Demystifying the Correlation of Forces Calculator

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A correlation of forces (COF) calculator is a tool used to help planners compare the relative combat power of two forces and estimate the outcome of engagements between them. Several versions of COF calculators are in use in the Army today. Most take the form of Excel spreadsheets, but they have been converted into Command Post of the Future (CPOF) products as well.[1] Because the Army has not adopted an official version and the versions floating around in staff officers' "kit bags" come without instructions or documentation, leaders and staff officers invariably question the validity and utility of their use. This article describes the development of the COF calculator currently in use with the Department of Army Tactics (DTAC) at the U.S. Army Command and General Staff College (CGSC). It will address the methodology used to determine the values, suggest appropriate uses of the tool, and suggest some ideas for adding professional judgment to the results.

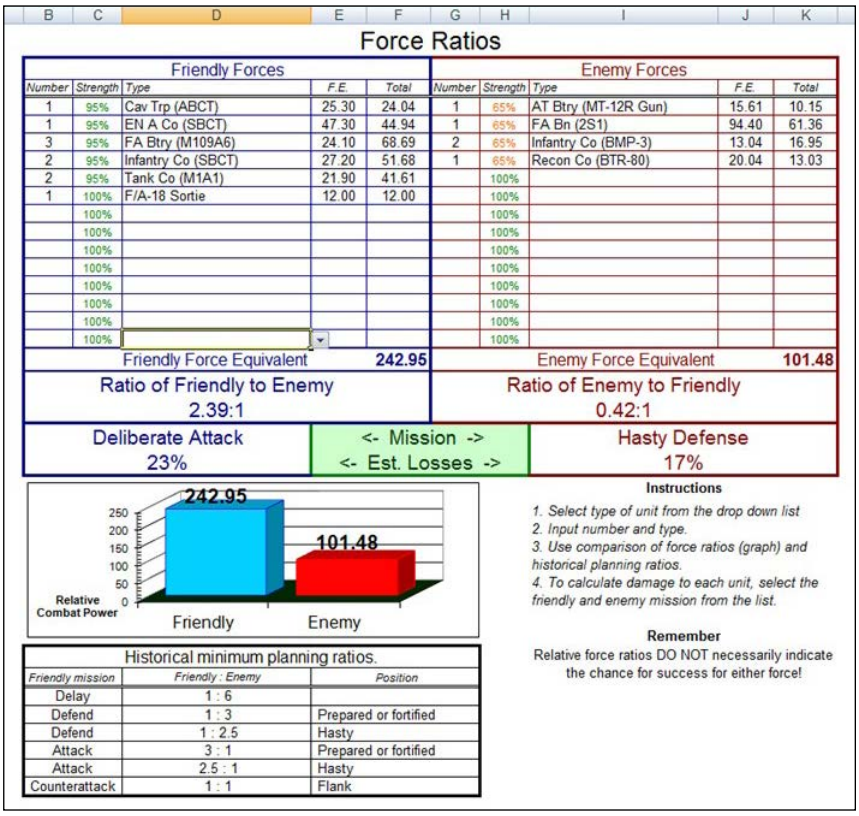
Background

The idea of force ratios (outnumbering an enemy by at least three to one in the attack for example) is found in historical text throughout the ages. When combatants were all armed symmetrically, that math was both easy and intuitive. As weapons became more complex and varied, the ability to measure and compare combat power became more challenging. Two men with a Maxim machine gun were clearly not equal to two with rifles. This complexity drove a demand for increasingly complex models and simulations to predict the outcome of battles when leaders lacked actual combat experience. Unfortunately, the tactical planner rarely has time for this complexity and has the need for a simple tool that can give the staff insight. A CGSC student handbook served this purpose through most of the 1980s.

