Combat! Bootcamp

INTELLIGENCE REPORTS

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Intelligence Report 2

THE DFET MODEL

In this report we're going to get a little technical in an effort to bring you 'behind the scenes' in the Combat! Game System's armored warfare model. In the next installment, we'll tell you how to use all this information.

The Direct Fire Effects Table (DFET) firing model used in the Combat! Game System is a new system devised to model the effects of ordnance on various AFV targets. DFET was designed by ordnance and proving ground expert Hal Hock as the core of his computer-program-driven model analyzing these effects. It provides probabilities, expressed as percentile 'odds' to achieve different levels of damage on the target.

The original DFET model was first used in the game Combat! Normandy. In that game, the small number of firer/target combinations allowed the designer to utilize the data literally in the format it was output by Hal's program. Each case was generated by the program as a 'Case', consisting of a specific firing weapon, utilizing a specific ammunition type, against a specific target-type. Percentages for K-KILL (elimination with burning wreck as the outcome), M-KILL (inability to move) and F-KILL (inability to fire) outcomes were provided by the program at range intervals from 0-100 yards to the maximum range of the weapon in question. An overlap of the percentages listed for M-KILL and F-KILL would result in *both* outcomes, the equivalent of a non-burning wreck.

BY THE BOOK

In his yet-un-published book, STEEL ON STEEL, Hal Hock describes his data as follows, "I would like to believe that the heart of Steel on Steel is not a bunch of dry technical analyses from historical sources but, rather, a rendering of those analyses into a form that can be appreciated by both historians and technocrats..." It is in the use of his system in Combat! that the designer sincerely hopes Hal's wish comes to fruition.

The target AFV used in BRL MEMORANDUM REPORT BRL-MR-3755, "COMPUTER SIMULATIONS OF THE ABRAMS LIVE-FIRE FIELD TESTING" consists of an Abrams MBT. This model uses an advanced model known as 'SQuASH' to predict the results of various types of anti-tank munitions, including damage predictions for 5,000 individual target sub-components, against the Abrams tank. In the companion report to BRL-MR-3755, BRL-MR-3815, a startling statement is made. BRL-MR-3755 states the advanced modeling of a single firer/target combination might take up to 1 1/2 man-years of technical effort. In BRL-MR-3755, the 5,000 sub-components in the target AFV consist of individual hydraulic lines, wires, ammunition and humans. Each item requiring its own separate analysis.

The DFET model breaks down each AFV target into 150 discrete target elements. This was deemed sufficient for our World War II era tanks and was an acceptable parameter for producing a private study where resources in manpower hours are admittedly limited. The goal was to produce effects in keeping with what would be output by studies that are much more complex. In addition, in an understandable format to laymen.

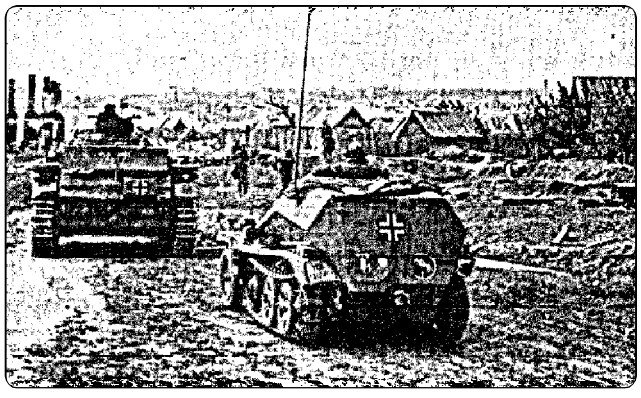
The writing of the DFET program, compiling of the data and model preparation by Hal was still a seven or eight year affair using data collected over a twenty-year period. Hal readily admitted he could have used GED, GIFT, SQuASH or several other models instead of coming up with a new one. All of the above were produced using American taxpayer dollars and are in the public domain. However, they do not meet the goals of our general gaming audience. DFET is still somewhat complex, but in comparison to the above programs, it produces easily understandable results and can be manipulated to model new firer/target combinations in relatively short order.

We can easily expend hundreds of pages here explaining the ins and outs of the DFET model. This is not the forum to go deeper. Hal's STEEL ON STEEL, the companion volume to the DFET program, is a tome of over 1,000 pages. In fact, Hal's very first oral presentation of the material to this writer spread over a good ten hours. That said, the use of the DFET data in game terms is rather simple. Utilize two percentile dice to determine the outcome of fire from a specific piece of ordnance against a specific target at a specific range.

DFET ASSUMPTIONS

DFET makes certain assumptions. The most important is that the firer and the target is stationary. In this assumption, DFET really has the feel of a proving-ground study. Line them up and fire! A second assumption made by DFET is that the gunner will follow his training and continue to fire at the target silhouette, aiming for the most vulnerable portion of the target. We are assuming the crew is well-trained and follow their training. As an aside, earlier 'tweaking' of the model when outputs were being run for our upcoming TOBRUK game led to a slight downgrading of crew performance in this regard. They were simply acting too much like robots, reflecting a high state of training that ignored certain battlefield realities.

