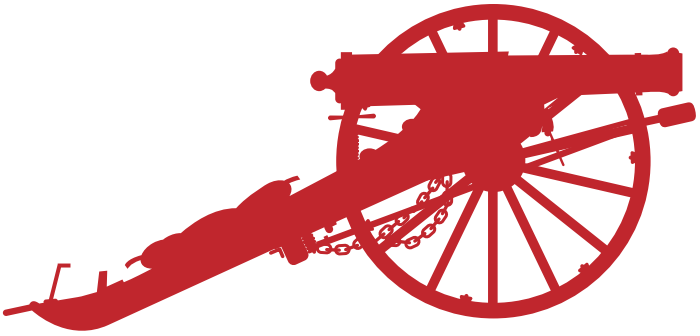
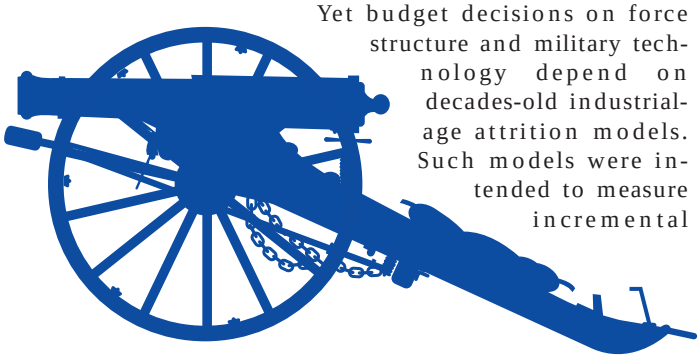
The Force-on-Force Model:

An Anachronism in the Information Age

By MAGGIE BELKNAP





If confronted with an enemy sniper in a darkened room would you want more ammunition, a larger caliber weapon, or night vision goggles? Those who make decisions on how to man and equip our forces depend on models that cannot answer this question. Built during the Cold War to respond to concerns over incremental changes in force structure and weaponry, these models are unable to measure the impact of revolutionary advances in information technologies. Born of the industrial age, they are inadequate for the information age. At stake is operations research, a product of the industrial age, and more importantly our national security which depends on this discipline.

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A much promised peace dividend and consensus on the dawn of the information age raised expectations that we could anticipate significant decreases in defense budgets and force structure. While the military has indeed been downsized, this has been a response to budget cuts and the end of the Cold War, not to investments in information technologies. The Armed Forces are smaller, but we have not restructured to realize savings in the same way as the private sector. This reflects the failure of decisionmakers and those operations research analysts who support them to abandon the industrial age force-on-force models of the past.

The information revolution sweeping our lives will also sweep the battlefield of tomorrow. Yet budget decisions on force structure and military technology depend on decades-old industrial-age attrition models. Such models were intended to measure incremental change and not to explore revolutionary advances. The longer decisionmakers take to adapt, the less likely it is that we will attain the security innovations that capitalize on emerging technologies. Moreover, we risk failing to demonstrate the tangible cost benefits associated with information technology.

Changing Models

Knowing why a particular model was built is key to understanding the types of questions it can answer. Generally models were designed to measure the impact of improvements in weapons systems or estimate force structure requirements. Force structure models served a variety of useful purposes during the Cold War when incremental changes in either force structure or modernization occurred. Large contests by land and air forces along the inter-German border or smaller

but more compressed clashes along the 38th parallel in Korea were ideal for conversion into linear models which is why steady state assumptions were acceptable. (But what does war conducted at a steady state look like?) The builders of such models never claimed that they could accurately predict the outcome of combat in terms of casualties or geographical displacement. They simply asserted that they could demonstrate a relative advantage of one force over another or help distinguish between alternatives for force sizing and modernization.

Model building focused on combat forces. Thus many combat support and service support functions were not included at the outset and were added only as an afterthought or—in the case of logistics—modeled by separate simulations and then used as input to combat models. The force-on-force, attrition-based notion of war emphasized kill rates and weapon efficiency factors such as accuracy and circular error probable. In the industrial age this mirrored manufacturing problems of optimizing processing rates and outputs in light of scarce resources. It also supported decisions on which technology advancements in weapons improvements should be explored.

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While there have been changes in the models over the past decade none were a result of the end of the Cold War or a commensurate change in national security strategy. One can be attributed to passage of the Goldwater-Nichols Act in 1986 which saw an end to models designed to support service-specific budgets and force structure allocations. TACWAR is a model adopted by the Joint Staff in 1988 that marked the recognition of a need to demonstrate the impact of such decisions in a joint environment. It models land and air components in a single theater-level model. Widely used because it is joint, this model falls short of realizing joint warfare synergies, let alone incorporating enhancements produced by information technology. In fact, it is a low resolution model that is not sophisticated enough to be used as service-specific model. Like its predecessors, TACWAR does not account for much beyond the force-on-force, attrition-type warfare.

