

INTRODUCTION

Sun Tze's ancient work, *The Art of War*, is a classic that remains as timeless today as when he wrote it several centuries before Christ in China. Questions of morale, leadership, cunning, and innovative tactics are still central to warfare and always will be. Similarly, the Prussian general and scholar Carl von Clausewitz's book *On War*, written two hundred years ago, remains brilliant in its depiction of war as an extension of politics, a fundamentally human endeavor in which national and individual will and the core character of fighting men (and now women) are central in understanding battle and determining outcomes.

But there is also a science of war—that is, a structured, analytical, often quantitative, often rather technical side to preparing for combat. The science of war is also important for keeping peace. It can help improve and ensure deterrence, by scrupulously evaluating the capacities of one's own military and trying to strengthen it where possible. Finally, it is important for defense budgeting and resource allocation, a matter of importance not only to war planners but to all participants in the public policy process.

The use of quantitative tools in defense policy analysis is almost always imprecise, not only in the quality of the data available, but even in knowing what concept and what formula to apply to a given problem. All the tools developed and discussed in this book need to be viewed in this spirit.

We have little choice, however, but to try to refine the science of war as much as possible. What would the alternative be? To base defense budget levels on pure guesswork or politics? To make war plans only using the intuition of generals (or secretaries of defense?). To develop any weapon that seems technically within reach without regard to its likely cost, effectiveness, or other strategic effects? As imprecise as the science of war may be, we must attempt to understand it. And even policy generalists must grapple with it themselves, unless they wish to cede some or all of the defense policy debate to specialists—which cannot be in the national interest in any country. Given the importance of military debates, which in the United States presently involve more than \$600 billion a year in

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annual spending and two significant wars simultaneously, it is essential that as many as possible feel capable of wading into defense debates with some degree of understanding and some sophistication.

The yin and yang of this book is that, recognizing scientific methods in defense analysis to be imprecise, we must nonetheless strive to understand, improve, and employ them. Studying the science of war should never be seen as a substitute for studying the art, history, and contemporary aspects of warfare. It is instead an essential complement.

This textbook is written with the national security agenda and problems of the United States of America central in mind. However, most of the analytical methods discussed here have a wider applicability as well. It is not first and foremost a discussion of contemporary defense debates, however, nor an examination of defense policy. It is about methodology for military analysis. That said, many defense policy matters are ultimately discussed by way of illustrating the use of various methods. From questions of how to size and shape the Pentagon budget, of which wars to fight and how many casualties they might entail, of how large forces should be for peacekeeping and counterinsurgency missions, the methods here should be of considerable use. This book is a textbook, but with a policy edge and a policy motivation.

After a very brief primer on defense matters, specifically concerning the U.S. military, in the following pages of this chapter, the book begins with a discussion of budgeting methods. It focuses particularly on the American defense budget debate. This chapter will probably be of interest to the widest audience. Subsequent chapters on modeling warfare, on understanding defense logistics, and on understanding scientific issues in defense policy such as space warfare, missile defense, and nuclear weapons development are intended for a somewhat more specialized audience—though my goal is always to make the material as straightforward and accessible as possible. Graduate students in public policy should be able to navigate the book's material even if not specialists in the field; undergraduates with sufficient background and interest in national security matters should be able to do so as well.

I have attempted to help draw the material together with several exercises at the end of each of the book's four main chapters. These are designed in the spirit of textbook review and practice questions. Defense analysis being as much an art form as a quantitative exercise or an exact science, the answers provided are not always the only way to tackle the question posed. They should help define a problem, orient a reader and a user regarding the methodologies discussed here, and show one way to

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begin to attack each problem. They should not be interpreted as the only “right answer” to any question.

Large numbers of people work (in official capacities) all the time on the defense analysis problems considered here. Take budgeting, for example. Specialists in this activity include uniformed officers slaving away within their respective service headquarters, a mix of officers and civilians doing the same sort of work within the Office of the Secretary of Defense, and contractors working for the Department of Defense (DoD) at one of many consulting firms. Combat modeling is quite frequently done by contractors as well (some with strong ties to one service, others with more ecumenical client bases, such as the Institute for Defense Analyses). It is also carried out by the Pentagon’s Joint Staff and its regional military commands, and by its war colleges: Quantico for the Marines, as well as the Army War College in Carlisle, PA, the Air War College in Montgomery, AL, and the Naval War College in Newport, RI. All tend to employ elaborate and classified computer models requiring dozens or hundreds of data inputs, generally involving tens of thousands of lines of computer code.