The final important assumption is that the firer and target are in open terrain with no particular aerosols or terrain affecting the firer's Line-of-Sight. We'll talk more about the model's assumptions regarding target acquisition later in this report.



As discussed thus far, our Combat! Normandy model in game terms is an almost exact approximation of the model as communicated by the data output by DFET. The model took a turn in the direction of game/simulation with the development of Combat! Stalingrad. With a much greater number of firer/target combinations found in the new game (and inherent in a growing system), DFET output was altered to reduce the number of tables a gamer would have otherwise had to shuffle through during play. By comparing the percentages for each ordnance firer on the array of targets, comparative results were averaged, resulting in one table for each ordnance type, and 'armor modifiers' for each target. We use the term 'armor modifiers' loosely. Since these modifiers take in the gamut of data input into the DFET model, they are not purely based on armor thickness. Other aspects of the target, including target size and silhouette are rolled into these 'armor' modifiers.

SCREENED SHOT MODEL

So now, we know DFET is based on stationary firers aiming their rounds at stationary targets out in the open on a clear day. What use is this model when so many battlefield confrontations fail to fall into such a neat little description? In his companion book, author Hal Hock states plainly, "the probabilities of obtaining Line-of-Sight through various types of terrain (sometimes termed "landforms" in LOS evaluations)...are extremely important in the real world and are fairly complex to evaluate analytically." In addition, analyzing them is only the first step. These probabilities must be quantified to be useful in our game.

BRL Memorandum Report No. 702, "TERRAIN AND RANGES OF TANK ENGAGEMENTS" is the classic study on the subject and states that most Allied tank casualties in Northwest Europe occurred at less than 1,000 yards (statistical mean range was 744 yards in the study). BRL 702 concludes this short range was almost totally driven by LOS. Another study, BRL 798, "DATA ON W.W. II TANK ENGAGEMENTS INVOLVING THE U.S. THIRD ARMY AND FOURTH ARMORED DIVISIONS" stated that a "great advantage was had...by defenders" in the employment of ordnance against armor. So we can conclude that ordnance/tank vs. tank warfare was a close-in affair with the defender holding the edge. Our question moves now to whether DFET, as presented in the Combat! system along with other rules sub-systems, renders these theories a reality on our gaming battlefield.

Enter the Screened Shot rules. While a review of BRL 798, as well as studies like AMSAA Technical Report TR 6-77, "SIMULATING COMBAT UNDER DEGRADED VISIBILITY" provides some methods for taking smoke, dust and weather effects into effect on the battlefield, there is no known source that quantifies this data into usable form. That said, Hal recommended we follow the well-known K.I.S.S. rule and prepare a simple model that would interface with the DFET system, in effect determining whether a weapon would get a roll on a DFET in a particular situation involving aerosol (air-borne limitations on LOS) or terrain interaction on the firer/target relationship.

We tip our hat here to Steve Pleva, who came up with the Screened Shot methodology after hearing Hal's feedback on the subject. What we must admit right up front is that the old 'fudge' factor entered the picture with the Screened Shot methodology. This is not necessarily a bad thing; all concerned agreed that a system that was both simple to understand and implement was in order in the absence of statistical data comparing the different effects various landforms and aerosols have on target acquisition.

The Screened Shot system provides for a dice roll modifier for each landform (woods) and aerosol (smoke) present in the battlefield environment. A simple d10 dice roll exceeding the sum total of all of these modifiers allows the firer to proceed to the applicable DFET table for a crack at the target AFV. In effect the Screened Shot methodology introduces a compartmentalized system to quantify the LOS effects of various battlefield factors without including parameters already 'dialed in' to the DFET model itself.

'TRIGGER PULLS' 1-2

A brief review of any of the DFET tables provided in the game will clearly reveal the effects of crew performance. The tables use two columns for fire at a particular range, 'Trigger Pull 1' and 'Trigger Pull 2'. These are reduced to the numbers one and two in a circle on the tables to save space.

Trigger Pull 2 fire actually consists of 'shot' two and beyond. It is most lethal, with K-KILL probabilities typically at least doubled from the first to second and subsequent shots. While we'll consider the raw probabilities found on the DFET tables in this part of our discussion, the reader should note that armor modifiers and any Screened Shot dice rolls needed to move to the DFET will affect the overall probability of causing damage in a particular shot.

The use of Trigger Pull 2 data has been modeled across the system starting with Combat! Stalingrad. Gone are the dice roll modifiers for acquired targets in HE fire. Instead, increased probabilities to achieve a hit, thus placing the effects of HE rounds on the target, are represented by the use of the Trigger Pull 2 column on the HE To Hit Table. It is from the DFET model that the 'TP 1-2' approach came into play. The second and subsequent shot represented by 'TP 2' columns depict 'getting the range' and firing away with only

minor adjustments to continue placing rounds on the target.