The Soviet Union made extensive use of correlation of forces and means (COFM) computations in military decision making in the latter half of the 20th century.[2] The Soviets perceived the prediction of outcomes based on mathematical modeling as an efficient means for commanders to reduce risk and to allocate forces.[3] In 1993, LTG David Hogg, then a major, researched the topic and concluded that the Army continued to rely on several subjective methods for comparing forces. He differentiated the COFM calculator as the addition of intangible factors such as morale, training, terrain, weather, and leadership to the more quantifiable aspects of combat systems captured in the COF calculator.[4] He proposed that the Army adopt a standardized COF model based on objective data to facilitate staff planning.[5] Usage of COF and COFM calculator terms has blurred over the decades as Army doctrine codified the need for such a tool.

Field Manual (FM) 101-5, *Staff Organization and Operations*, and FM 5-0, *Army Planning and Orders Production*, described comparing force ratios in the initial step of coarse of action (COA) development. Both manuals — as well as the current manual for deliberate planning, FM 6-0, *Commander and Staff Organization and Operations* — observed that mathematical comparisons are subjective and should be tempered by judgment surrounding intangible factors as well as the number and type of vehicles in units. In 2012, faced with the requirement to re-green students on atrophied skills associated with

Figure 1 — Example Force Ratios (Microsoft Excel [R] Version)



combined arms maneuver, instructors at the CGSC dusted off the old COF calculator referenced by LTG Hogg. The existing CGSC product proved to be too outdated and insufficient for the formations employed in instructional scenarios. It based unit values on a subjective comparison of Soviet-era forces against U.S. forces with BTR- and M113-equipped battalions serving as the base units.[6] An updated tool based on modern brigade combat team (BCT) and enemy formations was necessary. Furthermore, unit values needed some objective basis to ensure utility and some degree of validity in anticipating outcomes in combat operations. Finally, the tool's construction needed to use data that could be updated as modified tables of organization and equipment (MTOEs) and combat system changes occurred in the future.

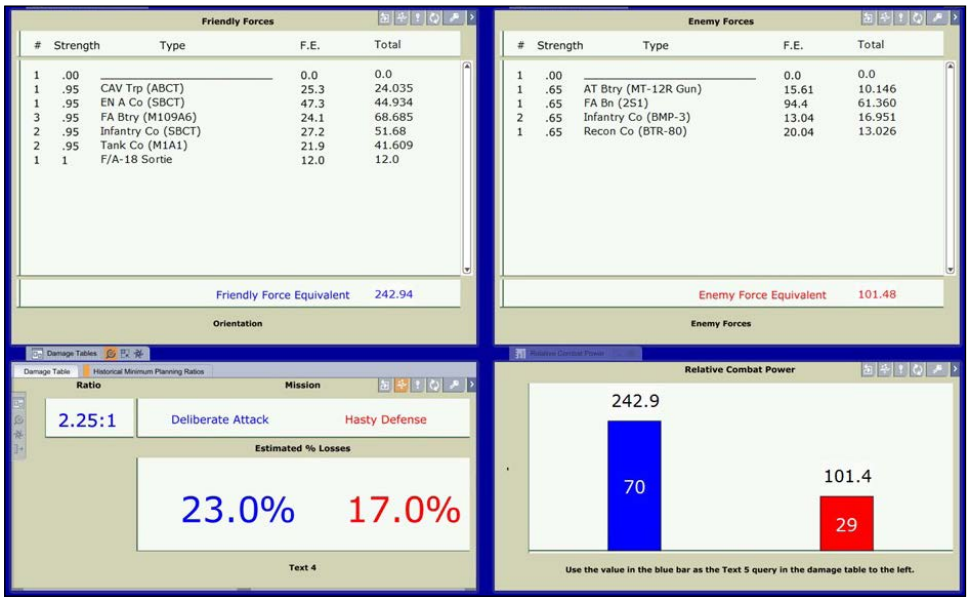


Figure 2 — Example Force Ratios (Mission Command Workstation [CPOF] Version)

To get objective values for combat systems, DTAC turned to work done in 2004 by the Training and Doctrine Command Analysis Center (TRAC). The center had analyzed the characteristics of many NATO and threat systems — principally in the areas of mobility, firepower, and protection — to create a tool to aid exercise designers in developing appropriate force mixes for their training audiences. These spreadsheets were available in the Army Knowledge Online file area and became the basis for more objective values for systems within the updated CGSC COF calculator.

