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Russian Assessments and Applications of the Correlation of Forces and Means

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Preface

Russian assessments of the correlation of forces and means (COFM) are of interest to a number of U.S. and Western agencies responsible for military strategy, planning, doctrine, and training. As the Russian military has begun to rebuild and reassert itself, it has again become necessary to understand how the Russian military functions and how it assesses its relative strengths and vulnerabilities when compared with its main competitors and threats. This report—which relies exclusively on publicly available sources and information—examines the methods Russia uses for COFM assessments and provides a new baseline outlining recent developments in Russian military thought on the subject. This report will be useful to U.S. and allied military strategists and planners working on U.S. and NATO force posture, force development, and deterrence.

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Summary

Throughout the Cold War, the United States and its allies sought to understand virtually every aspect of the Soviet military—including how it defined and assessed correlations of forces and means (COFM). The international environment and new security threats that emerged following the collapse of the Soviet Union shifted the United States' focus away from the large-scale military problems prevalent during the Cold War to different concerns such as terrorism, regional ethnic conflict, and nuclear proliferation. As U.S. security concerns evolved, in-depth analysis of COFM and other issues related to understanding military balance and competition between major powers received relatively little attention from military planners and analysts. To bridge this gap in knowledge that emerged in the early 1990s, this report examines COFM's evolution in Russian military thinking and explores current definitions and applications in Russia's operational and military planning. The report also briefly describes other Russian comparisons of state power that historically were a part of Soviet policy-level assessments of the correlation of forces.

In modern Russian political and military parlance, COFM describes the military balance between two opponents at the global, regional, and local levels by providing a relative rating of one side's military superiority over the other. A COFM calculation primarily serves as an operational planning tool that uses general quantitative and qualitative indicators. At the operational level, these calculations help Russian commanders make decisions on force composition and courses of action. At Russia's most-senior defense policy levels, COFM analyses inform broader security assessments such as the military-political situa-

tion (*voennaia-politicheskaia obstanovka*, VPO, in Russian) and strategic decisionmaking on issues such as force structure and disposition. The National Defense Management Center is responsible for monitoring and processing information, such as COFM assessments, and providing them to Russia's General Staff, the Ministry of Defense, and possibly to the president. Using historical experience, COFM at this level likely is less detailed than operational assessments and is focused on broad regional and overall counts of weapons and combat formations. In particular, policy-level COFM assessments emphasize the strategic nuclear balance, weapons developments disrupting strategic nuclear parity, and large adversary force deployments that might threaten Russian security. For example, Russian Minister of Defense Sergei Shoigu, in a 2018 interview, emphasized the importance of monitoring foreign force postures in Europe and other strategic directions to identify deployments resembling the buildup of combat power that preceded recent conflicts, such as Yugoslavia in 1999.[1]

At the operational level, a COFM assessment is part of a planning process that involves running "operational-tactical" calculations with the use of computer-based computations. COFM in this context is often based on what the Russians refer to as *combat potentials* (*boevye potentsialy*), which are values assigned to weapons and formations that serve as the building blocks of COFM. The values quantify the quality of military weapons and equipment within a formation. Beginning in the 1970s, the most prominent approach used by the Soviet General Staff to derive combat potential values that were subsequently used for operational COFM assessments in command staffs was a system of models that included the Model of Strategic Operations, which also provided planners with forecasted outcomes of operations. The model was particularly useful because it could account for a wide variety of operational and environmental factors including weather, terrain, and troop morale and training. Regardless of the model's effectiveness and widespread use, it required considerable resources, time, and expertise to run, and the data obtained were only applicable to the specific sce-

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1 Rossiya24, "National'nyi tsentr upravleniia oboronoi," video, YouTube, December 30, 2016.

nario contemplated by the model. As resources available for the maintenance of large-scale combat modeling and field testing diminished in the 1980s, the Soviet General Staff sought new approaches to derive combat potential values in more cost-effective manner.

In 2008, the Russian General Staff mandated the use of a method (hereafter, "the Method") using qualimetry (a Russia-based field that attempts to use mathematical methods to quantify the quality of any object) and expert elicitation to determine combat potentials of weapons, military equipment, and combat formations of the Russian Armed Forces and foreign militaries, from the division to battalion level.[2] These combat potential values are published in tables that are used by command staffs to calculate COFM and assist commander decisions on force composition and courses of action. The current Method for combat potential and COFM assessments has drawn considerable criticism within the Russian military. One of the most common concerns is that the Method does not consider specific combat conditions of military formations or the synergies between them in a sophisticated way (i.e., how they interact and are employed). This and other apparent flaws of the current approach to COFM remain a source of intense debate within the Russian military today and raise questions about the quality of output this methodology provides to Russian commanders and planners.

The changes that have taken place in modern warfare over the past four decades have had an impact on the way Russians think about COFM beyond methodological considerations. In World War II, Soviet quantitative superiority in key combat areas—approximately three to one in most cases—led to significant operational successes in 1944 and 1945. During the Cold War, when prepared defenses of large formations characterized the most probable theaters of operations, the Soviets staked their conventional strategy on overall superiority in ground forces personnel and armor. For example, Soviet General Staff calculations suggested a rough requirement of a 6:1 advantage in

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[2] The Method, known as the "Method for Assessing Combat Potentials of Arms and Military Equipment and Combat Formations of the Armed Forces of the Russian Federation and the Armed Forces of Foreign States," is examined in detail in Chapters Three and Four.

tanks at breakthrough points during a war in Europe. More recently, Russian observations of the Western way of war have shifted emphasis to war waged predominantly from air and sea. This type of warfare is supported by a large number of long-range precision munitions; unmanned aerial systems; a highly capable command, control, communications, intelligence, surveillance, and reconnaissance (C4ISR) infrastructure; and air-based electronic warfare capability, all of which precede the introduction of ground forces. The Russian General Staff now views the concept of warfare that requires a protracted conflict with attrition of forces at the front to have a strategic effect as anachronistic. In Russian military literature, the most common planning scenario for Russia is a North Atlantic Treaty Organization (NATO) aerospace attack theoretically involving up to 12,000 cruise and ballistic missiles against a variety of targets using forces based far from Russia's immediate periphery and ground forces.

"Noncontact warfare," as the Russians often refer to the Western way of war, can have a strategic effect during the initial period of war. This means that the attrition phase is no longer the critical phase due to the strategic threat to the economy, political order, and national leadership, which has to be defended from the outset. Given the proximity of a possible large-scale war to Russia's border, long-range precision-strike weapons create significant military planning challenges because of perceived threats to Russia's military-industrial production capacity to sustain a fight, among other critical military and political infrastructure. The production timelines and large supply chains of modern weapons make the destruction of military-industrial potential even more consequential than in the past. Thus, the quality and quantity of adversary air and sea platforms and of cruise and ballistic missiles, the enabling information infrastructure, the timelines to build up such forces in theater, and the capabilities required to counter these assets and disrupt their deployment are considered decisive factors by Russian military officers and analysts.

Because of the disparity in overall conventional military and nonmilitary potential between NATO and Russia, tactical and strategic nuclear weapons, in addition to conventional long-range strike and strategic air defense capability, are central components in current Russian

military strategy to deter NATO, with ground forces playing a smaller role than in the past. As mentioned previously, the critical force correlation, from the Russian perspective, is NATO's capability to build up forces and execute conventional precision strikes at depth from air and sea, and Russia's capability to disrupt such an attack. Unofficial Russian analyses of a hypothetical NATO-Russia war have suggested that in the event of a large-scale aerospace attack that expands beyond a localized area with conventional munitions, Russia might respond with tactical nuclear weapons. One report, for example, noted that the maintenance of a stockpile of tactical nuclear weapons is, in part, a means to respond to a large-scale (i.e., not localized to a single region) NATO conventional aerospace attack involving thousands of cruise and ballistic missiles, and that Russian tactical nuclear weapons could be used in the early phases of such a war.[3] The lack of ability to respond in kind to a conventional aerospace attack with precision munitions has been described as NATO's "escalation dominance," because Russia, given the assumption of inferiority in precision munitions, platforms, and enabling infrastructure, could be faced with the choice between capitulating on unfavorable terms or escalating to nuclear use with the accompanying risks of mutual assured destruction that would bring.[4] As a result, since 2011, Russia has been attempting to reduce the quantitative imbalance by rebuilding its own conventional long-range strike capability and capacity as a form of nonnuclear deterrence.[5]

Changes in geopolitics and domestic realities also had considerable influence on the overall force structure of the Russian armed

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[3] A. G. Arbatov, Vladimir Dvorkin, and Sergei Oznobishev, eds., *Rossiia i dilemma iadernogo razoruzheniia*, Moscow: Institute of World Economy and International Relations, 2012, pp. 86–87.

[4] Andrei Kokoshin, *Ensuring Strategic Stability in the Past and Present: Theoretical and Applied Questions*, Cambridge, Mass.: Belfer Center for Science and International Affairs, 2011, p. 78; N. E. Makarov, "Vazhneishaia zadacha voennoi nauki—razrabotka kontseptsii netraditsionnykh voin i vooruzhennykh konfliktov," *Vestnik Akademii voennykh nauk*, Vol. 2, No. 35, 2011, p. 15; A. A. Dynkin, ed., *Mir 2035: Global'nyi prognoz*, Magistr, 2017, p. 261..

[5] V. M. Burenok and O. B. Ochasov, "Neiadernoe sderzhivanie," *Voennaia mysl'*, No. 12, 2007.

forces. The conceptual framework for Russia's current conventional force structure, which remains largely a product of deep reforms begun in 2008, rested on several key assumptions. First, the Kremlin judged the probability of large-scale war involving Russia to be low, which, as of early 2020, remains an official assessment found in all strategic planning documents and official speeches. Second, the General Staff found that Russia should no longer plan to fight a war on two fronts simultaneously. To some degree, the Ground Forces personnel target of 300,000 troops by 2020 was a consequence of these assessments. Until recently, Russia did not possess a strategic reserve of ready forces, and the current numbers of such forces are perhaps 5,000 personnel. Third, Russia had neither the economic nor demographic capacity to maintain a force structure capable of sustaining large-scale war.[6] As a result, although the Russian military retains meaningful local superiority across its western front (in particular, in terms of land-based systems and personnel) Russia's current force structure on the whole is intended to overwhelm potential nonaligned adversaries on Russia's periphery using permanently ready forces and to deter a conventional or strategic nuclear NATO aerospace attack with tactical and strategic nuclear weapons, conventional theater strike assets, and strategic air defense systems.[7] Should a regional war break out, a critical element in Russia's military strategy is to exploit strategic mobility. Given the disposition of permanently ready ground forces, however, the movement of large force groupings could require Russia to accept greater risk in

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[6] Yurii Baluevskii, ed., *Voennaia bezopasnost' Rossiiskoi Federatsii v XXI veke*, Moscow: Center for Military-Strategic Studies of the General Staff of the Russian Federation, 2004, pp. 10–25; President of Russia, Voennaia doktrina Rossiiskoi Federatsii, February 5, 2010; President of Russia, Voennaia doktrina Rossiiskoi Federatsii, December 25, 2014.

[7] Andrew Radin, Lynn E. Davis, Edward Geist, Eugeniu Han, Dara Massicot, Matthew Povlock, Clint Reach, Scott Boston, Samuel Charap, William Mackenzie, Kaya Migacheva, Trevor Johnston, and Austin Long, *The Future of the Russian Military: Russia's Ground Combat Capabilities and Implications for U.S.-Russia Competition*, Santa Monica, Calif.: RAND Corporation, 2019, RR-3099-A, p. 14; Mikhail Barabanov, ed., *Russia's New Army*, Moscow: Centre for Analysis of Strategies and Technologies, 2011, pp. 20–21. For a view on problems for NATO posed by Russia in the Baltic region, see David A. Shlapak, *The Russian Challenge*, Santa Monica, Calif.: RAND Corporation, PE-250-A, 2018.

other key areas, such as along its southwestern border with Ukraine or in the Russian Far East.

Implications

There are several implications of the findings listed in the previous section. The Russian military leadership remains committed to the use of combat potentials in COFM assessments for operational planning. For a variety of reasons explained in this report, Russia is relying on an approach to COFM using expert elicitation whose veracity has been questioned by the former Chief of the General Staff, Nikolai Makarov, and numerous MOD scientific research institutes. Second, the combination of a reliance on data-intensive operational-tactical calculations, such as COFM, and apparent technological deficiencies in running them means that speed and complexity could create challenges in the way Russia prefers to plan operations during conflict. Relatedly, in the course of a conflict, Russia's military will require uninterrupted ability to conduct battle damage assessments to update required data and to run subsequent COFM calculations.

Third, the maintenance of conventional quantitative and qualitative superiority by NATO in capability areas that Russia believes most decisive—air and naval platforms, precision munitions, and the enabling C4ISR infrastructure—along with the assurance of strategic mobility in the face of resistance could have a deterrent effect against a conventional military attack, particularly given Russian concerns about NATO aerospace potential and a Russian ground force structure primarily intended for contingencies in nonaligned countries of the former Soviet Union. Relatedly, quantitative-qualitative superiority in weapons that could threaten Russian protection of forward forces and critical political, economic, and military infrastructure in the rear could strengthen NATO deterrence throughout the European theater. Because of the proximity of a possible conflict to Russia, there is an increased homeland defense burden created by holding at risk a wide range of targets both forward and rear along several axes.

Abbreviations

ADE	armored division equivalent
ALCM	air-launched cruise missile
APC	armored personnel carrier
BTG	battalion tactical group
C2	command and control
C3	command, control, and communications
C4ISR	command, control, communications, computers, intelligence, surveillance, and reconnaissance
COF	correlation of forces
COFM	correlation of forces and means
CBR	chemical, biological, and radiological
COA	course of action
EW	electronic warfare
FEBA	Forward Edge of Battle Area
FLOT	Forward Line of Own Troops
GDP	gross domestic product

GRU	Main Directorate of the General Staff of the Armed Forces of the Russian Federation
IMEMO	Institute of World Economy and International Relations of the Russian Academy of Sciences
KV	killer-victim
MED	Military-Encyclopedic Dictionary
MOD	Ministry of Defense (Russia)
MSO	Model of Strategic Operations
NDMC	National Defense Management Center
RARAN	Russian Academy of Rocket, Missile, and Artillery Sciences
SAM	surface-to-air missile
SFS	situational force scoring
SLCM	sea-launched cruise missile
TsNII MOD	Central Scientific Research Institute of the Ministry of Defense
TsVSI GSh	Center for Military-Strategic Studies of the General Staff
TVD	Theater of Military Operations
VAGSh	Military Academy of the General Staff
VPO	military-political situation
VUNTs VVS VVA	Military Scientific Training Center of the Air Force Military Academy
WEI	weapon effectiveness index
WUI	weighted unit value

CHAPTER ONE

Introduction

During the Cold War, the Soviet usage of the concept known as correlation of forces (COF) elevated what traditionally had been a routine military calculation. The term was ubiquitous in the speeches of senior Soviet political figures, which led to interest on the part of the West in determining what exactly the Soviets were referring to.[1] Greater clarity on how the Soviet leadership understood the COF vis-à-vis the United States and its allies could have had any number of policy implications for strategic competition with the Soviet Union. Documents from the Cold War suggest that a broad spectrum of data were compiled and presented to Soviet leaders who invariably concluded publicly that the COF was shifting toward the socialist camp, although behind the scenes "[e]ach leader [would] tend to be receptive to information or analysis that supports [favored policies] or that promises increased influence to himself or his bureaucratic constituency."[2] Other Western research in the 1970s and 1980s that analyzed Soviet political usage of the term also concluded that COF was an analytical concept for measuring the state of competition between the opposing camps using political, economic, and military indicators.[3] In the latter years of the Cold War,

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1 Judith K. Grange, J. Battilega, S. Bennett, and M. Summers, *Soviet Measures of Strategic Balance and Arms Control*, Greenwood Village, Colo.: Science Applications International Corporation, DNA-TR-86-229, April 21, 1986.

2 Director of Central Intelligence, "National Intelligence Estimate: The Soviet Assessment of the U.S.," NIE 11-5-75, October 9, 1975, pp. 1, 17.

3 See, for example, Julian Lider, "The Correlation of World Forces: The Soviet Concept," *Journal of Peace Research*, Vol. 17, No. 2, June 1980, p. 157; Richard Pipes, "*Correlation of*

despite continual forecasts of superiority and triumph over the West, the Soviets became concerned about new military technology—in the form of precision-guided munitions—and the Soviet Union's inability to keep pace.[4]

After the collapse of the Soviet Union and the end of the ideological competition that dominated the Cold War, political usage of COF as an all-encompassing measure largely disappeared. What remained were separate strategic assessments that encapsulated a variety of military and nonmilitary data—gross domestic product (GDP), military-industrial capacity, level of technological development, military and political alliances—and the traditional military application, which is most often referred to as correlation of forces and means (COFM).[5] Although military assessments of COFM informed Soviet political conclusions on the broader trend lines of international and regional force balances, the Soviet military understood a COFM calculation primarily as an operational planning method to evaluate the military superiority of one group of forces over the other in a given theater, with consideration also given to timelines of follow-on forces. As of late 2019, the Russian military continues to apply COFM to the same ends as its Soviet predecessor. In the rare cases in which Russian senior politicians use the term, they generally are referring to a balance of military forces overall or within a given region, and they are particularly focused on the strategic nuclear balance.[6]

Forces" in Soviet Usage—Its Meaning and Implications, Arlington, Va.: SRI International, SSC-TN-4383-2, March 1978.

4 Lester Grau, *Soviet Non-Linear Combat: The Challenge of the 90s*, Ft. Leavenworth, Kan.: Department of the Army, Soviet Army Studies Office, AD-A231 789, September 1990.

5 In COFM, *forces* represent formations and the personnel that comprise them, while *means* are the weapons and military equipment employed by the forces.

6 Putin rarely, if ever, uses the term correlation of forces and means and most often refers to a *strategic balance of power* in which he seems to have in mind strategic nuclear parity between Russia and the United States that is not threatened by the development of "global" missile defenses. See, for example, Vitalii Petrov, "Putin: Rossiia stremitsia sokhranit' strategicheskii balans sil v mire," *Rossiiskaia Gazeta*, November 18, 2016.

Scope of the Report

This report is generally limited to answering the question of how the Russian military assesses and applies COFM today. Although we briefly digress into a discussion of other Russian measures of state and military power, the emphasis is on the Russian military term, *sootnoshenie sil i sredstv*, or correlation of forces and means. The report is organized into six primary chapters. Chapter Two addresses the important question of the definition of COFM. Given the range of usage of the term during the Cold War, we devote considerable attention to how the Soviet and Russian militaries have understood and defined COFM since World War II. Because the evaluation of COFM evolved beyond a straightforward count of personnel, weapons, and equipment into a seemingly more sophisticated calculation, the third and fourth chapters provide a technical overview of how the Soviets and Russians incorporated the concept of "combat potential" into COFM assessments.[7] The fifth chapter identifies the Method most likely used in command staffs within the Russian military today, despite the many problems that Russian military researchers have identified with it.[8] We also show that the General Staff is attempting to impose unification across the Russian Armed Forces in terms of how COFM is calculated.

Chapters Six and Seven examine the application of COFM. The sixth chapter puts COFM in the context of operational planning. This is the primary area in which "operational-tactical" calculations like COFM are applied by staffs to inform commanders' decisions. Chapter Seven describes the intersection between COFM and Russian thinking about modern warfare and force structure. During the Cold War, the Soviet General Staff calculated a necessity for a 6:1 advantage in tanks under certain conditions and in certain breakthrough locations to conduct strategic operations in Europe. The chiefs of the Russian General

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[7] In Chapter Four, we summarize similar and significant U.S. efforts for scoring the "potential" of weapons and formation.

[8] The Method is based on principles of *qualimetry*, a Russia-based field that attempts to use mathematical methods to quantify the quality of any object, and expert elicitation to determine combat potentials of weapons, military equipment, and combat formations of the Russian Armed Forces and foreign militaries, from the division to battalion level.

Staff have argued that collisions of large fronts of ground forces are a thing of the past. From their perspective, modern war among advanced militaries will largely be waged in the aerospace and naval domains, particularly in the initial period of war, which is deemed to be decisive given the existence of strategic nuclear weapons. We also present our analysis of how the changing character of warfare is influencing force structure and capability development within the Russian military, and the areas in which military superiority or inferiority might be most consequential in the context of deterrence and the modern battlefield.

The Role of Military Science in the Russian Armed Forces and COFM

The discussion of COFM methodology at the operational-tactical level over the past fifty years has largely taken place within the Russian military science community. This group of experts works together with members of the military to solve problems associated with armed combat. Military science has a long history in Russia dating to at least the 16th century, although it draws inspiration from ancient Greece, Rome, and China. Russian military science is devoted to the study of future war using the laws and character of war, the latter of which evolves along with political, economic, and technological changes.[9] From the early 19th century through to 1991, one of the most important trends in military affairs was the buildup of massive armies and navies in Europe, equipped over time with more-sophisticated and lethal weaponry. The task of Russian and Soviet military science over this period was to understand how to build, train, and employ a force capable of defending the interests and survival of the state.

Military analysis since the early 20th century has emphasized the marriage of strategy, operations, and tactics in conflicts involving large

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[9] Jacob Kipp, *The Methodology of Foresight and Forecasting in Soviet Military Affairs*, Ft. Leavenworth, Kan.: Soviet Army Studies Office, AD–A196 677, May 31, 1988, p. 2; David M. Glantz, *Soviet Military Operational Art: In Pursuit of Deep Battle*, London: Routledge, 1991, p. 5.

combat formations to achieve desired military and political objectives.[10] Developments in military thought led to innovations during WWII, such as ". . . flexible forms of preparing and executing defensive operations that could transition to a counterattack . . . [and] breakthroughs of tactical and operational defense followed by the encirclement and destruction of large force groupings."[11] In the postwar period, critical questions included the role of nuclear weapons in warfare and desired conventional and strategic nuclear force structures to manage existing threats, first in Europe and later in Asia.

Russian military science remains organizationally divided into topic areas such as the theory of military art, force structure of the armed forces, military training, arms, command and control, military economics, and military history, among others. Russian military science falls under the purview of the Military-Scientific Committee (MSC) of the Armed Forces, which is led by General-Lieutenant Igor' Makushev and directly subordinate to the General Staff. The MSC oversees the work of various Central Scientific-Research Institutes (TsNII, in Russian) of the Russian Ministry of Defense (MOD). These institutes are either tasked with investigating questions related to the topic areas previously discussed, or they are directly assigned to support the service branches and combat arms. The 3rd Military-Scientific Research Institute (3rd TsNII), for example, conducts research for the Ground Forces and Airborne Troops. There are many other elements of the Russian military science system that fall outside this formal structure. The General Staff has the Center for Military-Strategic Studies (TsVSI GSh), which has produced influential research on the character of future war and COFM, and the General Staff Military Academy. Within each of the service academies there are also institutes that conduct relevant research. Independent organizations such as the Russian Academy of Military Sciences and the Russian Academy of Missile, Rocket, and

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10 As David Glantz notes, there was a brief departure from this approach in the Khrushchev era, when the predominant view centered on a "single option" concept that relied primarily on strategic nuclear weapons and gave less emphasis to operations and tactics of the ground forces. See David M. Glantz, *The Soviet Conduct of War: An Assessment of Soviet Military Capabilities (1982-1987)*, Soviet Army Studies Office, Ft. Leavenworth, KS, 2009, p. 2.

11 "Voennaia nauka," *Voenno-entsiklopedicheskii slovar'*, Moscow: Voenizdat, 2007.

Artillery Sciences (RARAN in Russian) provide forums for debating important military topics (see Table 1.1 for a list of selected military science organizations). Finally, civilian institutions and organizations, such as the Council on Foreign and Defense Policy, Moscow State University, and the Institute of World Economy and International Relations (IMEMO in Russian) continue to be important voices in the discussion of broad topics such as force structure, technology development, military strategy, and strategic stability.

Soviet and Russian specialists have examined the question of COFM methodology and its application to operational planning in journals and conferences sponsored by these military science organizations over the course of many decades, which continues to the present. The relevance of this background will become apparent throughout

Table 1.1
Selected Russian Military Science Organizations

Name	Functional Area
2nd TsNII MOD	Aerospace defense
3rd TsNII MOD	Weapons development for Ground Forces and Airborne
4th TsNII MOD	Missile, space, and aviation system research
12th TsNII MOD	Strategic nuclear weapons research
27th TsNII MOD	Command, control, and communications technology
46th TsNII MOD	Weapons development; state armaments program
Military Academy of the General Staff	Character of war; various
Center for Military-Strategic Studies of the General Staff	Character of war; various
Academy of Military Sciences	Various
Russian Academy of Missile, Rocket, and Artillery Sciences	Various

SOURCE: Ministry of Defense of the Russian Federation, "Nauchno-issledovatel'skie organizatsii," webpage, undated.

the report, as a number of the above organizations and individuals have played a role in the COFM debate. Members of TsVSI GSh have had the most important influence on the methodology, as have researchers at the 46th and 27th TsNIIs. The former chiefs of the General Staff, Yurii Baluevskii (2004–2008) and Nikolai Makarov (2008–2012), along with former Defense Minister Anatolii Serdyukov (2007–2012), were key players in the massive force structure changes that took place after 2008, along with the aforementioned civilian organizations and institutions. It is difficult to know which individuals or institutions are the most influential within Russian debates on various subjects. It is often possible only with the benefit of hindsight to identify important arguments or publications that carried the day. In the case of the 2008 military reforms, neither Serdyukov, Baluevskii, nor Makarov were broadly supported across the armed forces, but policymakers ultimately accepted their views and those of some civilian organizations as the most prudent approach at that time. Similarly, experts within TsVSI GSh apparently proved more persuasive than their detractors in developing a method for COFM.

CHAPTER TWO

The Definition of Correlation of Forces and Means

A challenge in understanding Russian approaches to assessing COFM is the fact that there is neither an authoritative Russian source on the subject, nor unified agreement among Russian military and political practitioners on a single approach to its assessment.[1] Today, Russian senior civilian officials who refer to COFM between Russia and the West likely have in mind a simple quantitative military balance and are particularly focused on strategic nuclear parity.[2] Colonels in the Russian military who work on command staffs understand COFM quite differently. For these officers, a COFM assessment is an important numerical indicator that uses a large volume of qualitative and quantitative data that informs operational planning. These assessments facilitate a substantiated decision by a force grouping commander on the proper force package and course of action (COA). Even within the Russian military, however, there are differing views on how COFM is best calculated, depending on the rank and service branch of the offi-

1 V. S. Brezgin and A. I. Buravlev, "O metodologii otsenka boevykh potentsialov tekhniki i voinskikh formirovanii," *Voennaia mysl'*, No. 8, 2010.

2 President of Russia, "Zasedanie Komissii po voprosam voenno-tekhnicheskogo sotrudnichestva Rossiiskoi Federatsii s inostrannymi gosudarstvami," press release, July 8, 2016; See, also, "NATO uvelichila prisutstvie v raionakh Evropy, gde dogovorilis' etogo ne delat'," RIA Novosti, June 28, 2017.

cer running the calculations and the context in which COFM is being discussed.[3]

Soviet political leaders from Lenin to Brezhnev invoked COF in reference to the struggle between the socialist and capitalist camps. They used this assessment to define which side was winning the competitive struggle of ideological systems. Key factors in the Soviet COF concept at the senior political level were not limited to military force balances. COF included economic and political capacity assessments, the number of ideological partner-states, and the perceived success of working class movements around the globe.[4] One historian observed that the Soviet view of "force," and the correlation thereof, went beyond military capability to include political and societal cohesion, economic potential, and the will to fight.[5] Declassified U.S. intelligence reports also suggested that military and nonmilitary data were compiled by the Soviets to assess the correlation of forces.[6]

Throughout the Cold War, Soviet military officers and analysts were also writing about COF—or, more often, COFM. The military discussions of COFM had a narrower connotation that was typically limited to the methods of comparison of opposing military formations, weapons, and equipment. Although the Soviet military literature on COFM evolved over time, the conversation most often focused on the military superiority of one side over another in peacetime and in wartime, with little discussion of nonmilitary factors.[7] According to one analyst who examined the Soviet literature on the military-strategic

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[3] A. S. Bonin and G. I. Gorchitsa, "O boevykh potentsialakh obraztsov VVT, formirovanii i sootnosheniiakh sil gruppirovok storon," *Voennaia mysl'*, No. 4, 2010.

[4] Michael J. Deane, *The Soviet Concept of the Correlation of Forces,* Arlington, Va.: Stanford Research Institute, SSC-TN-4383-1, May 1976, pp. 18–19.

[5] Pipes, 1978, p. 5.

[6] Director of Central Intelligence, "The Soviet Assessment of the U.S.," NIE 11-5-75, October 9, 1975, pp. 1, 17.

[7] See, for example, V. Siniak, "Problemy kompleksnoe avtomatizatsii urpavleniia sukhoputnymi voiskami," *Voennaia mysl'*, No. 11, 1958, p. 35; S. Tyushkevich, "Metdologiia sootnosheniia sil storon v voine," *Voennaia mysl'*, No. 6, 1969; B. I. Strel'chenko and E. A. Ivanov, "Some Issues in the Assessment of Correlation of Forces in Operations," trans. Clint Reach, *Military Thought*, No. 10, 1987.

balance, " . . . the decisive factor in achieving and sustaining military-strategic parity [with the United States] was the action taken by the leadership of the USSR in equipping the armed forces with missile-based nuclear weapons and modern conventional arms."[8]

The collapse of the Soviet Union brought an end to the struggle between the two ideological camps. As a result, the political application of the Cold War COF concept has all but disappeared from the vernacular of senior Russian officials. Although there are some contemporary examples of Russian officials using the term "correlation of forces" or even "correlation of forces and means," they are typically referring to matters of traditional nuclear or nonnuclear military balance and not to a broad conceptual framework to measure the condition of geopolitical competition among states.[9]

COFM in today's Russia is almost exclusively a military assessment that refers to an operational planning tool within the armed forces. It has additional applications in force-structure planning, weapons development, and other strategic decisionmaking. Considerations of such factors as political and economic potential, societal cohesion, and the will to fight remain important in Russian assessments of state power, but these inputs are not part of a formal COFM assessment that would occur within the General Staff or lower military command elements.[10] This section will therefore focus on how the Russian military defines COFM today, and this definition will serve as the foundation and scope for the remainder of the report.

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8 Vladimir Shardakov, *Otechestvennyi opyt dostizheniia i poderzhaniia voenno-strategicheskogo pariteta (40-80-e gg.)*, dissertation, Institute of Military History of the Ministry of Defense of the Russian Federation, 1994, p. 24.

