2.00	0.2
Jarama	3/14/37	Natnlst Bde	600	100	AL & Brit bn	350	22	4	1.50	0.0
Qunts Ebro	8/24/37	XV Int'l Bde	2200	91	Natnlst Bde	2000	810	40	5.00	3.0

World War II

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Front	Advance
Binalonan	12/24/41	47th Inf (+)	3000	600	26th Cav (+)	900	350	14.5	3.00	2.50
Quinauan 1	1/23/42	3d/1 Const.	450	20	bulk 2/20 IR	600	12	8	1.00	0.30
Quinauan 2	1/24/42	3d/1 Const.	430	20	bulk 2/20 IR	588	12	10	0.85	0.02
Lngskwyn 1	1/25/42	Bridget USN bn	580	30	elm 2/20 IR	300	12	8	0.50	0.00
Lngskwyn 2	1/27/42	Bridget bn (+)	600	40	elm 2/20 IR	288	15	9	0.50	0.01
Lngskwyn 3	1/28/42	2/57 PS (+)	600	50	elm 2/20 IR	273	85	10	0.50	0.65
Quinauan 3	1/28/42	3/45 PS (+)	650	25	bulk 2/20 IR	576	8	10	0.85	0.09
Lngskwyn 4	1/29/42	2/57 PS (+)	550	30	elm 2/20 IR	178	150	7	0.50	0.40
Quinauan 4	1/29/42	3/45 PS (+)	725	50	bulk 2/20 IR	568	15	10	0.85	0.02
Quinauan 5	1/30/42	3/45 PS (+)	675	220	bulk 2/20 IR	553	140	60	0.85	0.05
Quinauan 6	2/2/42	3/45 PS (+)	455	70	bulk 2/20 IR	413	60	26	0.85	0.02
Quinauan 7	2/4/42	3/45 PS (+)	455	50	bulk 2/20 IR	353	200	9	0.80	0.30
Corregidor	5/5/42	61 IR (-/+)	800	120	4th Mar (-)	1115	200	10.5	0.40	1.28
Arzew	11/8/42	1 Rngr Bn	550	14	Vichy forces	520	400	12	2.50	6.40
Pte du Hoe	6/6/44	2 & 5 Rngr Bns	400	260	elms 352 VGD	400	300	72	4.00	5.00
Hosingen	12/16/44	elms 26 VGD	3000	85	K(+)/110th Inf	303	17	52	1.20	2.00
Clervaux	12/17/44	elms 2d PzD	4000	60	HQ/110th Inf (-/+)	700	250	15	2.40	3.00
Wiltz	12/19/44	5 FJD (-), PzLD (-)	7500	186	elms 28 ID	1505	285	10.5	4.00	4.00
Noville	12/19/44	elms 2d PzD	8000	500	TmC/CCB/10 AD (+)	1120	380	20	3.00	2.00
Parker's XRds	12/23/44	elms 2d SS-PzD	6000	30	elms 589 FABn	120	85	2	1.20	1.50