Construction

With objective data in hand, CGSC instructors computed new unit values using approved MTOEs from the Force Management System website (FMSWeb) for U.S. forces and decisive action training environment (DATE) opposing force (OPFOR) tables from the Army Training Network (ATN) for enemy forces. The instructors computed a combat potential for each unit from brigade down to company level by multiplying the approved number of systems for the organization against the TRAC-developed combat potential value for the system. Individual and crew-served weapon values multiplied against the TRAC value for each system replicated individual Soldiers in the formation. Company-through-brigade echelons allowed the calculator's use in deliberate planning for brigade-through-corps operations. All system combat potentials were summed, and the value for each unit was added to the data spreadsheet in the calculator.[7]

The next area for improvement was in the damage tables that estimated results after comparing combat potentials for the two sides. The existing calculator damage table referenced historical loss rates, and losses were given in 5 to 10 percentage point increments. Force ratios ranged from 1:4 odds to 4:1 odds with few subdivisions. This often created situations where students added significant forces to an engagement with no change to the result because there was not an intermediate loss level. A CGSC student deduced the formulas for the damage value curves within the older calculator.[8] CGSC instructors expanded the odds ratios to provide more subdivisions between ratios and included a 5:1 ratio (principally for deliberate attacks) and then integrated the appropriate damage values. These simple changes gave much more granularity and credibility to the results.

Application

FM 6-0 carries forward much of the original verbiage (and warnings) from FM 101-5 in using the COF calculator during the military decision-making process (MDMP). In COA development, COF provides an objective ratio of maneuver and artillery forces for an initial assessment of combat power. Doctrinal adherence to COA development requires allocating generic forces first and then specific type units in step 3.[9] The COF calculator can assist in this step by quickly checking whether the type of unit (infantry, Stryker, armor, engineer, etc.) assigned at the end of step 3 is appropriate against the OPFOR-type unit.

The strength of the calculator, however, is in the COA analysis step of MDMP. Typical use of the calculator is at the end of the reaction portion of wargaming. When the maneuver and fire support systems of both sides are entered into the calculator, the appropriate type of operation is selected for both sides, and the results are determined for each engagement. Based on the outcomes, planners might reconsider the allocation of forces to the engagement or tactical task to create a more favorable outcome — or accept greater risk by reducing forces when those additional forces result in the same outcome. For example, in a friendly attack, the blue force might determine that 14 percent losses were inconsistent with the commander's planning guidance and therefore change the task organization to add another unit to the engagement. The enemy defender in the same engagement might determine that the reinforcing artillery allocated to the fight will not create additional effects

but raises the exposure of that unit to counterfire and possible loss, so the red force might remove the fire support unit from the calculation. By adjusting the forces in the engagement, both sides create conditions more favorable to success and in doing so come closer to the reality of the upcoming engagement. From the outcomes, sustainment planners can anticipate the number of battle losses and casualties within each engagement to validate the maintenance, recovery, and medical treatment plans. Typically, staffs make a screen shot or copy results to a new worksheet within the COF calculator to maintain a record of the outcome for each engagement during wargaming. These products can help describe the outcomes of the wargame should the staff conduct a wargame results brief with the commander. Outcomes from one engagement affect subsequent engagements so both forces have a better appreciation for the attrition that will occur prior to the decisive operation.