9 "NATO uvelichila prisutstvie v raionakh Evropy, gde dogovorilis' etogo ne delat'," June 28, 2017.

10 A. I. Buravlev, "K voprosu ob otsenke mogushchestva gosudarstva," *Vooruzhenie i ekonomika*, No. 1, No. 34, 2016.

Soviet Definitions

The current Russian military concept of COFM is a derivative of more than a century's worth of military thought. During World War II, the assessment of military superiority—which is the essence of COFM—was a relatively straightforward process because weapons on the battlefield were considered qualitatively similar, and there were few types of weapons employed. Soviet literature on this subject makes it clear that the military, up to the 1950s, defined COFM as a strictly quantitative friendly-to-enemy ratio of personnel and a few types of weapons and equipment. COFM could apply both to overall numbers and to a given theater of military operations (TVD).[11]

Marshal Georgii Zhukov, who occupied several senior military positions in the Red Army during World War II, described the correlation of forces in the weeks prior to the massive Soviet counterattack against the Germans in Stalingrad in his memoirs. In his book, *A History of the Second World War, 1939–1945*, Zhukov recounted, "By early November 1942 the Nazis had on the Soviet-German front 266 divisions with a total strength of about 6.2 million officers and men, around 51,700 guns and mortars, 5,080 tanks and assault weapons, 3,500 combat aircraft and 194 warships."[12] A side-by-side comparison with Soviet forces, as presented by Zhukov, is shown in Table 2.1. Using these data, Zhukov argued that the " . . . correlation of forces began to tilt in favor of the Soviet Union."[13] Zhukov's COF assessment is consistent with many other Soviet and Russian military historians: It is limited to military personnel and material and is strictly quantitative, despite the fact that there were qualitative differences in weaponry at that time. Table 2.2 shows correlation of forces figures in key Soviet operations in 1944–1945.

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[11] See, for example: A. D. Borisov, "Am'enskaia operatsiia," *Voennaia mysl'*, No. 8, 1939, p. 33.

[12] Georgii Zhukov, *Marshal of the Soviet Union G. Zhukov—Reminiscences and Reflections*, Moscow: Progress Publishers, 1985, p. 109.

[13] Zhukov, 1985, p. 110.

Table 2.1
Correlation of Forces on the Soviet-German Front as of Early November 1942

	Totals	
Forces and Means	**Germany**	**Soviet Union**
Divisions	266	*
Personnel	6.2 million	6.6 million
Guns and mortars	51,700	77,800
Tanks/ assault weapons	5,080	7,350
Combat aircraft	3,500	4,544
Warships	194	—
Strategic reserves	—	27 rifle divisions, five tank or mechanical corps, six rifle brigades

*Not provided.
SOURCE: Zhukov, 1985, p. 109.

Table 2.2
Correlation of Forces in Critical Soviet Operations in World War II, 1944–1945

	Correlation of Forces (Soviet:German)				
Operation	**Manpower**	**Tanks**	**Guns**	**Airplanes**	**General**
Lvov-Sandomierz	1.3:1	2.4:1	2.2:1	4:1	2.2:1
Eastern Carpathian	1:1	3.2:1	1.5:1	2.5:1	2:1
Petsamo-Kirkenes	1.8:1	2.5:1	2.8:1	6.3:1	2.9:1
Vistula-Oder	4:1	5.7:1	6.7:1	7.9:1	5.8:1
Eastern Prussia	2.1:1	5.5:1	3.1:1	4:1	3.6:1
Berlin	2.5:1	4.1:1	4.2:1	2.3:1	3.4:1
Manchuria	1.2:1	4.8:1	4.8:1	1.9:1	3.3:1

SOURCE: V. N. Tsygichko and F. Stoekli, “Combat Potentials Method: Past and Present,” trans. Melissa Shostak, *Military Thought*, No. 4, 1997.

The 1980 *Soviet Military Encyclopedia* described the application of COFM and the quantitative boundaries of the assessment at the time of the war: "During the Great Patriotic War [World War II] depending on the echelon of command and control the correlation of forces and means was determined based on personnel; the number of formations (divisions, brigades, battalions), tanks, and self-propelled artillery, equipment and mortars (usually by caliber), antitank weapons, and aircraft."[14] There is no mention in the military encyclopedia of a more detailed analysis of qualitative factors considered during the war in comparing the troops, weapons, and equipment of the opposing sides, or a discussion of a broader consideration of nonmilitary factors.[15]

As the types of weapons proliferated and became more technologically advanced in the 1950s and 1960s, the Soviet General Staff sought an updated understanding of COFM that accounted for the increased sophistication in weaponry and went beyond simple bean-counting.[16] According to General-Colonel Andrian Danilevich, a Soviet General Staff officer from 1964 to 1990, in the early 1970s Soviet analysts worked to incorporate quality—which included control, accuracy, and reliability—into strategic COFM assessments. Danilevich went on to explain, as summarized by interviewers, " . . . there was a belief that analysis of quantity alone provides only half the analytical picture. Because of qualitative deficiencies, one side could have a tenfold advantage and still be behind."[17]

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14 "Tashkent—Iacheika," *Sovetskaia voennaia entsiclopediia*, Moscow: Voenizdat, Vol. 8, 1980.

15 Qualitative factors vary by context or author. For COFM assessments, *qualitative factors* often include unquantifiable technological characteristics of weapons and the type of battle, terrain, and related similar features exclusive of purely social or psychological ones such as morale or leadership. However, more-inclusive COFM assessments might also incorporate these additional features.

16 Vitaly Tsygichko and Fritz Stoeckli, "Combat Potential and Operational Planning—Past and Present," in Reiner Huber and Rudolf Avenhaus, eds., *Models for Security Policy in the Post-Cold War Era*, Baden-Baden, Germany: Nomos, 1996, p. 100.

17 John Hines, Ellis M. Mishulovich, and John F. Shull, *Soviet Intentions 1965-1985, Vol. II: Soviet Post-Cold War Testimonial Evidence*, McLean, Va.: BDM Federal, September 22, 1995, p. 22.

To resolve the issue of accounting for quality in COFM assessments, the Soviets adopted an approach using a concept called combat potential (*boevoi potentsial*). *Combat potential*, which reportedly was first coined by E. G. Anan'ev in 1958 in a doctoral dissertation at the Zhukov Air Force Engineering Academy, was a theoretical tool that allowed the Soviets to account for qualitative characteristics of a variety of weapons and military equipment, in addition to quantitative indicators.[18] The addition of combat potential values to COFM calculations was particularly useful if there were significant technological differences between the weapons and equipment of opposing sides. Although there is not a definition of combat potential in either the 1980 *Soviet Military Encyclopedia* or the 1986 *Military Encyclopedic Dictionary*, other Soviet and Russian sources have offered various definitions, which will be explained in detail in the following paragraphs but can be roughly summarized as contribution of a weapon or equipment (or combat formation) to the overall mission objective under certain conditions.

By 1980, combat potential had become a formal part of the approach to comparing heterogenous opposing forces.[19] As the 1980 Military Encyclopedia explained, " . . . [in cases] where combat capabilities significantly differ, coefficients for comparing combat potentials that have been calculated in advance are used."[20] In addition to combat potentials, other qualitative factors were also considered, such as level of training, will to fight, resiliency of command and control, among others, to find a "more objective determination of COFM."[21] The encyclopedia also noted that a strict quantitative comparison of

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[18] Brezgin and Buravlev, 2010, p. 42.

[19] The U.S. intelligence community in the 1980s had also identified combat potentials as an important part of Soviet COFM calculations. See, for example, Stephen E. Nichols, "Net Assessment Is the Threat," memorandum for the Deputy Director of Central Intelligence, Director of Central Intelligence, Washington, D.C., NIC 02651-87, June 24, 1987.

[20] "Tashkent—Iacheika," 1980.

[21] "Tashkent—Iacheika," 1980; *Objectivity* has different meanings in this field. One meaning is that an objective COFM assessment relies only on measurable, repeatable, and quantifiable factors (e.g., tactical technical characteristics). The second meaning is that a scientific or systematic process was followed in the COFM determination. Objective COFM assess-

combat power was appropriate when there was not a clear disparity in the quality of arms and equipment between the opposing sides. Strict quantitative comparisons were also used at the most senior levels of the Soviet government for purposes of brevity and simplicity. To avoid complexity when briefing senior policymakers, the Soviet military relied on "basic methods of comparison—for example bar graphs of force deployments."[22]

The 1986 *Soviet Military Encyclopedic Dictionary* offered a similar definition of COFM in comparison with 1980. It did not specifically mention combat potentials, but it did emphasize the need to consider both quantitative and qualitative characteristics of personnel (formations) and weapons in COFM calculations at all echelons:

> Correlation of forces and means is an objective indicator of the combat power of opposing sides, which allows for a determination of the degree of superiority of one of the sides over the other. A correct determination of correlation of forces and means and its evaluation facilitate substantiate decisionmaking and the timely formation and sustainment of the necessary superiority over the enemy along selected axes. [COFM] is determined through a comparison of the quantitative and qualitative characteristics of subunits, units, formations, and weapons of friendly and troops (forces) and of the enemy. [COFM] is calculated at the strategic, operational, and tactical levels along the entire stretch (area) of activity, along the main and other axes. To expedite the calculation various manuals, tables, and computational equipment are used.[23]

To summarize, a COFM assessment was used by the Soviet military to determine the superiority of one group of forces over another

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ments might rely on data systematically collected from expert evaluations, and, because of possible expert biases, are inherently subjective.

22 Stephen M. Meyer, *Soviet Style Theater Assessments*, Cambridge, Mass.: MIT Center for International Studies, September 1989, p. 4.

23 "Sootnoshenie sil i sredstv," *Voennyi entsiklopedicheskii slovar'*, Moscow: Voenizdat, 1986, p. 691; *Subunits* (*podrazdeleniia*) typically refer to a battalion-size unit; *formations*, or *soedineniia*, are usually divisions, brigades, or regiments.

and to substantiate commander decisions. For cases in which there was a clear disparity in the quality of arms and equipment, the Soviets developed a method of combat potentials to account for qualitative factors in key areas such as firepower, mobility, protection, and command and control. As is shown in the subsequent section, there is a large degree of continuity in terms of how Russia defines COFM today and the role that combat potentials play in quantifying combat capability.

Russian Definitions of COFM and Combat Potentials

The most recent Russian Ministry of Defense *Military-Encyclopedic Dictionary* (MED) was published by the Ministry of Defense in 2007 and provides the working definition of COFM (translated in the following paragraph) used in the rest of this report. There is overlap from the 1986 definition: Both quantity and quality remain key considerations to determine superiority of one side over the other. Also repeated are the notions that COFM applies to a given area of operations and is used to help the commander adopt informed decisions on the operational COA and the required force package to achieve assigned objectives. One key difference is that in the 2007 definition, COFM is considered only at the operational and tactical levels, whereas previously the strategic level was considered. This suggests that a COFM assessment is understood within the Russian military primarily as an operational planning tool. According to the 2007 MED, COFM is defined as the following:

> The result of a correlation (comparison) of quantitative and qualitative characteristics of forces and means (subunits, units, military weapons, military equipment, etc.) of friendly and enemy troops (forces). It is calculated at operational and tactical levels within an entire area (region) of action, along primary and other axes, and it allows for a determination of the degree of objective superiority of one of the opposing sides. The assessment of correlation of forces and means facilitates the adoption of an informed decision on the operation (battle) and the timely creation and maintenance

> of necessary superiority over the enemy through improving (or changing) decisions during military (combat) actions.[24]

As in the final years of the Soviet Union, the latest military definition of COFM does not explicitly mention combat potentials. However, as will be explained in the following chapters, there is a large body of evidence that shows combat potentials remain an important building block to a Russian COFM calculation in operational planning as well as broader considerations such as weapons and force structure development.[25] According to Russian military scientists, there is not a unified definition of combat potential in the context of COFM.[26] The definition of combat potential that is provided in the aforementioned 2007 Russian MED is a much broader concept than that which is most often discussed in both Soviet and Russian military writing on COFM. Most often, the authors cited in the following section view combat potential as a notion that requires the scoring of the relative military capability of some military asset or formation with respect to an existing reference asset or formation. Some of them understand combat potential more narrowly as expressing the maximum effectiveness of an asset or formation by some effectiveness criterion.[27] Alternative Russian sources, such as *Voina i mir v terminakh i opredeleniiakh* (*War and Peace in Terms and Definitions*), a military and defense dictionary edited by Dmitri Rogozin, the former deputy prime minister of Russia, similarly offers only an expansive description of combat potential as it relates to the armed forces as a whole. The primary elements of combat potential in Rogozin's definition include the composition of

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[24] "Sootnoshenie sil i sredstv," *Voennyi entsiklopedicheskii slovar'*, webpage, 2007.

[25] A. I. Buravlev, S. R. Tsyrendorzhiev, and V .S. Brezgin, "Osnovy metologicheskogo podkhoda k otsenke boevykh potentstialov obraztsov VVT i voinskikh formirovanii," *Vooruzhenie i ekonomika*, Vol. 3, No. 7, 2009, p. 5.

[26] Brezgin and Buravlev, 2010, pp. 41–42.

[27] What constitutes military capability in both theory and practice will vary by author.

the armed forces, manning levels, equipping levels, operational readiness, mobilization capability, training, morale, and reserve levels.[28]

The broad definitions of combat potential contrast with that of two authoritative sources on COFM. In 1997, Colonel Vitalii Tsygichko (retired), who worked as the head of the Theater Force Modeling Department of the Main Intelligence Directorate of the General Staff, defined combat potential as a numerical indicator that conveys "the contribution of the different types of weapons to the outcome of the combat action."[29] Aleksandr Bonin, a senior researcher at the 30th Central Scientific Research Institute (which focuses on force structure and weapons development for the Russian Air Force), and Gennadii Gorchitsa, a vice-president of RARAN, defined the combat potential of a weapon or military equipment as an "integral indicator that characterizes the maximal total of executed tasks using the full purpose [of the weapon/equipment] in implementing the finite tactical-technical characteristics in a given time under average (typical) hypothetical conditions."[30] Put simply, combat potential in the context of a COFM calculation is a means to quantify the value of a weapon with a single numeric indicator, or the coefficient of combat potential.

The coefficient of combat potential, according to Bonin and Gorchitsa, is the "relationship of the quantitative measure of combat potential of a given weapon or piece of military equipment to the value of combat potential of a standard [weapon or equipment], conditionally taken as the reference."[31] In the Soviet military, the reference weapon with which all other weapons were compared was the T-55 tank while today it is possibly the T-72A or T-80B.[32] To give an example, the Soviets in the late 1970s assessed an F-15 to have a combat potential value

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[28] D. O. Rogozin, ed., *Voina i mir v terminakh i opredeleniiakh*, Vol. 1, Moscow: Veche, 2017, p. 379.

[29] Tsygichko and Stoekli, 1997, p. 24.

[30] Bonin and Gorchitsa, 2010, p. 65.

[31] Bonin and Gorchitsa, 2010, p. 65.

[32] V. A. Valezhanin and A.A. Tarchishnikov, *Combat Capabilities of the Motorized Rifle (Tank) Platoon, Detachments (Tank) and Their Calculation*, trans. Eugene Han, Minsk: Belarus National Technical University, 2011, p. 9. Here, the Belarus authors use the T-72A as

of 9.5 T-55 tanks.[33] Typically the coefficients (*koeffitsienty*) of combat potential of weapons and military equipment are added together and multiplied by the quantity of a given weapon or equipment type to find the combat potential of a formation, such as a motorized rifle division. This single value is then compared with opposing forces for a final COFM assessment. Equation 2.1 shows how combat potentials factor into the COFM formula, which is: P_A / P_B.

$$P_A = \sum_{i=1}^{i=I} X_i C_i$$
$$P_B = \sum_{j=1}^{j=J} X_j C_j \qquad (2.1)$$

"where X_i and Y_j represent the number of weapons of type i=1 . . . I and j=1 . . . J on sides A and B, with the corresponding combat potentials C_i and C_j."[34]

Russian Terms for Comparisons of State Power and Related Concepts

There is much that is not captured by a modern COFM calculation in regard to common perceptions of state or military power. Levels of technological development, military-industrial capacity, GDP, mobilization potential, alliances and partnerships, and many other inputs are considered by Russian military organizations, but fall outside operational-level planning, which is where COFM calculations are

a reference. In the mid-1990s, the reference weapon in Russia was the T-80B (see Tsygichko and Stoeckli, 1996, p. 100).

[33] John N. McMahon, "Combat Potentials of the Armament and Combat Equipment of the Ground Forces and Aviation of the USSR and of the Armies of the Probable Enemy and Table of Combat Potentials of Large Units," memorandum to the Director of Central Intelligence, TS 778417-A, August 25, 1980.

[34] Tsygichko and Stoeckli, 1996, p. 100.

most often conducted.[35] Although many of these power indicators go beyond the scope of this report, we will briefly touch on a few overarching Soviet and Russian concepts to further delineate what COFM is and is not.

The Russian term *voennyi potentsial* (military potential) has appeared in Soviet and Russian assessments of overall military power or the capability of a state to launch and sustain a large-scale attack. The Rogozin dictionary defines military potential of the state as the "total active and potential material and spiritual capabilities of the state, which can be used for military objectives through their maximal deployment and use."[36] In a 2005 book, *Modeli v sisteme priniatiia voenno-strategicheskikh reshenii v SSSR* (Models in the System of Military-Strategic Decisionmaking of the USSR), Vitalii Tsygichko used the term "military potential" in several discussions of military and operational planning in the Soviet Union. First, he stated that "[a]ll force structure plans in the Soviet Union were always oriented toward an assessment and forecast of the development of the military potential of the West."[37] He also used the term in a description of analysis for the Soviet General Staff regarding the Chinese capability to mobilize and deploy troops along three axes and carry out a large-scale military operation against the Soviet Union. According to Tsygichko, at the operational planning stage for a potential conflict with China in the 1970s, analysts within various scientific research institutes of the Ministry of Defense " . . . applied a scenario method using a system of models for the assessment and forecast of the military potential of foreign countries."[38]

This military potential analysis examined macroeconomic indicators of China, the mobilization capacity of the Chinese armed forces and economy for war, the Chinese transportation system, and the expected operational behavior of the ground forces, aviation, and air

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[35] Buravlev, 2016.

[36] Rogozin, 2017, p. 376.

[37] Vitalii Tsygichko, *Modeli v sisteme priniatiia voenno-strategicheskikh reshenii v SSSR*, URSS, 2005, pp. 20.

[38] Tsygichko, 2005, pp. 20–21.

defense. The research concluded that, economically speaking, China "was neither ready nor capable of carrying out any kind of large-scale, prolonged war, especially against the USSR."[39] The investigation also found that China would require up to four months to deploy a million personnel along the maritime (*primorskii*), Mongolian, and Xinjiang operational axes, and that it would be able to sustain combat operations for only three weeks because of limitations in the Chinese transport system. Interestingly, the Soviet General Staff calculations and estimates prior to this study had found that in a month's time, China could deploy half a million soldiers along each of the operational axes and successfully execute an operation.[40] A similar though less-rigorous assessment by senior researchers at the 46th TsNII in 2017 found that it was a " . . . doubtful possibility that the United States and NATO could initiate and conduct large-scale military actions in the European theater of military operations over the next 5–10 years."[41] Russia's strategic planning documents—the Military Doctrine (2014), National Security Strategy (2015), and Foreign Policy Concept (2016)—also have concluded that large-scale war was unlikely.

Yet another term that is used by Russian military experts to compare the overall ability of a country to ensure security and wage war is state power (*mogushchestvo gosudarstva* or *moshch' gosudarstva*), which resembles Tsygichko's and Rogozin's formulation of military potential. Andrei Kokoshin, for example, who served as Secretary of the Security Council of the Russian Federation, remarked that the primary characteristics of state power included GDP, population size, territory, and the size of the armed forces, "including, first of all, the number of nuclear warheads and their means of delivery . . . ."[42] Similarly, Aleksandr Buravlev, a senior researcher at the 46th TsNII MOD, defined

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[39] Tsygichko, 2005, p. 21.

[40] Tsygichko, 2005, p. 20.

[41] E. V. Gorgola, V. L. Gladyshevskii, and S. R. Tsyrendorzhiev, "O realistichnoi otsenki ekonomicheskikh potentsialov sub'ektov mezhduranodnykh otnoshenii v dostizhenii voenno-politicheskikh tselei gosudarstva," *Vooruzhenie i ekonomika*, Vol. 3, No. 40, 2017.

[42] Andrei Kokoshin, "Rossiia v mire. Rossiia—sverkhderzhava, velikaia ili regional'naia derzhava?" *Mezhdunarodnaia zhizn'*, No. 9, 2002, p. 42.

state power as the aggregate of indicators of political, economic, and military potential, though he went on to define them in greater detail in a 2016 article, which we briefly summarize below.[43]

Buravlev established values of each of the three aforementioned categories of potential for a number of countries and then aggregated them for an overall comparison of state power. Economic potential consists of measures of national wealth such as GDP, population, natural resources, and material and financial assets. Political potential includes, *inter alia*, the authority of the state, standard of living, level of development of education, and cohesion between the state and civil society.[44] Buravlev applied what the Russians often refer to as the *expert methods* approach (which, in the United States, is commonly referred to as expert elicitation) to arrive at an overall comparative assessment of state power. As in many other assessments, including combat potential coefficients for COFM calculations, the Russians often use the analytic hierarchy process developed by the late U.S. mathematician Thomas Saaty.[45] Using Saaty's method for elicitation, Buravlev conducted a survey of experts from the Military Academy of the General Staff, Moscow State University of International Relations, the 4th TsNII, which conducts research for the Strategic Rocket Forces, and the 46th TsNII. Buravlev also used Saaty's method to obtain the findings for political potential, although the experts were drawn from the Moscow State Institute for International Affairs and Moscow State University. The results of the expert elicitation comparing the conventional and nuclear military potential and the political potential of Russia to many other powers, including the United States, are shown in Table 2.3.

The terms defined previously do not constitute an exhaustive list that would show the complete Russian view on comparisons of

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[43] The 46th TsNII focuses on the development of weapon systems, the State Armaments Program, and the domestic technological base.

[44] Buravlev, 2016, p. 25.

[45] For information on this methodology, see Thomas L. Saaty, *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*, new edition, Pittsburgh, Pa.: RWS Publications, 2001.

Table 2.3
Russian Comparative Assessment of State Power

Country	Conventional Military Potential	Nuclear Military Potential	Political Potential	Economic Potential
United States	1.000	1.000	1.000	1.000
China	0.500	0.500	0.200	0.425
Russia	0.250	0.670	0.200	0.176
Germany	0.170	0.100	0.200	0.164
France	0.125	0.200	0.170	0.089
England	0.125	0.200	0.140	0.379
Italy	0.080	0.067	0.125	0.142
Japan	0.100	0.067	0.140	0.586

SOURCE: Buravlev, 2016.

military or state power. In addition to those terms already identified, military power (*voennaia moshch'*), strategic stability (*strategicheskaia stabil'nost'*), the military-political situation (VPO), asymmetry (*asimmetriia*), and other concepts also offer insight into Russian thinking on issues such as COFM and great-power competition (see Chapter Five for a broader discussion of VPO and its possible connection to COFM).

Nevertheless, using the work of Buravlev and others related to assessments of state power, Russia perceives itself to be lagging behind in several key areas with the important exception of strategic nuclear arms.[46] Kokoshin has generally described Russia's position in the hierarchy of states as a great power whose strategic nuclear capability is comparable with that of the United States, which he described as a

[46] See, for example, V. M. Burenok, ed., *Kontseptsiia obosnovaniia perspektivnogo oblika silovykh komponentov voennoi organizatsii Rossiiskoi Federatsii*, Moscow: Rossiiskaia Akademiia raketnykh i artilleriiskikh nauk, 2018, pp. 300–309; S. R. Tsyrendorzhiev, "Osnovy metodicheskogo podkhoda k otsenivaniyu voennoi bezopasnosti s uchetom tekhnologicheskikh faktorov," *Vestnik Moskovskogo gosudarstvenogo universiteta*, Seriia 25, Mezhdunarodnye otnosheniia i mirovaia politika, No. 4, 2015, p. 57.

“superpower” along with China.[47] A key discriminator separating the superpowers from the great powers, according to Kokoshin, is GDP. Those surveyed by Buravlev similarly see Russia as trailing considerably behind the United States and China in economic and conventional military power, with the exception of Russia’s nuclear capability.

At the same time, despite economic and technological weakness, Russia believes asymmetric responses can compensate—in some ways—for relative weaknesses. According to a 2015 speech by the Chief of the Main Operations Directorate of the General Staff, Lieutenant General Andrei Kartapolov,

> . . . non-standard forms and methods of using our armed forces are being developed, which will help to level the enemy’s technological superiority. To do this it is necessary to . . . develop ‘asymmetric’ methods to confront the enemy. Asymmetric actions are inherent in a conflict situation in which the weaker [side] uses economic, diplomatic, informational, and direct military measures to conduct an asymmetric strategy (tactics) in accordance with his limited resources to mitigate the military-technological advantages of the stronger side.[48]

In brief, there is not a single concept within Russian strategic thinking that captures all of the elements of state and military power. COFM is one element of the discussion, but it should not be viewed as the single key to unlock the answers to all questions concerning Russian military and defense strategy. Rather, an understanding of how the Russian military calculates COFM can provide insight into its thinking on military superiority, what it prioritizes in modern warfare, and Russian operational planning more generally.

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[47] Andrei Kokoshin, “Natsional’nye interesy, real’nyi suverenitet i natsional’naia bezopasnost’,” *Voprosy filosofii*, No. 10, October 2015, p. 15.

[48] A. V. Kartapolov, “Lessons of Military Conflicts and the Perspectives of the Development of the Forms and Methods of their Conduct: Direct and Indirect Action in Modern International Conflicts,” trans. Clint Reach, *Journal of the Academy of Military Sciences*, Vol. 2, No. 51, 2015.

Conclusion

The concept of COFM in Russian political and military thought has existed for more than a century. During the Cold War, COFM had a dual connotation depending on the context of usage and the speaker. Today in Russian discourse it still is not possible to say that the term has the same meaning to all Russian officials and military officers. Furthermore, there are many Russian terms that have some similarities to COFM and attempt to describe the superiority of one side over the other through consideration of a broad range of factors. As the primary research question we are addressing concerns how the Russian military approaches and applies COFM assessments, this report examines the COFM concept as defined by the Military-Encyclopedic Dictionary and as described by Soviet and Russian military officers. These sources show that COFM is, by and large, an operational planning tool used by commanders at the operational and tactical levels to substantiate decisions on courses of action and force size. We examine alternative applications in the latter part of Chapter Six.

CHAPTER THREE

Technical Overview of COFM and Combat Potential

The attractiveness of having a single numerical figure that provides insight into the probable outcome of a complex military scenario is unquestionable, because it would greatly simplify decisionmaking by commanders and foster greater certainty in the resulting outcomes. In strategic situations where the qualitative factors and capabilities of similar assets on both sides are deemed equal, the purely numerical force ratio would be a sufficient figure for analytic purposes, which could include forecasting the number of casualties and estimating the rates of advance. Qualitative differences in the capabilities of the assets involved and other factors (e.g., training; terrain; weather; morale; command, control, communications, computers, intelligence, surveillance, and reconnaissance [C4ISR]) matter, and therefore these differences should be incorporated into the numerical assessment. This chapter discusses how Soviet and Russian military analysts have attempted to accomplish this in particular situations with certain mixes of assets and combat formations.

COFM is, conceptually, a numeric indicator of the military superiority of the assets or combat formations of one side over another at a given level of operations. However, consistent quantification of the numerous capabilities and qualitative factors for a broad range of weapons is the central analytic difficulty with the assessment of COFM. Consistency required that capabilities and qualitative factors of diverse weaponry and formations be measured in reconcilable units. Although this was achievable when all assets and combat formations on both

sides were not too dissimilar (e.g., tank-on-tank warfare), it was not self-evident how to conduct an assessment with dissimilar assets—for example, just how many tank divisions are equally effective as a single tactical nuclear weapon or a fighter squadron? Soviet analysts, intent on advancing the idea that COFM was something more than a mere numerical force ratio, inevitably confronted this difficulty and proposed various methodologies to resolve it.[1]

To resolve the issues surrounding dissimilar assets and qualitative factors, analysts introduced the concept of an asset's or formation's combat potential. As mentioned above, the term combat potential has never been used consistently nor defined precisely by various authors. *Combat potential*, conceptually, is the measured combat capabilities of a given asset or formation, often relative to a reference asset or formation in specific conditions. Like COFM, various Soviet and Russian authors have offered multiple mathematical definitions and measurements over the years to implement the concept. Mathematically, combat potential acts as a sort of adjustment that accounts for qualitative factors of an asset or formation when computing COFM.

This chapter summarizes the application of COFM as considered by Soviet and Russian military analysts since the 1970s. We adopt a terminology that is used throughout the chapter, explain the various concepts and notions involved, review various methodologies that are used to calculate combat potential and the correlations of forces and means, compare these methods with similar efforts by U.S. analysts, and discuss some of the past applications.

We find that COFM is a sound concept. Since its inception, the standardization of COFM methodologies has been difficult to implement consistently. This has been particularly true in situations with heterogenous weapons, in which researchers and planners have varying views on how to calculate combat potential. Before going further into the technical overview of combat potentials and COFM, we will first provide clarifications on terminology used in this section and address a few thematic challenges that are routinely confronted by analysts.

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[1] V. N. Tomashev, "On the Improvement of Methods for Assessing the Combat Capabilities of Troops," trans. Bilyana Lilly, *Science and Military Security*, No. 2, 2006.

Terminology

Because of varying usage of terminology in the literature and potential ambiguities arising from translation, we provide more-precise definitions on several terms in the following subsections.

Weapon, Asset, and Formation

We consider a *military asset* to be either an individual weapon system, military equipment, or unit (usually one combat arm at the division level or below). We also use the term *weapon* interchangeably with *asset*, particularly when referring to the asset's role or effectiveness in combat. A *formation* is an aggregation or grouping of assets. Formations might consist of qualitatively similar assets (e.g., a grouping of multiple armored divisions) or dissimilar assets (e.g., combined arms divisions or an infantry division supported by aerial squadrons). We might refer to the former as a situation with homogenous assets or weapons and the latter as a situation with heterogenous assets or weapons. Lastly, formations might consist of even smaller formations or groupings of assets.

Thematic Challenges

General Versus Specific Combat Potentials

Methodologies vary in how broadly estimates of combat potentials for assets might be used. Some combat potentials are highly specific—they work only for a specific effectiveness criterion (e.g., destruction of the enemy); in specific types of engagements, terrain, weather, operational plans, or other factors; and are highly sensitive to changes in these conditions or the numbers and types of other assets involved. Such potentials tend to arise from the most rigorous methodologies, often involving detailed modeling of operational outcomes. High specificity is the price to pay so that the potentials are more predictive of actual operational outcomes.