1945–Present

Engagement	Date	Attacker	Att Str	Att Cas	Defender	Def Str	Def Cas	Time	Front	Advance
UK Convoy	3/11/46	Indo Rebels	1200	200	1/Patiala	850	105	80	5.00	4.00
Deskati	9/24/46	EAN force	300	70	GNA co (+)	135	47	13	1.20	1.20
Agrafa-Vini.	9/18/47	GNA TF	1100	60	EAN force	375	40	7	3.00	0.00
Mt. Vermion	5/26/47	EAN force	700	20	GNA Garrison	400	54	6	1.50	0.00
Florina 1	5/29/47	EAN bn TF	820	45	GNA inf bn	600	12	4.5	2.00	0.00
Grevena	7/25/47	EAN lg TF	1200	200	GNA inf bn (+)	640	34	6.5	3.00	0.00
Kfar Etzion	5/11/48	elms Arab Leg (+)	1500	300	Haganah Garrison	440	400	38	10.00	3.00
Degania	5/20/48	Syr 1st Bde	700	50	Degania Garrison	300	20	9	2.40	0.00
Latrun 1	5/25/48	Isr 7 Bde	1200	300	elms Arab Legion	700	27	9	3.50	0.00
Latrun 2	5/30/48	Isr 7 Bde	1900	250	elms Arab Legion	700	35	6	7.50	0.50
Def. Negba	7/12/48	Egypt Army trps	2000	200	Negba Garrison	140	20	10	1.60	0.00
Iraq-el-Mnsh	10/16/48	Negev, 8 bdes	900	85	Egypt Army trps	500	34	5.67	3.00	0.50
Beersheba	10/21/48	IDF 8 Bde (-/+)	2200	50	Egypt Inf bn	720	120	5.25	6.00	2.50
TF Smith	7/1/50	NKPA 4th ID	2400	120	TF Smith (+)/24th ID	540	185	7	2.20	2.50
Alfonso Ridge	8/15/50	A/19/24th ID	160	50	u/i NKPA	200	20	2.5	0.40	0.00
Saga	9/3/50	u/i NKPA co	120	45	A/64 FABn	130	19	1	0.50	0.00
Chongju Pass	10/29/50	D/89 TkBn, 3 RAR	900	30	NKPA mecz TF	400	60	3	1.50	0.70
Chipyong-ni	2/13/51	PLA Inf Regt	2500	500	2/23 Inf (+)	920	110	30	1.10	0.40
Chichong-ni	4/23/51	PLA Inf	1200	400	92 AFAB (-/+)	600	15	10	1.50	0.00
Hill 800	5/17/51	PLA Inf		4000	3/38th Inf	750	30	3.8		0.00
MDollar Hill	8/3/51	PLA Inf	400	75	K/5th Inf	150		7.25	0.50	0.00
My Coi	7/1/54	VM 9 IRgt (-)	1200	110	S/Gpt B. 2	642	13	5	5.00	0.00
Kuseima	10/30/56	Isr Bn/4 IB	600	26	Egypt 6th IB (-)	500	100	2	2.25	2.00
Thamad	10/30/56	Isr elms 202 PB	600	10	2 cos, DesFF	250	25	2	2.00	
Nakhl	10/30/56	Isr elms 202 PB	400	0	Egypt 2 MtzBdrBn	200	35	0.42	2.50	
Mitla Pass	10/31/56	Egypt 2d IB (-)	1848	711	Isr 202 PB (-)	1000	188	24		6.00
Abu Aweigila	10/31/56	Isr 7th AB (-)	950	10	elm Egypt 6 IB	600	40	3.5	1.75	
Port Fuad	11/5/56	2d RCP	991	27	elms Egypt 2d ID	1000	88	12		4.00
Gamil Airfield	11/5/56	3d Para Rgt	780	40	Egypt NG bn	750	100	10		5.00
Agounnenda	5/23/57	2d RCP	700	37	FLN Azedine	300	105	60		6.00
Hassi Rhambou	11/21/57	3,4/3d RCP	300	20	FLN Militia	100	15	4		2.00
Jebel Akhdar	11/26/59	Sqn, 22d SAS	200	3	ORM coy	180	25	1.75	3.00	
N'djilli Airport	7/13/60	2d Co/6 Cdo bn	80	0	ANC forces	120	10	1	1.50	
Boende	7/17/60	2d Co (+)/6 Cdo	225	0	ANC forces	100	5	1	1.50	
Bunia Airfield	7/17/60	1st/4 Cdo Bn	150	0	ANC forces	80	4	0.25	1.20	
Mongbwalu	7/17/60	C/1st/4 Cdo Bn	30	4	ANC roadblocks	40	7	1.5	0.10	
Niemba	11/8/60	Baluba Irr	100	8	Irish Patrol	12	12	2		0.20
Bukavu	11/15/60	Nigerian TF	112	0	ANC force	200	30	40		1.00
Bay of Pigs	4/17/61	Brig 2506	1453	1303	Cuban Army	3500	800	78	25.00	12.00
Rotunda	4/18/61	Cuban TF	2100	500	Oliva's TF	370	70	8	2.50	0.00
San Blas	4/18/61	Cuban force	1200	80	1 (Para) Bn	180	100	54	1.00	1.75
Sidi Ahmd AB	7/19/61	2d RPIMar	760	28	Tun Army trps	500	40	6		3.00
Bizerta	7/21/61	3d RPIMar (+)	1715	113	Tun Army	3000	650	24		4.50
Ap Bac I	1/2/63	ARVN 7 ID (-)	7000	300	VC elms	600	100	8	10.00	0.00
Tebedu PolS	4/12/63	Indo Plat.	30	0	Sar. Police	15	3	0.5	0.10	
Gumbang	4/23/63	IBT section	15	5	Pol+C/40 Cdo	20	1	1	0.10	
Rajang R.	8/16/63	TNI Plat (+)	55	6	patrol 2/8 GuR	30	0	0.75	1.00	
Rajang R.	9/2/63	Indo. Squad	12	5	plat 1/2 GuR	35	1	0.25	0.10	
Long Jawail	9/28/63	Indo. Coy	135	0	squad Gur/Po	14	5	2	0.10	
Long Jawail 2	10/2/63	11 Pl 1/2 GuR	35	0	Indo Pl.	26	26	1	0.20	
Kalabakan	12/29/63	Benny, Wyng grp	72	5	RMR & Police	85	27	2.75	1.00	1.20
nr LongPaSha	1/23/64	2 sqd, 1/RLcst	20	0	IBT camp	45	6	0.25	0.20	
Track 6/6A	3/7/64	elm A, 2/10 GR	75	2	pl, TNI regs	40	13	3	0.30	
Kluah	3/24/64	A, 2/10 GuRfl	140	3	2 pl TNI camp	80	5	4	1.00	
Batu Lintang	6/15/64	ap pn, 2/2 GR	35	1	IBT platoon	50	15	0.75	0.50	
base 1/6GR	6/21/64	IBT company	100	7	2 pltns, 1/6 GR	70	10	4	0.20	
Stass ambs	7/21/64	11 pn, 1/GuRfl	35	0	Ind Reg A pn	30	11	0.1	0.10	
Dragon Rdge 1	11/23/64	Belg Para Cdo (-)	600	7	Simba rebels	800	11	1.5		
Dragon Rdge 2	11/23/64	Vandewalle Col	700	12	Simba rebels			20		
Dragon Nr	11/26/64	Para Cdo Rgt (-)	400	7	Simba rebels			34.17	2.00	6.00
Pesiagnan	1/2/65	C, 1/2 GurRfl	130	5	Ind Army co (-)	50	28	2		0.30
Duo My	7/20/66	5th RAR (-/+)	625	1	VC forces	100	6	12		3.00
FSB Blmrl 1	5/26/68	VC Inf bn	700	70	3d RAR (+)	900	8	2		1.50
FSB Blmrl 2	5/28/68	VC Inf bn (+)	1000	120	3d RAR (+)	900	9	2		2.25
Bhaduria	12/10/71	KumaonBn/20MtD	850	300	Pak Gar. TF	300	120	18		4.00
Kolwezi	5/19/78	2d REP (-)	405	13	CNLF rebels	1000	175	5		2.00
Metal Shaba	5/20/78	4/2d REP (+)	385	3	CNLF garrison	400	80	8		1.60
Luilu 1	5/24/78	elms 2d REP	405	3	CNLF group	100	17	1		1.50
Honduras Border	3/26/86	elms Hond Army	800		elms Nicarg Army	1100		24	5.00	

Notes to charts on previous pages:

* Strength and casualty data for Simba rebel forces for the three "Dragon" engagements in November 1964 will be forthcoming from Leavenworth Paper #14: *Dragon Operations: Hostage Rescue in the Congo, 1964–1965.*

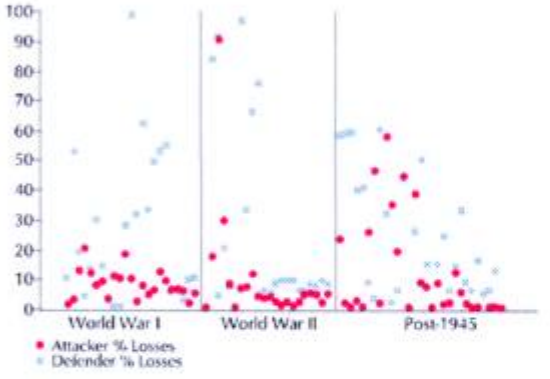
* Casualty figures for the Honduras Border engagement (1986) will require further research.

Looking at Casualties using the BLODB

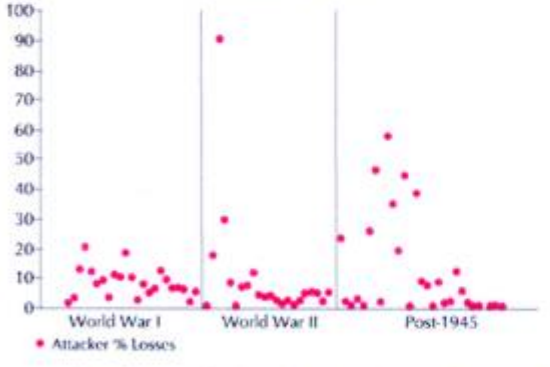
by Christopher A. Lawrence

In anticipation of the battalion–level validation, I took Dave Bongard's list of engagements, which in most cases listed the strength and losses for each side, and created the Battalion–Level Operations Data Base (BLODB). This was primarily to test the data to see if it was showing any unusual characteristics. This was from the original collection of 74 engagements, including 23 WWI, 22 WWII and 29 post–WWII engagements. As this was a preliminary look at the data, in some cases we had not completed the data for all these engagements, but all the graphs are assembled from over 140 data points.