A third main topic of this book, military logistics, is the focus of U.S. Transportation Command based at Wright-Patterson Air Force Base in Ohio (largely for intercontinental transport to a possible combat theater, and supported by various key facilities and organizations such as Air Mobility Command at Scott Air Force Base in Illinois and Military Sealift Command, headquartered in Washington, D.C.). Many others have key roles in logistics, too, including the military services, the individual units making up their combat force structures, and the larger echelons of organizations such as the corps headquarters of the U.S. Army. These organizations get forces to ports or airfields of embarkation, and then upon arrival in a combat theater determine how to support them. Finally, issues in military technology development are handled by the services’ weapons laboratories, which number in the dozens throughout the country (such as the Navy’s Patuxent River Naval Air Station in Maryland, Dahlgren Surface Warfare Center facility in Virginia, Kirtland Air Force Base in Albuquerque, and China Lake Naval Air Weapons Station in California), by dedicated parts of major defense contractor organizations, and at a more basic scientific level by many of America’s universities (such as the Applied Physics Laboratory run by Johns Hopkins University in Maryland, parts of the Department of Energy’s laboratories at Los Alamos and Sandia in New Mexico, and Lawrence Livermore National Laboratory in California).

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This book does not seek to replicate the detailed calculations used in these various organizations, which together employ tens of thousands of individuals. Nor could it. To some extent, this means that the methods discussed here must be somewhat simpler and less precise than those used officially. However, for many, if not most, purposes in defense analysis, methodological simplicity is not a weakness and may even be an advantage. Too many elaborate models focus attention on detailed numerical analysis—data crunching—rather than on linking the mathematics to a conceptual understanding of warfare and other military operations. Once analysts get into data crunching mode, it is often difficult to keep asking basic—and crucial—questions about one’s assumptions. Given this, as discussed in the following pages, official Pentagon models and computations often wind up no more accurate than simpler approaches. Such analyses are also much more difficult for outside organizations (often acting individually or in small groups and without classified information) to mimic. So by necessity, but also by design and by preference, this book seeks simpler methods. In fact, many individuals working within the defense community will themselves use these simpler methods as checks on their more elaborate work, or as a way of orienting themselves and understanding the broad contours of a problem before delving into detail. In defense analysis, a field often afflicted by mistaken assumptions and by a false sense of confidence on the part of its practitioners, simpler is not necessarily less valuable—and it may not even be less rigorous or accurate.

A Brief Orientation to Defense Matters

This book is not a primer on the American military, other countries’ armed forces, or defense matters in general. Those interested in probing such issues in detail might consult books such as James Dunnigan’s *How to Make War*. Though dated a bit, it is still quite informative. They might also value various Department of Defense publications available at www.defenselink.mil, such as the 2008 National Defense Strategy, the 2006 Quadrennial Defense Review, or more technical and data-rich reports on matters such as personnel statistics and annual budgets. Nor is this a book on military doctrine and tactics. Such subjects are addressed, for example, in the Army’s *Operations* manual and in more specialized reports on subjects such as peacekeeping and stability operations. This is also not a book about military culture or about many service-specific issues and interests (see publications such as the *Marine Corps Gazette*, *Airpower*

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Journal, Pa ram e ter and *Proceedings* for the latter, or more generally Carl Builder's timeless book, *Masks of War*). I am not particularly well equipped to write the latter types of tomes, and in any case, doing so is not my purpose here.

Before delving into methodology and calculations in the pages that follow, a few paragraphs may help situate the general reader who is not familiar with day-to-day defense matters. Most of this book does not require its reader to have a detailed background on the military. That said, since I do not devote much time or attention to explaining "Defense 101" in the chapters that follow, it is appropriate to include a few brief words here, particularly on how the American armed forces are configured, commanded, and operated.