The second type of potentials are more general and are apparently divorced from a specific engagement in a specific area of operations. According to some Russian specialists, general combat potentials

can be used in a wide variety of operational scenarios.[2] This generality often requires a tradeoff, however, as these potentials often arise from expert evaluations that are difficult to validate and correlate against operational performance. Thus, there is some risk involved with relying on them. The difference described here—between specific and general combat potential value—is, among Russian analysts, arguably the most important question in Russia's approach to COFM.[3]

Multiple Criteria and Systems Complexity

An asset will often have multiple criteria or characteristics that determine its overall effectiveness and capability (i.e., its combat potential). To obtain "a single number," either one criterion must be chosen or several weighted and combined. There is no consensus on how to accomplish this. The more-rigorous and highly specific studies tend to focus on a single criterion or a few of them whereas the more-general expert evaluations focus on multiple criteria and confront the weighting problem.

Second, complex assets will often be composed of multiple subsystems. It is unclear how the characteristics and effectiveness of these subsystems determine the combat potential of the whole system. This issue tends to be tackled by the expert evaluations more frequently, although it is often argued that a system cannot be considered a simple summation of its parts without taking into account multiple synergies.

Homogeneity and Heterogeneity

Depending on the level of analysis (tactical, operational, theater, or strategic), the level of similarity among the assets that are examined will vary greatly and affect interpretations of combat potential. For example, comparing the combat potentials of different types of tanks

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[2] O. K. Ponomarev, "On the Qualitative Comparison of Forces and Means," trans. Polina Kats-Kariyanakatte, *Military Thought*, No. 2, 1977. Strelchenko and Ivanov, 1987.

[3] V. N. Tsygichko (*Models in the System of Strategic Decisions in the USSR*, Moscow: LAP Lampert Academic Publishing, 2017a, pp. 103–105) discusses how specific combat potentials calculated from one model might fluctuate widely across different operational scenarios. This suggests that calculating a single combat potential for use in many operational scenarios would be a challenge.

is an easier proposition than comparing the combat potentials of a tank and aircraft. It might be found that the combat potential of an F-15 is 18 and a T-55 tank is 1, and many interpret this as an F-15 is equivalent to 18 T-55 tanks. This can be catastrophically misleading, particularly in studies that obtain commensurability coefficients (discussed below).[4] What is truly meant in these studies is that the contribution from the Soviets adding a T-55 tank contributes to the operational outcome of the operation to the same extent as if the United States were to remove one-eighteenth of a F-15 from the scenario. That is, such results on commensurability coefficients are always on the margin and should be interpreted this way. Moreover, coefficients of combat potential estimated using commensurability coefficients are highly specific and sensitive to various changes.

However, what might compound this confusion is that such an equivalence might sometimes be true for very similar or homogenous assets—a tank with twice the destructive power of a reference tank might itself indeed be worth two reference tanks. Some authors misleadingly extend (or seem to extend) this intuition in the heterogenous case, and in effect they seem to claim that an F-15 is indeed equivalent to 18 T-55 tanks. This is more likely to occur in situations where a general combat potential is emphasized over a specific combat potential or if the high degree of specificity of specific combat potential estimate is not emphasized enough. Such interpretations should be met with skepticism.

Correlation of Forces and Means

COFM is, conceptually, a numerical indicator of superiority of one side over another incorporating both quantitative and qualitative characteristics of assets and formations of both sides in a specific area of responsibility. A Soviet law of armed warfare stated, "The dependence of the course and outcome of armed struggle is on the correla-

[4] A commensurability coefficient is one way to estimate the coefficient of combat potential introduced in the previous chapter. This is often employed by studies focusing on modeling, whereas coefficient of combat potential is estimated differently (not using commensurability coefficients) in other studies, typically those relying on expert evaluation methods.

tion of forces and means of the parties."[5] For example, according to the results of a COFM analysis, it was predicted that at least three to one COFM would need to be achieved before pursuing a successful advance against well prepared defenses in the European theater.[6] In this example, if the assets were qualitatively similar on both sides, then the actual advice would be to pursue an advance when the force was at least 3:1 in one side's favor. Additionally, if all friendly assets had half the combat potential of enemy assets, then the necessary 3:1 COFM would actually imply a 6:1 force ratio.

The authors and literature that we reviewed often used an equation that adjusts the force ratio for the varying capabilities and qualitative factors of the assets or formations involved. Similar equations also appear in Lanchester and Ospiov modeling. As referenced in Chapter Two, Equation 3.1 presents the most common mathematical formulation of the COFM, also referred to as the qualitative-quantitative COFM, and hereafter abbreviated as COFM:

$$COFM = \frac{P_A}{P_B} = \frac{\sum_{i=1}^{i=I} X_i C_i}{\sum_{j=1}^{j=J} X_j C_j} \tag{3.1}$$

where X_i is the number of friendly assets or formations of type i, of I total possible types of friendly weapons or assets (forces). X_j is the number of enemy assets or formations of type j, of J total possible types of friendly weapons or assets (forces). C_i is the combat potential of a friendly type i asset or formation. Similarly, C_j is the combat potential of an enemy type j asset or formation.

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5 James Womack, *Soviet Correlation of Forces and Means: Quantifying Modern Operations*, dissertation, Ft. Leavenworth, Kan.: U.S. Army Command and General Staff College, 1990, p. 19.

6 Tsygichko and Stoeckli, 1996, p. 104.

Mathematically, combat potential acts as a force multiplier that adjusts for differences in asset capability or other qualitative factors. Usually, a reference asset is assigned a combat potential of 1; the T-55 tank or T-55 division was a common choice for the reference asset or formation.[7] The calculation of combat potentials is discussed in the following sections.

A notable special case of COFM is when all combat potentials on both sides are assumed equal. COFM then simply reduces to the overall quantitative force ratio, as qualitative factors do not matter. There is no loss of generality by considering the concept of COFM in lieu of force ratios. Assessments of the COFM during World War II did not consider qualitative factors and were implicitly using COFM with equal combat potentials.

A more general version of Equation 2.1 for COFM, which attempts to correct for assets and formations in heterogenous situations, is discussed or applied by different authors (see Equation 3.2):[8]

$$\frac{\sqrt{\sum_{i=1}^{n} \frac{N_i}{\sum_{j=1}^{m} K_{ij} M_j}}}{\sqrt{\sum_{j=1}^{m} \frac{C_j}{\sum_{i=1}^{n} K_{ji} N_i}}} \tag{3.2}$$

7 McMahon, 1980; Tsygichko, 2017a, p. 102.

8 Ia. L. Speshilov, R. I. Pavlovskii, and A. I. Kabysh, "On the Question of a Quantitative-Qualitative Assessment of the Correlation of Forces of Heterogenous Force Groupings," trans. Clint Reach, *Military Thought* No. 5, 1981; R. I. Pavlovsky, A. I. Chubarenko, B. S. Safnov, *Fundamentals of the Theory of Combat Effectiveness*, TRADOC Analysis Center Report, TRAC-WSMR-SPR-98-018, U.S. Army, 1998; Womack, 1990, p. 40.

where N_i and M_j are the quantities of friendly and enemy assets or formations, respectively. K_{ji} are the comparability coefficients of friendly asset or formation *i* to enemy asset or formation *j*.

Coefficients of comparability try to account for combined effects of friendly assets or formations (e.g., aircraft squadron) to counter those of the enemy (e.g., ground air defense division). The comparability coefficient K_{ji} is also the commensurability coefficient of *i* when the reference asset is *j*.

However, despite the additional accuracy that would be obtained theoretically, to our knowledge, Equation 3.2 was not as widely used, even in cases where it would have been more applicable. We believe this was mainly because it was difficult and resource-intensive to obtain the necessary information to compute the equation, which would require modeling the potential outcomes of an engagement of every possible friendly-enemy asset combination.[9]

Another example of a different formula for COFM involving heterogenous weapons was examined by S. I. Anureyev, a general-major in the engineer-technical service of the Soviet military, who derived a COF measurement for nuclear weapon strikes using the number of nuclear assets available and the number of enemy assets that could potentially counter their delivery.[10]

Although perhaps obvious given the historical context, it is important to note that COFM is most relevant for Cold War–style symmetric warfare in which both parties have comparable aims and where the difference in levels of technology is not too extreme. A counterinsurgent enemy might not possess entire classes of weapon systems, nor even be able to pursue strategic- or theater-level operations. Instead, this enemy must rely on tactical successes for which a different style of COFM assessment is needed—for example, regional conflicts in the former

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[9] Higher-order effects (i.e., effects having a friendly asset being countered by two or more enemy assets instead of just one and vice versa) could be captured in even further refinements of Equation 2.1. But to our knowledge, despite the possibility of refining this formula being acknowledged, it was never implemented.

[10] S. I. Anureyev, "Determining the Correlation of Forces in Terms of Nuclear Weapons," in Joseph D. Douglass and Amoretta Hoeber, eds., *Selected Readings from Military Thought, 1963–1973*, Vol. 5, Part 1, Washington D.C.: U.S. Government Printing Office, 1982.

Yugoslavia, counterinsurgency operations, and internal conflicts such as the one in Chechnya.[11] However, to our knowledge, such applications neither have been validated nor used by the General Staff or Russian Air Force in any meaningful way.

In our view, the most appropriate domain for using COFM, as described in Equation 2.1, is beyond the tactical level for symmetric, conventional warfare with homogenous assets or formations on both sides, although this view might not be shared by current Russian operational planners. As will be discussed in following section, these situations are where the COFM concept is demonstrably effective—the reason being that combat potential is then less ambiguous to calculate.

Combat Potential

The combat potential of an asset or formation numerically expresses its total capability or effectiveness in fulfilling its primary combat mission.[12] For most assets, measurements of capability incorporate ratings of tactical-technical characteristics of weapons and military equipment and properties limited by their design (e.g., rate of fire; effective range; survivability; resistance to impact; mobility; strike capability; ammunition capacity; command, control, and communications [C3]; ease of interaction with other weapons in combined arms situations).

Mathematically, in the COFM formula, the combat potential for friendly weapon i, C_i, can be interpreted as a function of numerous characteristics (and similarly so for enemy assets). Which characteristics are included and how they are to be measured are recurring topics in the literature. Soviet and Russian analysts have not always consistently maintained the distinction between *specific* combat potential

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[11] V. N. Tsygichko, "On the Category of 'Correlation of Forces' in Potential Military Conflicts," trans. Melissa Shostak, *Military Thought*, No. 3, 2002; V. Moltenskii and Y. Martsenyuk, "On the Methodology of Assessing the Effectiveness of Employing a Joint Troop (Force Grouping) in Resolving an Internal Armed Conflict," trans. Clint Reach, *Military Thought*, No. 12, 2004.

[12] N. V. Aleshkin, "The Assessment and Comparison of the Forces of the Opposing Sides Based on Their Means of Destruction," trans. Bilyana Lilly, *Military Thought*, No. 10, 1975; O. K. Ponomarev, "On the Methods of Quantitative and Qualitative Assessment of the Correlation of Forces," trans. Eugene Han, *Military Thought*, No. 4, 1976.

and *general* combat potential, although they should do so in principle.[13] Specific combat potential reflects the asset or formation's capability as affected by attendant circumstances and external qualitative factors (e.g., type of engagement, terrain, weather, morale, C3). General combat potential reflects the asset or formation's overall capability in all situations. Because it is unclear how to assess capability in all possible situations, the general combat potential is an ambiguous concept; yet, it is considered a useful notion for strategic decisionmaking, as it encapsulates an asset or formation's overall contribution to the forces in all circumstances. Authors also tended to conceive of the general combat potential as either a specific potential in average circumstances or conditions or as an average of a large sample of specific combat potentials across various circumstances and conditions.[14] In any case, either view is quite limited because they involve either determining which conditions are "average" for the former case or performing a prohibitively costly calculation for the latter. In actuality, any practical calculation of combat potential yields a specific combat potential, as every method assumes that certain conditions or qualitative factors apply and that others do not, either explicitly or implicitly; however, certain estimates might apply for a wider range of conditions and qualitative factors.

The most-reliable estimates of combat potential are closely linked to capability or effectiveness criteria. At the asset level, such criteria might include the probability that an asset could destroy a target, the probability of detecting a target, the number of targets destroyed per unit time or per cycle of ammunition, or the probability of surviving enemy counterattack, among others.[15]

Actual estimates of combat potential are relative to a reference asset or formation and often are presented as coefficients of commensu-

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[13] Ponomarev, 1977; Strelchenko and Ivanov, 1987.

[14] Y. D. Ageev and A. P. Geraskin, "On the Issue of Increasing the Reliability of the Assessment of the Correlation of Forces," trans. Eugene Han, *Military Thought*, No. 8, 1979.

[15] N. M. Fendrikov and V. I. Iakovlev, *Methods for Calculating Combat Effectiveness of Armaments*, Washington, D.C.: Joint Publications Research Service, U.S. Department of Commerce, July 1972; Pavlovsky, Chubarenko, and Safnov, 1998.

rability (also sometimes referred to as coefficients of comparability).[16] A *coefficient of commensurability* is the number of reference assets or formations equivalent or substitutable to a given asset or formation (either enemy or friendly) for a given effectiveness criteria. Equivalence refers to the notion that a hypothetical substitution of the asset/formation for the requisite number of reference assets would ensure the same outcome in a given model of combat operations (even if outcome is unfavorable).[17] For example, the T-55 tank or division could serve as the reference asset, and other assets would be assigned relative values (e.g., a value of 2.2 for the M60A2, or a value of 1.5 for the T-72).[18] The interpretation of these values is that if an additional M60A2 division was given to the opposing side, then, providing an additional 2.2 T-55 divisions to the Soviet side would "compensate" for the added M60A2 tanks—i.e., ensure the same outcome as before (whatever it was) according to the presumed model or approach.[19] Similarly, adding a friendly T-72 division would be compensated by removing 1.5 friendly T-55 tank divisions. As mentioned previously, this interpretation usually applies for homogenous assets or for very small changes in the

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[16] Speshilov, Pavlovskii, and Kabysh, 1981; McMahon, 1980.

[17] Tomashev, 2006.

[18] McMahon, 1980.

[19] A similar concept is also prevalent in economic theory as the *marginal rate of substitution*—the amount of one good that must be given to an individual for him or her to maintain the same level of satisfaction after losing some amount of a second good. Mathematically, it is defined as

$$\frac{\delta U\left(x_1, x_2; \mathbf{z}\right) / \delta x_1}{\delta U\left(x_1, x_2; \mathbf{z}\right) / \delta x_2}$$

where U is utility (a measure of satisfaction) and x_1 and x_2 are the quantities of the first (the reference or numeraire good) and second goods respectively. This definition can be extended to more than two goods. The vector **z** describes additional, often unknown factors that might influence the individual's satisfaction from consuming these goods. Much of the same intuition applies for calculating combat potential via coefficients of commensurability. The coefficients are marginal (i.e., only applicable to small changes in quantities of assets), assessed relative to a reference asset, presume an appropriate model of combat operations (analogous to the role of utility), and are affected by often unknown factors that are assumed fixed for the calculation.

number of assets, and often refers to a given model or simulation of operations.

Coefficients of commensurability, although used frequently by Soviet and Russian analysts, have important limitations that were inconsistently acknowledged in the literature. First, the coefficients are dependent on either having some mechanism for translating the impact of an asset's capabilities and effectiveness on operational outcomes or having some method for inferring what the impact could possibly be. There are various models or methods of inference that we discuss in a following section detailing approaches, all of which have varying degrees of reliability and varying ease of implementation.

Second, depending on the approach that was employed, use of coefficients of commensurability might only be only valid for measuring the impact on operational outcomes for *marginal* changes in the number assets on either side. In such cases, analysts have determined through experience that coefficients of commensurability were reliable if the number of assets or formations did not change by more than 5 to 10 percent relative to the baseline assumed by the model or simulation.[20] We find this limitation more commonly in the more rigorous modeling- or simulation-based approaches that we reviewed. Such a limitation is often necessary, because the accurate prediction of operational outcomes when there are extreme changes in the force structure on either side is often intractable. Less-rigorous methods that attempt to calculate combat potential without reference to some operational model or simulation, in our opinion, often neglect this fact. And because they are not bounded by models or simulations and tend to overstate the range of force structures for which the calculated commensurability coefficients are reliable. In other words, because operational outcomes tend to be very sensitive to changes in the size and composition of forces, extrapolating operational outcomes in scenarios with very different sizes and compositions of forces using combat potential calculations should be done with caution.

Third, a coefficient of commensurability is limited by the conditions and qualitative factors that are assumed by the underlying

[20] Tsygichko, 2017a, p. 104.

approach. This is perhaps more explicit in approaches with rigorous modeling and simulation of operations, as the result of a model could depend on inputs other than the numbers and types of assets on either side (e.g., terrain, weather, C3). In other words, the combat potential that is obtained is indeed a specific combat potential—specific to the inputs of the that model, and limited by whichever inputs were chosen by the modeler. Less rigorous approaches also try to account for specificity, but all approaches are inherently limited by the conditions and qualitative factors they include and exclude.

Illustration of Concepts and Terminology

Before discussing various approaches to calculating combat potential and subsequently COFM, for illustrative purposes we demonstrate the aforementioned concepts and their potential usefulness in strategic decisionmaking using the game of chess. We assume the reader is familiar with the basic rules of the game. Rather fittingly, chess was and remains one of the most popular pastimes in the Soviet Union and Russia, and Soviet players dominated the sport for decades.[21] Although not necessarily adopting the terminology, chess players, including computerized players, use these concepts and even continue to do so today.

Theoretically, chess is a symmetric, deterministic game of perfect information.[22] That is, each side has complete knowledge of the current status of the game, the rules, and all past moves and decisions that have been made. Moreover, the deterministic property implies that there is no fog of war and that the outcome of a selected move, such as a player electing to capture an enemy asset using a friendly asset, does not depend on chance. Just as implicitly assumed by Soviet analysts for COFM assessments, chess also assumes a symmetry in that both sides have the same overall objectives (to checkmate the opposing king and destroy opposing enemy forces). Lastly, with some limited exceptions,

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[21] Andrew Soltis, *Soviet Chess 1917-1991*, Jefferson, N.C.: McFarland, 2000.

[22] Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Boca Raton, Fla.: Chapman and Hall/CRC, 2011.

the assets in chess are largely homogenous, as different assets are really only distinguished by their moving or attacking pattern, but functionally behave the same otherwise.[23]

Combat Potential of Chess Pieces

Newcomers to the game are often taught point values for all the assets. A common scheme is that a pawn is worth one point, a knight or bishop is three points, a rook five points, a queen nine points, and the king, because of its special role, is given an infinite value. The purpose of this scoring is to help beginners with strategic decisionmaking so that when they are confronted with multiple possible assets for capture, they can select the most valuable asset. The valuations are intended as strategic guidelines and not meant to override tactical awareness or be implemented mechanically. For example, a player would be justified in exploiting a short-term tactical opportunity and incurring the loss of a queen (a nine-point deficit) if the next series of moves guaranteed a winning checkmate. However, if no such tactical opportunity were available, such a decision would likely be a strategic blunder.

The point values of the assets reflect their combat potentials. By convention, a single pawn is treated as the reference asset and assigned a value of unity (1). The combat potentials for the other assets evolved from centuries of experience and experimentation but are roughly based on their effectiveness and mobility/attack capability on the board (Figure 3.1).

Correlation of Forces and Means in Chess

Given that combat potentials of assets in chess can be calculated, human players and computerized chess engines can and do conduct assessments similar to COFM. A minor difference between chess and standard COFM assessments is that COFM in chess is quoted in terms of the total point differential (i.e., the difference between both sides in

[23] The homogeneity can be understood by noting, for example, the fact that an asset, such as the queen, is just the combination of the moving or attacking pattern of the individual rook and bishop. The king's movement pattern (when not threatened by capture) is just the queen's pattern with an effective range restricted to no more than one square.

the aggregated combat potential of the assets that have been captured, for example, one side being up a bishop would have a correlation of forces and means of three points in their favor). This convention is valid because both sides begin with the same types and numbers of assets and is slightly more helpful as it avoids having to explicitly calculate the summation in the COFM formula for each possible move. Using collective and historical experience, even intermediate and above-average human chess players know a certain COF will be decisive (e.g., a five-point difference would be considered decisive for most intermediate players and above; grandmasters might resign after incurring a two-point disadvantage). An example is provided in Figure 3.2. According to the aforementioned combat potentials, white is up two points and possesses a more favorable—although not decisive—COFM that suggests an eventual advance, which could be decisive if he or she is able to widen the differential even further.

A computerized engine could make strategic decisions.[24] It would select a potential move, predict the opponent's next move, followed by the engine's reply, and so on for selected number of moves ahead (usually between 6 and 20). The engine would then calculate the COF (i.e., the point differential) at the end of each of these sequences and select the move which leads to the best COF at the end of the sequence. Because of modern computational advances, the engine can, through "brute force," calculate the COFM for hundreds of different possible sequences in mere seconds and select the best choice. It is practically impossible for the computer to calculate every possible sequence until its termination (and the computer is not playing "perfectly") but most human players will be unable to see deeper or evaluate more sequences than the computer. Human players must rely on experience and talent to anticipate which sequences are more likely and worthy of calculation, as they cannot use the same "brute force."

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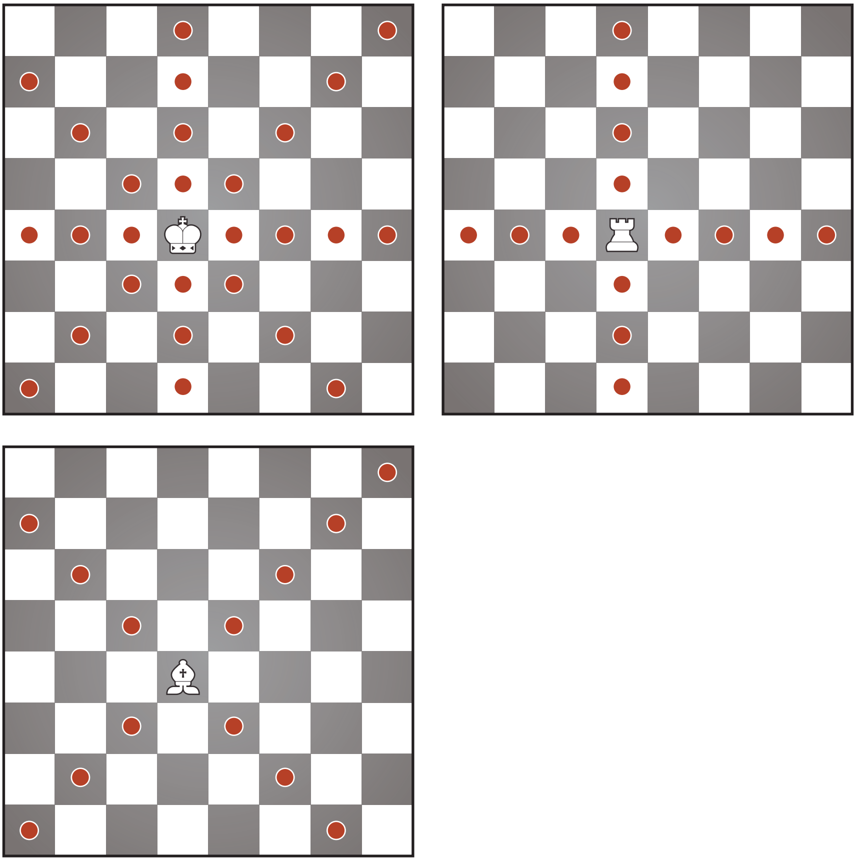
[24] For readers more familiar with chess, we are referring to positional decisions made by the computer engine when either an opening or endgame database is not applicable.

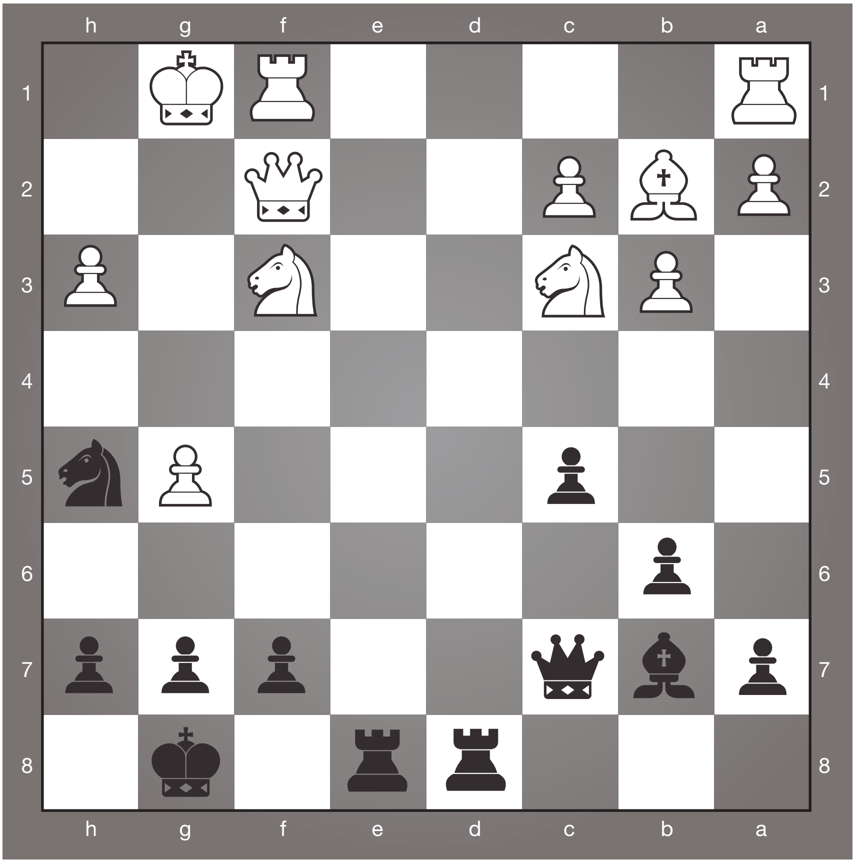
Figure 3.1
Calculation of Combat Potentials for Queen, Rook, and Bishop in Chess



SOURCE: Chess Variant Pages, "Illustrated Rules of Chess," webpage, June 23, 2000.

NOTE: A rook can always attack 14 squares on an open board, a centralized bishop can attack 13 squares and as few as seven (averaging 10), and a centralized queen can attack up to 27 squares. Observe that the ratios of the various assets' point values reflect the relative potential (rook/queen = 5/9 ≈ 14/27, bishop/queen = 3/9 ≈ 10/27).

Figure 3.2
Example Correlation of Forces and Means Assessment in Chess



SOURCE: Chessfox, "The Idea of Compensation in Evaluating a Chess Position," webpage, undated.

NOTE: This is an example chess position with white preparing to move. Using the standard combat potentials, white is up 2 points (i.e., down a pawn for an extra knight). For grandmasters and sophisticated computer players, white's advantage is significant, although not necessarily decisive. The suggested COA would be for white to further centralize its pieces. Winning an additional pawn or piece would likely be decisive and could justify an advance. We verified this using a computerized chess engine.

The Theoretical Value of the Concept of the Correlation of Forces and Means

The evidence that COFM is a powerful concept is represented by the fact that computerized engines have used this method in their artificial intelligence and algorithms to consistently defeat the best human players since the 1990s. This demonstrates the value of the ideas, otherwise COFM and combat potentials would only be theories. Additionally, there exist other examples besides chess demonstrating the credibility and value of scoring units (i.e., assigning potentials) in both recreational and professional gaming.[25] Moreover, adjudication rules for such games can be considered analogous to COFM assessments and might sometimes bear resemblance to actual COFM methodologies.

The exact scheme for calculating combat potentials of the assets varies by implementation and author. The exact potentials we discussed were the traditional values. For example, some computer engines and players assign the bishop a combat potential of 3.1–3.2 to reflect the qualitative fact, using experience, that the bishop pairs better with the other assets than the knight. This also underscores that qualitative factors also inform COFM. Although the measurable potential mobility or attacking capability of the assets is the most-salient component of their combat potential and main effectiveness criterion, players and computerized engines do incorporate qualitative factors in their assessments. For example, engines might adjust COFM for a side that has castled its king (more survivability) or to a side having a rook that is not obstructed by a friendly pawn (this gives the rook more ability to penetrate enemy territory more easily, i.e., firepower). Moreover, a queen's traditional combat potential is nine, one greater than the sum of the rook and bishop whose combined capabilities equal the queen's. These issues are acknowledgment that specific conditions, circumstances, or qualitative factors (e.g., terrain, weather, combined arms) can affect assets' combat potentials. As discussed in the following chapter, incorporating these factors is largely an art, although necessary for practical use of a COFM assessment. The main difficulty is not straying

[25] James F. Dunnigan, *How to Make War : A Comprehensive Guide to Modern Warfare in the Twenty-First Century*, fourth edition, New York: HarperCollins, 2003.

too far from the measurable effectiveness criteria and being able to validate the qualitative adjustments to the potentials. Combat potentials used by chess engines, regardless of the implementation, stay close to the mobility or attacking capability of its assets as an effectiveness criterion. Adjustments to COFM because of qualitative factors can be validated—at least in principle—by having different engines play against each other to verify whether the assessments and subsequent decisions are, in fact, in accordance with the outcomes.

Chess is a simplified war-based game with fixed rules, largely homogenous assets, symmetric sides, perfect information, and a finite number of possible positions. The above properties make it computationally feasible for artificial intelligence to exploit the concepts of COFM and combat potential. Actual warfare does not have any of these properties, and operations research, mathematics, or computers have not advanced enough to algorithmize operational planning, despite their potential. Of course, these difficulties did not prevent various Soviet military analysts and their Russian successors from trying.

CHAPTER FOUR

Soviet and Russian Approaches to Determining Combat Potential

This chapter discusses how Soviet and Russian analysts have approached calculations of combat potential that are the foundation of a COFM assessment. Over the decades, numerous approaches have been proposed with nuances varying by the author. There are two styles of approach—those that calculate or infer commensurability coefficients directly, and those that do not. Within the former category are operational testing, statistical approaches, and modeling and simulation of operations. Within the latter are expert evaluations—often using systems analysis—and potentialometry. All approaches will use tactical-technical information obtained from operational testing. There is also some degree of overlap across the approaches. For example, some modeling and simulation applications might rely somewhat on systems analysis and expert evaluations, or some expert evaluations might make use of statistical methods and theory. For purposes of comparison, we also briefly examine U.S. approaches to combat potentials and COFM.