Percent Battalion Losses by Period

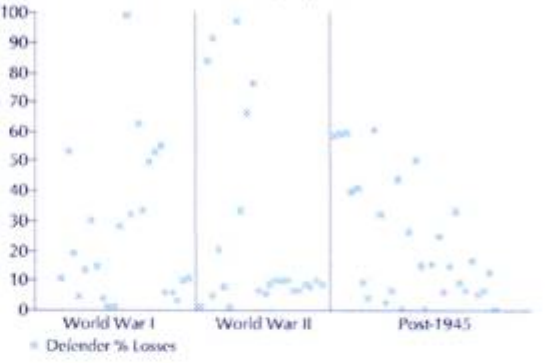


Percent Battalion Losses
Attacker, by Period



The first graph shows the percent losses for around 140 results, both attacker and defender. The second and third graph show the same information, but only showing either the attacker or the defender so any patterns are clearer. As can be seen, there appears to be no significant difference in loss rates from the World War II and modern periods. The

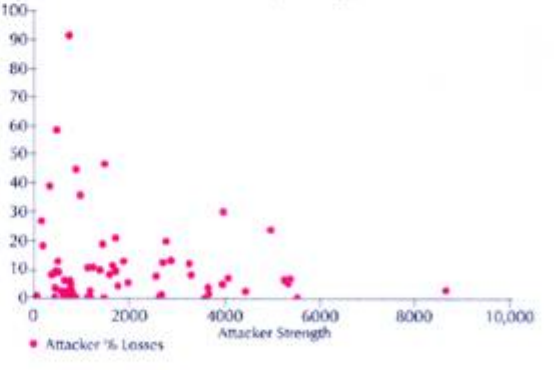
Percent Battalion Losses
Defender, by Period

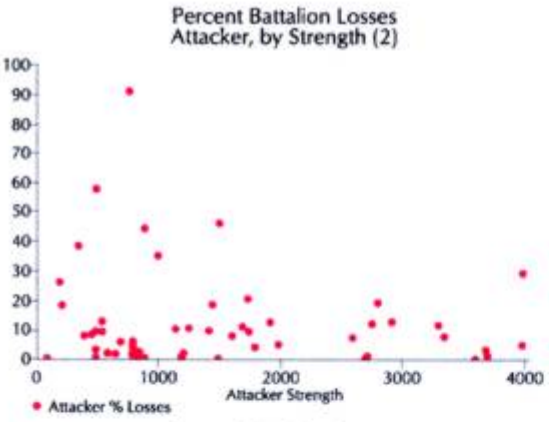


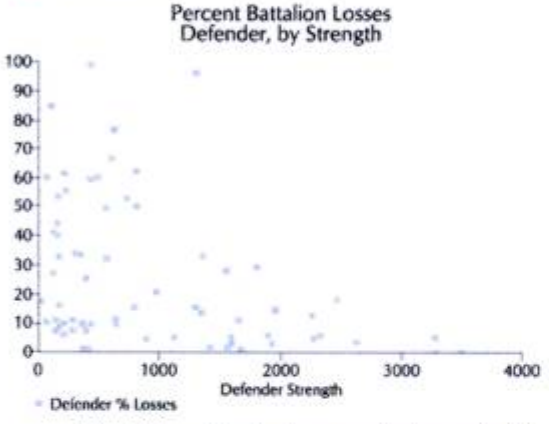
World War I rates do look a little higher. Most of the battles from World War I are larger unit actions, and larger units tend to suffer lower percent losses in combat than small units. This indicates a trend of higher losses in World War I data.

The next three graphs show the percent of losses based upon unit strength. There is a definite trend here, which has shown up in all of Trevor Dupuy's work. As discussed in the previous issue, the TNDM has tables in the model that account for casualties versus unit size (see the article in issue 3: "Exactly How the Unit Size Modifiers Are Calculated").

Percent Battalion Losses
Attacker, by Strength







The data used in the above graphs shows the following characteristics (number in parenthesis is the number of engagements that had good data):

	WWI	WWII	Post-WWII
No. of Engagements	23	22 (20)	29
Avg Attacker Strength	3139	1542	1170 (28)
		1344 (20)	1023 (25)
Median Attacker Strength	2753	800	775 (28)
Avg Attacker Losses	225	166 (20)	163 (25)
Median Attacker Losses	210	40.5 (20)	32 (25)
Percent Avg Losses	7.2	12.4 (20)	15.9 (25)
Avg Defender Strength	1275	602	771
		477 (20)	646 (26)
Median Defender Strength	1352	335	400
Avg Defender Losses	211	158 (20)	104 (26)
Median Defender Losses	181	26 (20)	60 (26)
Percent Avg Loss	16.5	33.1 (20)	16.1 (26)

The next eight graphs, printed on the following pages, are:

1. Ratio of Attacker/Defender Strength versus Loss Ratio (Attacker/Defender)
2. Ratio of Attacker/Defender Strength versus Loss Ratio (Attacker/Defender), less 3 data points
3. Ratio of Attacker/Defender Strength versus Percent Loss
4. Ratio of Attacker/Defender Strength versus Percent Loss, less 3 data points
5. Ratio of Attacker/Defender Strength versus Loss Ratio (Defender/Attacker)
6. Ratio of Attacker/Defender Strength versus Loss Ratio (Defender/Attacker), less 5 data points
7. Ratio of Attacker/Defender Strength versus Percent Defender Loss/Percent Attacker Loss
8. Ratio of Attacker/Defender Strength versus Percent Defender Loss/Percent Attacker Loss, less 2 data points

These eights graphs were an attempt to see if there were any trends that could be deduced by comparing the attacker/defender strength ratios to the loss ratios. This was compared in four ways: the ratio of attacker to defender losses, the ratio of the percent of attacker to defender losses, and the inverses of those two ratios (defender to attacker). Basically what we got was noise. This did not surprise me, as when Trevor Dupuy did force ratio comparisons at the division level (see *Understanding War*), he also got noise. This does tend to raise questions about using Lanchester equations at this level of combat.

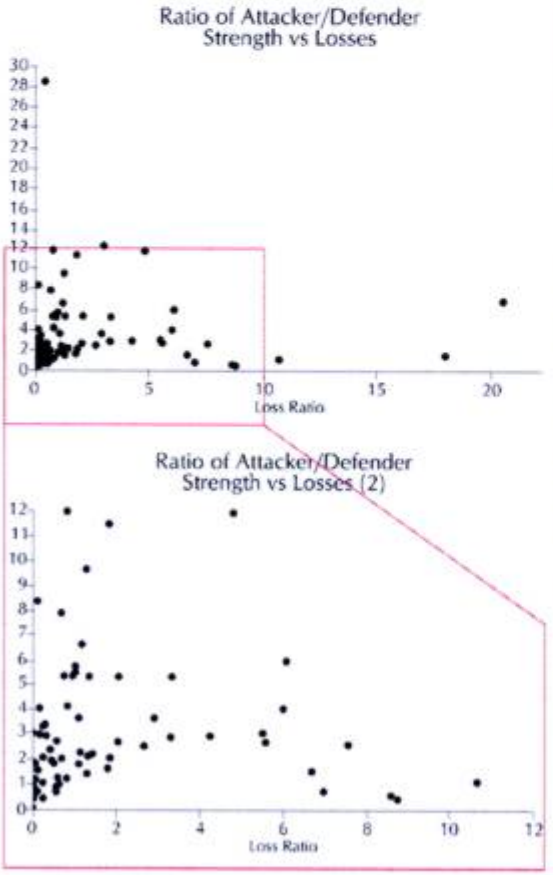
As our battalion–level data includes some fairly large engagements (up to around 3,000 people on one side), I looked at the engagements were we had a lower number engaged. This simply was done by applying a filter to the data base on force size. What we looked at were:

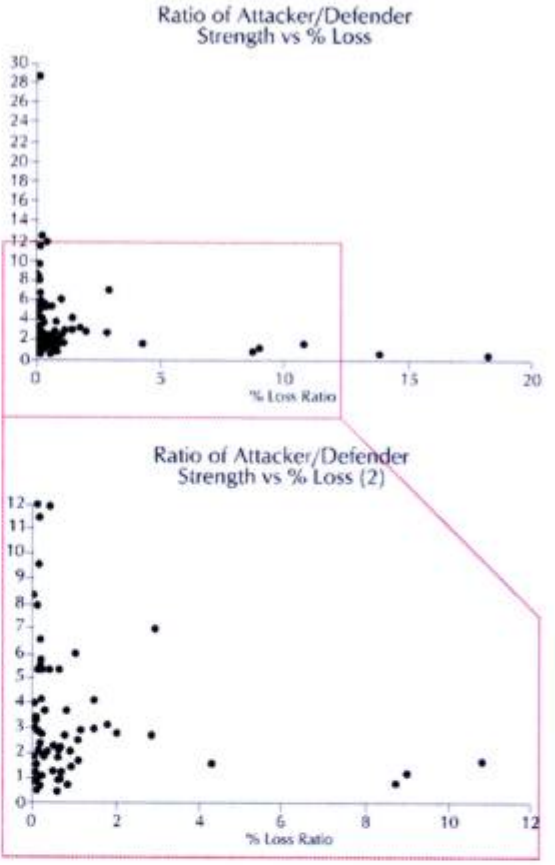
Conditions	Number of Engagements
Both sides less than 2000	50
Both sides less than 1600	41
Both sides less than 1000	32
Both sides less than 800	13
Both sides less than 500	7

This resulted in 20 different graphs. I have not bothered to reprint them here. There was some hint of a pattern in the following graphs:

1. Ratio of Attacker/Defender Strength versus Percent Defender Loss/Percent Attacker Loss (50 cases, attacker and defender < 2,000
2. Ratio of Attacker/Defender Strength versus Loss Ratio (Attacker/Defender) (32 cases, attacker and defender <1,000, no WWI cases).
3. Ratio of Attacker/Defender Strength versus Loss Ratio (Defender/Attacker) (32 cases, attacker and defender <1,000, no WWI cases)
4. Ratio of Attacker/Defender Strength versus Percent Defender Losses/Percent Attacker Losses (32 cases, attacker and defender < 1,000, no WWI cases)
5. Ratio of Attacker/Defender Strength versus Loss Ratio (Defender/Attacker) (13 cases, 2 WWII and 11 post-WWII, attacker and defender <800).
6. Ratio of Attacker/Defender Strength versus Percent Defender Losses/Percent Attacker Losses (13 cases, 2 WWII and 11 post-WWII, attacker and defender <800).

The first graph tended to show an "upward" linear correlation between the Attacker/Defender Ratio and the Defender Percent Loss/Attacker Percent Loss Ratio. The second graph tended to show a linear correlation where the attacker/defender ratios was less than 3. This was an "upward" linear correlation between the Attacker/Defender Ratio and the Loss Ratio (Attacker/Defender). The third graph showed a "downward" linear correlation between the Attacker/Defender Ratio and the Loss Ratio (Defender/Attacker). In light of the previous graph, this is not surprising. The fourth graph shows a "downward" correlation between the Attacker/Defender Ratio and the Percent Defender Losses/Percent Attacker Losses. In the fifth and sixth graphs, we are well below any type of statistically significant number of samples, especially considering the fuzziness of the data. But two graphs showed some pattern. The fifth graph showed a slight "downward" correlation between Attacker/Defender Ratio and Loss Ratio (Defender/Attacker). The sixth chart showed a more noticeable "downward" correlation between Attacker/Defender Ratio and Percent Defender Losses/Percent Attacker Losses. Of note, fourteen of the graphs that I produced showed no discernable pattern that I could detect with my eye (a very precise measuring tool indeed).

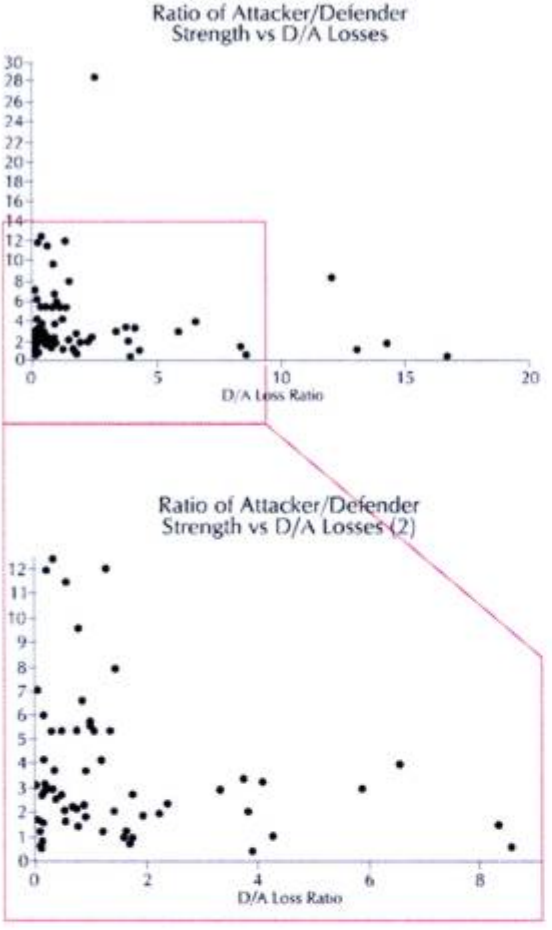


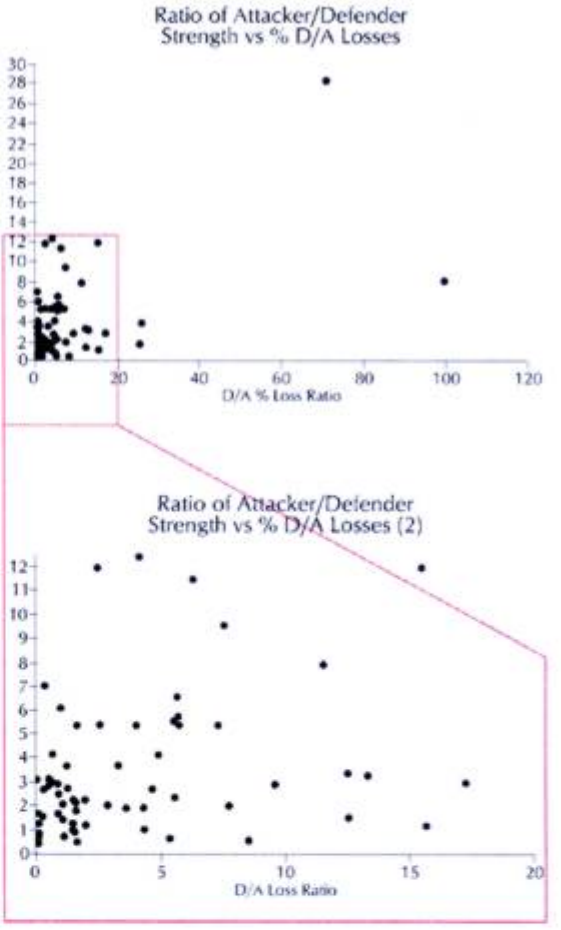


While there is a hint of pattern in the lowest level of the data, and at a statistically insignificant level, this most likely is noise. This could be tested further with considerable more effort that would require additional research. This is not on our corporate agenda at the moment.