NOTES ON TARGET ACQUISITION

The concept of target "acquisition" is often incorrectly assumed to mean being able to see a potential target at a particular range. This assumption is not made in the model used on the Combat! Game System for target acquisition. Instead, the simple system for determining if a target has been 'acquired', thus allowing for the potent (or more accurate) 'TP 2' data, takes a number of different battlefield factors into account. The target acquisition model used in the game is admittedly simplistic. There are numerous complex studies that treat the subject, including, "DARCOM Pamphlet DARCOM-P 706-102, "ENGINEERING DESIGN HANDBOOK, ARMY WEAPON SYSTEMS ANALYSIS, PART TWO" and "A COLLECTION OF UNCLASSIFIED TECHNICAL PAPERS ON TARGET ACQUISITION", a compendium of available reports.

The factors involved in our model include the "search process", which is the process of evaluating everything between the human optics (eye) and the target, and everything in between. Prior to landing the first round *on the target* (TP 1), the search process is assumed to take place. The combined DFET an Screened Shot models attempt to take into account the following factors in the search process:

1) Time to detect;

2) Probability of detecting.

Between the target and the firer lies the 'environment', or everything that impacts the probability of laying a round on the target. In game terms the environment will necessarily also include the terrain the target is in. We can get very technical here, bringing in studies involving visibility, or the distance in which a 'large dark object' can be seen against the sky. Suffice it to say the difference between TP 1 and TP 2 data in the model accounts for all that goes on between noting that 'large dark object' and making the decision to engage it, followed by initial firing orders, the observation of the fall of the shot followed by new firing orders to account for the location of lack of hits, etc.

In 1958 the US Army published the original study, "Proceedings of Image Intensifier Symposium, "ANALYSIS OF IMAGE FORMING SYSTEMS". This important study defined the process of target acquisition into broke it down into four levels: 1) Detection; 2) Classification; 3) Recognition; and 4) Identification. In this study, it was only at step four, 'classification' that we can assume our firer would actually engage the target. This approach is at odds with the conclusions drawn by CACDA-TR-6-76, referenced below, and used in our Combat! Game System model.

DFET makes an important assumption regarding target acquisition that had to be dealt with in our game design. The only two target types are used in the evaluation process; a fully-exposed tank and the approximation of a dug-in anti-tank gun. The author of DFET admits, "these assumptions are highly abstract in real world terms where hundreds of different types of target signatures are encountered in combat." This reality is neatly dealt with by our Screened Shot methodology, while maintaining the impact of 'acquired fire' from the DFET model via our 'Acquired Target' rules.

Another important assumption made by DFET is defined as follows: *only the detection range is the limit.*

This assumption goes along with the conclusions found in U.S. Army Combined Arms Combat Development Activity Technical Report No. CACDA-TR-6-76, "TETAM MODEL VERIFICATION STUDY, VOLUMES I-III". This study concludes, based on recorded combat experiences, that an un-recognized object *firing in your area* or *moving toward your position out of a known enemy area* will be *engaged upon detection*.

Thus, the only limitations we treat in the Combat! Game System are limitations on LOS, eschewing any complex modeling to simulate classification, recognition or identification.

MOBILITY AND FIREPOWER KILLS

In Combat! Normandy Mobility (M-KILL) and Firepower (F-KILL) probabilities were an inherent part of the DFET tables for each firer/target combination. Probabilities for K-KILL, as well and M-KILL and F-KILL may overlap. While the rules explained that M/F-KILL results were ignored in the case of a K-KILL, things could be a little confusing. What was also explained was the overlapping of M and F-KILL results would lead to a tank that was unable to move or fire for the remainder of the game. Such a tank was differentiated from a K-KILL in that the latter was 'brewed up', i.e., burning, whereas a tank suffering both an M and F-KILL result would be a non-burning hulk.

M and F-KILL results have been removed from the DFET tables in Combat! Stalingrad, getting their own table. The M/-KILL Table only comes into play if a K-KILL result is achieved on a DFET with a doubles dice roll. In the event, there is no effect (i.e., the subsequent dice roll fails to fall within the listed percentages for an M-KILL, K-KILL [or both]) the K-KILL result stands. Otherwise, the M/F-KILL result(s) are applied instead.

It is important to note that armor factors *do not apply* to the M/F-KILL Table or the Suppression Table. They are only used on the DFET tables.

AFV SUPPRESSION

The concept of AFV suppression is both simple and critical as modeled in the Combat! Game System. The effects of fire on an AFV that results in no other 'results' may cause Suppression. A roll is made on the Suppression Table, noting the gun caliber of the firing weapon, as well as the range.

The effects of being Suppressed are simple to implement in that a Suppressed tank functions normally in all respects with the following exceptions:

1) Cannot use Trigger Pull 2 columns on any table;

2) Remove already-placed Acquired Target markers;

3) Penalized by Screened Shot Table DRM.

The inability to use TP 2 data is a very stiff penalty. For this reason we 'dialed down' the probabilities of becoming Suppressed in Combat! Stalingrad to allow tank vs. tank engagements to flow more freely.