Approaches to Calculating Commensurability Coefficients

Operational Testing and Tactical-Technical Characteristics

Operational testing and determination of tactical-technical characteristics is sufficient for assets whose combat potential is fully described by their tactical-technical characteristics (e.g., range, rate of fire, survivability). The effectiveness criteria for these assets, particularly weapon

systems, can be estimated directly in the laboratory or proving ground. However, this is not always the case. Laboratory or operational testing might be cost prohibitive, or the assets might not be available for testing (especially enemy assets).

Commensurability coefficients can be calculated directly by comparing two assets' characteristics directly.[1] For example, an asset with twice the firepower compared with the reference asset will have a combat potential of two. Multiple characteristics can be featured in the comparison, but they will have to be weighted somehow to derive a single estimate. The selection of weighted coefficients is a more-subjective exercise and analysts might have to resort to judgment or a formal qualitative method, such as expert evaluations, to obtain these weights (this issue is explored further in Chapter Five).

However, assets that are not purely weapon systems and formations that are more-complex aggregates of assets are affected by factors beyond tactical-technical characteristics (e.g., terrain, weather, C3, logistics support) and therefore might have combat potentials that cannot be estimated in this way.

Statistical Approaches

There are two variants within this class—the statistical analysis of retrospective data, and ensemble methods that average combat potentials obtained using other approaches from numerous studies or assessments.

The former variant, used as early as the 1950s, is a scientifically principled albeit limited method to calculate combat potential.[2] The approach entails using retrospective data from past wars and engagements. From the data, an effectiveness criterion for estimating combat potential is formulated and linked to various information about the assets and formations participating in the battles. Using established statistical techniques, such as linear regression, coefficients of commensurability might be inferred from the asset or formation while controlling for external conditions (e.g., terrain, weather) and other qualitative factors. This type of approach was applied to analyze

1 Tomashev, 2006.

2 Tsygichko and Stoekli, 1997; Tomashev, 2006.

engagements between Soviet and German forces during WWII. The effectiveness criteria could be formulated in terms of the capabilities of infantry, tanks, artillery, and aircraft to inflict casualties, or the average displacement of the forward edge of battle area (FEBA) and combat potentials estimated for each type of asset, using data. The strength of this approach is its reliability, which is guaranteed by statistical theory and also resembles established economic techniques for calculating rates of substitution, which resemble coefficients of commensurability.[3] The weakness of this approach is the limited applicability of retrospective data. Such data will be limited by the types of assets and formations participating and the external conditions (e.g., terrain, weather) and other qualitative factors that were or were not observed. Therefore, results will not be generalizable and significant changes in weapon technology, types of conflicts, doctrine, organization, training, and other factors over time will reduce confidence in any type of extrapolation. This sort of limitation is inherent in statistical analyses of observational datasets and is a recurring theme in social sciences.

The second variant of this broad class of approaches might be described as ensemble methods that average specific combat potentials or measurements of combat potentials from different sources or studies. The combat potentials are not necessarily commensurability coefficients under these methods. These methods are acknowledged though not necessarily used by sources we consulted.[4] To our knowledge, these methods have not been widely used. The details of how the different potentials are combined or what sources are used can vary. Two different sources might estimate a combat potential for the same asset or formation in different conditions or might even use a different approach entirely (e.g., one study might use an expert evaluation method, and another might use a mathematical model). Moreover, the justification for this approach is that statistical averaging of combat potentials across multiple studies will limit errors associated with the idiosyncrasies of the individual sources. Although technically true,

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3 Ponomarev, 1977. The similarity between coefficients of commensurability and economic rates of substitution were noted in a previous section.

4 Ponomarev, 1977; Ageev and Geraskin, 1979; Tomashev, 2006.

this assumes that each individual source provides an unbiased estimate of combat potential and that the obtained average could be validated externally. Given the reliance on potentially biased methods appearing in some of the sources, such as those using expert evaluations, and the inability to validate combat potentials (particularly for assets that have never been used repeatedly in engagements), we would be skeptical of combat potentials obtained in this way.

Modeling and Simulation Approaches

Modeling and simulation approaches are among the most sophisticated approaches to estimate combat potential and commensurability coefficients. It is difficult to expound upon each type of mathematical model or simulation; therefore we focus on the essentials for calculating commensurability coefficients.

There are two variants of this approach. The first variant applies mainly in close combat with homogenous assets and formations, and often uses mathematical models of combat and strategical kinematics—such as Lanchester and Osipov differential equations—in addition to applied-probability and operations-research models.[5] These models often take inflicted casualties or rates of advance as the effectiveness criterion, and they model those as a function of factors such as time, the number of assets, vulnerability, rates of fire, detection ammunition, and others. Coefficients of commensurability are estimated by comparison of the casualty rates or rates of advance with the reference asset. A mathematical model for tank-on-tank engagements and from which commensurability coefficients are obtained in this way is discussed in Pavlovskii, Chubarenko, and Safnov.[6] We find this study notable in that the authors used their analytically obtained estimates of commensurability coefficients and COFM to reproduce the rate of advances observed by tank divisions in World War II—an achievement for the use of COFM and combat potentials when involving homogenous assets at the division level.

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[5] Tsygichko, 2017.

[6] Pavlovkskii, Chubarenko, and Safnov, 1998.

The basis for the second approach is having a mathematical or computer model whose outputs are operational outcomes (e.g., casualties, rate of advance) and whose inputs, at a minimum, are the force structure (numbers and types of assets or formations) and operational plans describing command and control of the assets or formations for both sides. The most notable example is the Model of Strategic Operations (MSO) that was commissioned by the Soviet General Staff in the early 1970s and approved for use around 1974.[7] MSO, which is explained in detail in this chapter, was a computer simulation that addressed the planning of troop operations at the theater level and forecasted how COFM would evolve over the course of combat actions conducted under specified conditions.

Other Approaches to Calculating Combat Potential

The approaches covered in this section differ from the previous section in that they estimate combat potential—but not necessarily commensurability coefficients—using some model or data on weapon systems characteristics or past battles. The overall idea of these approaches is to decompose assets or formations into subsystems with measurable characteristics. Then experts will weigh the importance of these characteristics. The potential *of the subsystem* is obtained by multiplying the known values of these characteristics by the weights provided by the experts and summing across all characteristics. The combat potential of the asset or formation is obtained by multiplying a weight characterizing the relative importance or contribution of each subsystem and summing across subsystems (these weights might also be obtained from experts).

The details of expert selection, how an asset or formation is decomposed, and how subsystems or characteristics are weighted depend on the exact technique used. We do not discuss specific techniques except for potentialometry, which has gained prominence in the literature.

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7 Tsygichko, 2017, pp. 31–37.

Expert Evaluations and Systems Analysis

In the post-Soviet period, expert evaluations and systems analysis have been the most popular set of methods to estimate combat potentials.[8] Several formal expert evaluation methods exist and are used, particularly the process developed by Thomas Saaty, but they all employ the same overall steps shown in Figure 4.1. Each application must make specific choices regarding the details of each step in the approach. The first step is critical: the assets or formations for analysis will have to be determined and the effectiveness criteria or characteristics for them identified. Depending on the complexity of the asset or formation, this might entail conducting a systems analysis.

Systems analysis techniques have supported assessments of combat potential in multiple studies, such as that described by the

Figure 4.1
Design of Expert Evaluation Study for Estimating Combat Potential of Asset or Formation

8 Tomashev, 2006.

former head of TsVSI GSh, V. I. Ostankov.[9] The need for systems analysis stems from the fact that assets or formations at the theater and strategic levels will have multiple effectiveness criteria under consideration that are difficult to compare individually (e.g., benefits of additional firepower vs. easier command and control), and that the assets or formations themselves will be composed of complex and possibly heterogenous subsystems (e.g., a motorized rifle brigade consists of several assets such as personnel equipped with small arms; weaponized vehicles; C3 assets; logistics support).

With respect to estimating combat potential and using systems analysis, some Soviet analysts desired that the combat potential of an asset or formation be derivable from the potentials of the comprising assets or formations.[10] Some form of this aggregation principle or linear additive assumption is maintained in such applications. For many observers, there is no compelling justification for this assumption other than analytic convenience, especially beyond the battalion level.[11] The reason is that the effectiveness of a complex system is not necessarily the sum of the effectiveness of its subsystems, especially for formations that are combinations of very different assets (e.g., a formation with some combination of heterogenous strike assets [ground, air, nuclear], C3 assets, or support assets [logistics, medical, etc.]). Moreover, it is not possible to validate this assumption without operational data or additional modeling. But in doing such modeling, commensurability

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[9] V. I. Ostankov, "The Substantiation of the Military Composition of Groupings of Troops (Forces)," trans. Eugene Han, *Military Thought*, No. 1, 2003; V. I. Ostankov and P. S. Kazarin, "The Methodology of Comparative Evaluation of Combat Potentials of Military Formations and the Qualitative Correlation of Forces in Operations," trans. Eugene Han, *Military Thought*, No.11, 2012; Moltenskii and Martsenyuk, 2004.

[10] If a subsystem comprising the asset or formation is denoted by i, the combat potential for subsystem i, by P_i and the number of that particular subsystem in the asset or formation by n_i, then the aggregation principle implies that the combat potential of the full asset or formation is $\sum_i n_i P_i$.

[11] In this, we agree with V. N. Dorokhov and V. A. Ischuk, "Combat Potentials of Subunits [Battalion-Level] as an Integral Criterion for Assessing Combat Capabilities of Combat Formations and Combat Effectiveness of Arms and Military Equipment," trans. Clint Reach, *News of the Russian Academy of Missile, Rocket, and Artillery Sciences [RARAN]*, Vol. 4, No. 99, 2017.

coefficients could then be calculated instead. This position was also shared by analysts favoring commensurability coefficients that relied on operational-, theater- or strategic-level modeling, most notably Tsygichko.[12]

An expert evaluation method would then proceed with selection of the experts that evaluate the asset or formation or some subsystem. Although high-quality evaluations are possible, this step risks potential biases and relies on subjective information that is difficult, particularly in assessments of heterogenous assets, C3 systems, reconnaissance, and other types of support. Finally, the data collected from the experts must be analyzed and the ratings of the asset or formation using multiple effectiveness criteria or characteristics must be weighted and synthesized so that a single number is obtained to reflect the combat potential of the asset or formation. Moreover, if the evaluation is for a subsystem of a larger system, then a numerical weight indicating the relative importance or contribution of that subsystem must also be obtained from experts.

Different expert evaluation techniques (e.g., Saaty's Analytic Hierarchy Process) will perform this weighting in different ways and perhaps might even again invoke a linear additive assumption (for combining the effectiveness criteria or characteristics). This additive assumption also risks biases, because it further removes the combat potential estimate from operational performance (i.e., the correlation of the asset's or formation's combat potential and expected performance in an actual operation would be ambiguous).

The primary benefit of expert-based approaches is that they can almost always be implemented or must be refined after initial estimation, especially to assessments of COFM beyond the tactical level and to formations that are complex systems comprised of heterogenous assets. These methods are also relatively inexpensive, do not require sophisticated modeling expertise, and do provide the single numerical estimate that is desired for decisionmaking. In our view, these benefits might become a curse for those actually applying such combat potentials for operational decisionmaking. Unlike the approach of com-

[12] Tsygichko, 2017.

mensurability coefficients, these potentials are difficult to validate and correlate with operational performance. The purported universality of these potentials in all possible situations tempts misuse and might not be predictive of operational outcomes.

U.S. Approaches to Calculating COFM and Combat Potential

Combat potential and COFM assessments were also of some interest to U.S. military planners.[13] This related research was often undertaken by the U.S. Army and focused on operational planning of ground forces. U.S. analysts confronted many of the same methodological and conceptual issues as Soviet analysts.

Similar to the Soviet experience, raw force ratios were the main method of COFM assessment in the immediate post-WWII period (i.e., the special case of the COFM with equal combat potentials). Army doctrine trained operational planners in necessary force ratios based on experience and analysis of historical data until the Vietnam era, after which updated techniques were adopted.[14] Multipliers to the force generated by each asset or formation could adjust for qualitative factors and external conditions to yield a single numerical estimate, but to our knowledge, this was not pursued as deeply or systematically as by Soviet analysts. Instead, U.S. analysts relied more on numerical force estimates and only incorporated qualitative factors into a single numerical estimate of relative force if there was compelling and mea-

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13 Bruce W. Bennett, Arthur M. Bullock, Daniel B. Fox, Carl M. Jones, John Y. Schrader, Robert Weissler, and Barry Wilson, *JICM 1.0 Summary*, Santa Monica, Calif.: RAND Corporation, MR-383, 1994; Patrick D. Allen, *Situational Force Scoring: Combined Arms Effects in Aggregate Combat Models*, Santa Monica, Calif.: RAND Corporation, N-3423-A, 1992; William J. Krondak, Rick Cunningham, Oren Hunsaker, Daniel Derendinger, Shaun Cunningham, and Matt Peck, "Unit Combat Power (and Beyond)," paper presented at the Annual Meeting of the International Symposium on Military Operational Research (ISMOR), Cranfield, UK, 2007; James A. Zanella, *Combat Power Analysis is Combat Power Density*, Fort Leavenworth, Kan.: Army Command And General Staff College, School Of Advanced Military Studies, AY 2012-001, 2012.

14 Zanella, 2012.

surable evidence of their effect. Obviously, command decisions had to account or adjust for qualitative factors present, but this was done with less emphasis on using a single number for all possible scenarios. In the terminology of this report, U.S. analysts were less interested in obtaining general combat potentials for large-scale COFM assessments but instead were interested in having the appropriate specific combat potentials available to the commander.

The Use of Modeling and Simulation

With the same starting point as Soviet analysts, U.S. Army analysts developed combat models and simulations, based on Lanchester and Osipov differential equations, to predict necessary force ratios at the theater or operational levels.[15] These often were for close combat and involved homogenous assets or formations (e.g., tank-on-tank battles at the division level) and also favored inflicted casualties and FEBA movements as effectiveness criteria. Regarding qualitative factors and other conditions, analysts focused primarily on troop strength, terrain or weather, and the level of prepared enemy defenses (i.e., unprepared, hastily prepared, prepared).[16]

However, these models initially focused on prediction of operational outcomes, such as casualties and FEBA/Forward Line of Own Troops (FLOT) movements, rather than assigning a numerical indicator of value for assets or formations. Eventually, some U.S. analysts came to hold similar beliefs as Soviet analysts: that this outcome might be desirable. To our knowledge, assigning numerical indicators was not done primarily through commensurability coefficients from modeling or statistical analysis, but through expert evaluation. It led to the development of measurements such as the weapon effectiveness index (WEI), weighted unit value (WUI), killer-victim (KV) scoreboards, and situational force scoring (SFS), among other methods.

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[15] Zanella, 2012.

[16] Analysis typically did not account for networked combat (i.e., detailed target assignment for each individual asset in a model above the division-level as opposed to modeling the outcomes based just on the total number of assets or formations on each side). Analysts did develop combat models and force assessments accounting for network warfare, but we do not know to what extent these were used.

Weapon Effectiveness Index and Weighted Unit Value

Beginning in the 1970s, U.S. analysts conducted assessments of the combat potential of assets or formations and developed the concepts of WEI and WUI.[17], For WEI, assets—mainly for ground forces at the division level or below—were decomposed into firepower, mobility, and survivability subsystems, similar to several of the aforementioned Soviet (and now Russian) applications. Each subsystem was described by several characteristics, whose effectiveness in each regard was weighted using expert evaluation methods, specifically the Delphi method. The weights were similarly summed and aggregated across subsystems to yield the WEI. The WEI for the asset was analogous to its combat potential as understood by Soviet and Russian analysts.

To extend the WEI calculation for larger formations of assets above the division level, individual assets were grouped into broad categories. Experts weighted these categories using the Delphi method, and to obtain WUI, calculated the sum of the number of assets or formations weighted by their WEI. For example, after conducting WEI calculations for individual assets within a standard U.S. armored division in 1983, its WUI was 47,490—known as the armored division equivalent (ADE). For example, a U.S. infantry division had an ADE of less than one, or equivalently a WUI of less than 47,490.

The WEI/WUI/ADE methodologies are analogous to Soviet approaches that also used expert evaluation for estimating combat potential, and are therefore subject to similar limitations, including reliance on subjective information, risk of biases in selection and opinions of experts, appropriateness of adding the effectiveness of individual subsystems to obtain effectiveness of the whole system, and, to our knowledge, limited validation in operations or correlation with operational outcomes. For these reasons, these methodologies fell out of favor with the U.S. Army in the 1980s.[18]

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[17] William P. Mako, *U.S. Ground Forces and the Defense of Central Europe*, Washington, D.C.: Brookings Institution Press, 1983; Bennett et al., 1994; Allen, 1992; Bruce W. Bennett, Carl M. Jones, Arthur M. Bullock, and Paul K. Davis, *Main Theater Warfare Modeling in the RAND Strategy Assessment System (3.0)*, Santa Monica, Calif.: RAND Corporation, N-2743-NA, 1988.

[18] Bennett et al., 1994.

Killer-Victim Scoreboards

Because of limitations of WEI, WUI, and ADE, U.S. analysts moved toward more specific and situational uses of combat potential. One example is KV scoreboards.[19] A KV scoreboard is a matrix in which rows are attacking assets and columns are targets in a specific battle (described by terrain or weather and level of preparedness of each side). Elements of the matrix are the number of kills of that target allocated to the attacking asset over a fixed assessment period. These elements correspond to a score or combat potential (accounting for terrain or weather and level of preparedness) emphasizing an effectiveness criterion of casualties or target destruction. They are often calculated based on mathematical or computer models of engagements that allocate kills given to an attacking asset.

Example of KV methodologies include the attrition-calibration and anti-potential/potential models developed by the Army and Institute for Defense Analyses.[20] Each scoreboard can be configured for a type of engagement, terrain, weather conditions, unusual force mix, doctrine, and training. The number of kills can be calculated using modeling, simulation, expert evaluations, or some combination thereof. The aim of these methods is to provide decision aids to the commander for predicting the outcome of particular engagements or for aggregation into a higher-level campaign model. They are considered accurate for the specified conditions, but resource- and time-intensive to develop. Moreover, a different scoreboard will be needed for different types of engagements, terrain, weather conditions, unusual force mixes, doctrine, and training. The possibilities would be too numerous to have a scoreboard for all possible cases, and could be irrelevant if an effectiveness criterion besides destruction of the enemy is considered.

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[19] Allen, 1992.

[20] Allen, 1992.

Situational Force Scoring

SFS is a comprehensive method that was developed by RAND in the 1990s to rectify shortcomings in WEI, WUI, and ADE.[21] SFS is more detailed than WEI, WUI, and ADE, but less specific than KV scoreboards (to reduce the number of scoreboards that have to be generated). However, SFS has the advantage of allowing extrapolation of combat results when weapon-on-weapon data is scarce or unreliable. The SFS model takes as an input the numbers and types of assets and multiplies them by their WEI/WUI value. SFS then multiplies these values using multipliers for training, nationality, and cohesiveness. Next, it applies situational multipliers representing qualitative factors and other conditions, specifically type of engagement, preparedness of defenses, terrain, and weather. Multipliers are chosen based on a combination of historical data and expert judgement. The result of these force multipliers to WEI/WUI yield more-specific combat potentials, which are summed to yield the total force strength of that side. The analysis is repeated for the opposing side to obtain the force ratio (analogous to COFM). Using lookup tables, commanders could look at the obtained force ratio to predict the casualty distribution and FLOT movements.

SFS presents an interesting middle ground between specific combat potentials that are situationally sensitive and general potentials that can be used widely. To our knowledge, except for use in wargaming and modeling efforts (such as the Joint Integrity Contingency Model or Integrated Theater Model), we are not aware of an operational use of SFS.[22] Moreover, it focuses on ground forces at the theater level and shares the limitations of the various methodologies used to obtain the multipliers—particularly expert evaluations when using WEI/WUI values.

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21 Bennett et al., 1994; Allen, 1992; Patrick D. Allen, "The Need to Represent a Wide Variety of Battle Types in Air-Ground Combat Models," *Military Operations Research*, Vol. 1, No. 3, Fall 1995.

22 Bennett et al., 1994.

Other Related Methods

Somewhat related to COFM assessments pursued by U.S. analysts is relative combat power analysis and troops-to-task analysis.[23] Relative combat power analysis was developed by the U.S. Army in the 2000s to incorporate morale factors into combat potential and create decision aids that produce qualitative insights into which side has an advantage with respect to maneuver, firepower, protection, leadership, and information. To our knowledge, these methods cannot be used for quantitative calculations of operational outcomes and determination of force requirements. In principle, they should be subsumed by quantitative force analyses, but this has not been carried out. Troop-to-task methods are loosely based on similar types of analyses and were formulated for tactical/operational level planning in counterinsurgency environments. In a troop-to-task analysis, a given mission (e.g., secure infrastructure, conduct population control, base security) is assigned, and other qualitative factors are applied to calculate the number of platoons that would be needed.

Comparison of Soviet and U.S. COFM Efforts

Like Soviet efforts, U.S. efforts began with numerical force ratios and tried to incorporate qualitative and situational factors. U.S. development of WEI/WUI and ADE was analogous to Soviet estimates of combat potential using expert evaluation methods. In addition to the U.S. Army, as noted earlier, the Office of the Secretary of Defense's Shape Technical Center was among the Western users of these scores. However, possibly because of the inherent limitations, these scores were not as widely used after the 1980s. It is also possible that U.S. and Soviet analysts made different assumptions about the dynamics of engagements that could have resulted in more- or less-conservative estimates. Moreover, U.S. efforts did not attempt to incorporate qualitative factors as much as Soviet analysts did, particularly in the infor-

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[23] Zanella, 2012. There might be other methods not discussed in this report that were used by others. This report does not give an exhaustive list. An example is the quantified judgement model presented in Trevor Nevitt Dupuy, *Understanding War: History and Theory of Combat*, St Paul, Minn.: Paragon House, 1987.

mational component, as incorporating the influence of command and control (C2) or C3 in an asset's or formation's effectiveness and potential was less studied. Instead, U.S. analysts attempted to incorporate situational factors in force multipliers or to create decision aids that estimate potential in specific situations (e.g., KV scoreboards, SFS). These analyses were focused on effectiveness, particularly destruction of the enemy, and were often done at or below the theater level and more frequently for ground forces. For example, in the 1970s and 1980s, the U.S. Army Command and General Staff College's Department of Tactics used COFM-like assessments in doctrinal planning at the battalion and division levels (Table 4.1 provides a current example).[24] Strategic-level decisionmaking was more likely concerned with raw force counts and ratios for different situations (Table 4.2).

[24] Another discussion of the calculations is provided by Dale Spurlin and Matthew K. Green, "Demystifying the Correlation of Forces Calculator," *Infantry*, January–March 2017.

Table 4.1
Example Force Assessment Using Qualitative Factors

Friendly Forces					Enemy Sources				
#	Strength %	Type	Force Equivalent	Total	#	Strength %	Type	Force Equivalent	Total
5	100	Armor Bn (44 M1A1)	1.24	6.20	3	75	Infantry Bn (BMP-3)	0.65	1.46
2	100	Armor Bn (44 M1A2)	1.30	2.60	1	75	Tank Bn (TB 40xT90)	1.06	0.80
1	100	155 (SP) Bn (M109A6, 3x6) (Paladin)	1.50	1.50	1	75	2S7 Bn	1.28	0.96
1	100	Attack Helicopter Bn (24x AH-64)	5.00	5.00	1	75	AT Bn (12 x 2A45, 6 x AT 5/6)	0.35	0.26
	100					80			
	100					80			

Friendly Force Equivalent = 15.30		Enemy Force Equivalent = 3.48
Ratio of Friendly to Enemy = 4.40 : 1		Ratio of Enemy to Friendly = 0.23 : 1
Deliberate Attack = 5 percent	←Mission→ ←Est. Losses→	Hasty Defense = 85 percent

SOURCE: Zanella, 2012.
NOTE: Bn = battalion; SP = self-propelled; AT = antitank. Example computation of force ratios for ground forces. Observe that qualitative factors (i.e., type of engagement) were incorporated into the assessment of losses in addition to numbers, types, and strengths of assets.

Table 4.2
Example Force Assessment Using Historical Planning Ratios

Historical Minimum Planning Ratios		
Friendly mission	**Friendly : enemy ratio**	**Position**
Delay	1 : 6	
Defend	1 : 3	Prepared or fortified
Defend	1 : 2.5	Hasty
Attack	3 : 1	Prepared or fortified
Attack	2.5 : 1	Hasty
Counterattack	1 : 1	Flank

SOURCE: Zanella, 2012.

CHAPTER FIVE

Toward a Unified Russian Approach to COFM

The importance of combat potentials in COFM calculations has been apparent for many decades in both Soviet and Russian military art. As the previous chapters demonstrate, however, there is a broad range of ideas and approaches to most accurately calculate combat potential. As Tsygichko and Stoeckli pointed out,

> the determination of the different combat potentials was—and remains—a crucial point. It was [found] through a variety of approaches, such as "expert methods" or the pairwise comparison of systems (for example, tanks and antitank weapons). The former is highly empirical and therefore is not always reliable. The latter is valid at the tactical level . . . but a direct transposition to the operational level is not obvious.[1]

Illustrating their own point, the authors went on to argue that a large-scale combat model was required to provide useful insight on combat potentials and COFM at the operational level.

U.S. observers of the Soviet military also noted a variety of Soviet approaches to calculating combat potential. For example, the Soviets used a "proving ground" method, in which the performance of weapon systems in exercises or in labs was measured against preestablished system parameters in areas such as firepower, mobility, and protection to come up with a cumulative score of the weapon. Alternatively, the Soviets applied a computer model to substitute various weapon systems

1 Tsygichko and Stoeckli, 1996, p. 100.

to determine the change in contribution from system to system based on a measure of effectiveness, such as kills.[2]

To address this issue of diversity of views and methods, in the early 1990s representatives from all of the scientific research institutes of the Russian Ministry of Defense met at a conference to discuss the varied approaches within the service branches. The goal of the conference was to agree upon a unified approach to the determination of combat potentials. However, the conference ended with neither a unified method nor any clear agreement on a way forward.[3] Although there might be broad agreement that a COFM assessment derived from combat potentials is a useful and necessary tool to build force packages and forecast the outcome of military engagements at the operational level, the Russian General Staff, the service branches, and their respective research institutes continued to promote different methodologies. In 2008, however, the General Staff attempted to resolve this decades-old debate by requiring integration of the Method throughout the Russian armed forces.

This chapter will narrow the discussion from a broad range of approaches, some of which remained exclusively theoretical, to focus on the transition from the most-prominent method of the late Soviet period—the MSO—to the Method that is required for use today in operational-tactical calculations. Specifically, we address both why and how this transition took place and examine the rather open debate that is currently taking place within the Russian military-science community about the widespread adoption of the Method for the determination of combat potential.

The Model of Strategic Operations

As referenced previously, there was a concerted effort on the part of the Soviet General Staff to improve the accuracy of COFM calculations and move beyond purely quantitative assessments. According to Tsygichko, he and a colleague, Yurii Fedulov, were instructed by the General Staff

2 Womack, 1990, pp. 33–37.

3 Bonin and Gorchitsa, 2010, p. 62.

to "develop a coherent theory of combat potentials."[4] Over the course of two years the two mathematician-officers created the MSO, which by 1974 was in use by the Soviet General Staff to determine combat potentials for COFM assessments. Relatedly, a 1981 article by Speshilov, Pavlovskii, and Kabysh noted that a large-scale combat model was used to determine combat potentials, which were compiled into tables and used in command staffs for operational planning.[5]

Initially published in 1986 with a second edition released in 2017, *Prognozirovanie sotsial'no-ekonomicheskikh protsessov* (*Forecasting Socioeconomic Processes*) describes the theoretical foundation for the MSO.[6] A central thesis of the book is that socioeconomic processes are understood as complex systems made up of interacting subsystems with varied purposes, which often need to be compared and evaluated.[7] The resolution of this issue of evaluating and comparing subsystems is important because a strategic operation is also made up of subsystems that are interrelated but have different functions. How to measure and assign quantitative value to such system components to compare and assess opposing systems is a crucial question that remains highly important (and debated) in the Russian military science community.

MSO was a computer simulation that addressed the planning of troop operations at the theater level and forecast how the COFM would evolve over the course of combat actions conducted under specific conditions and ultimately predict the outcome of a large-scale engagement. The interacting subsystems (or blocs) include C2, aviation and air defense, and strike assets, among others (see Figure 5.1). The outputs of this model included both sides' losses of assets, the location and movement of the front, troop movement for each day, and time and place of each sides' introduction of second echelon and reserves. The inputs included the numbers and types of assets or formations; the operational plans for both sides; and other conditions and

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4 Tsygichko and Stoeckli, 1996, p. 100.

5 Speshilov, Pavlovski, and Kabysh, 1981.

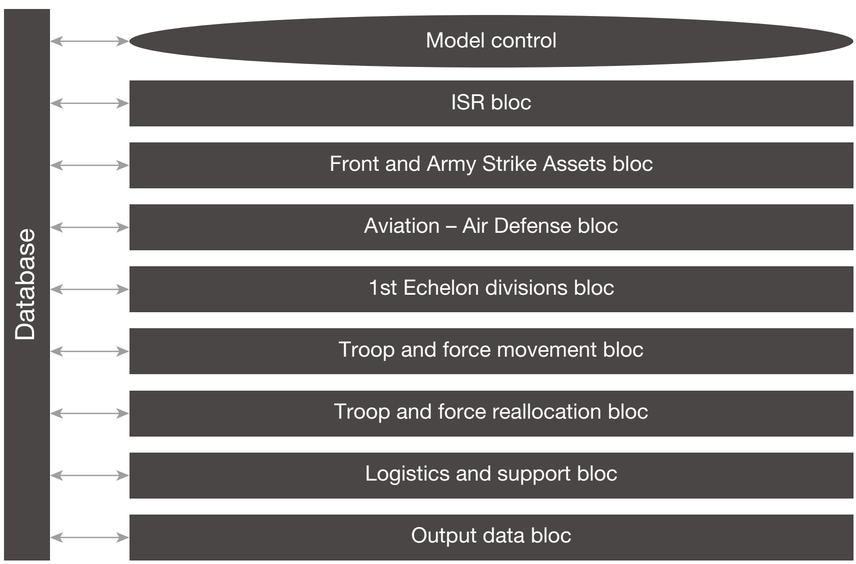
6 V. N. Tsygichko, *Prognozirovanie sotsial'no-ekonomicheskikh protsessov*, second edition, Moscow: URSS, 2017b.