What these charts show me is that there is no visible "Lanchesterian" type effects in battalion-level combat. If "Lanchester" effects show up in combat, it is probably at some level well below battalion. It would probably show up if we could test the Gunfight at the OK Corral, but the effect is not visible at any level of combat that we have been able to look at.

When the battalion-level data base is completed with all 188 engagements (giving us 376 data points), I would like to go back and retest this work. I would also like to do a proper statistical analysis and look for mathematical correlations. If time permits, we may also add these engagements to the LWDB.


Ratio of Attacker/Defender
Strength vs D/A Losses
D/A Loss Ratio


Ratio of Attacker/Defender
Strength vs % D/A Losses
D/A % Loss Ratio

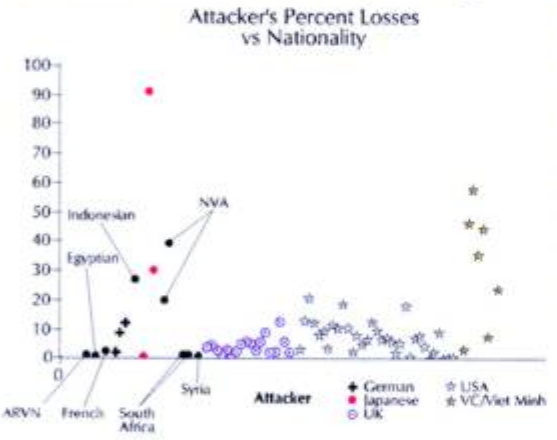
Ratio of Attacker/Defender
Strength vs D/A Losses (2)
D/A Loss Ratio

Ratio of Attacker/Defender
Strength vs % D/A Losses (2)
D/A Loss Ratio

Looking at Casualties Based Upon Nationality Using the BLODB

by Christopher A. Lawrence

I am afraid this article will open up a Pandora's box of criticism. Everyone is aware that different armies have different doctrines and fight in different styles. Some of this is embedded in training manuals and training systems, but some of it is based upon tradition and culture of the army. But when you hint at the discussion of national differences, people begin getting nervous, especially in our very politically sensitive and politically correct American society. Unfortunately, the field I had to key on in the Battalion-level Operations Data Base (BLODB) was called nationality. I did not have a field for "type of doctrinal system." Therefore, I had a choice of saying nothing or pushing forward and discussing the comparison of casualties by nationality. For better or worse, I choose to say something.

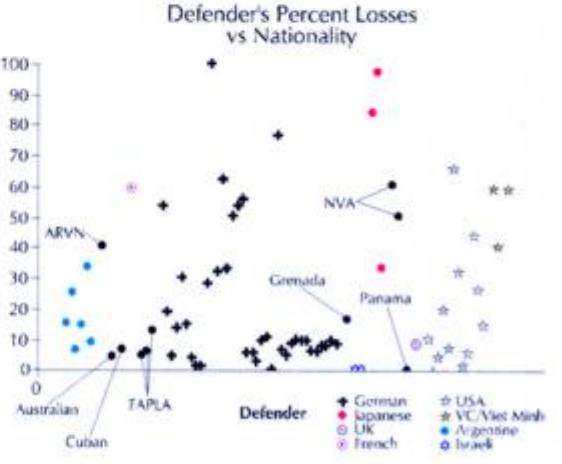


The first chart shows the percent losses of the attacker versus nationality. Note that there is a distinctly different casualty pattern shown by the Indonesians, Japanese, NVA (North Vietnamese Army), VC (Viet Cong), and Viet Minh from that shown by Germany, US and UK.

It appears that the upper threshold for attacker losses for the UK, US and German forces is around 20%. For other forces (unfortunately based upon very few data points), it appears that this threshold for losses is much higher. It certainly went as high as 99% for the Japanese Army in WWII. This is not something that you would ever expect to see in the US, UK, or German armies, unless something truly unusual was occurring.

The intensity and duration of a battle is usually determined by the attacker. The battle ends when the attacker ceases to attack or the defender withdraws. Or...the defender chooses to reverse roles and become the new attacker. As such, if there is a difference in doctrine in the armies, it would be expected to show up in the percent of losses taken by the attacker. Unfortunately, the data is confused somewhat by the fact that the attacking forces taking above 20% losses were often at a notable firepower inferiority compared to their opponents. This is certainly true of the NVA/VC/Viet Minh and is usually the case with the Japanese. But in many of these cases, the units could have broken contact much earlier than they did and minimized their losses. In many of these cases, the increased casualties did not result in an increased chance of winning.

The next chart shows the percent losses of the defender by nationality. Notice that there is still a difference in the pattern of losses in the first group of nations listed from the second group, but the pattern is not as distinct. Obviously, as the attacker determines the intensity and duration of combat, it is quite possible for any defending force to be overrun and destroyed, regardless of doctrine. But, from the few points provided here, it appears that there are a few nations that appear to take higher casualties in the defense than is usually encountered. This appears to be the case with the NVA, VC, Viet Minh and Japanese. This may be entirely due to the opposing attacking force having a significant firepower advantage. Unfortunately, these are also the cases in which we have the least data. More work, with more data, would need to be done before any conclusions could be reached.



Most of the nationalities with high losses have low CEVs (Combat Effectiveness Values). This certainly provides a counter to the argument that by declaring a force to have a low CEV, we are making a criticism of some nation's bravery or manhood. Of course, this does not change the

fact that the low CEV may be providing an implicit criticism of the ability of the nation's armed forces to conduct a battle.

In the TNDM, the CEV is accounted for in three different areas of the model. First and most important, it is used as a divisor of the less capable side's OLIs.

Second, it is used to increase the opposing side's casualties by the multiplier of the side with the larger CEV. This is limited to a multiplier effect of 1.5. The same CEV formulation is used for tank and artillery losses, but the multiplier effect is limited to 2.0. Infantry Weapons, AT Weapons, and General Vehicles use the same formulae, times a scaling factor, as the personnel casualty rate; while APCs are calculated with the tank loss formula, and AA weapons are calculated with the artillery formula.