The U.S. military is organized into four independent services: the Army, Air Force, Navy, and Marine Corps. For administrative purposes, the Marine Corps functions within the broader Department of the Navy (meaning there are three "departments," but four services). The services are constitutionally and legally responsible for raising, training, and equipping the men and women of the U.S. armed forces. Together, they currently employ about 1.5 million active-duty troops, with the Army being the largest service (just over half a million active-duty soldiers), and the Marine Corps the smallest (about 200,000 active-duty Marines). Over 200,000 of these 1.5 million are officers; the rest are enlisted personnel. The armed forces also include roughly one million reservists spread across six organizations (each service has a reserve component, and the Army and Air Force also have National Guard units distributed across the country). Military personnel are located at hundreds of bases around the United States. In addition, some 400,000 are presently stationed or deployed abroad, with about half in the broader Middle East / Central Asia theater (as of this writing in late 2008) and the other half distributed mostly in Europe and East Asia.

Since the National Security Act of 1947, the four services have been organized within the Department of Defense, which is run by the Secretary of Defense, a key member of the president's cabinet. A number of entities make up the Office of the Secretary of Defense (OSD), with numerous undersecretaries, assistant secretaries, and other civilian officials directing them. The military services all have their own organizations and units to provide analytical support as well (civilian service secretaries also provide leadership to them). It is the services and OSD, in conjunction with the president's Office of Management and Budget, that work with Congress on the annual budget process. The Pentagon's funding is approved year to

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year—that is, it is a “discretionary” account, in federal budget parlance. At roughly half a trillion dollars a year (not counting war costs), it constitutes about half of all discretionary spending, approximately one-fifth of total federal spending in normal times.

Since the Goldwater–Nichols Act of 1986, the military’s joint-service organizations and operations have also been strong. Within the Pentagon is a joint staff. The four service chiefs, plus a chairman and vice chairman, make up the Joint Chiefs of Staff (JCS). There are six regional military “combatant” commands, again organized and run at the joint-service level (even if only one person from one service can command any of them at a time). These are Central Command, Pacific Command, European Command, Southern Command, Northern Command, and Africa Command (the last two both having been created during the Bush 43 presidency). These commands run operations in their respective theaters, but depend on the services—and thus on Washington—for the means to do so, since they have few if any dedicated forces “of their own.” The chain of command to these commanders runs from the President through the Secretary of Defense (SecDef), but not through the Joint Chiefs (though the latter are charged with providing their best military advice on various issues to the President, the SecDef, and the Congress).

There are also four functional combatant commands— Strategic Command, Special Operations Command, Transportation Command, and Joint Forces Command. Each of these ten regional and functional commands is run by a four-star officer (a general or admiral), and each of the service chiefs as well as their vice chiefs is a four-star officer as well. Together these eighteen individuals represent almost half of all the four-star officers in the U.S. military at any one time; most of the others run individual commands within the various services, such as Air Combat Command.

It is useful to be aware of a few more key pieces to the organizational configuration. Numerous joint-service agencies perform tasks of importance across the Department of Defense. They include such organizations as the Missile Defense Agency or, during the recent wars in Iraq and Afghanistan, the Joint Improvised Explosive Device Defeat Organization (JIEDDO, to give an example of the acronyms of which the Pentagon is so fond). They are staffed by military personnel as well as full-time civilian employees of the Department of Defense, who number nearly 700,000. Defense contractors are critical to America’s defense efforts as well. Including those working in the defense industry, and in various support activities, their numbers are cumulatively comparable to those in the direct employ of the Department of Defense.

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Much of the nation's intelligence community, estimated to cost nearly \$50 billion a year by unclassified sources, is funded within the Department of Defense budget, including the CIA and the National Security Agency. Other large chunks of the intelligence community work for the Department directly as well, since in addition to the Defense Intelligence Agency, each of the services and regional military commands has its own intelligence organization.

Much of the military can be organized in an "order of battle"— a detailed force structure typically consisting of several categories of units within each service. Each unit is itself individually numbered and often named as well. Much of this type of information, on not only American but other countries' militaries, can be found in an extremely useful reference guide, *The Military Balance*, published annually by the International Institute for Strategic Studies in London.

The complexity of the U.S. military can be daunting. But as with the overall philosophy of this book's methodologies in the chapters that follow, it is often possible to get a rough feel for the basics and understand the core concepts without knowing every detail or nuance. That said, for those wishing such details, many references can be found to provide them.