7 Tsygichko, 2017b, p. 28.

factors such as use of C3, reconnaissance, logistics support, terrain, and weather. To calculate the commensurability coefficient (combat potential value) of a given asset or formation, an amount of the reference asset or formation is added or subtracted from the appropriate side (usually 5 percent) and the operational outcomes are observed by running the model. Next, the asset for which the commensurability coefficient is desired is added to the appropriate side—the percentage amount producing the same change in operational outcome as when the reference asset was first varied is the commensurability coefficient. Different models of operational outcomes were used for this purpose.

Although MSO was a preferred method of the Soviet intelligence directorate for its rigor and ability to analyze very different assets and formations, there are several important limitations regarding the estimation of commensurability coefficients. First and foremost, the coefficients obtained using the compensatory scheme are specific to the values of the inputs that were used in the model when obtaining the

Figure 5.1
Model of Strategic Operation Blocs



SOURCE: Tsygichko, 2005. Adapted from image courtesy of East View Information Services, and used with permission of the author.

coefficients, and they were sensitive to all but marginal changes at the operational or strategic level (no more than a 5–10 percent change in the numbers of an asset or formation). One of the developers of the MSO observed that coefficients could vary wildly if nonmarginal changes in the assets or formations were made or if other inputs in the model were changed.[8] The same author and others argued that combat potentials arising from such models were too specific for use in COFM assessments, and that commensurability coefficients for use in a wide variety of situations were not possible to estimate.[9] Second, combat potential estimates obtained through MSO are limited to specific effectiveness criteria and the assumptions of the corresponding model that do require some subjective judgement.

To our knowledge, MSO was among the most sophisticated models used by Soviet analysts to calculate combat potential values. However, with the collapse of the Soviet Union and the significant resources allocated for a wide variety of defense purposes, the Russian General Staff sought new methods to determine combat potential values in a more cost-effective manner. As explained in a 2012 patent for an automated system to assess the combat potential of a formation taking into account communications, surveillance, and EW capabilities, which was granted to military scientists from the 27th TsNII of the Ministry of Defense:

> It is known that the traditional method for assessing combat potential is modeling the processes of combat employment of weapons and military equipment in operations of varying scale followed by testing in combat exercises. . . . However, in recent times, as a result of a reduction in expenditures for scientific research and combat training of troops on the one hand, and the desire for an efficient and cost-effective way to obtain the same type of assessment on the other hand, a new methodological approach was created that is based on expert assessment of combat potential through qualimetric methods.[10]

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8 Tsygichko, 2017b, pp. 100–104.

9 Strelchenko and Ivanov, 1987.

10 Anatolii Gural'nik, Evgenii Morozov, Kirill Chebotkov, Vladimir Chekir, and Sergei Iakovlev, "Avtomatizirovannaia sistema otsenka realizuemogo boevogo potentsiala voinsk-

Method of the Center for Military-Strategic Studies of the General Staff

The Method referred to in the above patent and throughout contemporary Russian writing on COFM was first conceived in the 1980s by a group of military experts headed by Lev Zakharov and further developed under the auspices of a research and development program called Lava, which ran from 1995 to 2001.[11] In 1992, Zakharov coauthored an article with the noted military theorist Sergei Bogdanov, "O vyrabotke edinykh podkhodov k otsenke boevykh potentsialov vooruzhenii (On the Development of Unified Approaches to the Assessment of the Combat Potentials of Arms)," in which the authors describe a Method for determining the combat potential of both weapons and combat formations.[12] In 2001 the ideas within this article were codified into an official approach known as the "Method for Assessing the Combat Potentials of Weapons and Military Equipment and Combat Formations of the Armed Forces and Foreign States."[13] The Method was updated and republished by the Center for Military-Strategic Studies in 2009.[14] It is based on what Zakharov refers to as "military potentialometry" and principles of qualimetry, both of which we briefly explain below before examining the Method in detail.

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ogo formirovaniia s uchetom taktiko-tekhnicheskikh kharakteristik sredstv razvedki, sviazi i radioelectronnoi bor'by," Patent No. RU113385U1, February 10, 2012.

[11] S. G. Chekinov and S. A. Bogdanov, "Voennaia futurologiia: zarozhdenie, razvitie, rol' i mesto v sisteme voennoi nauki," *Voennaia mysl'*, No. 8, 2014, p. 26; Brezgin and Buravlev, 2010, p. 43.

[12] S. A. Bogdanov and L. V. Zakharov, "On the Development of Unified Approaches to the Evaluation of Combat Potentials of Arms," *Voennaia mysl'*, No. 8–9, 1992.

[13] L. V. Zakharov and V. V. Semenov, "Povyshenie effektivnosti primeneniia voisk (sil) v operatsiiakh za shet povysheniia kachestva sistemy upravleniia," *Vestnik Akademii voennykh nauk*, Vol. 1, No. 38, 2012, p. 70; The full citation of the Method is S. G. Chekinov and L. V. Zakharov, "Metodika otsenki boevykh potentsialov vooruzheniia i voennoi tekhniki i voiskovykh formirovanii vooruzhennykh sil Rossiiskoi Federatsii i inostrannykh gosudarstv," Tsentr voenno-strategicheskikh issledovanii General'nogo shtaba Vooruzhennykh sil Rossiiskoi Federatsii, 2009.

[14] Zakharov and Semenov, 2012, p. 70.

Qualimetry

The central concern of qualimetry is to assess the quality of a commodity, service, or system. Quality is a term that cannot be defined precisely but is a generalized notion of effectiveness. It is a multidimensional indicator of the value and reliability of the asset/formation that is highly dynamic as external conditions evolve.

Russian analysts trace the origins of qualimetry to a 1968 article in the *Standarty i kachestvo* [*Standards and Quality*] journal by G. G. Azgal'dov and A. V. Glichev. Current Russian approaches to COFM, however, rely on the text, *Kvalimietriia v priborostroenii i mashinostrenii* (Qualimetry in Device and Machine Building), which was published in 1990. The contribution of the latter work, according to the authors, was that it was building on the former through the addition of a "systems approach" to measuring and assessing the quality of "any objects or processes that are created or used by human beings," which is the problem the field of qualimetry is intended to solve.[15] The systems analysis element of the work is derived from the idea that quality itself can be seen as a system made up of interconnected components such as property (*svoistvo*), structure (*strukturnost'*), and dynamism (*dinamichnost'*). For example, quality is defined by leading experts on qualimetry as the "aggregate of properties . . . associated with the result of consuming the object."[16] Once identified by the researcher, these properties are first quantified using Equation 5.1, where K_i is a relative measure that "expresses the degree of manifestation of the property relative to a benchmark (reference) measure, Q_i^{ben}, and a rejection one, Q_i^{rej}."[17] Weighted coefficients, G_i, which are established by experts or through analytical methods, are applied to differentiate the importance of one property over another in a given context.

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[15] Yu. M. Andrianov and A.I. Subetto, *Kvalimietriia v priborostroenii i mashinostrenii,* Leningrad: Mashinostroenie, 1990, p. 6.

[16] Garry Azgaldov and Alexander Kostin, "Applied Qualimetry: Its Origins, Errors and Misconceptions," *Benchmarking: An International Journal*, Vol. 18, No. 3, 2011, p. 434.

[17] Azgaldov and Kostin, 2011, p. 434.

$$K_i = \frac{Q_i - Q_i^{rej}}{Q_i^{ben} - Q_i^{rej}} \qquad (5.1)$$

So-called "reliability properties" are input through an "efficiency retention factor, K_{eff}, which is the ratio of the total usable time of an object to its benchmark lifetime."[18] To obtain an overall value for quality, Equation 5.2 is used.

$$K_{rel} = K_{eff} \sum K_i G_i \qquad (5.2)$$

The influence of the above approach is readily apparent in the application of qualimetric principles to military problems. The term "quality" in the qualimetric formulation is exchanged for "combat potential." As Zakharov explained, "In military systems it is accepted to express quality through potential (combat potential) of formed or temporarily created systems."[19] Transforming quality into combat potential is the essence of military potentialometry.

Military Potentialometry

Military potentialometry is a subfield of the Russian discipline of qualimetry that focuses on military applications.[20] It is distinct from other approaches in that it does not estimate commensurability coefficients directly. At the same time, the Method does rely on expert evaluation and systems analysis. As mentioned above, a central idea is that the combat potential of an asset or formation is exactly its quality, as understood in qualimetry. That is, the combat potential or the quality of an asset or formation reflects the asset's value and reliability

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18 Azgaldov and Kostin, 2011, p. 435.

19 Zakharov and Semenov, 2012, p. 70.

20 Bogdanov and Zakharov, 1992.

under very general rather than specific conditions. The authors of the Method argue that the quality of an asset or formation ought to be distinguished from any small number of effectiveness criteria that might be demanded from the asset or formation at one particular time. For example, during actual operations, the plans adopted by both sides will inevitably change, as will the effectiveness criteria that need to be prioritized (e.g., additional survivability of an asset might become more important than increased firepower). Due to this dynamism, the various subsystems of the asset or formation, particularly C2, will have to adapt and previous effectiveness criteria might no longer be relevant. In other words, an asset or formation with superior C2 capability will emphasize overall quality by being able to achieve results that meet varying effectiveness criteria rather than the single effectiveness criterion that seems important to the commander at the time. This notion that a high-quality system will consistently produce the intended result effectively is one of the two fundamental concepts in potentialometry and is known as the reflection principle.[21]

Method of the Center for Military-Strategic Studies in Practice

Perhaps in response to signals from the General Staff (see the following section), Zakharov and Semenov published an article in 2012, on increasing the effectiveness of C2, that explained how the Method could be applied. With respect to C2 assets, the authors estimate the combat potential or quality as a numerical score indicating its overall ability to execute assigned tasks and meet requirements. They use as an example a chemical, biological, and radiological (CBR) defense force grouping, or "system." The CBR defense system was decomposed, using systems analysis, into a C2 subsystem, a troop defense subsystem, and counterstrike subsystem (see Figure 5.2). Each subsystem was further decomposed into sub-subsystems (weighted by experts)

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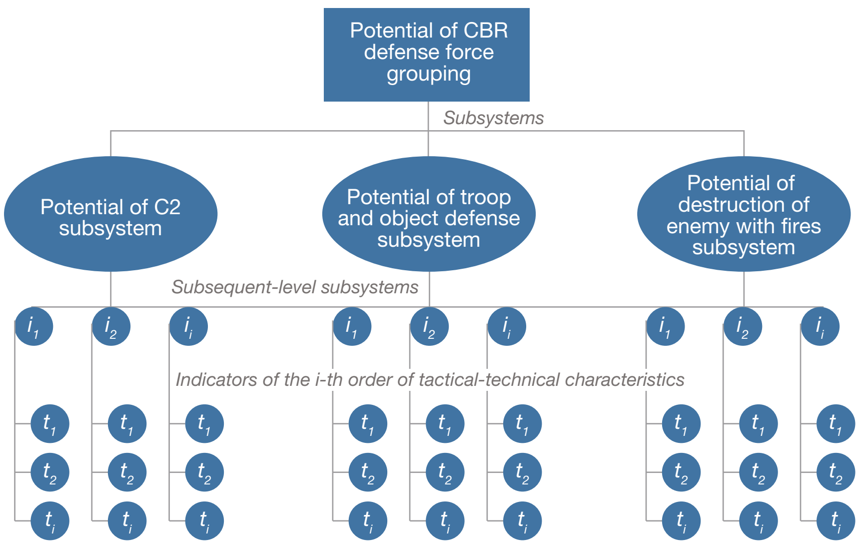
[21] There is also a second principle of qualimetry or potentialometry known as the *life cycle principle*. The life cycle principle emphasizes how the actual design and production of the asset or formation is translated into effectiveness; for example, a high-quality design and production process for a C2 system will emphasize the asset or formation to meet various effectiveness criteria as operational requirements vary.

and benchmarked against requirements related to combat readiness, resource consumption, productivity, and so on.[22]

For approaches using qualimetry, there is a precise scheme for weighting multiple criteria. This is similar to benchmarking that might be more familiar to Western audiences.[23] Bogdanov and Zakharov illustrated how this can be done in their 1992 article; in that work, the authors decompose an asset into strike, C2, mobility, and survivability subsystems and a formation into arms, C2, and logistics support subsystems defined by various quality characteristics.[24] Mathemati-

Figure 5.2
Combat Potential of a CBR Defense System and Subsystems



SOURCE: Zakharov and Semenov, 2012. Adapted from image courtesy of East View Information Services.

[22] Zakharov and Semenov, 2012, p. 71.

[23] Azgaldov and Kostin, 2011.

[24] Bogdanov and Zakharov, 1992.

cally, these subsystems can be described by the nonnegative indices $P_1, P_2, \ldots, P_n$, where P_i is the value of quality of the subsystem *i*. The application of qualimetry is that these characteristics of the systems are benchmarked, that is:

$$P_i = \sqrt{\sum_{j=1}^{m} b_j \left(\frac{X_j}{X_{j\,\max}} \right)} \qquad (5.3)$$

where X_j is the value of the *j-th* characteristic of the weapon or equipment comprising the subsystem (e.g., the speed or range of the missile), $X_{j\,max}$ is the maximum possible (threshold) value of the *j-th* characteristic of the weapon or equipment comprising the subsystem, and

$$0 \leq b_j \leq 1 \,|\, \sum_{j=1}^{m} b_j = 1$$

are the weighted coefficients of the significance of the characteristics of the weapon or equipment.[25]

The combat potential of a system in military potentialometry is then defined as:

$$CP = \sqrt{\sum_{i=1}^{n} a_i * P_i^2} \qquad (5.4)$$

where

$$0 \leq a_i \leq 1 \,|\, \sum_{i=1}^{n} a_i = 1$$

[25] Vladimir Stepanov, “Voennaia potentsialometriia—novaia nauka ili starye zabluzhdeniia,” *Vestnik Akademii voennykh nauk*, Vol. 4, No. 49, 2014, p. 159. This article explains the Method in some detail in order to critique it.

are the weighted coefficients of significance of the functional properties (*funktsional'nykh svoystv*), or subsystems.

Mathematically, this combat potential is bounded by 1 (which would represent a subsystem with all characteristics at the maximum). For assets or combat formations composed of multiple subsystems, the combat potential of the whole system is the weighted sum of the individual systems' combat potentials.

The final step is to establish a coefficient of combat potential by comparing the combat potential of the weapon under examination to a reference weapon of the same class—for example, an M1A1 tank would be measured against the reference tank, T-80UM, while the Su-24 might be measured against a reference aircraft, F-15E.[26] A comparison of weapons within a specific class is a departure from previous practice, when a single reference weapon was used for all other weapons and equipment. Table 5.1 presents the 1992 data provided by Zakharov and Bogdanov after applying the Method—which had not been codified at that time—and that was updated in 2009. The most notable disparities are seen in Russian artillery, which the Method found to be quite superior as a percentage from western counterparts, and U.S. aircraft, which were rated substantially higher than the Russian Su-24.

Two issues arise during execution—obtaining the benchmark reference values $X_{j\,max}$ and obtaining weights to aggregate the subsystems. This relies on expert evaluations and is subject to the same limitations discussed previously. Bogdanov and Zakharov also explain how this approach was executed during the joint modeling study, which we discuss in a subsequent section.

Growing Prominence and Integration of the Center for Military-Strategic Studies Method

Around 2008, the Russian General Staff apparently mandated that the Russian military science community adopt the Method in its practice

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[26] S. A. Bogdanov and L. V. Zakharov, "O vyrabotke edinykh podkhodov k otsenke boevykh potentsialov vooruzhenii," *Voennaia mysl'*, No. 8–9, 1992, p. 46.

Table 5.1
Comparison of Russian and Western Weapons Using Method of Combat Potentials

Class	Reference Weapon	Combat Potential	Weapon	Combat Potential Coefficient
Tank	T-80UM	1		
			M1A1	1.08
			Challenger	0.98
			Leclerc	0.99
Armored combat vehicle	M1A1	1		
			BMP-3	0.83
			M2A1	0.98
			Warrior	0.77
Artillery and multiple-rocket launcher	Smerch	1		
			M108	0.51
			Abbot	0.54
			BM-24	0.66
Aviation	F-15E	1		
			F-15C	0.93
			Su-24	0.65
			Buccaneer	0.38

SOURCE: Bogdanov and Zakharov, 1992.

of assessing the combat potential of weapons, equipment, and combat formations, and adapt any proposed innovations to conform to the principles of the Method. In 2009, echoing the language of the aforementioned patent, senior researchers at the 46th TsNII MOD described how a technique developed at the TsVSI GSh was filling a void left by the lack of resources committed to combat modeling and actual weapons testing. The researchers explained that this transition to a more cost-effective approach was consequential because " . . . assessments of combat potential, to some extent, are used in justifying the State Armaments Program as well as the development of the modern force structure of the Armed Forces."[27]

By 2014, the Method was growing in prominence. Vladimir Stepanov, the director of the Research and Development Center of the TsNII of the Russian Air Force, noted the " . . . development and widespread integration into everyday practice of the 'Method for Assessing the Combat Potentials of Armaments and Military Equipment and Military Formations of the Armed Forces of the Russian Federation and Foreign States,' established by the Center for Military-Strategic Studies of the General Staff of the Armed Forces of the Russian Federation." Stepanov later pointed out that the reason for the increased application of the Method was because of an "administrative imposition on the service institutions."[28]

In 2015, the department head at the Electronic Warfare Scientific Research Center of the Air Force, in an article on assessing the effectiveness of electronic warfare to disrupt enemy command and control, wrote that it was necessary to "harmonize" existing methods for measuring effectiveness of weapons and equipment with the "'Unified Method for Assessing the Combat Potentials of Arms and Military Equipment, Combat Formations, and Troop (Force) Groupings of the Armed Forces of the Russian Federation and Foreign States,' which

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[27] A. I. Buravlev, S. R. Tsyrendorzhiev, and V. S. Brezgin, "Fundamentals of the Methodological Approach to the Evaluation of the Combat Potential of Military Weapons and Equipment and Combat Formations," trans. Clint Reach, *Arms and Economics*, Vol. 3, No. 7, 2009, p. 5.

[28] Stepanov, 2014, p. 158.

was accepted for mandatory use when performing operational-tactical calculations."[29] In an article on a similar topic the following year, one of the coauthors of the 2015 piece confirmed that the Method required for use during operational-tactical calculations was that which was developed by TsVSI GSh.[30] Finally, in late 2017, researchers from the Russian Academy of Missile, Rocket, and Artillery Sciences and the 3rd TsNII MO, the latter of which is the central research institute for the Russian Ground Forces (*sukhoputnye voiska*) and Airborne troops, stated that combat potential measurement methods were the "most widespread" for measuring the effectiveness of weapons in the Ground Forces, and that the most-used combat potential methods were based on qualimetry.[31] This was a likely reference to the Method of the TsVSI GSh, which the authors cited in the paper.

These quotes demonstrate not only the widespread integration of the Method across the service research institutes but also the apparent requirement that it be used in operational-tactical calculations, such as COFM. The Method is not without its detractors, however. In fact, over the past ten years, there has been a vocal debate within Russian military science journals that is particularly focused on the accuracy and utility of the Method, relative to other approaches for assessing combat potentials and the effectiveness of weapons and equipment. The following section will explain the ongoing debate and highlight some of the flaws of the Method in the view of its opponents.

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[29] A. S. Korobeinikov, D. V. Kholuenko, and S. I. Pasichnik, "Effektivnost' gruppirovki voisk radioelektronnoi bor'by v khode kompleksnogo porazheniia informatsionno-upravliayushchei sistemy protivnika," *Voennaia mysl'*, No. 8, p. 31.

[30] D. V. Kholuenko, V. A. Anokhin, and N. M. Gromyko, "Uchet effektivnosti sistem razvedki i upravleniia pri raschetakh boevykh potentsialov voinskikh formirovanii," *Voennaia mysl'*, No. 10, 2016, p. 40.

[31] Dorokhov and Ishchuk, 2017, p. 27.

The Debate over the Method

The Method and the expert evaluation it relies upon have been criticized by a number of Russian military officers and analysts.[32] First, the limitations ascribed to all expert evaluations apply; such evaluations are subjective, there is risk of bias, and they are difficult to validate. This could lead to a number of potential problems. Tsygichko and Stoekli emphasized that in assessments of the potential of C2 and other information-based capabilities, for example, the application of such a method would be problematic in attempting to assess C2 equipment. Recalling that the Method does not consider the employment of systems and that weighted coefficients are attached to each of the considered subsystems of a weapon (or combat formation), one of which was C2, Tsygichko and Stoekli argued that the weighted coefficients " . . . were assigned in a purely speculative manner" and did not account for the "nature, forms, scale, [or] conditions of combat."[33] Although both of these issues are potentially significant flaws of the Method, the authors argued that the failure to take such variables into account was particularly problematic in the case of C2, intelligence, and surveillance, without elaborating further.

Fifteen years later, the Chief of the General Staff, Nikolai Makarov, again highlighted the concern about the lack of a methodology that could account for the information component of modern warfare:

> For some reason we continue to apply a classical correlation of forces [assessment] in all of our calculations. But this has long since ceased to correspond to the actual state of affairs. The information component, the information-command and control system that is used in many of the leading militaries of the world, for some reason is not considered. Over the course of two years we have not been able to make any progress in this area. We have not seen any scientific developments that would allow us to transition to new methods and technologies to calculate the correla-

[32] Stepanov, 2014, p. 158.; Dorokhov and Ishchuk, 2017; Tsygichko, 2017.

[33] Tsygichko and Stoekli, 1997, p. 24.

> tion of forces taking into account new arms and methods of warfare. There are certain initiatives, but they are very primitive and do not reflect the actual situation.[34]

Russian experts have grappled with not only with how to measure effectiveness of C2-related functions but also with the implications of potential flaws in the Method. In 2007, Viktor Riabchuk, a prolific author on command and control, observed that analysts at that time were attempting to better account for "information warfare" in combat potentials methods with coefficients, with apparently little effect.[35] In 2016, researchers at the Military Scientific Training Center of the Air Force Military Academy (VUNTs VVS VVA) were specifically looking into the challenge of measuring the effectiveness of capabilities such as surveillance and reconnaissance and C2 in the calculation of combat potentials of formations. They noted that based on the Method's guidance the " . . . potentials of reconnaissance and communication should be summed with combat potentials of weapons and military equipment (CPWME), taking into account certain coefficients of importance [*koeffitsienty vazhnosti*] which vary from 0.1 to 0.3."[36] Interestingly, according to the authors, C2 in particular was deemed by the Method to be "very insignificant." The implications of such an assumption include underestimating the force multiplication value of a highly advanced C2 system and the impact of capabilities such as EW—attack and protection—on C2.[37]

Another key point of contention involves the idea of combat potential as a constant value that, once calculated, can be applied in any number of scenarios to calculate COFM. Detractors claim that combat potential is only a useful tool when determined in conditions

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[34] N. E. Makarov, "Vazhneishaia zadacha voennoi nauki—razrabotka kontseptsii netraditsionnykh voin i vooruzhennykh konfliktov," *Vestnik Akademii voennykh nauk*, Vol. 2, No. 35, 2011, p. 15.

[35] V. D. Riabchuk, V. I. Nichipor, V. V. Kondrat'ev, and A. V. Riabchuk, *Intellektualizatsiia urpavleniia*, Moscow: Rudomino, 2010, p. 149.

[36] Kholuenko, Anokhin, and Gromyko, 2016, p. 40.

[37] Kholuenko, Anokhin, and Gromyko, 2016, p. 41.

of a specific scenario. In other words, combat potential, according to critics of the Method, is a variable value that is scenario-specific and will change, potentially in a dramatic way, depending on the combat circumstances. To reiterate, the Method involves a relatively straightforward summation of combat potentials of weapons and equipment—with some consideration of combat conditions and other factors through weighted coefficients determined by experts—to establish a combat potential value for a military formation. A number of Russian (and Soviet) experts have raised this objection to any approach that does not limit the application of combat potential to calculate COFM to a very specific scenario. Speshilov, Pavlovskii, and Kabysh made exactly this point in 1981.[38]

More recently, researchers from across the service branches have expressed similar reservations about the notion that combat potential, applied outside the conditions in which it was calculated, can produce a useful COFM assessment.[39] Relatively detailed analyses in Russian military journals describe the essence of the problem in the view of the Method's opponents. Buravlev and Brezgin argue that, particularly in the case of a combat formation, a computer-based combat model ideally would be used to account for the synergies within the combat formation (or combat system) and the external variables that would also influence the outcome of an operation. Because of the time constraints of command staffs in conducting their analyses, the researchers note that advanced combat models are not suitable at the operational planning phase. However, some simulation of the " . . . combat operations of a combat formation against a specific operational-tactical background" that takes into account various support functions, such as C2 and logistics, that must be applied to reliably calculate the combat potential of a formation.[40] Buravlev and Brezgin proposed such an

[38] Speshilov, Pavlovskii, and Kabysh, 1981.

[39] Stepanov, 2014.

[40] Brezgin and Buravlev, 2010, p. 47.

"aggregated model of the confrontation between combat systems" in 2009.[41]

A particularly detailed rebuke of the Method, referenced previously, came from Air Force colonel Vladimir Stepanov in 2014. In a critique of military potentialometry, Stepanov attempted to show how the preferred air combat simulation model of the Air Force, which is based on probabilities of destruction in an air engagement, is superior to an approach based on qualimetry and expert methods. In his 2014 article, Stepanov applied both the Method and an Air Force model, which was based on probability theory, to compare the results of combat potentials assigned to aircraft in the context of an air-to-air engagement. Stepanov found a high degree of volatility in the value of combat potential depending on the weighted coefficients applied to "fire power" and "survivability" (mobility was not considered, as it was assumed to be "realized in full").[42] Variance between the results of the two methods was, in some cases, several hundred percentage points. Stepanov explained the variance: A constant combat potential cannot account for the fact that the employment of weapons in actual combat occurs in stages, each of which requires a reformulation of the input data.

Our own analysis of what is known of the Method identified a number of other problem areas. First, as mentioned above, expert evaluations have a number of limitations. Second, the focus on *quality*—as understood in qualimetry—instead of effectiveness poses additional risks. What proponents of the Method desire is to obtain a general combat potential, a single numerical value that can be used widely. Coefficients of commensurability obtained from more-rigorous methods were found to be highly specific and very sensitive to changes in conditions. This is the price paid for being predictive of operational results, as coefficients of commensurability explicitly measure the potential contribution of an asset or formation to an operational outcome, such as inflicting casualties or the increasing rate of advance. If

[41] A. I. Buravlev and V. S. Brezgin, "Agregirovannaia model' protivoborstva boevykh sistem," *Vooruzhenie i ekonomika*, No. 5, 2009.

[42] Stepanov, 2014, pp. 161-162.

anything, this would indicate that general combat potentials might not be very meaningful or highly predictive of operational effectiveness. Potentials obtained using potentialometry *might* yield useful results, but it is impossible to know without external or operational validation of the decisions that use them. Moreover, because potentialometry emphasizes quality rather than effectiveness, there is increased risk that the estimated combat potential would not correlate with one specific operational requirement such as increasing the rate of advance.[43] Third, the earlier caveat about the validity of weighting multiple subsystems and aggregating them also applies here. Lastly, potentialometry is often justified by mathematical and physical intuition; this, at times, can be misleading or result in mathematical inconsistencies when compared with other methods if the analogy is taken too far.[44]

Conclusion

Implicit in our discussion is that Soviet and Russian military leadership (i.e., the General Staff) over the course of decades have consistently believed that the concept of combat potential is a valuable mechanism for determining COFM. This is for two reasons. First, combat potential adds a qualitative dimension to the COFM assessment to account for disparities within classes of friendly and enemy weapons. Second, precalculated combat potential values offer command staffs a relatively straightforward and time-efficient way to perform the most critical operational-tactical calculations, such as COFM. The desire to reduce the "friction" of the operational planning process and reduce the human factor by implementing mathematical methods is a longstanding practice in Soviet and Russian operational art.[45]

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[43] Buravlev, Tsyrendorzhiev, and Brezgin, 2009.

[44] The formulas in potentialometry involve taking the Euclidean norm of some unit vector.

[45] Gary J. McCarty, *Norms and the Red God of War—Gospel for the King of Battle?* Ft. Leavenworth, Kan.: School of Advanced Military Studies, United States Army Command and General Staff College, August 21, 1990.

According to some Russian military experts, the only way to appropriately determine combat potential values is through an advanced simulation model that considers very specific combat conditions. Some even argue that a sophisticated combat model mitigates the need to use combat potentials all together. The General Staff and the advocates of the Method apparently disagree, despite explicit reservations from senior leaders and within the military science community. In essence, the former camp believes that a cost-effective shortcut can provide commanders with a COFM assessment that is operational and accurate enough to justify force-package and COA decisions, at least until a viable solution can be found. Although there is some evidence that the Russians are devoting more attention to modeling now than they were perhaps ten years ago, the Method appears to be the least worst option at the moment.[46] In the next chapter, we consider how COFM based on combat potentials fits into the overall operational planning process.

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[46] P. A. Dul’nev, “Vstupitel’noe slovo,” *Vestnik Akademii voennykh nauk*, Vol. 4, No. 65, 2018.

CHAPTER SIX

COFM in Operational Planning and Other Applications

The purpose of COFM calculations is to assist the commander in deciding on the most appropriate force package and COA to execute an assigned mission. In the immediate prewar and postwar periods, COFM calculations were carried out by hand by staff officers in the operational planning phase. As computational and computer technology developed, the Soviets sought to integrate machines into operational planning processes. Before, staff officers had been reliant on the data that could be obtained by soldiers in the field, transferred back to headquarters, and copied down with pen and paper. Technology allowed larger amounts of data to be input and stored on computers, which would then run the numbers and produce COFM and other calculations. Furthermore, the increasing complexity of warfare, in the Soviet view, required the assistance of technology to assist in operational decisionmaking that could no longer rely exclusively on the experience and intuition of the commander.[1]

In Soviet practice, a COFM calculation was part of a broader set of planning actions called "tactical calculations" (*takticheskie raschety*) or "operational-tactical calculations" (*operativno-takticheskie raschety*), depending on the planning context. Today they are most often referred to as operational-tactical calculations, which remain a central part of

[1] A. Ia. Vainer, *Takticheskie raschety*, Moscow: Voenizdat, Ministry of Defense of the USSR, 1977, p. 6.

the Russian operational planning process.[2] Operational-tactical calculations were defined in Soviet times as "computations conducted to determine the quantitative and qualitative indicators necessary for decisionmaking, operational (tactical) planning, and for command and control of troops during combat actions."[3] The most important calculations, according to the Soviet Military Encyclopedia, were the calculation of the combat capabilities of forces and means and the COFM "taking into account the capabilities and probable actions of the enemy."[4] A noted Soviet author described these calculations as an ". . . important instrument for obtaining the quantitative data that were necessary for the commander . . . to effectively assess [various combat] actions" to deliver the greatest damage to the enemy while sustaining the minimum amount of casualties.[5] In other words, the commander often has several potential courses of action to choose from, and the question is how to most effectively decide. The Soviet and Russian answer to that question is to combine the experience of the commander with automated decision aids that can more quickly run calculations like COFM. This chapter will examine the operational planning process and address the role that combat potentials and COFM play in facilitating commanders' decisions and will briefly address other applications of COFM assessments beyond operational planning.