Third, it is adjusted in the "set–piece" factor, which effectively temporarily increases the CEV of the lower CEV force making a planned attack.

The use of the CEVs to increase opposing losses by 1.5 may sufficiently cover the higher losses displayed by the Japanese, NVA, VC and Viet Minh, but I suspect this will not entirely cover their losses. I have reason to believe that the TNDM will have a problem with the Japanese. If that is the case, then we will seriously need to consider whether there is some other factor that we should be considering (like Dave Bongard's postulated fanaticism).

If indeed, there is a "fanaticism effect" that needs to be displayed in combat modeling, this could be incorporated into a hypothesis for breakpoints. As you may have gathered from reading Trevor N. Dupuy's *Understanding Defeat*, there are multiple causes for breakpoints, and any model of breakpoints is going to have to address these multiple aspects, probably as some form of a decision tree. One of these might be two different sets of postulated breakpoints related to heavy casualties, depending on whether the army fights in a "fanatic" style or not.

Looking at Time Using the BLODB

by Christopher A. Lawrence

The TNDM treats engagements of less than 24 hours as simply a portion of a 24 hour engagement. A unit in a six–hour engagement takes one–fourth the casualties as the unit would in a 24–hour engagement. For various reasons, I am uneasy about that construct as discussed in the article in Issue 3, "Time and the TNDM." I then looked at the data we were getting from the BLODB to determine is if we could discern some casualty patterns from the length of an engagement. I have enclosed three graphs below that show the data.

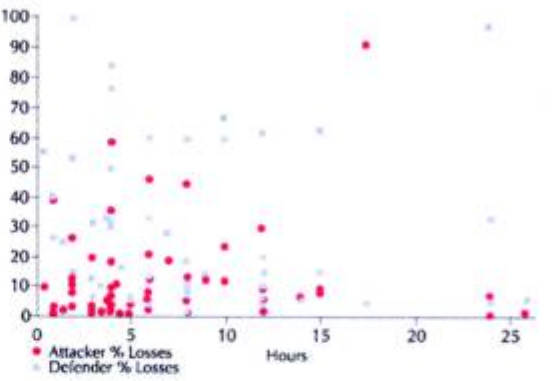
First, I looked at percent losses over time and could see no pattern. I then looked at the total losses over time, and the only pattern that I could see is that casualties tend to be lower for engagements of less than two hours.

This led me to see if larger forces had longer battles. Again, the only pattern that I could discern is based upon the defender's force size:

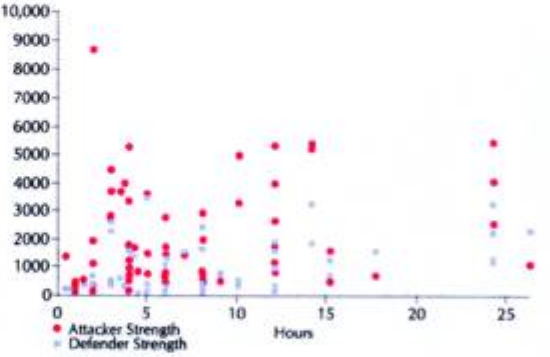
DEFENDER'S FORCE SIZE	ENGAGEMENT LENGTH
> 1,000	3 to 24+ hours
< 1,000	.5 to 12 hours (one outlier)

It is obvious that we need to study more engagements if we are going to see a pattern. As our values for time were obtained from secondary sources, in many cases these were "roughed–in" values. More precise values could be determined if we did further research on these engagements.

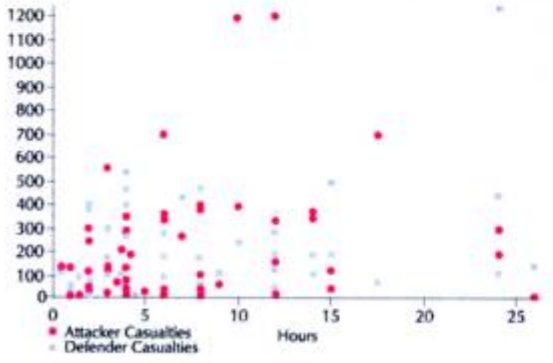
Percent Losses vs Hours of Combat



Force Size vs Hours of Combat



All Losses vs Hours of Combat



Looking at Winners and Losers Using the BLODB

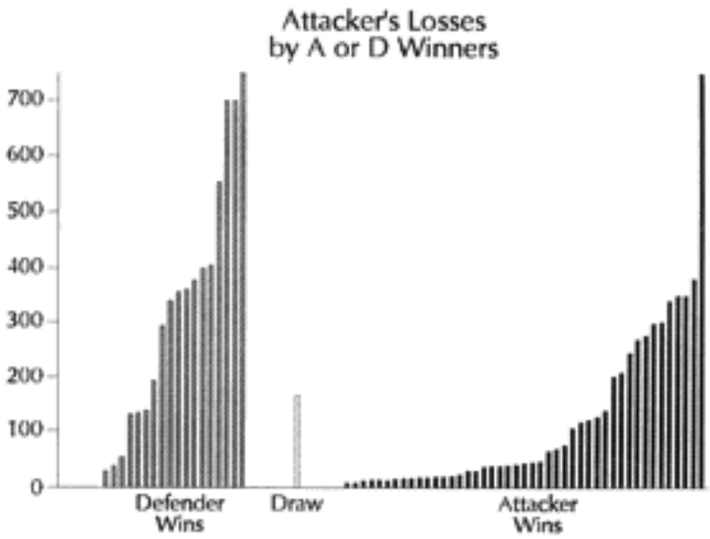
by Christopher A. Lawrence

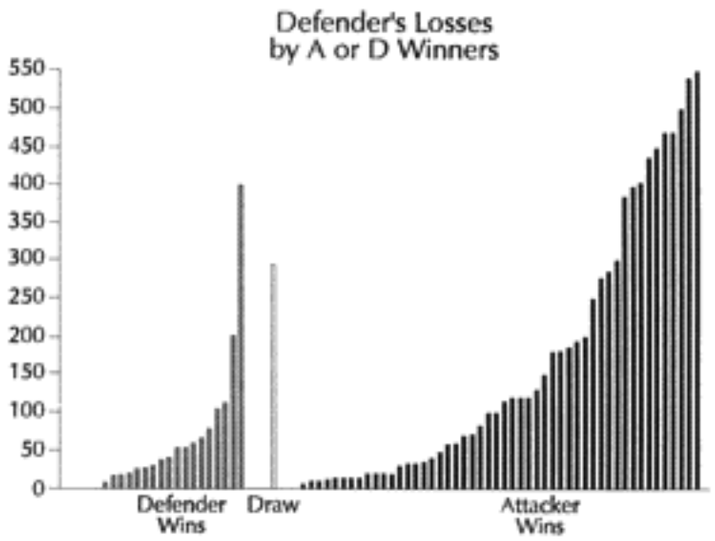
The last element of the data that we looked at before the actually conducting the battalion–level validation was the nature of the battle when compared to who won and who lost.

