Part II – The Methodology Used for Analysing Weapon System Effectiveness, and the Structure of the 1941 Soviet and Axis Resource Database

One of the objectives of this work is to formalise a generic analytical methodology for creating a realistic model of a country's armed forces, mobilisation, war-economy and military proficiency. In later volumes of this work, this methodology is then applied to the belligerents on the East Front during 1941, and can be used (if desired) to create a realistic simulation of Operation Barbarossa. With this in mind a Fully Integrated Land and Air Resource Model (FILARM), or a Partially Integrated Land and Air Resource Model (PILARM), will be created for all the combatants involved on the East Front from 22nd June to 31st December 1941; a period of 193 days.[1] One of the key foundations of the integrated land and air models is the concept of 'resources'. This is a rather clinical way of describing the mass of people and equipment involved in making up the particular armed forces involved. The integrated land and air models need to represent all resources present at the start of the campaign, and all resources received from all sources during the campaign period. These resources are therefore the basic building blocks to be used in all model construction.

Accordingly, in each country's FILARM or PILARM model the initial chapters are concerned with reviewing, analysing and defining the specific resources that were available to that country from June 1941 to January 1942. The resultant list of defined resource entities is termed the 'Personnel and Equipment Resource Database', or simply the 'Resource Database', for that country.

Volume I, Part II of this work is concerned with defining what the individual resource entities contain in the Resource Database, and the methodology used to calculate each resource entity's attribute values. Although the methodology detailed here is generic (it can be applied to any weapon system or organisation), the focus is on technology from the first half of the twentieth century, and primarily on weapons and organisations from WWII.

1. The Database Resolution Level

For the largest and costliest military campaign in history involving many millions of personnel, hundreds of thousands of vehicles and heavy weapons, and thousands of combat units, the Resource Database cannot practically go down to individual soldier and small arms level. In addition the detailed variations in the internal structure of every small combat unit cannot be fully detailed as there were simply too many of them.

As late as the 1980s, the magnitude of Operation Barbarossa has dictated that most military simulations of this campaign went down to only division and brigade level. This was particularly true for manual map based simulations.[2] This means entire divisions were represented as single manoeuvre units with one set of numbers representing 10-20 000 men and thousands of heavy weapons. Individual divisions and brigades were the defined resource entities available to that side. In military simulation jargon we would define the '**database resolution level**' of these simulations as brigade level, and the smallest defined resource entities or 'database units' as brigades.

Even today most computer based simulations of Operation Barbarossa only go down to brigade level, although a few have attempted to go down to regimental level. Some existing operational level simulations (relating to the East Front in 1941) have a database resolution down to battalion and occasionally company level, but they usually only simulate particular operations within a limited geographic area and over a period of weeks. Ultimately the degree of realism achievable in any military simulation is proportional to the simulation's database resolution level. However it must be borne in mind that this is still only one of many factors contributing to the eventual realism of the simulation.[3]

The very ambitious goal of 'Operation Barbarossa: the Complete Organisational and Statistical Analysis, and Military Simulation' is to go much further than even company level. The objective is to create a Resource Database with a database resolution level down to individual vehicles, heavy weapons, and small self-contained personnel based entities (such as infantry squads, cavalry squads and combat engineer squads). Heavy weapons in this case include anything equal to or heavier than a light machine gun (LMG).

[1] For the Slovakian, Hungarian, Rumanian and Italian forces we only require and will use a Partially Integrated Land Air Resource Model, (PILARM). Partial in this case means a model of only those forces directly involved in Operation Barbarossa and not all the armed services of those countries.
[2] Refer to Volume I, Part I 1. 1) – 'Studying Military History Using Operational – Strategic Simulations - The Evolution of Military Simulations and War Gaming'.
[3] Refer to Volume VI - for more on other factors affecting the realism achievable by a military simulation.

There are five very important reasons for selecting this level of database resolution:

i. **The 'squad' is a suitable level to use because during WWII the squad was normally the smallest tactical manoeuvre unit on the battlefield**.[4]

The crew of individual heavy weapons larger than a HMG are also of similar size to a squad, and able to function similarly.

ii. **The historical TOE information available for WWII is largely structured down to this level**.

This implies that when staff officers and high commands thought up new TOEs for organisations to fulfil particular missions, they never seriously thought in terms of resource combinations below this level.

iii. **Software exists today which enables the continuous tracking of millions of individual database resources over time and space, with each resource being affected by individual external factors**.

These factors include combat, movement, logistical supply, terrain and weather. The speed of PCs today enables us to create this 'monster', and once it is created we can concern ourselves with day to day operational decision making. We do not have to execute the millions of calculations each turn to determine the change of state of each individual resource over time. This latter consideration is the main limitation on even the largest and most sophisticated board based military simulations.

iv. **The true impact of individual weapons and weapon types on an armed force's overall combat power can be determined**.

At database resolution levels higher than company level, the effect of one side having superior weapons (and superior numbers of weapons) is very difficult to ascertain. Weapon effects are treated in an abstract fashion, and any weapon effects usually manifest themselves in estimates of higher attack and defence values in the basic database unit. These global type estimates tend to be very inaccurate and in many cases are simply the results of 'educated' guesswork. They don't consider in detail the true relative combat power of individual weapons or their actual distribution within the database unit.

For example, in military simulations with a database resolution level down to only brigade level, the combat power of panzer or armoured divisions is most often tied directly to the number of tanks in the unit. Yet in these divisions 50-80% of their combat strength resides in motorised infantry, artillery, engineer, reconnaissance and other support units, and not simply armour. This is particularly the case in a defensive posture or in the exploitation phase of a breakthrough. The full impact of weapon effects on determining each side's Relative Overall Combat Proficiency (ROCP), is discussed in Volume V on combat proficiency.[5]

v. **This level of database resolution allows us to create a fully integrated model that tracks the availability of resources resulting from that country's war and mobilisation effort**.