Soviet Operational Planning and COFM

Throughout the Cold War, the Soviet publications conveyed a preference to apply mathematical methods to aid military decisionmaking on such questions as how effective fires would be against given tar-

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[2] Lester W. Grau and Charles K. Bartles, *The Russian Way of War Force Structure, Tactics, and Modernizarion of the Russian Ground Forces*, Ft. Leavenworth, Kan.: Foreign Military Studies Office, 2016.

[3] M. M. Kir'ian, ed., *Sovetskaia voennaia entsiklopediia: radiokontrol'—tachanka*, Vol. 7, Moscow: Voenizdat, 1980, p. 70.

[4] Kir'ian, 1980, p. 70.

[5] Vainer, 1977, p. 7.

gets, how long it would take for troops to arrive at a specified location, and how much combat power would be needed to be relatively assured of successful completion of the mission. As mentioned previously, for many of these questions, a person must decide on the effectiveness indicators to be able to answer any question related to mission accomplishment; one example is the amount of damage inflicted on the enemy by fires to consider an action successful.

Technology served as a double-edged sword for Soviet staff officers responsible for operational planning. On the one hand, the increased range, power, and quantity of missiles and warheads created all sorts of challenges related to

- the requirement to obtain, transfer, and process battlefield information needed to run calculations based on reliable data
- the speed with which the situation on the ground could change continued to increase over time and placed a greater premium on command staffs to deliver recommendations more quickly
- the increased ability to intercept a greater amount of enemy communications and emissions created challenges (and opportunities).

On the other hand, automation offered the capability to substantially shorten the amount of time, effort, and personnel needed to process greater amounts of information once it had been obtained.

In general, the primary responsibility of the Soviet planner was an "assessment of the situation" (*otsenka obstanovki*). This broad tasking included, first and foremost, an understanding of COFM. According to a 1958 article on automation of C2 of ground forces, in addition to other situational assessment factors such as terrain analysis and weather, "a large amount of time and effort is required to determine the qualitative and qualitative correlation of forces of the opposing sides both overall and along the axis of the joint formation or division as well as along separate axes during combat operations in the tactical zone and at operational depth."[6] With the help of computers, the time required for COFM and tasks such as determining the average rate of

[6] Siniak, 1958, p. 35.

attack, the importance of enemy targets, and the distribution of fires assets could be significantly reduced.

By the 1970s, the use of mobile automated systems was becoming widespread in Soviet planning. To manage the new technology and the complex processes to efficiently and effectively exploit the computational power of such systems, a different type of officer was required. So-called "operator-mathematicians" became fixtures in command staffs. According to one description of the staff work, the sequence of tasks of the operator-mathematicians was the following:

- First, the mathematicians gathered the available "fixed information" (*postoiannaia informatsiia*), such as the level of combat training of each side, the equipment within the TVD, the tactical-technical characteristics of weapons and equipment, information on logistics and C2 assets, and indicators of combat readiness, among others, and entered these data into a computer.[7]
- Next, "variable information" (*peremennaia informatsiia*), such as changes in troop locations, the ability to reinforce personnel and material, the probable intentions of the enemy, were also input into a computer.
- They then tested a number of courses of action, with the computer providing ratings for each.[8]

The following list illustrates a collection of selected tasks or tactical calculations that were commonly assigned to operational staffs during joint Warsaw Pact exercises after 1975, and the software programs that were used by the rocket and artillery forces. These were task-specific software programs that were developed and used within the staffs of the air defense, engineering, communications, and logistics troops.[9] As will be shown in the subsequent section, there is a large

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[7] L. Ia. Speshilov and A.I. Kabysh, "Voprosy dal'neishego sovershenstvovaniia planirovaniia operatsii," *Voennaia mysl'*, No. 9, 1978, p. 29.

[8] Speshilov and Kabysh, p. 30.

[9] R. Oganesian, "Primenenie sredstv avtomatizatsii i mekhanizatsii na sovmestnykh ucheniiakh ob"edinennykh vooruzhennykh sil," *Informatsionnyi sbornik shtaba ob"edinennykh vooruzhennykh sil Varshavskogo Dogovora*, 1975.

amount of continuity in this process today within the Russian armed forces.

Operational-level tasks (calculations) involved:

- COFM
- establishing maneuver timelines
- measuring effects of nuclear strikes on enemy forces
- measuring effects of radiation environment on friendly forces
- other tasks.

Rocket and artillery software program functions included:

- calculating ammunition requirements
- calculating strike packages and effects
- predicting radiation environments
- establishing maneuver dynamics during combat.[10]

As was the case in 1958, COFM remained a central component of the operational planning process for the Soviet Union and its Warsaw Pact allies. However, it was clearly not the only calculation being considered within staff headquarters. COFM was best understood as a necessary but insufficient element in Soviet planning, which remains the case today.

The process for calculating COFM within Soviet staffs was explained by Colonel-Engineer L. Ia. Speshilov and his coauthors, who included the well-known Soviet technical expert, Rostislav Pavlovskii. First, the authors note that the introduction of combat potentials to assist staffs in calculating COFM was a "step forward." They go on to describe the prevailing COFM method as it related to mixed force groupings as " . . . a ratio of the sum of combat potentials of various types of arms and military equipment found with the ground, air, and air defense forces of each side."[11] Importantly, the combat potentials were calculated "in a large-scale model and input into a table in the form of constant values" and distributed to command staffs in pre-

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[10] Oganesian, 1975.

[11] Speshilov, Pavlovskii, and Kabysh, 1981, p. 44.

prepared tables.[12] On the basis of the combat potential data within those tables, COFM could be calculated in a relatively straightforward manner assuming that the quantities of the key weapons categories were known. Table 6.1 provides an abbreviated collection of combat potential values from 1977 "that were calculated on the basis of mathematical methods based on the use of a computer."[13] Notably, the title of the document included the phrase "Table of Combat Potentials of Large Units" (see further sections for discussion of the "tables"). The reference weapon for the values within the table was the T-55 tank, and the reference unit for all other large units was the motorized rifle division with T-55 tanks and BMPs (infantry fighting vehicles, or IFVs). The reference weapon and unit are highlighted in bold in the table.

A central concern of Speshilov, his coauthors, and other Soviet experts who worked on COFM issues was that the combat potential values in preprepared tables, such as Table 6.1, were determined for specific combat conditions. It was possible, if not likely, that the combat conditions in which the values were applied to calculate COFM would be different from those that were assumed in the model. Nonetheless, this appears to be a drawback that Soviet military leadership was willing to accept.

Russian Operational Planning and COFM

The collapse of the Soviet Union brought with it two important challenges as relate to operational planning and COFM. First, the limited resources that were available for the military were committed neither to investment in automated C2 technology nor to continuing the large-scale combat modeling program that had existed since the 1970s and was used to determine combat potentials used in command staffs to inform operational decisionmaking. Second, with little money to devote to the modeling effort, the expertise largely dried up because there was no one to replace those that had been engaged with combat

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12 Speshilov, Pavlovskii, and Kabysh, 1981, p. 44.

13 McMahon, 1980.

Table 6.1
Combat Potentials of Selected Weapons and Large Units of the Soviet Union and the "Armies of the Probable Enemy," 1977

Weapon or Large Unit	Combat Potential
T-55	1.00
T-80 (improved)	2.80
BMP-1	0.80
Leopard-2	2.40
M60A3	1.40
XM-1 (experimental)	2.50
BM-21 "Grad"	0.87
122mm SP Howitzer "Gvozdika"	0.81
"TOW" ATGM	0.95
S-75 [SA-2] (battalion)	4.70
"Hawk" modernized (battery)	12.6
MiG-23M	4.00
Su-24	4.00
F-14	11.90
F-15	9.50
Motorized Rifle Division (T-55, BMP)	1.00
Guards Motorized Rifle Division (T-64A, BMP, SP Artillery)	1.29
U.S. infantry division	0.86
U.S. mechanized division	1.10
U.S. armored division	1.23
U.S. airborne division	0.68

SOURCE: McMahon, 1980, pp. 4–9.

modeling in the latter half of the Cold War. Another factor was that the geopolitical environment at the time of the Soviet Union's collapse simply did not incentivize continued investment in this costly endeavor, which was also the case in the United States.[14] Both Russia

[14] Based on informal discussions with U.S. experts.

and the United States were facing the prospect of conflict that was far removed from large-scale war of massive advanced militaries that drove all planning efforts up to the early 1990s.

These challenges did not mean, however, that the Russian military wholesale abandoned its previous approach to operational planning and COFM. In fact, what are now referred to as "operational-tactical calculations" remain a focal point in Russia's approach to substantiating commanders' decisions on key issues such as force composition and a selected COA. In a 2002 book, *Taktika—isskustvo boia* (Tactics—Art of Battle), Ivan Vorob'ev wrote that critical operational-tactical calculations included " . . . an assessment of the combat capabilities of units and subunits[;] the quantitative and qualitative correlation of forces and means of each side along given axes . . . an assessment of the effectiveness of nuclear and fires destruction of the enemy[;] the creation of a fires system[;] the determination of the methods of combat employment of field artillery, air defense, army aviation[;] the capabilities of combat surveillance, reconnaissance, and EW[;] and the organization of engineer and logistics support."[15] According to the 2007 Military-Encyclopedic Dictionary, operational-tactical calculations

> . . . are carried out by personnel of the command staff of joint forces, brigades, regiments, and units and by officers of battalion and below for the determination of the quantitative, qualitative, time, and other indicators for decisionmaking, operational (tactical) planning, and for the command and control of troops (forces) during the course of military actions. Operational-tactical calculations are used to determine the amount of time required for operational (tactical) planning; the combat capabilities of troops (forces); the correlation of forces and means; the formation of a troop (force) grouping; the presence and timeframes for arrival and distribution of fires and support assets . . . .[16]

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[15] I.N. Vorob'ev, *Taktika—iskusstvo boia*, Moscow: Combined Arms Academy of the Armed Forces of the Russian Federation, 2002, p. 602.

[16] Ministry of Defense of the Russian Federation, "Rashety Operativno-takticheskie," *Voennyi entsikopedicheskii slovar'*, 2007.

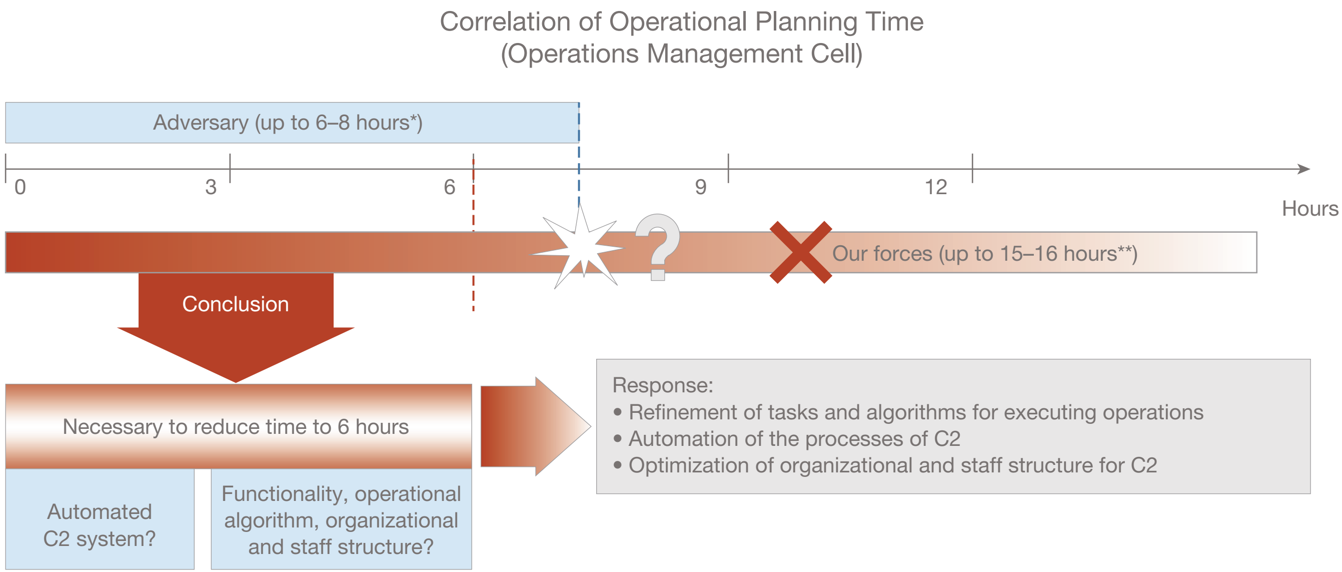
Since the collapse of the Soviet Union, a key challenge for Russia has been to develop or obtain the technology to facilitate the collection and processing of large amounts of information with which to run such calculations. Without effective technology, the amount of data required in Russian operational planning and the inability to process them in a time-efficient manner slows the work of staff and potentially leaves commanders with the choice of either waiting for recommendations or moving forward with a COA that has not been vetted in ways that are preferred in Russian operational planning. The reduction of planning timelines remains a central issue for the Russian armed forces (see Figure 6.1).

For example, over the course of two decades, Russian air defense analysts have observed the problems associated with inputting data and waiting for the software to process them and deliver a result. In 1991, S. G. Beglarin and V. N. Zimin wrote:

> Analysis of published materials on the indicators and methods for assessing the correlation of forces of opposing sides of air defenses and enemy air forces demonstrates that these indicators and methods can be used primarily during advanced preparation of an operation (combat actions) for subsequent consideration of various options for the distribution of forces and means along axes (boundaries) and the selection of the most effective distribution option. In the course of combat actions the use of these methods is difficult: They require a significant expenditure of time; they do not mitigate the possibility of missing the rational course of action if that course of action was not included in those assessed; and not reflected in the methods is the interconnection of correlation of forces indicators and the effectiveness of combat actions, which allows for a qualitative approach to the execution of various C2 tasks including one of the most important—choosing the optimal distribution of air defense (PVO) forces and means in the direction of the air-based enemy.[17]

[17] S. G. Beglarin and V. N. Zimin, "K otsenke sootnosheniia sil," *Voennaia mysl'*, No. 5, 1991.

Figure 6.1
Operational Planning Timeline



SOURCE: Grau and Bartles, 2016, p. 66.

* Information provided by the Department of Foreign Military Studies of the Combined Arms Academy of the Russian Federation

** In accordance with “Guidelines for the work of the staff and commander in relation to the organization of operations and practical preparations of subordinate commands and troops for combat”

Twenty-five years later, in 2016, Russian air defense analysts continued to lament the lack of operational utility of given calculation results as a result of "cumbersome software":

> Consideration of this principle [of defense sufficiency] in relation to forces executing air defense tasks requires the creation of a corresponding correlation of forces from the commander. In connection with this, at the operational planning phase of combat actions one of the most important elements in assessing the situation is the calculation of combat potentials of enemy offensive air-based assets, friendly SAM [surface-to-air missile] systems and fighter aviation, and a determination of the sufficiency of forces and means for the execution of tasks to effectively repel enemy airborne strikes. Military command and control centers typically have a minimum amount of time to come up with a plan of action and make decisions relating to combat actions. At the present time, in order to resolve the aforementioned tasks, cumbersome software products are used that require the input of a large amount of benchmark data. The degree of operational application of the calculations conducted with this software is not high.[18]

These examples demonstrate both that Russia continues to employ operational planning practices that rely on calculations to assist decision-making on a host of issues, and that technological development plays an important role in the speed with which commanders can make decisions.

Despite the technological concerns, the overall operational planning process appears to remain largely unchanged from the late 1970s. To recall what was described in previous sections, computers in the late Soviet period were used to accept a large amount of input data, which were processed to produce numeric values rating a number of different COAs under consideration. Based on a 2012 blog post (in addition to the aforementioned evidence regarding operational-tactical calculations

[18] S. A. Kostrov, S. G. Beglarian, and N. M. Tolkachev, "Metodicheskii podkhod k obosnovaniyu rekomendatsii po usileniyu gruppirovok zenitnykh raketnykh voisk i istrebitel'noi aviatsii," *Voennaia mysl'*, No. 9, 2016, p. 30.

and other sources), the process today is very similar.[19] The COA development process involves several steps, which are listed in Table 6.2.[20]

The blog post uses a simple tactical example to demonstrate the COA development process. If the objective is to take a high point, the considered COAs could include " . . . a flanking attack with advancement from depth; attack from a position of direct contact with the enemy with a preliminary occupation of the starting position; attack with preparatory fires; night attack without preparatory fires (to achieve surprise); flank (sweep) from the right, from the left; vertical sweep (landing of airborne forces in the rear of the enemy defending the high point)."[21] Each considered COA is tested against desired criteria within many operational-tactical categories, and the results are depicted as numerical values to compare one COA with another. According to Vorob'ev, as of 2002, running these calculations with the help of automated equipment occupied approximately 10 to 15 percent of the time allotted to staff to execute planning tasks. Without such equipment, the time expenditure rose to as high as 25 percent.[22] The notional values shown in Table 6.3 are presented in such a way to raise the point

Table 6.2
COA Development Steps

Step	Description
1	Receive combat task
2	Mission analysis
3	Situation Assessment
4	Define the plan (lay out COAs)
5	Analyze selected COAs
6	Select most effective COA
7	Formulate and depict combat tasks

SOURCE: "ASUV ESU TZ Chast' 9. Okonchanie," 2012.

19 "ASUV ESU TZ Chast' 9. Okonchanie," July 5, 2012, repost by user "ruser07" of original by user "dragon_first_ru." The original post has been removed.

20 See also, for example, Grau and Bartles, 2016, p. 66.

21 "ASUV ESU TZ Chast' 9. Okonchanie," 2012.

22 Vorob'ev, 2002, p. 318.

Table 6.3
Notional COA Decision Matrix

#	Tactical Calculations (assessment criteria)	COA Options			
		1	2	3	4
1	COFM	5	3	2	1
2	Number of critical targets	5	3	2	1
3	Expected probability of locating enemy targets and their amount	5	3	2	1
4	Capability of destruction of enemy targets by fires	5	3	2	1
5	Expected losses	0	3	2	1
6	Probability of mission execution (temporary parameter)	5	3	2	1
7	Distribution of forces and means	5	3	2	1
8	Required consumption of material means	5	3	2	1
9	Maneuver capabilities of subunits	5	3	2	1
10–[155]	Other calculations	...	...	...	...
	TOTAL points:	770	620	310	155

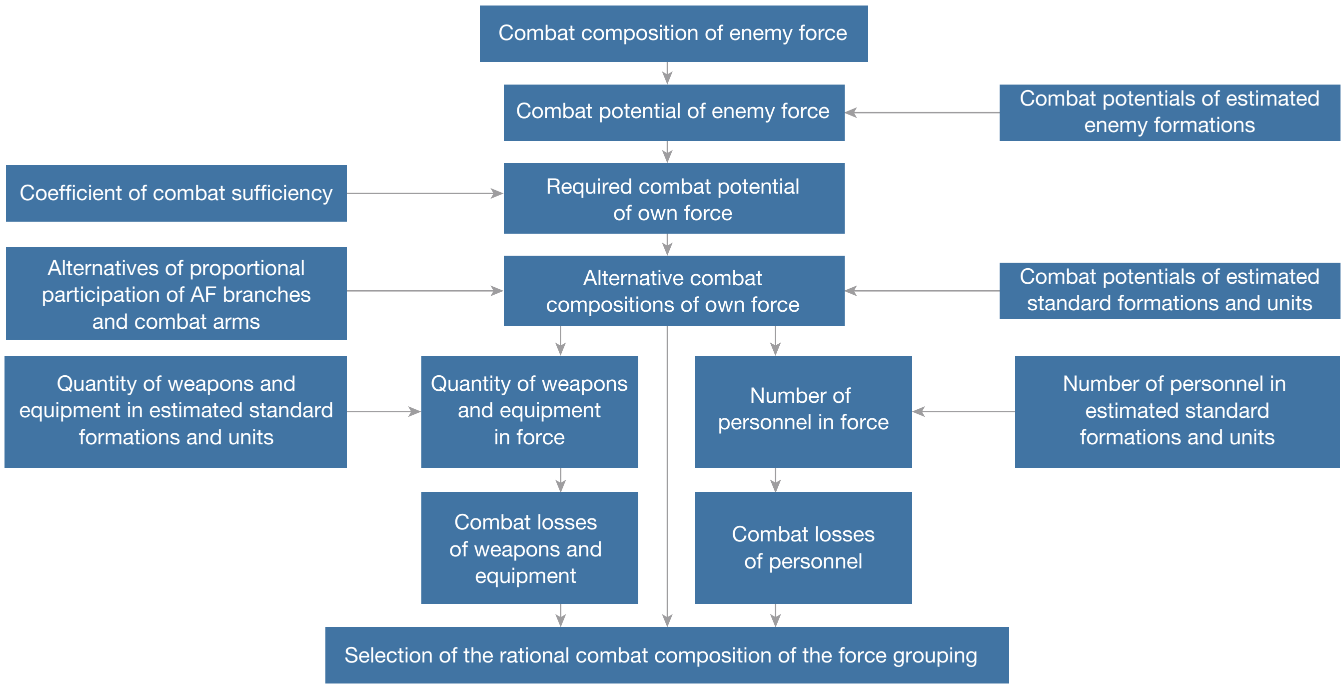
SOURCE: "ASUV ESU TZ Chast' 9. Okonchanie," 2012.
NOTE: Total points are calculated using assumed totals from "other calculations."

that the seemingly "best" COA might be fundamentally flawed in a critical area ("expected losses"), in which case the staff would need to select an alternative COA.

In the midst of this process, it is also necessary to consider the composition of the required force grouping, which is directly related to COFM. The way in which combat potential values factor into this process is shown in Figure 6.2.

The combat potentials used to inform decisions on force composition and to calculate COFM in various planning scenarios are most likely found using the aforementioned Method. There is also evidence that the Russian military is still using preprepared tables to establish COFM. In late 2016, the Military Academy of the General Staff (VAGSh) purchased the following materials for the 2017 academic year: "Tables of the Values of Combat Potentials of Arms and Military Equipment of the Armed Forces of the Russian Federation and the Armed Forces of Foreign States," "Excerpts [*vypyski*] from the Tables

Figure 6.2
Selection of the Rational Combat Composition of the Force Grouping



SOURCE: Ostankov, 2003. Adapted from image courtesy of East View Information Services.

for the Ground Forces and Airborne Forces," and "Excerpts from the Tables for the Aerospace Forces."[23] The fact that the VAGSh is continuing to use such materials (likely as training aids) in addition to what is known of historical practice suggests that tables of combat potentials continue to be parts of operational planning and COFM calculations within command staffs.

The only openly available combat potential values we have located were presented in a 2011 paper from the Tactics and General Military Training Department of the Belarus National Technical University to illustrate an example of how to conduct a tactical COFM calculation based on a duel scenario between an armored vehicle and an antitank weapon (see Tables 6.4 and 6.5).[24] Given the closeness of the military relationship between Russia and Belarus, and the similarity of some weapons in the respective inventories, it is possible, though far from certain, that the information below resembles the values in the aforementioned tables. The reference weapon for Table 6.4 and Table 6.5 below is the T-72A tank.

Other Applications of COFM: Strategic Decisions and Arms Control

COFM is primarily centered on informing COA development and building force groupings at the operational level. There are, however, other applications of COFM that fall outside the realm of operational planning that might or might not require a qualitative consideration. The most obvious area includes strategic assessments that would inform decisions on the use of force. As mentioned previously, historical research found that simple "bar graphs of force deployments" showing "fairly ordinary quantity-to-quantity comparisons . . . within

[23] Government of Russia, "Izveshchenie o provedenii zakupki u edinstvennogo postavshchika (isponitel'ia, podrachika)," state contract between the Ministry of Defense and supplier, Purchase No. 0173100004516002226, December 23, 2016.

[24] V. A. Valezhanin and A. A. Tarchishnikov, *Boevye vozmozhnosti motostrelkogo (tankogo) vzvoda, otdeleniia (tanka) i ikh raschet*, Beloruskii Natsional'nyi Tekhnicheskii Universitet, Minsk, 2011, pp. 8–9.

Table 6.4
Combat Potentials of Selected Weapons of Western Militaries

Weapon or Equipment	Combat Potential
Tanks, IFVs, armored personnel carriers (APCs)	
M1 “Abrams”	1.47
M1 A1 “Abrams”	1.87
“Leopard” 1A4	0.88
“Leopard” 2	1.90
“Leopard” 3	2.80
“Chieftain” MK-5	0.92
AMX-30-B2	0.65
“Leclerc” 1	1.80
BMP M2 “Bradley”	0.55
BRM-M3 [armored reconnaissance vehicle]	0.55
BMP “Marder”	0.26
BMP “Marder” A1 (A2)	0.45
“Lux” BTR with ATGM	0.26
BTR without ATGM	0.06
Antitank Weapons	
“Hot”	0.58
“Tow”	0.56
“Milan”	0.46
“Drakon”	0.32
“Vigilant”	0.24
“Iagdpanther”	0.37
120 mm BO [recoilless gun]	0.14
106 mm BO	0.16
90 mm RPTR [reactive antitank gun]	0.07
RPG [handheld antitank grenade launcher] “Panzerfaust” 3	0.20

SOURCE: Valezhanin and Tarchishnikov, 2011.

Table 6.5
Combat Potentials of Selected Weapons of Belarus' Military

Weapon or Equipment	Potential
Tanks, IFVs, APCs	
T-64A	0.88
T-64B	1.24
T-72	0.88
T-72A	1.00
T-72B	1.65
T-80	1.06
T-80B	1.65
T-80 UD	1.85
BMP-1	0.47
BMP-2	0.43
BMP-3	0.65
BMGT-T	0.88
BMD	0.47
Antitank Weapons	
"Konkurs" [AT-5 Spandrel]	0.45
"Fleyta"	0.46
"Falanga" [AT-2 Swatter]	0.41
"Malyutka-P" [AT-3 Sagger]	0.39
"Fagot" [AT-4 Spigot]	0.36
"Fagot" mobile	0.32
"Shturm" [AT-6 Spiral]	0.58
100 mm PTP MT-12	0.38
SPG-9	0.15
RPG-7B	0.07
RPG-16	0.09
RPG-7B (with tandem PG)	0.20

SOURCE: Valezhanin and Tarchishnikov, 2011.
NOTE: PG = propelled grenade launcher.

weapons systems types at the theater level [–] tanks to tanks, aircraft to aircraft, troops to troops," were presented by the Soviet General Staff to senior political and military leaders for the sake of simplicity.[25] As during the Cold War, the Russians continue to monitor force deployments to assess the threat level in a given region and the need to take corresponding countermeasures. Such force monitoring could fall under what the Russians refer to as a "military-political situation," (VPO, in Russian) assessment. The VPO is measured at the global, regional, and local levels on a periodic basis, and can be instructive in how Russia assesses the force balance in a given theater.[26] Although the VPO is typically not mentioned in Russian military discussions of COFM, which tend to be more technical in nature, any assessment of regional forces is, in the most general sense, related to COFM.

Today the Russian General Staff manages what is called the National Defense Management Center (*Natsional'nyi tsentr upravleniia oboronoi*), or NDMC. Although the NDMC has a wide variety of tasks, from monitoring deliveries of weapons to troop exercises, it also analyzes the VPO (see Figure 6.3). Based on a description of the VPO assessment process by a former chief of the Main Operations Directorate of the Russian General Staff, force dispositions in Europe are captured by this assessment, which used to be conducted periodically but might occur more often since the Russians stood up the NDMC. During a tour of the NDMC for the Russian media in 2017, Defense Minister Sergei Shoigu described the way in which a strategic decision might be taken based on an assessment of changes in force disposition in Europe:

> You recall the operation in the former Yugoslavia. It was a significant event that involved the deployment of NATO naval vessels, missile systems, aviation. All of these types of things are analyzed. If tomorrow, we are getting information from one sector or another, and the computers tell us, 'Friends, we have a situa-

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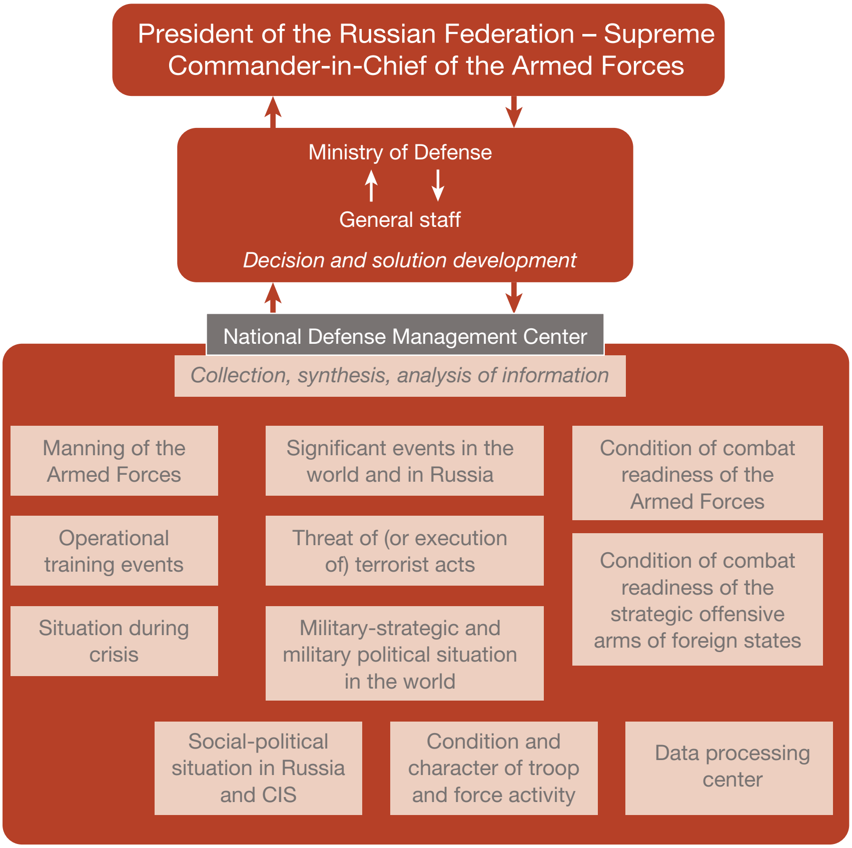
25 Meyer, 1989, p. 4.