At the opposite end of the spectrum, enhancements in computerization and simulation have led to higher resolution models. Precise computer mapping and graphics have made battalion-level models possible, such as Janus which can account for the impact of terrain on troop movements and weapons systems in various sectors of the battlefield. The growing infatuation with Nintendo-like computer graphics known as virtual reality has propelled enhancements in computer models, highlighted by the exact replication of portions of the "hundred-hour war" in time and space using the most advanced computer graphics.

Reengineering War

It is ironic that none of these advancements can measure the impact of the greatest emerging technology on warfare today—information technology. Instead, in aid of better and arguably more user-friendly models, such advancements bury the flawed assumptions of industrial-age, attrition-based warfare under a sophisticated veneer of information-age computer interfaces.

Although C^4I is often seen as a force multiplier, we are only beginning to explore its force structure implications.[1] In failing to realize the real benefits of information technology investments we join white-collar workers who have similar trouble identifying processes and measuring output. Many businesses have learned from automation and begun to *reengineer*, which means optimizing a process and automating it, as opposed to installing automation to support an existing process.

This coincides with an apparent divergence on how the military looks at technology. If its purpose is to support warfare as we know it, that is to simply automate it, there are only costs. If, however, there is a tremendous advantage to be harnessed, then we have a revolution together with a reengineering of warfare. Similarly, if decision support models are simply retooled to fit C^4I to existing force-on-force, assumption-based models, they will fail to capture potential innovations and commensurate force structure and cost savings.

This sets the stage for civilian and military leadership to direct the analytical community to advance decision support models in two possible directions. The first is to improve current models to incorporate C^4I or build new C^4I models. The second is to challenge military analysts to apply their skills to support experimentation, exploration, creativity, and innovations in warfare that may provide the basis for the next generation of models.

To illustrate deficiencies in the first course, it is worth noting the hypothesis that "If we have dominant battlefield awareness, we win," as advanced by the former Vice Chairman, Admiral William A. Owens.[2] Attaining this dominance requires enhancements in intelligence, surveillance, and reconnaissance (ISR) and in C^4I—neither of which is considered today.[3] But there are several methodologies used to compel models to provide insights on the possible impact.

One approach is to front-load the model based on some gross assumptions by invoking an "efficiency factor" for either side. That is, analysts may multiply weapons effectiveness indicators on one side (but not the other) by some value to express a relative difference between protagonists. This method requires front-end analysis; and it could be argued that it leads to convoluted results.

Another method allows one side to find targets immediately. Combined with old doctrine and battlefield arrays, this results in faster force-on-force wars. Targets are acquired and destroyed faster and with greater precision, mirroring the type of war conducted in the Persian Gulf. Hence the universal acceptance level of the results is supported by real world experience. Such modeling techniques might suggest that dominant battlefield awareness increases ammunition requirements because more targets become available and that ammunition costs may thus increase.

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Dominant Battlefield Awareness

But what if this dominance enables us to identify major enemy vulnerabilities? Such issues are beyond the capacity of current models that, for example, cannot simulate targeting and destroy a command headquarters. However, while such a strategy cannot be simulated with models today, it might result in lower ammunition requirements. Finding critical vulnerabilities requires network analysis, which is not beyond the ability of operations research analysts. Many network analysis tools are available but simply have not been used or are not compatible with force-on-force models.

Another method is to employ a "man-in-the-loop," which is much more promising because military strategists decide how to array their capabilities on the battlefield and define some order of battle. Analysts program the computer model accordingly, and it is then run for a specified time or until a certain objective is achieved. Presented with those results, strategists then make their next move, and so on. Although included, strategists cannot truly exercise creativity because they are restricted by the capabilities and assumptions of the models.

Vigilant Warrior provides a situation in which one might ask a "man-in-the-loop" about the value of improving ISR capabilities. Clearly they saved the cost of revisiting Desert Storm. Based on superior intelligence assets, we are able to enforce a strategy in the Persian Gulf today that relies on early warning, which has force implications. Perhaps an investment in technologies to integrate and present information more quickly to the National Command Authorities could have saved the cost of deploying troops in 1994. Investment in processing and integrating information might be compared with such deployment costs. Obviously this kind of analysis goes far beyond force-on-force models. But it also surpasses the "man-in-the-loop" wargames that one might try to support with these models.

