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Peter P. Perla

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Short of actual military operations, the Navy evaluates its combat capabilities in three ways: war games, systems or operations analyses, and exercises. The Navy uses all of these techniques extensively, and their roles often seem to overlap. Too often, wargaming, analyses, and exercises are viewed as functioning independently of one another or even in competition with one another.

This article outlines and describes the major roles of war games, analyses, and exercises; and, further, examines their interrelationships and defines some of the ways they can complement each other in the study of the Navy's warfighting capability. Only by integrating the information available from all three processes can the Navy obtain a balanced and well-rounded understanding of the potential problems and opportunities of actual combat. Because my emphasis will be on wargaming, this technique is compared first to analyses and then to exercises. The discussion concludes with a summary of the interrelationships and the complementary nature of the three processes.

Definitions

A war game is a warfare model or simulation whose sequence of events is interactively affected by decisions made by players representing opposing sides, and whose operation does not involve the activities of actual military forces. The key words in this definition are *players* and *decisions*. Fundamentally, wargaming is an experiment in human interaction and is best used to investigate processes, not to calculate outcomes.

Analysis, or operations research, on the other hand, has been defined as "a scientific method of providing [decisionmakers] with a quantitative basis for decisions."[1] Here, the key words are *scientific* and *quantitative*. Because the field of analysis is so large and diverse, many definitions of its nature have been proposed,[2] but the scientific and quantitative nature of the discipline appears to be its most fundamental characteristic.

Dr. Perla received a Ph.D. in Statistics from Carnegie-Mellon University and has been a member of the professional staff at the Center for Naval Analyses since 1977. Active in commercial wargaming for a number of years, he has concentrated on Navy wargaming for the past several years.

For the purposes of this discussion, a military exercise can be considered any activity involving the operation of actual military forces in a simulated hostile environment. Here, the key words are *forces* and *simulated.* Although the Navy conducts exercises of many types and for many reasons, true exercises are characterized by real-time operation of ships and aircraft. These forces generally expend real or simulated weapons against some "enemy" force. Of course, these "enemy" forces must also be played by U.S. units.

It is clear from the above definitions that, although often related, and in some ways similar, war games, analyses, and exercises tend to focus on different aspects of warfighting reality. Consequently, although each technique can be an effective learning device for specific areas, each also tends to be less effective in other areas.

The physical sciences are the paradigm of analysis. Analysis focuses on the physical processes of reality, adopting a philosophy of approximating those processes with mathematics that can, in some sense, be "solved." Analysts build mathematical models of reality, take measurements to quantify the parameters of the models, and then manipulate both models and parameters to learn about reality or to find the best solutions to the problems it poses. Although the mathematics is objective, the choices of models and parameters, underlying assumptions, and sometimes the method of solution are all subjective. As a result, to translate learning about the model into learning about reality can be difficult. In making this translation, analysis must simplify and often discard much that is not reproducible or readily predictable—including, at times, human behavior.[3]

War games, on the other hand, revolve around human decisions. Learning from war games comes both from the experience of making decisions and from the process of understanding why those decisions are made. The outcomes of decisions are defined by mathematical models that are often similar to those of analysis, however, these models are employed in a fundamentally different way. Wargaming models are typically stochastic in nature—the "roll of the dice" provides a wide range of possible outcomes or snapshots of reality with which the players must deal. In this sense, model results should be considered inputs to war games, whereas such results are often the outputs of analyses. War games do not, and should seldom attempt to, produce quantitative measures. Their value lies in qualitative assessments of why decisions are made. Thus, to exploit wargaming, the physical sciences must give way to a new paradigm, that of history. People and decisions become paramount.[4]

Exercises focus on doing. They are primarily tools for training and are usually designed with such goals uppermost. Decisions are sometimes restricted because of requirements to exercise systems and train personnel. Even free-play exercises are generally restricted because of safety requirements or geographic limits on operations. Exercises are often viewed as experiments providing data

for models used in analyses or games. In many cases, such a view is a useful one but one that requires care in interpreting numbers whose origins are sometimes difficult to judge. There is no known accurate way of adjusting for exercise artificialities. Thus, in order to focus on execution, exercises often restrict the physical parameters and processes and limit the potential decisionmaking. As with analyses and war games, the actual results or outcomes of the execution can only be approximated. Exercises, too, are not real.[5]

War Games and Analyses

On the surface, wargaming has much in common with systems or operations analyses. Scenarios underlie and structure the research; data bases provide the basic information about physical parameters and processes; mathematical models simulate some aspects of reality; and rules and procedures assure the logical flow of cause and effect. In both their goals and their operation, however, war games and analyses differ significantly.