26 V. M. Barynkin, "Otsenka voenno-politicheskoi obstanovki—metolodicheskii aspekt," *Voennaia mysl'*, No. 5, 1999.

Figure 6.3
Russian Collection, Synthesis, and Analysis of Defense and Security Information



SOURCE: Gerasimov, 2015. Adapted from image courtesy of East View Information Services.

tion here that very much looks like—with 90 percent certainty—what happened in that previous conflict. In other words, there is a threat that a similar outcome [outbreak of conflict] could be repeated in this region. It is necessary to take action.'[27]

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[27] Rossiya24, "National'nyi tsentr upravleniia oboronoi," video, YouTube, December 30, 2016.

In other words, in Europe or in other theaters, Russia is concerned about a force buildup that resembles those prior to other conflicts. Such force deployments are monitored, entered into databases in some way, and compared with previously entered data to offer a likelihood or threat of attack. The synthesis of such information might take place within the "data processing center" shown in Figure 6.3. As in the past, it appears that the primary concern at this level of command is on the change over time of gross counts of key weapon systems and military formations, which presumably are subject to more-comprehensive analysis along the lines of the planning described by Tsygichko in Chapter Two in relation to assessments on the capabilities of the Chinese military, economy, and transportation system in the 1970s.

Whether the Soviets or Russians used COFM assessments in strategic decisions is not yet clear based on limited available evidence of a comparison of quantitative military force or combat potential prior to or during the interventions in Hungary (1956), Czechoslovakia (1968), Afghanistan (1979), Chechnya (1994 and 1999), or Georgia (2008). Although the answer in most cases will have to be left to future research, we can briefly address the Afghanistan case and other strategic decisions not related to the use of force.

The case of Afghanistan is relatively well known and was also confirmed by the work of the noted historian on the war, Alesksandr Liakhovskii, who drew on declassified Politburo memos that showed that a small circle ultimately made the decision to invade Afghanistan.[28] Tsygichko recalled that in the leadup to the decision, "All of the military organizations that were participating in the analysis of this question, especially the General Staff and its Main Directorate for Intelligence (GRU), categorically opposed the introduction of troops and warned of the possible negative consequences for our country . . . ."[29] As for how the Politburo and General Staff settled on the

[28] Aleksandr Liakhovskiy, "Inside the Soviet Invasion of Afghanistan and the Seizure of Kabul, December 1979," trans. Gary Goldberg and Artemy Kalinovsky, Cold War International History Project, Woodrow Wilson International Center for Scholars, Working Paper 51, January 2007.

[29] Tsygichko, 2005, p. 10.

initial force grouping of around 50,000 officers and soldiers, this is not discussed by Liakhovskii or Tsygichko, or in the Russian General Staff retrospective on the war.[30]

Second, in the 1970s, the Soviet Politburo, over time, deployed 40 divisions along the Chinese border after a brief flare-up of hostilities in 1969. According to Tsygichko, this decision was made prior to any prolonged analysis being done on the infrastructure in the area and on the possibility and capability of China to respond.[31] Only several years later was there a more comprehensive analysis of the "military potential" of China to help Russian decisionmakers better understand how China might be able to mobilize and move its forces for a conflict. However, the impact of this study on the political leadership is unknown.

Finally, the Soviet political leadership in the 1970s reportedly was not convinced by modeling results that showed a large-scale strategic nuclear exchange could not be won and would likely result in virtual destruction of both sides at a minimum and a possible end to civilization at most. Instead, underground "cities" were constructed that were believed to be able to survive nuclear war. Factors that were apparently influential in the decision to reject such conclusions, according to Tsygichko, were the ideological rigidity of the leadership and the commercial interests of the military-industrial complex responsible for missile construction.[32] To be sure, a much more comprehensive analysis is required to definitively determine why certain decisions were made, particularly those that relate to the number of forces deployed in peacetime and wartime.

Another application of COFM and related concepts has been conventional arms control. In the course of talks and negotiations over conventional forces in Europe in the late 1980s and early 1990s, representatives from the Soviet side met with Western counterparts to discuss the most appropriate method to measure the balance of forces.

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[30] Lester Grau and Michael Gress, eds., trans., *The Soviet-Afghan War: How a Superpower Fought and Lost,* original by Russian General Staff, Lawrence, Kan.: University Press of Kansas, 2002.

[31] Tsygichko, 2005, p. 20.

[32] Tsygichko, 2005, pp. 17–19.

Articles also appeared in the Soviet press, in which ideas were promoted in the lead-up to talks in Vienna between the Soviet Union and the West. Writing in *Voennyi Vestnik* (Military Bulletin) in 1989, Tsygichko advocated using the combat potentials method to assess COFM to inform decisions on force reductions. Having already explained the general combat potential method, and Tsygichko's views in particular, it is enough to note that Tsygichko argued that an agreement on the conventional balance of forces in Europe should take into account the combat potential of forces (troops) and means (weapons and equipment) of both sides.[33]

Others have also discussed the use of combat potentials in the context of arms control talks. Bogdanov and Zakharov described meetings that were organized by Albrecht von Müller, the former director of the European Center for International Security, beginning in 1990 that included representatives of the General Staff of the Joint Armed Forces of the CIS and military counterparts from a number of Western countries, including the United States. During these talks, representatives of the Center for Operational-Strategic Studies of the General Staff, now known as TsVSI GSh, offered methods for calculating force balances in Europe. The starting point for the Center was to determine the coefficients of combat potential of ground troops, air defense forces, air forces, and navies.[34] The Method and the results obtained and presented during these talks are described in Chapter Five. The information that Bogdanov and Zakharov presented was clearly different from what Tsygichko had in mind. Indeed, the long debate over how to best calculate combat potentials, to a small degree, played itself out during this period in the early 1990s.

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33 Vitalii Tsygichko, "Combat Potential Method for Vienna Talks," *Voennyi Vestnik*, Vol. 5, No. 59, 1989.

34 Bogdanov and Zakharov, 1992, p. 44.

CHAPTER SEVEN

COFM and Modern Warfare

The original context of current Russian approaches to COFM—based on combat potentials—was the need to achieve high local ground force ratios and successfully execute breakthroughs in selected sectors in central Europe with support from air power and potentially nuclear weapons.[1] The possibility of deploying dozens of armored and mechanized units against prepared, echeloned defenses of approximately 30 NATO divisions and corps across a front of thousands of kilometers required that commanders had a sense of the quantitative-qualitative combat power of each side to come up with an appropriate force package and most effective course of action.[2] In the late 1970s and early 1980s, the Soviet leadership believed that a Soviet guards motorized rifle division and a U.S. armored division possessed similar combat potential. Soviet General Staff calculations around the same time period assessed that a 6:1 advantage in tanks (likely at a breakthrough sector) was sufficient " . . . in the conditions of nuclear war in Europe . . . for the successful execution of strategic offensive operations with the objective of a decisive defeat of the enemy."[3] Other research similarly found a Soviet preference for " . . . 4 to 7:1 at the breakthrough sector but [would]

[1] Womack, 1990, pp. 58–59.

[2] David C. Isby and Charles Kamps, Jr., *Armies of NATO's Central Front*, London, UK and New York: Janes Publishing Company, 1985, p. 194.

[3] Y. N. Baluevskii, *General'nyi shtab Rossoiskoi armii: istoriia i sovremennost'*, Akademicheskii Proekt, 2006, p. 319.

accept an overall superiority of 3 to 4:1 at Army and Front level."[4] As of 1978, the Soviets, compared with NATO, maintained a superiority in main battle tanks of 3:1 (21,000 to 7,000) in northern and central Europe.[5] Knowledge of the combat potentials of large formations could have offered some insight into how Soviet commanders would try to build a force package that could achieve assigned mission objectives. This would have been particularly relevant to air power, which would have required the Soviets to bring considerably more aircraft and air defense to the fight than NATO (or perhaps to compensate in other force areas) given the significant perceived differences in combat potential presented in Chapters Five and Six. Indeed, the Soviets possessed a 5:1 advantage over NATO (2,025 to 435) in interceptors in 1978 throughout all of Europe (northern, central, and southern).[6]

In the post–Cold War period, however, the character of war has changed to some degree, the disposition of forces in Europe is unrecognizable relative to the 1980s (given the lack of prepared defenses to break through), and the ground force numbers in both Russia and Europe are orders of magnitude lower than they were during Soviet times. Given this reality, aside from tactical discussions of massing artillery guided by new reconnaissance assets against targets in kill sacks, our research found very little discussion of a Russian military strategy of massing armor at key breakthrough points to surround and destroy the enemy and seize additional terrain. Therefore, it was not possible, based on open sources, to ascertain the Russian desired superiority in ground force or joint force numbers prior to launching an attack on NATO territory. The primary planning scenario that is most often discussed in Russian military literature, as will be addressed in more detail in following sections, is the defense against a NATO aerospace attack.

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[4] John G. Hines, "How Much is Enough for Theater War?: The Soviet Military Approach to Sufficiency of Conventional Forces in Europe," in *Assessment of the NATO-Warsaw Pact Conventional Forces Balance*, Washington, D.C.: U.S. Government Accounting Office, GAO/NSIAD-89-23, Supplement B, Appendix X, 1988, p. 231. See also Womack, 1990, pp. 71, 78; and Meyer, 1989, p. 8.

[5] International Institute of Strategic Studies, *Military Balance*, Vol. 79, No. 1, London: Routledge, 1979, p. 110.

[6] International Institute of Strategic Studies, 1979, p. 111.

Aside from World War II, which still serves as an important reference point for Russian military officers and analysts, the formative wars that drive the current discussion in Russia on the character of modern warfare are the first and second Gulf Wars (1991 and 2003), the conflict in the former Yugoslavia (1999), and the conflict in Libya (2011). The local wars in Georgia and Syria are also relevant, but in terms of forecasting and planning for a war with NATO, the former conflicts seem to be most salient. In those conflicts, in the Russian view, the role of NATO air power and the capability to launch massed missile strikes from air- and sea-based platforms with precision against key enemy targets—both military and nonmilitary—was paramount. Even prior to 1991, the number of U.S. aircraft carriers was a critical factor in Soviet planning.[7]

The evolution of warfare is having an effect on how Russian decisionmakers think about COFM in the realm of force structure and operational planning. There have been shifts in thinking about "trump card" capabilities based on the current force structure, disposition, and expected actions of NATO. Additionally, how decisionmakers calculate COFM has not necessarily kept pace with changes in how wars are fought. In fact, one could argue that the current approach is a regression from Soviet practice in the latter half of the Cold War. Nevertheless, the ability to conduct precision strikes against targets at great depth requires information infrastructure that facilitates targeting and battle damage assessments, among others. The discussions of Russian military leadership and the military science community demonstrate that there is a need to accurately account for the information component in COFM assessments. The contribution of a robust C4ISR capability and the role of EW in disrupting it are examples of topics often addressed in modern Russian thinking about COFM. The remainder of this chapter will briefly examine Russian observations of modern war and explore the potential ramifications on the future of Russian COFM assessments.

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7 Hines, Mishulovich, and Shull, 1995, p. 22.

First Gulf War: Watershed Moment

The results of the first Gulf War had an impact on Russian thinking about warfare for at least two reasons. First, the Iraqi military was largely trained and equipped by the Soviets, and the Iraqi strategic and tactical air defenses were organized "with the direct participation of Soviet military advisers and specialists."[8] Second, Western ground forces were neither quantitatively superior to the Iraqis nor were they found to be the determining factor in the outcome of the war. What was most decisive in the war, in the view of Russian observers, was the qualitative superiority of coalition forces in technology and quantitative superiority in assets such as precision munitions and naval warships. One of the most prominent Russian military tacticians, I. N. Vorob'ev, observed of the war:

> The past war has demonstrated that technological superiority can nullify the other side's quantitative advantage in divisions and conventional weapons. The MNF [multinational forces], yielding to the Iraqis in the number of combined arms units and artillery, many times surpassed them in the most advanced weapons—in particular, in the newest types of aircraft with a ratio of 13:1, in combat helicopters—16:1. To this should be added the absolute superiority of coalition forces in high-precision weapons systems—sea-based Tomahawk cruise missiles, Patriot anti-aircraft missile systems, space reconnaissance and navigation tools. In addition, the MNF had an overwhelming advantage in warships (20:1). As a result, the quality of weapons combined with the art of command more than compensated for the number of troops.[9]

The use of electronic suppression at the outset of the conflict—in addition to targeting C2 points—was another tactic that Russian analyses of the war have emphasized and that have had subsequent

8 A. S. Rukshin, ed., *Voennoe iskusstvo v lokal'nykh voinakh i vooruzhennykh konfliktakh*, Moscow: Voenizdat, 2009, p. 201.

9 I. N. Vorob'ev, "Uroki voiny v zone Persidskogo zaliva," *Voennaia mysl'*, No. 5, 1992, p. 69.

influence on thinking about COFM assessments from both an offensive and defensive perspective.[10] The ability of NATO to disrupt or destroy C2 infrastructure from greater ranges, and the greater reliance on the digital transfer of data, has increased the role of information in modern warfare and subsequently created a need to rethink how it is considered in COFM assessments (particularly in those that are not done with advanced combat modeling to assign value to weapons and combat formations). Although the discussion of these changes in warfare had been ongoing for decades prior to the war, the observation of theoretical concepts put into practice was the key issue.[11]

Yugoslavia, Second Gulf War, and Libya: Pattern of Way of War

Western intervention in Yugoslavia (1999), the second Gulf War (2003), and the conflict in Libya (2011) confirmed for the Russians that the United States and its allies have a distinct preference in the way they wage war. If the first Gulf War was a watershed moment that led Russia to rethink how it should build its military and organize national defense, subsequent conflicts only served to confirm what it had learned in early 1991. In each of these subsequent conflicts, Russia observed how the depth of the battlefield was greatly increased with the employment of long-range *conventional* precision munitions launched primarily from air- and sea-based platforms. In Yugoslavia (and previously in Iraq), Russian analysts saw a departure from the 1950s and 1960s, when the " . . . spatial scope of local wars and armed conflicts in the 1950s and 1960s usually was restricted to the territory where groupings of armed forces were operating."[12] In each case, military and civilian targets throughout the entire territory of the involved countries

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[10] Yu. G. Sizov and A. L. Skokov, "Znachenie vysokotochnogo oruzhiia v sovremennoi voine," *Voennaia mysl'*, No. 12, 1992.

[11] Grau, 1990.

[12] V. A. Vakhrushev, "Lokal'nye voiny i vooruzhennye konflikty: kharakter i vliianie na voennoe iskusstvo," *Voennaia mysl'*, No. 4, 1999, p. 23.

could be struck from the outset of operations, regardless of whether there was immediate tactical military value or not.

In Libya, Russia saw much that resembled previous campaigns, but also drew some interesting conclusions with regard to COFM. In his observation of the of the actions of the NATO-led coalition, then–Chief of the General Staff N. E. Makarov provided a COFM assessment, noting that

> [n]ow there is an operation "Odyssey Dawn" of the coalition in Libya. As before, the leading role is assigned to high-precision weapons. But to be able to employ these weapons, one must also have them[,] as well as reconnaissance, targeting, and correction, without which it is impossible to conduct military operations. The coalition, as a matter of priority, disables critical facilities: elements of the air defense system, air bases, communications, the system of state and military command and control, and strikes against troops supporting Qaddafi.[13]

Makarov's remarks in relation to precision munitions (and the enabling technology and equipment to employ them) are a continuation of a theme raised by Vorob'ev in 1992. A military that does not possess such assets, or loses them early in the war, is seen to be at a great disadvantage should it come up against one that does. As Kokoshin has stated,

> . . . effective nuclear deterrence against states that have nuclear weapons is ensured not only by the capability to inflict "unacceptable damage" through a retaliatory strike, but also by [conventional] means that provide the capability to prevent "escalation dominance" by the other side at the earliest stages of an armed conflict (war) before it moves to the nuclear phase.[14]

And if the national air defense system fails, as it mostly did in the latest conflicts that involved the United States and its allies (with some exception in Yugoslavia, although survivability at the price of effective-

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[13] Makarov, 2011, p. 15.

[14] Kokoshin, 2002, p. 43.

ness did not turn out to be a successful trade), then even superiority or parity in other force categories might not be enough to avoid defeat. To be sure, the possession of a large arsenal of nuclear warheads and corresponding delivery vehicles is a powerful mitigating factor that was not in play in Iraq, Yugoslavia, or Libya. At the same time, even in the case in which nuclear weapons arsenals exist on both sides, large disparities in conventional precision munitions could leave only a COA involving a "'leap' up the escalation staircase right to the nuclear level."[15]

The changing character of warfare, and a threat environment that is different from that of the Cold War, have had an impact on Russian thinking on COFM in the broad sense of the term beyond operational planning. As the 2000 Russian Military Doctrine explained:

> The condition and prospects for the development of the modern military-political situation are determined by the qualitative improvement of the means, forms, and methods of warfare, the increase in its spatial scope and severity of the consequences of war, and the expansion [of warfare] to new domains. The possibility of achieving military-political objectives with indirect, non-contact actions predetermines the particular danger of modern wars and armed conflicts to peoples and states and to the preservation of international stability and peace and necessitates the vital need to take exhaustive measures to prevent them, and to peacefully resolve contradictions in their early stages.[16]

The Origins of Russia's Current Force Structure

Russia's current force structure is based, in part, on the previous observations of warfare (mentioned earlier in this chapter) in addition to

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[15] Andrei Kokoshin, *Problems of Ensuring Strategic Stability: Theoretical and Applied Questions*, Cambridge, Mass.: Belfer Center for Science and International Affairs, 2011, p. 78. For additional discussion of this issue, see, Yu. A. Pechatnov, "Metodicheskii podkhod k opredeleniyu sderzhivayushchego ushcherba s uchetom sub"ektivnykh osobennostei ego vospriiatiia voriatnym protivnikom," *Vooruzhenie i ekonomika*, Vol. 3, No. 15, 2011, p. 23.

[16] President of Russia, *Voennaia doktrina Rossiiskoi Federatsii*, April 21, 2000.

economic and demographic considerations. Russian military and civilian leaders, after at least two decades of debate, concluded by 2008 that large clashes of frontal ground forces engaging in attrition warfare should no longer be the central scenario in military planning, which is how the Russian military was oriented to fight prior to 2008. Even prior to the war with Georgia, there was much discussion within Russia on the need to modernize the armed forces to participate in modern wars that could break out with little time to mobilize forces. As civilian security experts had argued as far back as 1997, the Russian Ground Forces in the 21st century needed to be

> . . . compact and combat ready, not larger than the size of the armed forces of Germany or France [each around 350,000, including conscripts in 1997], equipped with assets to deploy them from west to east (or to the south) and supported by a powerful and modern Air Force and Air Defense, comparable with that of the United States.[17]

Echoing these sentiments, Yurii Baluevskii, then–Chief of the General Staff, wrote in 2004:

> In connection with the fact that, geopolitically, potential military threats to Russia's security exist in the West, in the East, and in the South, their neutralization should rely on the concepts of strategic mobility and nuclear deterrence. [The threats] call for the presence of a small number of permanent readiness troops that could quickly and effectively influence local conflicts, rapid reaction forces capable of quickly moving to any region along the perimeter of Russia . . . .In equipping the troops and the fleet, priority should be given to high-precision, air-mobile, long-range weapons, as well as to . . . reconnaissance and command and control assets, [which together] are capable, based on their qualitative indicators, of significantly reducing the number of [required] armaments while maintaining sufficient combat power. At the

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[17] A. G. Arbatov, S. A. Karaganov, and V. T. Tret'yakov, eds., "Voennaia reforma v Rossiiskoi Federatsii: Tezisy Soveta po vneshnei i oboronnoi politike," *Nezavisimoe voennoe obozrenie*, Vol. 25, No. 52, July 12–18, 1997.

> same time, Russia's current economic and political weakness along with the nuclear and conventional arms race in a number of countries dictate the need to preserve for the foreseeable future a political reliance on nuclear weapons and a strategy for nuclear deterrence of aggression.[18]

During the five-day war with Georgia, serious problems were identified throughout the armed forces, particularly with regard to readiness. Despite the fact that, on paper, the Russian military appeared formidable, in reality ready personnel, weapons, and equipment turned out to be in short supply. At the outbreak of the war, under 20 percent of the Ground Forces were considered to be permanently ready, and the Russian Air Force was only marginally better.[19] As General Makarov explained in 2009,

> In order to find one person at the rank of lieutenant-colonel, colonel, or general that could ably command troops [during the war], it was necessary to search one-by-one within the armed forces because the full-time commanders who were sitting around leading 'paper regiments and divisions' simply were not in a condition to resolve issues that arose during the five-day war. And when you did send them troops and equipment they were simply confused, and some even refused to execute assigned tasks.[20]

As there had already been a decade or so of discussions regarding modernizing and downsizing the Russian armed forces prior to this performance, the 2008 war in Georgia became the catalyst for change.

The tenets of the 2008 reforms of the Russian armed forces, although quite controversial within the Russian military and defense community, were that the armed forces needed to be able to defeat

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18 Yurii Baluevskii, ed., *Voennaia bezopasnost' Rossiiskoi Federatsii v XXI veke*, Moscow: Center for Military-Strategic Studies of the General Staff of the Russian Federation, 2004, p. 24.

19 Dmitry Solovyov, "Russian Army Not Fit for Modern War: Top General," Reuters, December 16, 2008.

20 "Rossiiskaia armiia okazalas' ne gotova k voinam budushchego," *Izvestiya*, December 16, 2008.

potential adversaries along the periphery with fewer ready ground forces and be able to defend against modern militaries with greater numbers of long-range precision strike munitions, strategic air defense, and nuclear weapons.[21] Another factor leading to an emphasis on permanent readiness was the conclusion that modern wars would not likely be preceded by large buildups involving the mobilization of the country. As Makarov explained in a speech to the Academy of Military Sciences, "[i]t is important to understand that the combat zone is not far to the west or to the east, it is along the borders of the Russian Federation, in the CIS countries . . . .The condition of [force groupings along Russia's border] is such that upon receiving orders, in the course of a few days the aerospace component can conduct strikes against military and state command and control sites, the armed forces, and the industry of the country" in both the west and the east.[22] Following an assessment of the VPO, which Makarov described in some detail in the same speech, the Russian government " . . . decided that participation in large-scale war with several adversaries at once was no longer the primary scenario for which the Russian Armed Forces should prepare."[23]

Largely in keeping with these conclusions, the Russian Ministry of Defense force structure plan from 2013–2020 called for a total of 280,000 nonofficer personnel in the Ground Forces, evenly dispersed across Russian territory, 425,000 contract soldiers across the armed forces, and 220,000 officers (conscripts were to fill the remainder of a force, around one million soldiers in total).[24] As of late 2018, the estimated number of troops in the Russian Ground Forces was between 270,000 and 280,000, roughly divided between contract (including

[21] N. E. Makarov, "Kharakter vooruzhennoi bor'by buduschego, aktual'nye problem stroitel'stva i boevogo primeneniia Vooruzhennykh Sil RF v sovremennykh usloviiakh," *Vestnik Akademii voennykh nauk*, Vol. 2, No. 31, 2010.

[22] N. E. Makarov, "Tezisy vystupleniia nachal'nika General'nogo shtaba Vooruzhennykh Sil Rossiiskoi Federatsii—pervogo zamestitelia Ministra oborony Rossiiskoi Federatsii generala armii N.E. Makarova," *Vestnik Akademii voennykh nauk*, Vol. 1, No. 26, 2009, p. 21.

[23] M. Barabanov, ed., *Russia's New Army*, Moscow: Centre for Analysis of Strategies and Technologies, 2011, p. 20.

[24] Oleg Falichev, "Voiska s velikoi istoriei," *Krasnaia zvezda*, September 29, 2015.

warrant officers) and conscript soldiers, as well as officers.[25] At the tactical level, maneuver brigades were to field battalion tactical groups (BTGs), which are task-organized units manned, for the most part, with contract soldiers. BTGs, which on average number approximately 750 personnel, are the current "permanently ready" forces that Baluevskii referred to. According to Aleksandr Korabel'nikov, a colonel and professor of tactics at the Ground Forces Training Center of the Combined Arms Academy, as of early 2018, there were 79 contract-manned BTGs in the Ground Forces distributed across Russia's four military districts (see Table 7.1, which also provides estimates for 2019) and 20 BTGs in the Airborne and five in the Northern Fleet.[26] This force distribution again corresponds to the strategy outlined by Baluevskii and Makarov.

With ground-based combat power relatively evenly spread across all of its territory, Russian military strategy today is still largely predicated upon strategic mobility to reinforce or augment deployed formations responding to a major crisis along its periphery, although recent force structure and disposition changes along the Ukrainian border and in Kaliningrad suggest some recalibration toward the western and southwestern strategic directions of Russia. At the same time, were Russia to move a large portion of combat-ready Ground Forces from the Southern Military District, it would be accepting greater risk with respect to the ongoing conflict in Ukraine and the ever-present threat of unrest in the North Caucasus. Should relations break down with China at some point in the future, the same challenges would exist in the Russian Far East. Thus, Russia has strong security incentives to

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[25] The total estimated number is drawn from the work of Igor Sutiagin and Justin Bronk (*Russia's New Ground Forces: Capabilities, Limitations and Implications for International Security*, London, UK: Routledge, 2017), consultations with experts on Russian manpower, and RAND analysis. The number of contract soldiers in the Ground Forces was 131,000 as of mid-2018. See Ministry of Defense of the Russian Federation, "V Moskve sostoialos' zasedanie Kollegii Ministerstva oborony Rossii," webpage, February 27, 2019.

[26] Clint Reach, Edward Geist, Abby Doll, and Joe Cheravitch, *Competing with Russia Militarily: Implications of Conventional and Nuclear Conflicts*, Santa Monica, Calif.: RAND Corporation, PE-330-A, forthcoming; A. A. Korabel'nikov, "Faktory, vliiayushchie na sposoby deistvii soedinenii voinskikh chastei i podrazdelenii," *Vestnik Akademii voennykh nauk*, No. 1, 2018.

Table 7.1
Breakdown of Ground Forces BTGs and Overall Personnel by Military District, 2018–2019

Military District	# BTGs, 2018	BTG Personnel	# BTGs, 2019	BTG Personnel	Overall Ground Forces Personnel (2019)
Western	17	12,750	23	17,250	~80,000
Southern	21	15,750	~26	19,500	~70,000
Central	21	15,750	~21	15,750	~50,000
Eastern	20	15,000	26	19,500	~75,000
Total	79	53,250	96	72,000	~275,000

SOURCES: Reach et al., forthcoming; Ministry of Defense of the Russian Federation, 2019; discussions with analyst of Russian Ground Forces.
NOTES: Personnel numbers assume an average BTG size of 750 troops; ~ indicates estimated figure. These estimates are based on 2 BTGs per maneuver unit; although 2018 BTGs were described as exclusively contract-based, 2019 BTGs might include those filled by conscripts.

maintain good relations with at least one geostrategic flank—west or east.

The Russian modernization and procurement program, until 2019, largely followed the above plans. In 2015 the Centre for Analysis of Strategies and Technologies, a Moscow-based defense think tank, found that the first State Armaments Program following the 2008 reforms was weighted toward investments in the Navy, Air Force, and Air Defense.[27] Despite a prioritization shift in the latest ten-year State Armaments Program through 2027—from the Navy to the Ground Forces—the modernization of the Ground Forces has lagged behind. Just 48 percent of weapons and equipment are modernized (non-Soviet legacy) as of early 2019, compared with 74 percent in the Air Force and 62 percent in the Navy, and the overall personnel numbers have remained in line with recommendations from the Council on Foreign

[27] Tsentr analiza strategii i tekhnologii, *Gosudarstvennye programmy vooruzheniia Rossiiskoi Federatsii: problem ispolneniia i potentsial optimizatsii*, Moscow, 2015, p. 23

and Defense Policy in the late 1990s and early 2000s, which reportedly had some influence in the lead-up to the reforms.[28]

Based on the previously cited data and the work of other RAND studies examining most other aspects of the Russian Armed Forces, the Russian military, at least through 2020, is neither conceptually nor practically configured to numerically overwhelm NATO (or China) over the course of a protracted conflict, despite its well-documented local superiority in the initial period of an invasion into eastern Europe that could create a number of significant problems for NATO in the early stages of a conflict.[29] Although the number of personnel in the Russian Ground Forces in the European part of the country is far greater than the number of NATO forces in any of Russia's immediate neighbors or individual countries in western Europe, collectively NATO ground personnel in central and northern Europe numbered approximately 400,000 as of 2016.[30] In fact, the total number of U.S. Army personnel alone (not including the National Guard), all of whom are professional troops, numbered 477,709 as of July 2019, compared with approximately 150,000 contract personnel—including officers—and 120,000 conscripts in the Russian Ground Forces as of mid-2018. Furthermore, half of the Russian conscripts will have been in the military for at most six months in any given year because of the biannual

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[28] Sergei Shoigu, "Armiia Rossii kardinal'no obnovlena," *Krasnaia zvezda*, March 13, 2019; Aleksandr Golts, *Voennaia reforma i rossiiskii militarizm*, Uppsala, Sweden: Acta Universitatis Upsaliensis, No. 7, 2017, p. 112.

[29] Sam Charap, Dara Massicot, Miranda Priebe, Alyssa Demus, Clint Reach, Mark Stalczynski, Eugeniu Han, and Lynn E. Davis,, *Russian Grand Strategy: Rhetoric and Reality*, Santa Monica, Calif.: RAND Corporation, RR-4238, forthcoming; Andrew Radin, Lynn E. Davis, Edward Geist, Eugeniu Han, Dara Massicot, Matthew Povlock, Clint Reach, Scott Boston, Samuel Charap, William Mackenzie, Katya Migacheva, Trevor Johnston, and Austin Long, *The Future of the Russian Military: Russia's Ground Combat Capabilities and Implications for U.S.-Russia Competition*, Santa Monica, Calif.: RAND Corporation, RR-3099-A, 2019; Scott Boston, Michael Johnson, Nathan Beauchamp-Mustafaga, and Yvonne K. Crane, *Assessing the Conventional Force Imbalance in Europe: Implications for Countering Russian Local Superiority*, Santa Monica, Calif.: RAND Corporation, RR-2402, 2018; David A. Shlapak and Michael W. Johnson, *Reinforcing Deterrence on NATO's Eastern Flank: Wargaming the Defense of the Baltics*, Santa Monica, Calif.: RAND Corporation, RR-1253-A, 2016.

[30] Boston et al., 2018.