The inadequacy of such models with regard to advances in information technology justifies discarding them in favor of new ones. Leaving aside the tremendous time it takes to build a model that is valid and accepted, it is impossible to stay abreast of emerging information technologies that are improving exponentially. Some attempts to model C^4I are only representations of information flow, much like logistics. These are placed over existing force-on-force models and do not model the significance of information capabilities nor the impact of denial of information.

Emergence of C^4I

All these approaches simply layer dominant battlefield awareness, or any information age capability, over old doctrine and battlefield arrays. Models were not designed to identify critical vulnerabilities or exploit them—they can't reinvent *Blitzkrieg*. Once breakthroughs occur military analysts can account for innovations in modeling or build models that simulate such processes, but they cannot find them with models. Old models did not even account for basic synergies realized from combining land and air operations.

These old models provided important analytic tools to support resource allocation decisions during the Cold War. Built without consideration of command, control, and communications they were sufficient for making decisions on weapons systems and force structure in the industrial age. The emergence of C^4I, however, demands a change in the tools used to support decisionmaking on weapons systems and force structure. And the issues go beyond weapons and force structure to systems integration and process changes that might yield force structure changes.

Practitioners of operations research should instantly recognize that those who continue to use force-on-force models are breaking a fundamental rule: don't make the problem fit the model. This unfortunately describes attempts by analysts to get results through workarounds and tinkering with current models. Armed with only force-on-force models, they must ultimately reduce every question posed to fit a force-on-force analysis.

In relative terms the next century is here. But clearly current models cannot be retooled nor

U.S. Air Force (Marlene Barry)

Deploying for Vigilant Warrior.

quickly rebuilt to address the new issues that it will pose. Military leaders must direct the analytical community to develop efforts which support reengineering warfare rather than automating it. They must envision how strategy and doctrine would change as a result of new capabilities and structure the force accordingly.

If strategy is information- or knowledge-based, force enhancements might be measured in terms of how such capabilities are leveraged. For example, restructuring initiatives that eliminate layers of command and control, that simply filter information with no value added, would be such an enhancement. These capabilities enhancements might be measured in terms of how successfully they integrate or speed information processing.

From a cognitive perspective, future developments might focus on presenting commanders with the right information in an understandable and usable format. Psychologically, one might ask if the American people might be inclined to use unmanned autonomous vehicles and cruise missiles to lessen the chance of putting our forces in harm's way.

Tools Are Not Solutions

Operations research analysts cannot answer every question. But they might gather groups of specialists from various fields to examine the future of warfare. This would include evaluating the environment of the battlefield of tomorrow, how it will be changed by advances in information technology, how the national strategy must change, and how war can be revolutionized to support that strategy. In addition to the usual lineup of experts in national and military strategy, this group must include cultural, economic, and intelligence specialists, computer experts, systems engineers, network analysts, and social scientists.

This approach to problem solving is not new. Operations research traces its roots to World War II when diverse groups of scientists teamed up to solve complex problems. Many recognized the synergism in bringing diverse expertise and views to problem solving, so the practice spread. The success of the methodology and models that evolved is still widely recognized in the industrial sector. This discipline incorporates a common menu of techniques and mathematical models that have been developed over the years. But as operations research textbooks warn, these are tools, not solutions to problems. One of the most fundamental errors that any operations research analyst can commit is to apply the wrong model to a problem.

The essence of operations research is creativity and innovation—not employing models like cook book recipes. Its tools are useful in studying a wide range of problems. But often there are no appropriate models for particular problems. That is an opportunity for both the art and science of operations research to grow, to develop new models. Determining the impact of the revolution in information technology on warfare is one such opportunity.

Failure to redirect the analytical community toward reengineering warfare misses the chance for military strategists and operations research analysts to realize their potential. Yet the practice of making incremental changes in strategy and modeling may continue unnoticed. If strategists do not consider the consequences of C^4I beyond the safety of model-based wargames, tinkering with old ideas will be reflected in reworking models that support them. Contractors will support expensive computer-based models by investing in graphic interfaces and resolution improvements that give the impression that the models themselves have been modernized. But the opportunity will be lost to exercise the core competencies of both military professionals and operations research analysts. Military professionals will fail to apply their art in a new era while operations research analysts will fail to fulfill the potential of their art and science envisioned a half century ago. JFQ

NOTES

[1] The Army is exploring how to adapt with a three-phase training and learning program task force advanced warfighting experiment using a digitally equipped experimental force. The plan is briefly outlined in an Army pamphlet entitled *Force XXI: America's Army of the 21st Century*, pp. 23–29.

[2] William A. Owens, open letter to the Military Operations Research Society, December 1, 1994.

[3] William A. Owens, "The Emerging System of Systems," *Proceedings*, vol. 121, no. 5 (May 1995), p. 37.