In the defense community, the term analysis usually connotes systems, operations, or campaign analysis. As described earlier, such analysis may be characterized as a technique for quantifying and manipulating information about physical parameters to calculate the outcome of physical processes. Wargaming, on the other hand, is a tool for exploring the effects of human interpretation of information. War games focus on the decisions players make, how and why they are made, and the effects that they have on subsequent events. Classical campaign analysis is the form of analysis that most closely resembles wargaming. Thus, a comparison of these two techniques best highlights their differences.

When carefully structured and thoroughly carried out, campaign analyses might be expected to yield valid insights about:

- the feasibility of strategies;
- areas of strength and weakness on both sides;
- factors and parameters that critically affect the results and the sensitivity of the results to them;
- how the various types of forces can be used to advantage; and
- the relative contribution of the various types of forces.

To accomplish these sorts of objectives, campaign analysts usually define a sequence of events—often simply a string of engagements—and calculate the expected outcome of those events based on the postulated mathematical models and information about forces and capabilities. In rare cases, they calculate a distribution of possible results. Through trial and error, analysts go back through the sequence to determine what changes in strategy or tactics could result in a more balanced outcome. The old sequence is discarded and replaced by the new. This iterative procedure goes on until the analysts are

satisfied that both sides are employing nearly optimized strategies, and then the campaign is run to an analytical conclusion. The result, usually defined in terms of expected attrition, becomes the basis for assessing feasibility or identifying critical factors and for comparing variations of the assumptions underlying the analysis.

War games, on the other hand, allow for the continual adjustments of strategies and tactics by both sides in response to developing results and events not seen in campaign analysis. War games afford the players a large measure of control over events through their decisions. Usually, these decisions are not based on clear and complete understanding of all the facts, but rather on how the players view those facts through a cloudy and possibly incomplete frame of reference that is often distorted by the pressure of time limitations; in other words, the fog of war. In most cases, a decision once made cannot be recalled. Although the immediate outcomes of decisions are sometimes defined by mathematical models, their true effects ripple through all the subsequent game decisions and events. What and how much is lost in war game engagements and campaigns are far less important for interpreting the lessons of the game than how and why those engagements occurred as they did.

The end product of a classical campaign analysis can look very much like the play of a single war game, but it is a game in which all decisions are premade, poor decisions are self-correcting, uncertainty is eliminated, and chance is averaged away. Such analysis can provide important insight into the effects that systems and tactics might have in the circumstances assumed; yet, it has enormous difficulty in capturing the dynamic elements of warfare or in illuminating new facets of reality not already incorporated into its models. Because campaign analysis tends to focus on the quantifiable and reproducible, or on the mean rather than the outlier, it can provide little insight into why and how a brilliant hunch or incredible blunder, a bold gamble, or paralyzing indecision can turn carefully crafted plans into beautifully executed fiascoes, or *ad hoc* operations into decisive victories. There are no Chancellorsvilles in campaign analysis.

The true value of wargaming lies in its unique ability to illuminate the effect of the human factor in warfare. By their very nature, war games seek to explore precisely those messy, "unquantifiable" questions that campaign analyses ignore. War games can help the participants discover what they don't know they don't know. To do this, however, war games must sacrifice much of the mathematical structure of campaign analysis. A war game is not a mathematical experiment whose initial conditions can be re-created precisely and varied at will. The fundamental initial conditions of a game—the state of its players' knowledge base—changes with experience of the game and with replacement of individual players. Unlike campaign analyses, such parameters may not be varied readily over a wide spectrum.

Finally, because of the highly technical and quantitative demands of analysis, most of its practitioners remain civilians despite the increase in the number of military officers earning advanced degrees. The best analysts work closely with their military clients to keep their analyses militarily sound. Yet, it is rare to find an analysis in which all major decisions about force employment, missions, and operating concepts are made by active duty military personnel. Except for those games used by civilian analysts for strictly exploratory purposes, most military war games cast military officers in military decisionmaking roles. The differences in perspective and experience can sometimes result in significant differences between how a civilian might address a military problem and how the same problem is handled by someone in uniform. For similar reasons, having military officers play civilian roles can also be misleading.

Table 1 summarizes the comparison of campaign analyses and war games.