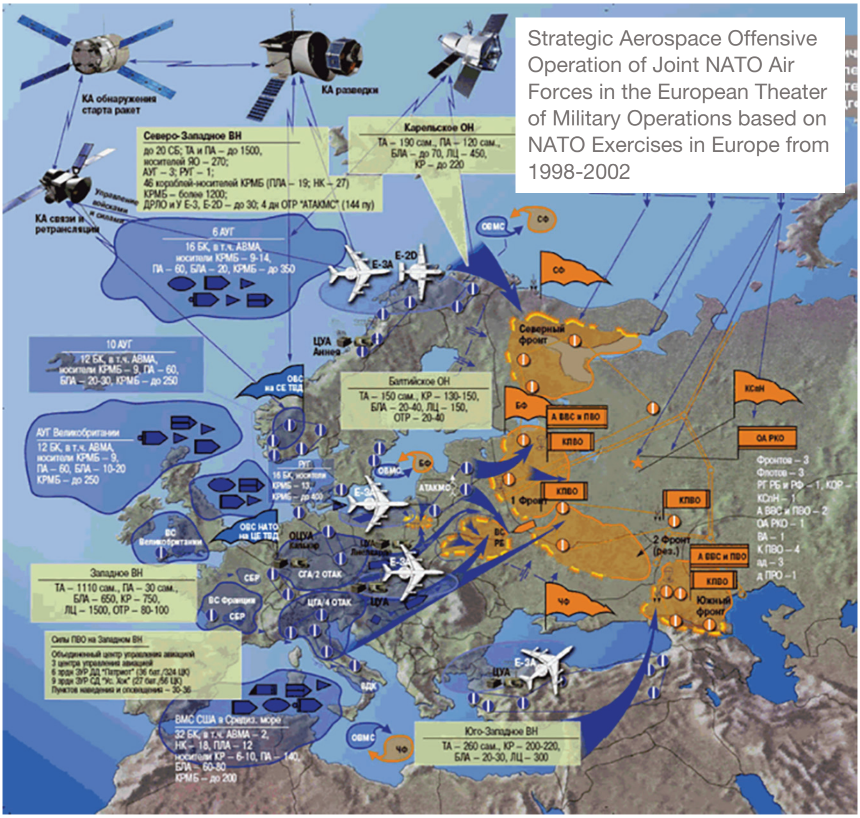
draft cycle in Russia. On the other hand, Russian decisionmakers are aware of the fact that U.S. military forces are dispersed across the globe and would require some time to concentrate in the European theater for a potential conflict. As Shoigu stated in a September 2019 interview: "[Russia] is not trying to compete with [the United States] on all fronts. If you look closely at the U.S. military budget, you will understand: They spend a lot of money on bases of all kinds that are positioned around the globe."[31]

The Aerospace Domain Is a Critical Planning Factor for Russia

Although the U.S. military is indeed broadly dispersed around the world, and the ability of NATO forces to deploy to a threatened theater on NATO's eastern flank and fight as an alliance is an important factor, a key issue is the weight that Russia places on NATO ground forces in its COFM assessments. As with any question of this nature, the answer would depend on a large number of variables, not least of which is the way in which a war would be fought and which phase is being considered. Nevertheless, it is clear, based on Russian analysis of previous conflicts and a broad range of military literature, that a common Russian planning scenario involves a large NATO aerospace campaign that could look something like what is depicted in Figure 7.1, which was based on the observation of NATO exercises in the early 2000s. The NATO forces in the graphic, which are attacking Russia from the north, west, and southwest in phases over several days, include 32 to 36 strategic bombers, over 3,000 aircraft of various types, approximately 100 submarine and surface combatants, around 800 unmanned aerial systems, a total of 2,000 air-launched cruise missiles (ALCMs) and SLCMs, and 300 nuclear-capable platforms. Some Russian analyses of this type of scenario are more pessimistic (see next section). The ability of NATO to build such a force grouping in the

[31] Mikhail Rostovskii, "Sergei Shoigu rasskazal, kak spasali rossiiskuyu armiyu," *Moskovskii komsomolets*, September 22, 2019.

Figure 7.1
Notional Joint NATO Aerospace Attack Against Russia, 2008



SOURCE: Borzov, 2008. Adapted from image courtesy of East View Information Services.

first place is a crucial issue that likely would be analyzed in far greater detail by Russian planners, who in past analyses have emphasized mobilization and deployment timelines and transportation and logistics capabilities. Quantitatively speaking, however, NATO possesses an approximate 4:1 advantage over Russia in combat aircraft and likely some superiority in precision munitions.[32]

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32 Boston et al., 2018.

To defend against this type of scenario, Russia has deployed a number of systems to carry out strategic (and tactical) air defense tasks. Although in-depth analysis to delve into a qualitative and quantitative COFM comparison of all of the systems that would be involved on both sides in this aerospace scenario is best left to modeling and war games, we will briefly examine one commonly discussed Russian system—the SA-21 (S-400). Overall, the Russian Ministry of Defense planned to acquire 56 battalions (roughly 28 regiments) of the SA-21 (S-400) by 2020, to replace outdated antecedents across all of Russian territory. As of early 2019, the Aerospace Forces, which have administrative control over the SA-21, had received at least 20 regiments (around 40 battalions).[33] Many of these systems are concentrated in the European part of Russia; as of 2018, there were approximately 30 battalions of the SA-21 SAM system in the western part of the country, not including the far north. Given that there are eight launchers in a battalion and each launcher contains four missiles, these systems in the western part of the country possess approximately 960 missiles, plus reloads if they are available. If two missiles are typically launched at one target, the maximum number of possible targets engaged by these systems would be 480, although more than a dozen battalions are concentrated around Moscow and likely intended for the exclusive protection of the capital in a conflict.[34] Finally, there is the question of combat potential, or the quality of these systems (in a degraded environment) relative to that of NATO aircraft and missiles that would be factored into the final Russian COFM assessment. These Russian data are not publicly available, however. Russian public discussions of predicted NATO actions and force numbers that can be compared with known Russian air defense forces are available. Although this is a simplified example that does not include tactical air defenses such as the SA-22 ("Pantsir," in Russian) some Russian analysts have raised questions about the suf-

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[33] Shoigu, 2019.

[34] Anatolii Khramchikhin, "Voiska mirnogo neba," *Nezavisimoe voennoe obozrenie*, November 22, 2018.

ficiency of munitions and strategic air-defense assets.[35] Ultimately, the sufficiency question is dependent on many details, not least of which is the force package of NATO in a specific scenario.

Separate Russian analyses have examined a potential conflict with NATO, many of which tend to focus on the air, sea, and information components in the context of a NATO attack against Russia. A 2012 report found that NATO could theoretically threaten Russia with up to 12,000 air- and sea-launched conventional precision munitions. In response, Russian tactical nuclear weapons at that time in this type of scenario " . . . [would] be considered by Moscow as a counterweight to American precision guided munition systems (as a means of striking U.S. forward Air Force bases and naval force groupings) and as a tool of asymmetric deterrence against the 'threat of the aerospace attack.'"[36] The report also suggested that the employment of nuclear weapons could occur relatively quickly, stating, "There is the opinion that the use of tactical nuclear weapons at an early stage in response to aggression with the employment of PGMs [precision-guided missiles] is more likely than a retaliatory strike with strategic nuclear weapons (which would attract a strategic nuclear strike of the other side)."[37] More-recent Russian analyses have also described a role for tactical nuclear weapons along a conflict escalation ladder.[38]

Vladimir Komoedov, a former commander of the Black Sea Fleet and Chairman of the State Duma Committee on Defense, discussed the naval threat in 2014, counting eight aircraft carriers and a total 439 warships and submarines that could be deployed by NATO in the north, west, southwest, and eastern strategic directions. Summing up the total missile threat from NATO, Komoedov wrote, "About 5,000 sea-based and air-based missiles are ready to attack us, capable of cov-

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[35] Anatolii Khramchikhin, 2018; Andrei Goncharov, "Voina budet vo vsekh sredakh," *Voenno-kosmicheskaia oborona*, No. 6, 2015.

[36] Aleksei Arbatov, Vladimir Dvorkin, and Sergei Oznobishev, eds., *Rossiia i dilemma iadernogo razoruzheniia*, Moscow: Institute of World Economy and International Relations, 2012, pp. 86–87.

[37] Arbatov, Dvorkin, and Oznobishev, 2012, pp. 86-87.

[38] Burenok, 2018, p. 221.

ering up to 80 percent of the European and Eastern territory of Russia and targeting up to 65 percent of the defense industry potential."[39] In 2014, researchers from the 46th TsNII modeled a barrage of precision strikes over four hours consisting of 800 cruise missiles targeting critical infrastructure, strategic air defense, and fighter aviation at airfields across three territorial zones in Russia the size of Texas, North Dakota, and Wyoming, respectively.[40] This particular study found that following a strike of this magnitude, a large percentage (96 percent) of targeted Russian air defenses would be destroyed or degraded, along with smaller percentages of the aircraft and critical infrastructure.

In 2019, Konstantin Sivkov, who served for 12 years on the Russian General Staff, examined two scenarios in which NATO launches an offensive aerospace attack against Russia. The first was in the context of a *large-scale* war (i.e., beyond a single theater) and involved 2,700 tactical and naval aircraft, 80 strategic bombers, up to a total of 2,000 ALCMs and SLCMs, and "thousands" of various types of unmanned aerial systems and decoys. Against such a force, Sivkov argued that the only possible response from Russia would involve the use of tactical and strategic nuclear weapons given the order of battle of Russia's Air Force as of 2019.[41] The second scenario involved a *local* war in which between 2,000 and 2,500 aircraft (of which 1,100 to 1,300 would be combat aircraft), 1,200 to 1,500 helicopters, 500 to 600 unmanned aerial systems, and 1,500 to 2,000 cruise missiles employed over the course of several weeks. If Russia were able to withstand or disrupt the first wave, in Sivkov's view, this would force NATO to reject consideration of escalating of the conflict.[42] Other analysts in Russia take a

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[39] V. P. Komoedov, "Analiz voenno-politicheskoi obstanovke v mire, sostoianie oboronsposobnosti Rossii na sovremennom etape i puti ee sovershenstvovaniia," in *Bezopasnost' Rossii 2013–2014: Ekspertno-analiticheskoe obozrenie*, Moscow: Fond sodeistviya nauchnym issledovaniyam problem bezopasnosti 'Nauka-XXI,' 2014, p. 31.

[40] O. B. Achasov and A. I. Buravlev, "Analiticheskaia model' otsenki effektivnosti vozdushno-kosmicheskoi oborony v usloviiakh global'nogo udara vysokotochnym oruzhiem," *Vooruzhnie i ekonomika*, Vol. 2, No. 27, 2014.

[41] Konstantin Sivkov, "Nebesnye bastiony," *Voenno-promyshlennyi kur'er*, February 18, 2019.

[42] Sivkov, 2019.

more sober view of the force balance and argue that neither side is practically prepared to launch an attack against the other.[43]

In a context in which NATO has the potential to launch concerted aerospace attacks along multiple axes and far within Russian territory, in conjunction with the continued development of the U.S. Conventional Prompt Global Strike program (a persistent preoccupation of the Russian military), the question arises whether Russia feels it has an overall qualitative and quantitative advantage vis-à-vis NATO.[44] Although today the Russians unquestionably have local advantages on the ground, they are also aware of overall inferiority in critical warfighting categories, such as air and naval power and C4ISR capability. Furthermore, there are very few strategic reserves—perhaps 5,000 personnel—that could, in relatively short order, reinforce Russia's forward forces.[45] This is combined with large perceived disparities in technological development (see Figure 7.2).[46]

The answer to the question of desired Russian military or operational superiority today would be largely speculative given the lack of any detailed discussion in available Russian literature, and force dispositions are much less indicative of a probable conflict scenario than they were during the Cold War. Today, unpredictable situational factors could lead to a conflict that looks much different than the scenarios depicted above in which quantitative superiority in ground personnel could play a decisive role and in which there would not be time for a large NATO force build up prior to the conflict. At the very least, however, the Russian observation of the Western way of war over the past two decades has—in the minds of some senior military officers and analysts—changed what force capabilities are most important in 21st century warfare, which could lead to a different interpretation of

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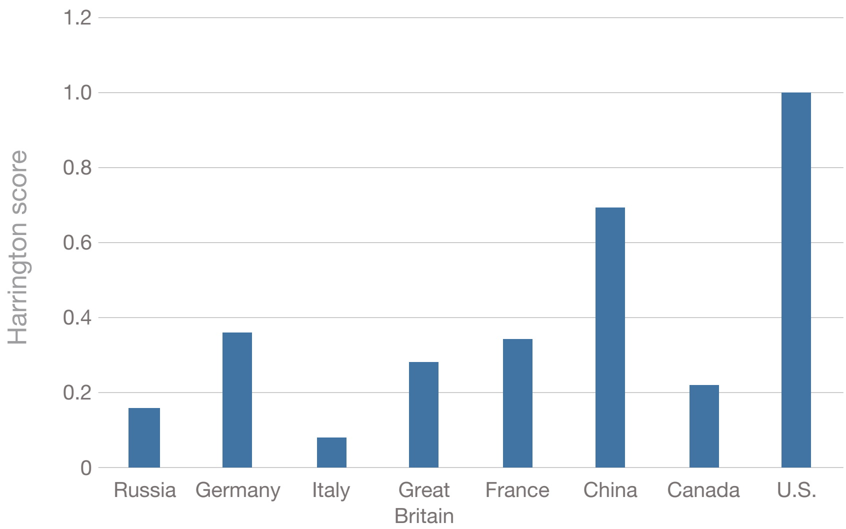
[43] Aleksandr Khramchikhin, "Rethinking the Danger of Escalation: The Russia-NATO Military Balance," Carnegie Endowment for International Peace, January 25, 2018a; Gorgola, Gladyshevskii, and Tsyrendorzhiev, 2017.

[44] Valerii Gerasimov, "Vektory razvitiia voennoi strategii," *Krasnaia zvezda*, March 4, 2019.

[45] Bogdan Stepovoi, Aleksey Ramm, and Evgenyy Andreev, "V rezerv po kontraktu," *Izvestiia*, February 13, 2018.

[46] Tsyrendorzhiev, 2015, p. 57.

Figure 7.2
Russian Assessment of Level of Technological Development of States



SOURCE: Tsyrendorzhiev, 2015.
NOTE: Chart data taken from Russian assessment using a Harrington scale from 0 to 1 that considered a number of factors including expenditures on research and development, expenditures of firms on information technology, number of experts involved in research, and so on.

an overall or regional COFM assessment than in the past. For example, the Chief of the Russian General Staff Valerii Gerasimov stated in 2016,

> if, in the middle of the 20th century, military conflicts were frontal clashes of troops, then by the end of the last century the concept of "high-tech wars" had become firmly established. The primary method of achieving objectives in military actions in such wars is noncontact impact against the enemy through massed employment of long-range precision munitions from the air, sea, and space.[47]

[47] Valerii Gerasimov, "Organizatsiia oborony Rossiiskoi Federatsii v usloviiakh primeneniia protivnikom 'traditsionnykh' i 'gibridnykh' metodov vedeniia voiny," *Vestnik Akademii voennykh nauk*, Vol. 2, No. 55, 2016, p. 19.

Ground forces are seen as tools to be deployed and reinforced after the initial period of war (between advanced militaries) to "mop up" whatever remains of the enemy after the aerospace attack.[48]

The ability of NATO to execute massed conventional precision strikes at depth, compared with Russia's nascent ability to respond in kind is critical, particularly in the context of deterrence in peacetime. Warfare in the past required a protracted conflict with attrition of forces at the front to have a strategic effect (i.e., a war-winning effect of capturing territory). Noncontact warfare can have a strategic effect in the initial period of war. This means that the attrition phase is no longer the critical phase of a large-scale war. The strategic threat to the economy, political order, and national leadership has to be defended against from the outset. That being the case, the emphasis within the quantitative and qualitative assessment of COFM has shifted in Russian military thought over the past several decades because the threat is immediate, and the *overall* resources of each side are significantly unbalanced in favor of the West.[49]

During the Cold War, the most important element of Soviet conventional strategy was to mass tanks at key breakthrough areas and surround and destroy the enemy. Today, given the lack of prepared defenses along the Russian border, the key "mass" involves strategic and tactical SAMs, fighter aircraft, air, ground, and sea-based long-range munitions, EW, and cyber capabilities. Whether Russia believes it has enough from both a quantitative and qualitative perspective to fend off the aerospace threat (based on the scenarios depicted above) and move the conflict to a "contact" war is arguably the crucial COFM issue of the day. Russia appears to take seriously the number of cruise and ballistic missiles and all of the enablers in the Western inventory that could be brought to bear against the Russian homeland and forward forces in a conflict (see Table 7.2, which is not representative of a theater estimate). It is possible that an inferiority in such weap-

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48 Sergei Chekinov and Sergei Bogdanov, "O kharaktere i soderzhanii voiny novogo pokoleniia," *Voennaia mysl'*, No. 10, 2013, p. 21; Mikhail Barabanov, "Zapad-2017 Strategic Drills," *Moscow Defense Brief*, No. 6, 2017.

49 Burenok, 2018, pp. 304–309.

ons and the capability to deliver them in wartime would be equally as important to a Russian planner as a superiority in the number of ground-based combat units. The same would likely be true of Russian air defense assets (including missiles) and NATO air power.[50]

Future of Russian COFM Assessments

In light of all of the issues raised throughout the course of this report regarding Russian approaches to COFM assessments, there is the question of where Russia will go from here. Given the decades of precedent in terms of operational planning, it seems unlikely that Russia will turn to an approach that reduces the role of automated decision aids and mathematical methods to assist commanders in making decisions on the employment of troops in a large-scale war.

There is some recent evidence to suggest the eventual reappearance of a more complex and multiechelon combat modeling system to assign combat potentials to be used by command staffs, to provide higher echelons with a forecast of the course and outcome of large operations based on preselected courses of action, and to support weapons development.[51] That said, as recently as 2009, there was a debate over the utility of combat modeling in general, given the opinion of some that existing mathematical tools "for comparing combat potentials needed for informational support of operational planning" were sufficient while still others argued for an increased role of the commander's competence and experience.[52] Furthermore, the current state of combat modeling development within the scientific research organizations of the Ministry of Defense was recently described by the vice president

[50] Aleksandr Khramchikhin, 2018.

[51] G. I. Gorchitsa, P. A. Dul'nev, and V. A. Ishchuk, "Nekotorye problemy voenno-nauchnogo soprovozhdeniia razrabotki sistem modelirovaniia voennykh deistvii v interesakh obosnovaniia perspektiv razvitiia vooruzheniia i puti ikh resheniia," *Vestnik Akademii voennykh nauk*, Vol. 1, No. 62, 2018.

[52] V. I. Vypasniak, D. B. Kalinovskii, and O. V. Tikhanychev, "Modelirovanie vooruzhennogo protivoborstva: perspektivy razvitiia," *Voennaia mysl'*, No. 7, 2009, p. 12.

Table 7.2
Russian Forecast of the Change in Number of U.S. Cruise Missiles and Platforms

Type	Launch Range	Platform	# of Cruise Missiles	# of Platforms 2010	# of Platforms 2015	# of Platforms 2020	# of Cruise Missiles 2010	# of Cruise Missiles 2015	# of Cruise Missiles 2020
SLCM	1,500–3,200km	Los Angeles–class submarine	12–26	31			4,100	4,800	>6,000
		Ohio-class submarine	126–180	4	6	6			
		Virginia-class submarine	12–26	6	10	8			
		Seawolf-class submarine	up to 50	3	3	3			
		Arleigh Burke–class destroyer	92	52	62	62			
		Destroyer (DD)	80–152	10	12	12			
		Tikonderoga cruiser	26	26					
ALCM	1,100–3,000km	F-16, F/A-18	2	>600	>600	>600	1,800	3,700	>5,400
		F-22, F-35	2	>80	>200	>200			
		Kh-45 (strike UAV)	2	---	60	60			
		B-52H	12	84	24	24			
		B-1B	24	16	16	16			
		B-2A	16	15	41	41			

SOURCE: Vadim Volkovitskii, “Prikrytie strategicheskikh iadernykh sil—vazhneishshaia zadacha voenno-vozdushnykh sil,” *Vozdushno-kosmicheskaia oborona*, No. 1, 2010, p. 11.
NOTE: SLCM = sea-launched cruise missile; UAV = unmanned aerial vehicle.

of RARAN as "troubled," relative to how it was in the 1980s.[53] On the other hand, there has been increased attention on the subject of combat modeling up to the level of the Main Operations Directorate of the General Staff. In fact, the Main Operations Directorate, together with the 27th TsNII (which focuses on automated C2 systems) tested a new large-scale combat model in command-staff exercises: Kavkaz-2016, Zapad-2017, and Vostok-2018. According to the Deputy Chief of the Main Operations Directorate, General-Lieutenant Andrei Petrov, several problems remain in the development process including (1) the incompatibility of dictionaries and classifiers in the software, which led to a large amount of data input by hand; (2) lack of knowledge with end users of the model; and (3) lack of systemization of software across the MOD, which, in addition to other issues, led to more effort inputting information that should be stored and readily available in a database.[54] In 2018, there was a roundtable discussion on the sidelines of the Armiia-2018 event outside Moscow organized by the Combined Arms Academy on the current state of combat modeling at the tactical level with representatives across the Russian military science community that attempted to address some of these issues.[55]

Should the Russians make progress in the area of combat modeling, one implication could be a potentially more representative way to account for the information component in modern warfare. Russia, on the one hand, seems to understand and appreciate the value that networkcentric warfare can bring to the battlefield, while on the other hand, it is increasingly using a Method that does not appear to value C2 relative to other force categories, which could potentially mean a lack of confidence that the true state of play is being reflected with current approaches at the General Staff level. Given the emphasis at all levels of the Russian military on the power of networkcentric warfare and on the ability to disrupt it through EW and perhaps cyber

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53 Gorchitsa, Dul'nev, and Ishchuk, 2018, p. 151.

54 A. N. Petrov, O. V. Sayapin, and V. N. Denisov, "Sistema modelirovaniia voennykh (boevykh) deistvii Vooruzhennykh Sil Rossiiskoi Federatsii," *Voennaia mysl'*, No. 8, 2019, p. 31.

55 Dul'nev, 2018.

means, there is a high probability that future COFM methods will need to be developed: Methods that can more satisfactorily account for the offensive and defensive sides of the information confrontation. In conjunction with this, there is an increasing amount of discussion within Russian military literature on measuring the effectiveness of EW within the framework of combat potential methods.[56]

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56 P. R. Liakhov and V. A. Orlov, "Uchet sil i sredstv radioelektronnoi bor'by pri opredelenii boevykh potentsialov gruppirovok voisk," *Voennaia mysl'*, No. 12, 2015.

CHAPTER EIGHT

Conclusion

A COFM assessment at the operational level is a math problem for Russia. Russia wants a single numeric value that takes into account the quantity and the quality of weapons, military equipment, and combat formations to inform operational planning in a time-effective manner. However, there is a wide range of views on how best to obtain that value because of the complexity in the variables and how they interact.

Technological differences exist at a number of levels. Within NATO, there are many different militaries, all of which are manned, trained, and equipped differently. Between Russia and the United States there are certain capabilities that do not exist at all on one side or there is a fair amount of qualitative difference in systems—the quantitative and qualitative disparity between the U.S. and Russian navies and air forces is an example, as are the differences in EW, rocket artillery, and short-range air defenses within the U.S. Army and the Russian Ground Forces. There is also the matter of synergy—one side might have quantitative-qualitative advantages, but how well do the pieces work together, and how can that be measured? Russia does not appear to have come up with a satisfactory answer to the latter question, but it seems sure that the answer matters quite a lot.

One of the most effective ways to address these issues is to develop a large-scale combat model that is capable of managing reams of data and producing combat potential values and a forecasted outcome of a so-called "strategic operation." The Soviet General Staff believed in this approach in 1970 and committed resources to developing and sustaining a program that apparently lasted until the end of the Cold

War. Because of a lack of funding and expertise, a sophisticated modeling capability to simulate strategic operations was partially replaced with a Method that is less resource-intensive but of dubious efficacy, according to Russian critics and our own analysis (although Russia is in the process of revitalizing a large-scale combat model within the Main Operations Directorate). Regardless, the Russian General Staff decided to integrate the approach to COFM under a unified Method to determine combat potentials based on qualimetry and expert elicitation. The combat potential values determined by this Method are likely updated periodically (perhaps once a year) and input into tables that are used by command staff to perform operational-tactical calculations like COFM during the operational planning phase. Although the combat potential values are prepared in advance, the use of "cumbersome software" can slow down the COA development process. These combat potential values also appear to factor into decisions on the "rational composition of a force grouping" for an operation. Given the lack of sophistication in the approach, Russians themselves have pointed out the potential for gross over- or underestimation of force capabilities and requirements. Our analysis agrees with the critics.

Beyond the technical discussion of the most appropriate way to calculate COFM, changes in modern warfare appear to be having an influence on how Russia thinks about COFM in terms of force structure. The transition from attrition-based to noncontact warfare has reduced the role of ground forces in the context of a high-intensity conflict, and it has increased the importance of air and sea power and the capability to effectively deliver precision munitions from range throughout the depth of enemy territory. An assessment of that threat, available resources, and trends in modern warfare led Russian leadership, in 2008 and 2009, to approve massive changes in the force structure of the Russian military, particularly the Ground Forces. Russia, in addition to preparing for other potential conflicts along its periphery, is focused on countering the threat of a large NATO aerospace attack that could target any number of critical military, political, and economic sites from the Kola peninsula in the north to the Caucasus in the south and the Kamchatka peninsula in the Far East. Based on a reading of Russian views on modern and future war, the maintenance of NATO's superiority in long-range conventional munitions,

naval power, air- and sea-based delivery platforms, and the information infrastructure that enables precision strikes weighs heavily on Russian military planners and places additional defense burden on homeland security that is less of a consideration for the United States. To avoid "escalation dominance," in which NATO has a preponderance of capability to achieve strategic effects through conventional means, Russia will need to either continue to invest in expensive conventional munitions and intelligence, surveillance, and reconnaissance platforms, or rely on tactical and strategic nuclear weapons as a deterrent, or some combination of both.

In addition to assessing the numbers and qualitative capabilities of key weapon systems, Russia is monitoring force buildups in Europe and elsewhere that resemble force deployments of previous U.S.-led conflicts, which were weighted toward air and naval platforms and long-range strike potential as opposed to large numbers of ground forces. Russia is also likely forecasting the speed with which the United States could deploy additional forces into theater and the ability of each side's economy to sustain a fight once initiated. In the case of a conflict with NATO, sustainment would be a challenge for Russia over the long term for a variety of reasons, from economic to demographic. Militarily speaking, the threat of a long-range strike to Russia in regard to sustainment is that high-tech modern weapons require longer production times and a much larger supply chain than in decades past. The threat of a conventional precision strike against such targets could bring Russia's ability to sustain a protracted war into question, thereby strengthening deterrence and imposing costs. As Danilevich explained in 1990, during the Cold War, the Soviet Union's response to this problem, in which " . . . our industry and all of our territory would be under constant conventional attack," was to build tens of thousands of tanks and replace them with new variants every few years.[1] Today, according to the president of the Russian Academy of Missile and Artillery Sciences, Russia faces a similar challenge, but with far fewer resources:

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[1] John G. Hines, *Soviet Strategic Intentions 1965-1985; An Analytical Comparison of U.S. Cold-War Interpretations with Soviet Post-Cold-War Testimonial Evidence*, dissertation, University of Edinburgh, 1995, pp. 175–176.

> The buildup of the mobilization production of modern weapons and equipment in the conditions of war, especially large-scale war, which is fraught with the destruction of industrial enterprises and communications, will be impossible. A high-tech weapon is the product of extremely extensive cooperation of industrial enterprises, and any disruption of the production chain could fatally affect the ability to create a weapon in accordance with the specified tactical and technical characteristics. At the same time, the cycle of manufacturing high-tech weapons takes many weeks or months (we are not talking about airplanes and ships—there, the production time is even longer).[2]

The changing character of warfare and the complexity of modern weapons against a backdrop of the increasing capability of long-range precision strikes has shifted the focus from capabilities that were seen as most decisive in the past toward different ones. During the Cold War, the tank was seen by the Soviets as " . . . our main trump card in a conventional war."[3] Given modern range capabilities of conventional weapons and the proximity of a possible conflict to Russia, superiority in munitions, delivery platforms, and enablers is viewed by Russia as the main trump card in a conventional war today, given NATO's potential to disrupt or destroy, at depth, a number of strategic assets or capabilities from the outset of a conflict. Massing ground troops and achieving high force ratios—particularly in tanks—at breakthrough sectors previously was assessed by the Soviet General Staff as a key to victory; today, the correlation of NATO long-range strike assets to Russian strategic SAM systems and fighters has likely tilted the balance away from heavy armor and artillery in importance. A key element of NATO strategy to deter Russia will be to ensure that it retains this quantitative and qualitative advantage—and the ability to deploy additional assets to the European theater—in the face of Russian symmetric and asymmetric attempts to mitigate it.

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[2] V. M. Burenok, "Prognozirovanie perspektivnogo oblika sistemy vooruzheniia," *Vooruzhenie i ekonomika*, Vol. 1, No. 47, 2019, p. 6.

[3] Hines, 1995, p. 176.

Translation of Key Related Russian Terms

Tsentr voennoe-strategicheskikh issledovanii General'nogo Shtaba	Center for Military-Strategic Studies of the General Staff
Tsentral'nyi nauchno-issledovatel'skii institut Ministerstva oborony	Central Scientific-Research Institute of the Ministry of Defense
koeffitsient boevogo potentsiala	coefficient of combat potential
sootnoshenie sil i sredstv	correlation of forces and means
modelirovanie voennykh deistvii	combat modeling
boevoi potentsial	combat potential
vukhoputnye voiska	ground forces
voennaia-politicheskaia obstanovka	military-political situation
voennyi potentsial	military potential
voennaia moshch'	military power
operativno-takticheskie raschety	operational-tactical calculations
kvalimetriia	qualimetry
vtrategicheskaia stabli'nost'	strategic stability

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https://ruser07.livejournal.com/91791.html

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During the Cold War, the United States and its allies sought to understand virtually every aspect of the Soviet military—including how it defined and assessed the correlations of forces and means (COFM). COFM is defined as the military balance between two opponents at the global, regional, and local levels.

The international environment and new security threats that emerged following the collapse of the Soviet Union shifted the United States' focus away from the large-scale military problems prevalent during the Cold War to different concerns, such as terrorism, regional ethnic conflict, and nuclear proliferation. As U.S. security concerns evolved, in-depth analysis of COFM and other issues related to understanding military balance and competition between major powers received relatively little attention from military planners and analysts.

To bridge the gap in knowledge that emerged after the dissolution of the Soviet Union, the authors of this report examine COFM's evolution in Russian military thinking and explore current definitions and applications in Russia's operational and military planning in response to changes in modern warfare. They also briefly describe other Russian comparisons of state power that historically were a part of Soviet strategic assessments of COFM.

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