There is one field for identifying the winner and loser in the data base. If the attacker wins, this field is assigned a value of 1; if the defender wins the field is assigned a value of –1. The one drawn battle in the data base is assigned a value of zero. All the attached charts have been drawn based upon these numerical values, with the defender wins (value of "-1") listed first across the x-axis, the draw listed next (value of "0"), and the attacker listed last (value of "1"). These were laid out in a bar chart format, as that was what was convenient to do with the software I am using. There are probably better ways to display this data.

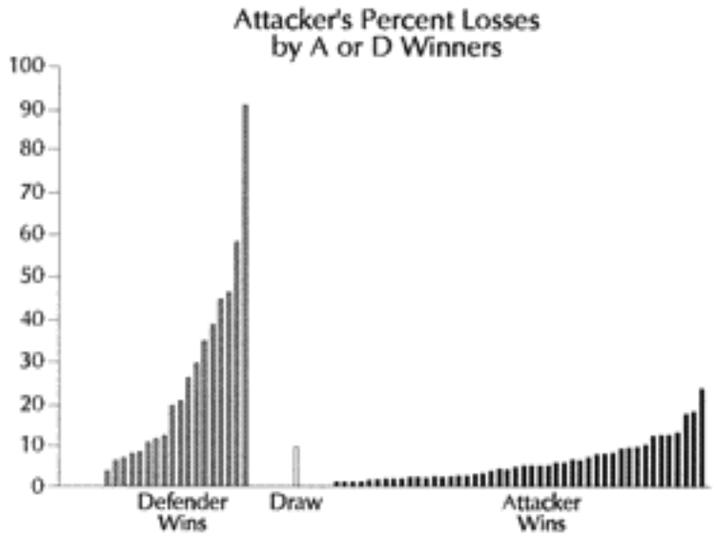
First I looked at whether the battles were longer depending whether the attacker or the defender won. It would appear that on the average, battles where the attacker won are longer. This might be something that needs to be addressed in a battle termination methodology. I suspect that any good battle termination methodology will automatically produce this effect as a by–product. This will not affect the validation as we declare the length of the battle in hours when preparing a TNDM run.

The next two charts show what the attackers or the defenders losses were depending on who won. The very clear pattern here is that the winner of a battle usually suffers reduced casualties. This is a pattern that Trevor Dupuy identified and designed into the TNDM.

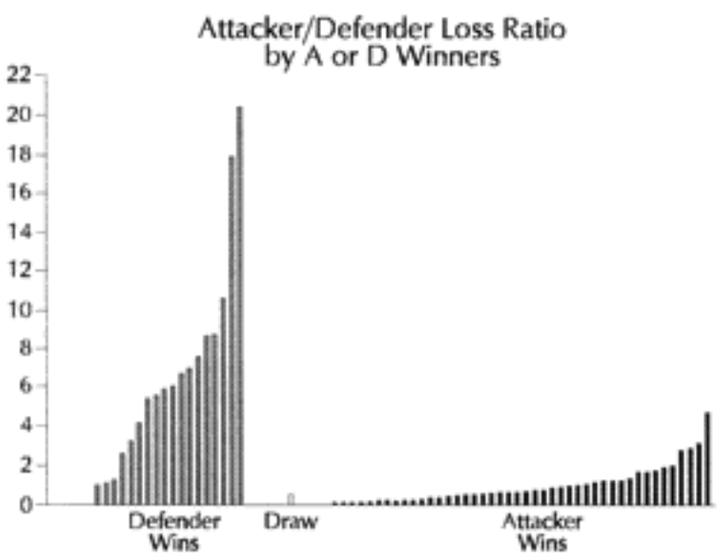


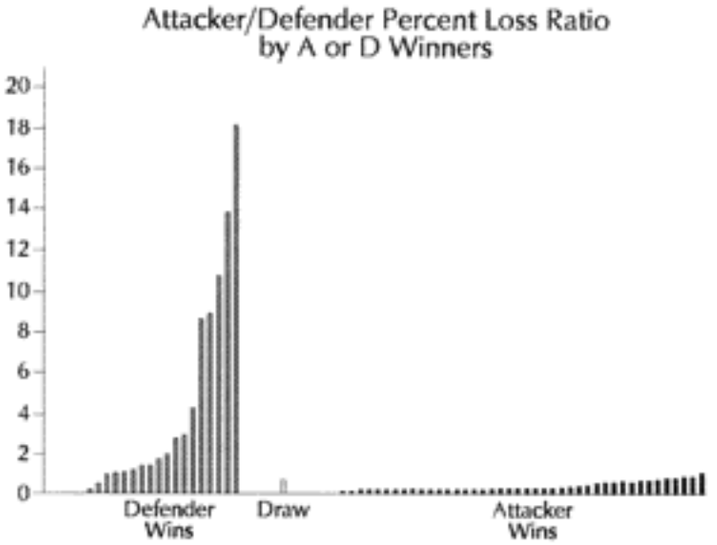


This pattern is even clearer if one looks at the percent losses. This is done in the next two graphs.

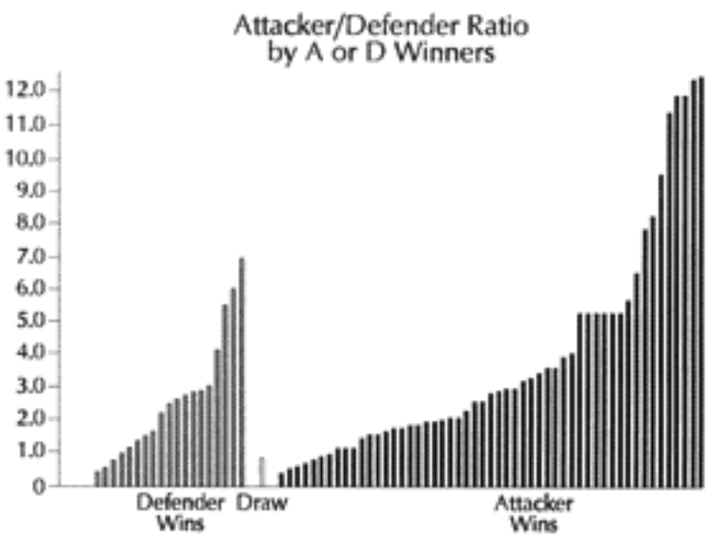


The next two charts simply look at the loss ratios of the attacker to the defender, both in straight numbers and in a percent of unit. This just further clarified the pattern. Failed attacks and failed defenses are costly. Exchange ratios on failed attacks heavily favor the defender. Exchange ratios on successful attacks often still result in the attacker taking higher casualties than the defender.





The last chart looks at the force ratio of attacker vs defender compared to who won. While overwhelming force ratios win, and a higher force ratio helps to win, in many cases the winning attacker has less than a 1–to–1 ratio. This is not unusual and is mostly related to human factors.