Comparison of Campaign Analyses and War Games

	Campaign Analyses	War Games
Objectives	Quantitative insights into feasibility, critical physical factors	Training; exploring decision processes
Event sequence	Preordained	Dynamic
Engagement outcomes	Typically expected value	Usually stochastic
Learning	Iterate until balanced outcomes	Few second chances
Interpret	Results	Processes
Participants	Primarily civilians with military advice	Primarily military in military roles

Table 1

War Games and Exercises

As indicated in earlier discussion, one can distinguish between war games and exercises in that the latter involves the actual movement and operation of military forces. (Command post exercises (CPXs) are an exception as they seldom involve ships putting to sea and are often similar to one-player games.) Exercises usually focus on training, with research interests largely centered on measuring operational capability. Wargaming has also been used traditionally as an aid for training, but it has become more and more popular as a tool for exploring decisionmaking processes. In addition, there are other differences between wargaming and exercises with regard to cost, time scale, flexibility, level of play, participants, and characterization of results.

Compared to exercises, war games are usually quite inexpensive. Actual game play seldom involves more than a few dozen officers, supporting technicians, umpires, and analysts over a period of several days. Even the planning and postgame analysis efforts, while lasting up to several months, involve only a relative handful of people. A major exercise, on the other hand, usually involves thousands of military and numerous civilian personnel. It also requires the operation, support, and maintenance of large numbers of ships, aircraft, and other equipment for periods of up to several weeks. As a result, the costs of a war game and an exercise that deal with the same general topic can differ by several orders of magnitude.

Because a war game does not employ actual forces, the advance of time during game play can be regulated to run much faster or much slower than real time. A game exploring strategy for a long war may have game time advance at a rate ten times that of real time. Alternatively, a training game may slow time down to allow players more opportunity to analyze and understand a tactical situation. Exercises, for the most part, must be played out in real time. Some time "jumps" between phases of an exercise are possible, but actual exercise activity can seldom be at anything other than real-time rates.

Because of the difficulties of staging large exercises, they typically must be played at the tactical level of the battle group or individual platforms. Some theater or major operational level exercises are played (for example, FLEETEX in the Pacific), but only infrequently. War games can be played easily at any level—up to and including that of the National Command Authority and global strategy and policy.

As a result of similar factors, active participation in exercises is usually restricted to military personnel and seldom includes high-ranking officers such as fleet or theater commanders. Political background and decisions are simplified and assumed away. In many war games, on the other hand, civilian players representing political authorities add their own, often quite different, perspectives to those of the military participants, with sometimes surprising and frustrating results. Unfortunately, the problem with high-ranking participation applies to war games as well.

Finally, although the results of war games are best characterized as qualitative, exercise results are usually considered to be quantitative. War game analysis documents decisions. Exercise analysis measures operational parameters such as system availability, speed of execution, numbers of targets engaged, or others.

Table 2 summarizes the comparison of exercises and war games.

Synthesis

This comparison of war games to exercises and analyses illustrates some of the similarities and differences among these three techniques for learning

Comparison of Exercises and War Games

	Exercises	War Games
Activity	Operation of actual forces	Simulation of operations
Goals	Training; evaluating performance	Training; exploring decision processes
Cost	Expensive	Relatively inexpensive
Time scale	Real time	Adjustable
Flexibility	Resource-constrained; limited by availability of forces	Requires relatively few resources; may be played nearly anytime or anywhere
Levels of play	Primarily tactical with limited operational	Tactical, operational, strategic—all possible
Participants	Military; seldom highest ranks	Both military and civilian; seldom highest ranks
Results	Quantitative measures of performance	Qualitative assessments of decisions

Table 2

about defense issues. It also demonstrates that no one of these techniques is sufficient for obtaining a balanced view of the critical features of wartime reality.

Because actual fighting does not occur, none of these methods can truly capture many of the human elements of real combat. History is full of examples in which courage, fear, morale, and leadership provided the decisive determinants of defeat or victory. War games and exercises provide greater opportunities for exploring these factors than does analysis, but even their ability to re-create the stress of combat is limited. War game hours seldom exceed those of a normal working day, and players know that at the end of the week or month they will be back at their normal duty stations. Even exercises, in which physical conditions are more similar to those of wartime operations, can only reproduce a fraction of the real pressures involved when real weapons may be fired in anger.

Similarly, the effects of such weapons can only be partially accounted for in mathematical models. The results of engagements, whether in analyses, war games, or exercises, are assessed on the basis of such models supplemented with military judgment. Yet, because many modern weapons have not been used extensively in combat, these models and judgments are seldom based on a substantial body of hard data.