Concurrent with determining the outcomes, planners use the calculator values as a means to determine appropriate commander's critical information requirements (CCIR) necessary for decisions. The calculator includes a strength field for the percentage of combat power remaining in the forces allocated to the engagement. The percentage strength of a unit affects the combat potential applied in the comparison. Therefore, manipulating the strengths of units (frequently based on assumptions in planning) can identify priority intelligence requirements (PIRs) and friendly force information requirements (FFIRs) where the engagement will result in a loss for the friendly side. For example, the blue side achieved success with an estimated combat power for its formations of 90 percent based on a standard operational readiness rate and the enemy force at 75 percent based on the expectations of higher to shape for the unit's engagement. If changing friendly force combat power below 85 percent results in unacceptable losses or failure to achieve the tactical task, then a friendly unit combat power at 85 percent becomes an FFIR indicating the commander might commit the reserve or allocate additional combat power (close air support, artillery fire priority, etc.) to avoid task failure. Conversely, if enemy forces at 80 percent cause the same effects, then enemy forces at that location above 75 percent might become a PIR to again trigger a decision to shift friendly combat power to the engagement or to shape the objective prior to committing forces to the close fight. With this data in hand, staffs are better able to justify force-related CCIR to the commander and to anticipate probable decision points during wargaming.

The calculator can also facilitate decision making during execution. Current operations and future operations cells can use the calculator to compare current capabilities of forces for an upcoming engagement to determine whether the outcomes are still consistent with the plan. Not only can commanders anticipate allocating additional forces (or perhaps reallocating "excess" forces) based on the calculator outcomes, but staffs can also anticipate enemy changes in force allocation when the enemy appears to be destined for failure. This can be critical in adopting greater protective measures as an execution decision rather than learning later that a force imbalance caused the enemy to deviate from his plan necessitating an unanticipated adjustment decision for the friendly commander.

The COF calculator can provide valuable insights into an engagement and is very useful in standardizing the results of wargaming. However, it has several obvious limitations that require sound judgment from the user to mitigate. These include factors such as terrain and weather, asymmetries in the engaged forces, the echelon of formations being compared, the duration of the wargaming turn, and the physical space of the action.

The Need for Professional Judgment

The COF calculator can provide valuable insights into an engagement and is very useful in standardizing the results of wargaming. However, it has several obvious limitations that require sound judgment from the user to mitigate. These include factors such as terrain and weather, asymmetries in the engaged forces, the echelon of formations being compared, the duration of the wargaming turn, and the physical space of the action.

First, the COF calculator in its current form makes no attempt to account for the effects of terrain. All units get the maximum value of all their weapon systems regardless of range. Clearly, all units do not fight equally well in all types of terrain. We would expect significantly poorer performance from a tank platoon in a marsh or from an infantry platoon in a barren desert. When terrain provides an obvious advantage to one formation or the other, the planner can either subjectively weight or devalue the combat power before it goes into the equation or subjectively adjust the outcomes. Similarly, the calculator does not consider the effects of weather or light on operations directly. Combat potential values in the data worksheet include maneuverability and night-vision capability in the total values, but there is no bonus or penalty for restricted terrain or limited visibility operations. One or both sides might have degraded capabilities and therefore fewer effects within the calculator. This typically applies to effectiveness of close air support and attack aviation; an executive officer (XO) might degrade combat power for both by 25 percent to account for limited visibility.

Second, asymmetries in weapon system capabilities can cause skewed results. For example, anti-tank platoons or air defense artillery (ADA) platoons often have very specific munitions that are only really useful against the targets for which they are designed. While there are formulas to mitigate these asymmetries, the COF calculator does not attempt to account for them.[10] Rather, these asymmetries average out when the engagement being modeled is a combined arms engagement, and the results are generally useful. But for an engagement where one side is predominantly one kind of specialized unit,

the results do not always reflect what we would expect. For example, a U.S. tank company has a value of 23 while a self-propelled artillery battery has a value of 28. In a direct-fire engagement, the tank company clearly has an advantage, and the planner's judgment would need to take over. The calculator focuses on the close-combat engagement and is not capable of assessing the effects of air defense against aviation or of counterfire against indirect fire systems. While staff officers might have the tools available to determine probability of kill for air defense or the reaction time of counterfire assets (and therefore the potential disruption of fire support to a close combat engagement), it might be easier to agree in advance to degrade the effects of aviation and artillery by 25 percent if engaged by ADA or counterfire, respectively.