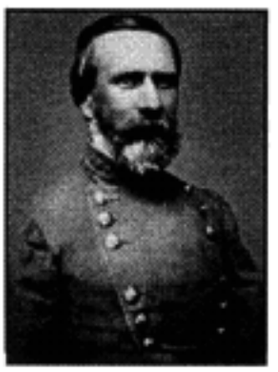
There is nothing in the charts from this article or the previous three articles in this issue that has not been pretty much covered by Trevor N. Dupuy in *Understanding War* using the Land Warfare Database. But it is interesting and instructive to be seeing the same effects in a battalion–level data base. So far, it would appear that except for the higher casualty percents due to the smaller unit sizes, there is a similarity in results from battalion–level battles that parallel the results seen in division–level battles.

TDI Profile: Richard Anderson

Richard C. Anderson, Jr. received a B.A. in History from George Mason University in 1977. Mr. Anderson concentrated on 19th and 20th Century European and American military history. His plans to continue study with the objective of an advanced degree were curtailed due to a combination of academic *ennui* and financial self–interest (also known as boredom and greed). Mr. Anderson then spent the following ten years working in the Washington area retail sales industry before seeking to return to a career in a history–related field.

Mr. Anderson began working for Data Memory Systems, Inc. in October 1987. DMSi was Colonel Trevor N. Dupuy's previous historically–oriented research and consulting organization. While he was with DMSi, Mr. Anderson worked on several major projects, including the *Breakpoints* study and the *Ardennes Combat Simulation Database*. Mr. Anderson also worked with the predecessor to Colonel Dupuy's TNDM, the QJM, in studies and analyses for various U.S. Government agencies.

Mr. Anderson left DMSi in February 1991 to work with Colonel Dupuy at his new company, TNDA and its non–profit successor, the Dupuy Institute. In the intervening six years he has participated as a contributor to Colonel Dupuy's book *Future Wars*, as an editor and a contributor to the Fourth Edition of the *Harper Encyclopedia of Military History*, and as a co–author, with Colonel Dupuy and David Bongard, of *Hitler's Last Gamble*—a history of the Battle of the Bulge, based upon primary source material. Mr. Anderson's most recent work has been in the development of the *Kursk Database*, a detailed study of the World War II battle considered to be the largest tank battle of history. He has also been involved with studies of casualties in operations other than war, landmine effectiveness, and suppression.



Mr. Anderson has also been co–author, with Curt Johnson, of *Artillery Hell*, an account of the role of artillery in the American Civil War Battle of Antietam. This stems from an ongoing interest in this period of American History. Note that the illustration accompanying this profile is of Civil War Lieutenant General Richard H. Anderson, C.S.A. —no relation to Mr. Anderson, whose Pennsylvanian ancestors included the President of the Borough Council of Gettysburg and a colonel who was killed in action at Spotsylvania. Mr. Anderson insists that he "has no damned rebels" in his family background. In addition to his historical studies and writing, Mr. Anderson enjoys painting military miniature figures, miniature wargames, and attempts to raise three sons (ages fourteen, twelve, and six) without having to resort to the use of whips or chains.

How to Run the TNDM from Windows 3.1 and Windows 95

by José Perez

Setting up the TNDM software to run within Microsoft (MS) Windows 3.1 is a straightforward process, but it does require some understanding of Windows and DOS. Luckily, most of the changes can be made from within Windows.

First, the TNDM software must already be installed. For the purposes of this article, I will assume that it has been installed in C:\TNDM. Next, you need to examine the C:\CONFIG.SYS file. In C:\CONFIG.SYS is a line that reads something like FILES=20. For the TNDM software to run properly, it must be set to at least 25. If your PC was configured properly it was probably set at a higher value (60 or more).

To determine the current setting, go into the Windows Program Manager. Select Main. If you cannot see Main, click on Window in the menu bar and find Main. Click on it. Once Main is open, look for an icon called SysEdit.

Creating an Icon for SysEdit

If the SysEdit icon is not present, it can be added. Click on File in the menu bar and select New. You will then see a window labeled New Program Object. Select Program Item. Click on the Ok button. In the Program Item Properties windows, enter SysEdit for "Description" and SYSEDIT for "Command Line." Click on the Ok button. You should now see an icon labeled SysEdit. Click on it.

Once SysEdit is running, it will display the contents of several files: WIN.INI, SYSTEM.INI, CONFIG.SYS and AUTOEXEC.BAT. Click on the one labeled CONFIG.SYS. Look for the line that begins FILES= and verify that it is set to a value of at least 25. If it is not, set it to a value between 25 and 60. If any changes were made, click on File in SysEdit's menu bar and then select Exit. You will be asked it the changes should be saved. Click on Yes.

Creating a Batch File for TNDM

After you have exited from SysEdit, click on the MSDOS icon. A small window with a DOS prompt will appear. At the DOS prompt, enter the command

```
EDIT TNDM.BAT
```

This will start the DOS Edit command. Once the edit screen appears, enter the lines

```
@ECHO OFF
C:\TNDM\TNDM.EXE
```

and then press the Alt key (it should be in the lower right-hand corner of the keyboard). Press F to activate the File menu and then press X to select Exit. You will then be asked if the changes you made are to be saved. Select Yes. When the DOS prompt reappears, enter the command

```
EXIT
```

Once you are back in Windows, select a group to add the TNDM icon to. Once the group is open, click on File in the menu bar and then select New. You will then see a window labeled New Program Object. Select Program Item. Click on the Ok button. In the Program Item Properties windows, enter TNDM for "Description" and TNDM.BAT for "Command Line". Click on the Ok button. You should now see an icon labeled TNDM. Click on it. It should start the TNDM.

Once the TNDM has started, you can adjust its appearance within Windows. If it runs within a window that takes up only a portion of the screen, you can increase the size of the screen that is allocated to TNDM. To do this, find the small box with a dash in it in the upper left-hand corner of the TNDM window. Click on it. A menu will appear. Select Settings. In the Settings for TNDM, change the Display Option from Window to Full Screen.

Setting up TNDM in Microsoft Windows 95

Setting up the TNDM software for Microsoft Windows 95 is more involved process.

First, version 1.86 of the TNDM software must be installed. Earlier versions of TNDM are incompatible with Windows 95. For the purposes of this article, I will assume that it has been installed in C:\TNDM.

Adding TNDM to the Windows 95 menu:

1. Click on the Start button.
2. Select Settings and then select Taskbar.

3. Click on the tab marked "Start Menu Programs."
4. Click on the Add button.
5. Enter C:\TNDM\TNDM.EXE and click on the Next button.
6. To put it into a folder, select Programs and click on the Next button.
7. Enter TNDM as the shortcut name.
8. Select an icon and then click on Finish.

Modifying TNDM's Windows 95 Properties

In order for TNDM to run properly in Windows 95, its properties must be changed from the default. To do this:

1. Click on the Start button.
2. Select Settings and then select "Start Menu Programs."
3. Click on the Advanced button.
4. In the window marked "All Folders", click on the + to the left of Programs.
5. Select Programs.
6. On the right-hand side of the screen in "Contents of Programs", find TNDM and select it.
7. In the menu bar, click on File and select Properties.
8. Select the tab marked "Memory".
9. Set Total to 480 and turn off Protected.
10. Click on the OK button to save the changes and click on any other OK buttons until you have exited from "Start Menu Programs."