In many WWII histories and military simulations, a country's war effort is credited with producing x number of divisions and x number of other military organisations, without any real analysis of what was actually in those units. A so called 'division' could have historically been a number on a map representing anything from a few thousand scraped together and ill equipped militia, to a Waffen SS panzer division with close to 20 000 men and a great deal of very lethal equipment. It is always misleading when historians talk of combat power or numerical strength on a particular front in terms of numbers of divisions.

A database resolution down to the squad level enables the true strength of any military organisation to be accurately ascertained, and enables accurate modelling of the flow of resources into and out of these organisations. Simply creating new divisions will not win a war if the country's war economy and manpower resources cannot fill them to anything like their TOE. Enabling us to accurately ascertain the true nature of the various combat units historically fielded, is the essence and power of the Fully Integrated Land and Air Resource Model (FILARM).

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[4] The squad usually had 6-14 men (normally around 10 in an infantry squad) with a leader, independent equipment and ammunition, and (in some armies) individual communication. The term 'section' is sometimes used to describe the same unit, or sometimes a half-squad. For our purposes a section will be used to describe a half-squad. Normally only 'special forces' or other covert groups would conduct independent operations with smaller units than a squad.

[5] Refer to Volume V, chapter and section titled – 'Relative Overall Combat Proficiency (ROCP): the ROCP of Soviet and Axis Forces from 1941-1945 – Axis and Soviet Relative Overall Combat Proficiency (ROCP) in 1941 - Weapon Density (WD) Effects on the 1941 German-Soviet ROCP'.

1) Database Unit Resources in the Integrated Land and Air Resource Model

The first step in creating the database resources down to individual squad, vehicle and heavy weapon level, is to select an appropriate yardstick or measure on which to base our analysis. The appropriate measure for our purposes is the lethality of the weapon or database unit. The lethality of the weapon or database unit is defined as 'the inherent capability of a given weapon or unit to kill personnel, or to make material ineffective in a given time period'. This capability is inherent in the weapon or unit: it is either independent of training and deployment, or it assumes the training and deployment is the same for all sides. The term we will use to describe this inherent lethality is **Overall Combat Power Coefficient,** hence referred to as the weapon's or database unit's **OCPC.**

The main focus in determining a weapon's OCPC, is on the inherent ability to inflict all types of personnel casualties and overall equipment damage. At first glance this can lead to apparently odd OCPCs for certain weapon types. For example, many fighter aircraft have a relatively low OCPC compared to most ground units because they are specifically designed to destroy enemy aircraft and gain air superiority. Their ability to inflict general personnel losses on ground troops and destroy most ground based equipment is limited. However their ability to kill aircraft, i.e. lethality against a specific target type, is very high.[6] Similar arguments apply to anti-tank guns, super heavy artillery and many other weapons. Generally, weapons designed to kill a specific target type will have lower OCPCs but obviously much higher lethality against specific targets. Weapons designed to kill many targets will have higher OCPCs but may be ineffective against certain target types. The reader should always bear this in mind when viewing a weapon or database unit's OCPC.

The task of calculating any weapon's lethality has been approached by several military simulation methodologies, because it is a fundamental first step in attempting to replicate any armed force's overall combat power. These analyses vary from the cursory to the very detailed. On balance, tactical level simulations spend a lot of time and effort on the physical attributes relating to individual weapon lethality, but very little on the inherent lethality of squad level units or combat units of platoon size and above. In addition many tactical level simulations produce attack and defence figures against specific target types, but only for very limited tactical scenarios. Operational level simulations usually only cursorily analyse weapon OCPCs. They mostly present generic values representing a weapon type's inherent lethality, without focusing on the actual weapon details.

What we require is a methodology to enable the inherent lethality (as defined above) of individual weapons (and weapon systems) to be calculated, which includes factors such as weapon range, rate of fire, accuracy, radius of effects and battlefield mobility. At the same time the methodology must enable the calculation of the inherent lethality of individual squads and all types of vehicles, both of which may have multiple heavy weapons.

After reviewing several established methodologies, the one producing results along the lines of what was required, was originally developed for the Dupuy Institute's Quantified Judgement Model (QJM), and (to a lesser extent) the Tactical Numerical Deterministic Model (TNDM).[7] QJM is probably one of the most well known, tested, reviewed, scrutinised, controversial and criticised combat models designed. In other words, quite acceptable as a starting point for an accurate calculation of a weapon or combat unit's inherent lethality.

However in relation to creating the 1941 Soviet and Axis resource database, this methodology lacks crucial aspects. To name a few: there is no methodology related to calculating lethality of small dispersed units such as infantry squads, the calculated defensive strength for non-mobile weapons (including small units such as squads) is missing, the defensive strength calculation for mobile land weapons (including tanks) is too simplistic, and the entire treatment of aircraft is missing several vital factors. For the purposes of this work, the QJM methodology has been heavily modified. This has mostly taken the form of additional factors not included in the original methodology. In many cases, modification of the basic underlying formula relating to certain factors has also been undertaken. Where appropriate, some of these changes are indicated by foot notation in the following methodology.

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[6] Note, fighter bombers generally have a considerably higher OCPC than pure fighters, but they are no more effective (and are usually less effective) against enemy aircraft.
[7] T. N. Dupuy, Numbers, Predictions and War, Hero Books, Fairfax Virginia, 1985. Also, T. N. Dupuy, Understanding War: History and Theory of Combat, Paragon House Publishers, New York, 1987.