System asymmetries apply similarly when comparing elements of disparate echelons. Because the combat values reflect the inclusion of logistics and command and control capabilities within each unit, larger formations have a higher combat potential value than the sum of their subordinate combat units. Whenever possible, only compare elements using the same echelon — probably two levels down to be consistent with the doctrinal allocation of forces in COA development. If the planner compared an entire U.S. armored BCT (ABCT) to a single enemy tank battalion, the results would be skewed heavily in favor of the ABCT because it includes all the personnel and equipment of the brigade including the support battalion and headquarters. To mitigate this, the planner should break the ABCT into its component battalions and only include the combat power actually committed to the engagement being modeled.

This brings us to the fourth concern. It is important to know how long a turn your engagement is considering. If you are modeling a small tactical engagement that would play out over the course of minutes or hours, adding in all the HQ and logistics units should be avoided. If, however, you are working at a higher echelon and you are wargaming the events that take hours or days, the inclusion of HQ and logistics elements makes sense as it helps measure the unit's ability to sustain combat over time and recover from losses.

The fifth warning concerns the footprint of the units in the engagement. A common mistake as planners try to achieve favorable ratios is to keep adding units to one side or the other. This is often done without regard to how much physical space is needed to mass that combat power. When the combat power of one side becomes too dense, it may not accurately reflect the unit's ability to use all that combat power simultaneously without fratricide or significant risk to massed indirect fires. When a planner spots this happening, he or she should break the engagement into parts and model the engagement into sequential fights. An analog display with unit pieces scaled to the doctrinal footprint of the unit can help ensure only those forces that can actually engage each other are included in the calculations.

The goal for using the calculator is not so much to predict the outcomes of engagements as it is to add some objectivity to the force allocation process and to facilitate staff synchronization of the warfighting functions to achieve the effects directed in the plan. Rules of thumb for calculator shortfalls allow the staff to focus more on synchronization by accepting the calculator outcomes as good enough rather than an intellectual tug of war between the S2 and S3 over whether a system or unit was truly destroyed. Wargaming will progress more smoothly, making the outcomes more timely and synchronized.

Future

With continual changes to Army formations, the CGSC version of the COF calculator will likely go through continued revision. TRAC is developing a stand-alone version of the calculator for use by force developers, but their version will remain classified. The CGSC version is unclassified to allow maximum use in Army units and schools. CGSC's next major revision will be the addition of U.S. Marine Corps units to create a joint tool for land operations planning. The most current version will always be posted for use by unit leaders and planners to DTAC's MilSuite page in the Battlefield Calculations section at https://www.milsuite.mil/book/community/spaces/cgsc/tactics_community. Although still a tool and not a simulator to predict engagement outcomes, the CGSC correlation of forces calculator will continue as a means to better anticipate the effects of force allocations in close combat planning and to drive better tactical decision making among future staff officers and commanders.

Notes

[1] Credit to William Plotner who originally designed the CPOF application for CGSC student use; the tool has since been used throughout the Army.

[2] MAJ James K. Womack, "Soviet Correlation of Forces and Means: Quantifying Modern Operations" (Master's thesis, CGSC, 1990).

[3] Ibid.

[4] MAJ David R. Hogg, "Correlation of Forces: The Quest for a Standardized Model" (Master's thesis, CGSC, 1993).

[5] Ibid, 6.

[6] Ibid, 16.

[7] The CGSC version of the calculator has values for British, Turkish, and Azeri units to support the CGSC curriculum. Values for these units are based on known equipment and personnel strengths when available and on like type organizations when not.

[8] Credit to MAJ Brian Merkl who reproduced damage value curves to best fit the damage values in the original COF calculator.

[9] FM 6-0, *Commander and Staff Organization and Operations* (May 2015), 9-20.

[10] Womack, "Soviet Correlation," 39-40.

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