Finally, there is a tendency, most pronounced in analysis but extending to a degree to exercises and war games as well, to seek the truth of combat in "typical," "expected," or "likely" results. If history teaches us anything, it should remind us that in war the unexpected is commonplace. Too often,

highly detailed engineering or expected-value models obscure "the tremendous influence of luck in all warfare, especially naval warfare."[6]

There are many other artificialities and shortcomings of war games, exercises, and analyses.[7] It is not the intent of this paper to catalogue all such artificialities. Rather, the goal is to suggest how such shortcomings can be overcome through the use of wargaming, exercises, and analyses to address those parts of the problem for which they are best suited and through the careful integration and interpretation of their results. Such a process has no magic formula; still, an example may demonstrate some of the possibilities.

A question of great interest to the Navy centers on whether aircraft carrier battle groups (CVBGs) can operate usefully and effectively in specific geographic areas when opposed by a particular type of Soviet submarine threat. Analysis can construct models and devise methodologies to describe the effectiveness of ASW barriers, direct CVBG defenses, and submarine attack capability. These models would be mathematical functions of sensor and weapon performance based on the best available theoretical and experimental data. Measures of effectiveness (MOE), such as the probability of an attacking submarine's being killed before firing at a carrier, can be defined and calculated on the basis of the assumed parameter values, and the effects of changes in those values can be quantified through the changes in the MOE. In this way, the analysis might identify critical physical parameters.

Informed by the results of the analysis and possibly using models adapted from it, the Navy could conduct a war game to explore the concept further. The game could include not only military commanders who might have to execute the operation but civilian decisionmakers as well, thereby yielding different points of view and value judgments. Such a game could shed new light on the political ramifications of deploying or not deploying CVBGs to the region, the availability of specific force levels under a variety of conditions, the rules of engagement under which those forces might have to operate and how those rules might change over time, and the possibly unexpected reactions of an enemy whose perceptions differ from our own. Similarly, the dynamic environment of a game may cause players to react differently than assumed by a static analysis.

However imperfectly large-scale political and operational decisions are modeled in a war game, they can sometimes have more important effects on the conduct and utility of an operation than the detection range of a sonar or the probability of accurate weapons placement given detection. Yet, without the understanding of the latter factors provided by good analysis, the decisions can be too abstract, too sterile, and their effects assumed rather than assessed. The gaming and analysis pieces must fit together.

An exercise can often help assemble the pieces and supply some missing ones of its own. The proposed operation could be practiced in the area of interest. Careful analysis and interpretation of exercise performance could

improve the parameter estimates for mathematical models. In addition, the physical execution of maneuvers and procedures required to carry out the operation can help identify important operational opportunities or problems that the analysis and war game may have downplayed or failed to consider.

Each tool strengthens and supports the others. Analysis provides some of the basic understanding, quantification, and modeling of physical reality that can underlie a war game. A game allows exploration of the implications that human decisionmaking has for the analysis, illuminates political or other nonmilitary assumptions and points of view, raises new questions, and suggests modified operational concepts. An exercise can test these concepts at sea with real ships, aircraft, and people; measure actual parameter values; verify or contradict key analytical assumptions; and suggest even more topics for gaming, analysis, and follow-on exercises, thus continuing the cycle.

Weaving war games, analyses, and exercises together in this continuous cycle of research allows each technique to contribute what it does best to the process of understanding reality. Only by integrating these techniques can the Navy hope to gain a better and balanced understanding of the potential reality of modern naval warfare.

Notes

1. Phillip Morse and George Kimball, *Methods of Operations Research* (Cambridge, Mass.: The MIT Press and New York: John Wiley & Sons, Inc., 1951), p. 1.

2. For example, see *Naval Operations Analysis*, 2nd ed. (Annapolis, Md.: The Naval Institute Press, 1977).

3. For further discussion of analysis see Morse and Kimball; George F. Brown, Jr., "Managing Analysis: The Client's Responsibility," *Naval War College Review*, May-June 1979; Gary D. Brewer and Martin Shubik, *The War Game: A Critique of Military Problem Solving* (Cambridge, Mass.: Harvard University Press, 1979).

4. For a thorough discussion on wargaming, see Peter P. Perla and Raymond T. Barrett, "What Wargaming Is and Is Not," *Naval War College Review*, September-October 1985.

5. For more on this subject see Frederick Thompson, "Did We Learn Anything from That Exercise? Could We?" *Naval War College Review*, July-August 1982.

6. Samuel Eliot Morison, *History of United States Naval Operations in World War II: Vol. I, The Battle of the Atlantic* (Boston, Mass.: Little, Brown, 1947).

7. In addition to the above, for further discussion, see Comptroller General of the United States, *Models, Data, and War: A Critique of the Foundation for Defense Analyses*, PAD-80-21, Report to Congress (Washington: 1980).