EFFECTIVE SELECTION AND USE OF CONFLICT SIMULATIONS (WARGAMES) FOR OPERATIONAL TRAINING OR CAMPAIGN ANALYSIS

Squadron Leader Patrick Beautement MSc, PGCE, RAF
Operational Doctrine and Training Element of the
Air Warfare Centre, Royal Air Force, Cranwell, United Kingdom.

ABSTRACT

1. This paper will cover the reasons why conflict simulations (better known as wargames) are used, the types of wargames that exist, how wargames are selected, how they need to be set up and what is required to make the best use of them. Some of the more common myths in wargaming will be dispelled. The impact of future technologies will also be highlighted.

2. Wargames (including models/simulations) have, in general terms, been used mainly for both analysis and training. This paper looks at the context in which gaming is carried out and asks "What types of wargames are available?". The games and simulations available fall into many categories depending on the level of interaction (political to tactical) the style of 'play' and the type of execution (eg manual or automated in some way). This paper considers what wargame choices are available and what selection criteria should be used. Above all, there should be a clear need for a wargame and the game selected should fulfil that need. Also considered in the paper is the impact of new technologies such as synthetic environments and inter-model protocols like ALSP.

3. Setting up a game correctly involves considerations beyond simply the game itself: ie, the selection of equipment and staff, data, rules and scenarios. Once a game is provided, using the game effectively involves further effort. How is the game to be used? Whether the game is to be used for training or analysis, seminar directors, ie subject experts, will be needed to interface with the users. Interpretation is a tricky business and needs to be done with care, as is deciding on the criteria by which "success" or "failure" is to be judged.

4. Overall, the paper will inform readers about wargaming issues and provide methodologies for effective selection and use of wargames.

Key Words:

wargame selection conflict simulation operational training campaign analysis

---

NOTES ON THE AUTHOR: Squadron Leader Patrick Beautement is currently the Wargame Systems Specialist at the Operational Doctrine and Training Element of the AIR WARFARE CENTRE, RAF Cranwell, responsible for running the wargame "Thunder" (used as an "exercise driver" on Battle Staff Training Courses), and for advising RAF staff on wargaming matters. He has been working with computers and computer simulations since he took his Masters degree in Intelligent Systems and Neural Networks before joining the RAF. More recently he has been involved in producing training systems for the Tucano, Tornado and Buccaneer aircraft, as well as managing training design for ground electronic equipment.

EFFECTIVE SELECTION AND USE OF CONFLICT SIMULATIONS (WARGAMES) FOR OPERATIONAL TRAINING OR CAMPAIGN ANALYSIS

Squadron Leader Patrick Beautement MSc, PGCE, RAF
Operational Doctrine and Training Element of the
Air Warfare Centre, Royal Air Force, Cranwell, United Kingdom.

INTRODUCTION

5. This paper will consider why conflict simulations are used, how to select them and how to get the best out of them. But, before I go on to consider these issues it is worth noting that I will be using the words 'conflict simulation' and 'wargame' (to include modelling and simulation) interchangeably. Wargames get 'bad press' in some circles as they do not sound like serious work. However, I would assure the reader that wargames are much more about war than game. As my perspective is military wargaming, I tend to use terminology relevant to that area, however, the selection criteria and guidance on effective use given below are applicable to all areas of work.

6. This article, then, will cover the reasons why wargames are used and, before listing what sorts of games are available, will dispel some of the more common myths about wargaming. The criteria to be considered when selecting games will then be detailed followed by some examples of wargames in current use. Next, the paper explains how games should be set-up and what is required to make the best use of them. Before discussing the future of wargaming, the paper considers some of the technology issues currently in the news. Finally then, I shall suggest some future uses of wargaming.

WHY WARGAME?

7. In essence, gaming is about "investigating the processes of combat", be that combat on battlefields or in other areas of human conflict. Consequently, gaming can be used as an "organising and exploratory device" leading to insights and understandings which would not be apparent unless the gaming occurred. The level of study, be it strategic, operational (ie theatre-level) or tactical, must be considered, as must whether pre-, during or post event issues are to be of concern. Also, are training or analysis tasks to be done? Table 1 shows how these main factors determine the type of gaming activity to be carried out.

8. Wargaming tends to be used mostly for either training personnel or for analysing situations. The reasons for this clear split are as follows:

a. ANALYSIS. In analysis, the purpose is to investigate, validate or prove a concept or plan. In this mode, the wargames are used to predict outcomes, and as such, are concerned with the product of the game; be it success, failure or some absolute outcome. For the product to be credible, there has to be a strong emphasis on the formulae used by the game to produce the results and on the input data. The wargame must mirror reality and there can be no suggestion of selecting data to produce a set result!

b. TRAINING. In training the purpose is to create a dynamic situation in which to instruct potential "Battle Staffs" or evaluate their performance. Because of this, the emphasis is on the processes that the staffs go through to achieve their goals, and their performance is evaluated against more subjective criteria than in analysis. As far as the students are concerned, as long as the game produces "acceptable" results, the method by which this is

achieved is irrelevant. In fact, wargame managers may change data to produce set problems and outcomes for the students to deal with.

TABLE 1

		Pre-event	During Event	Post-event
Training	Strategic	Politico - Military	-	Conflict studies
	Theatre	Campaign Planning	Battle Management	Conflict studies
	Tactical	Mission planning	Mission rehearsal	Mission debriefs
Analysis	Strategic	Capabilities, Procurement issues	Possible Settlements	-
	Theatre	Doctrine, Campaign Planning	Vulnerabilities	Ops Analysis
	Tactical	Trials and tactics	Mission Analysis	Ops analysis

Both these types of wargaming **can** be carried out pre- or post event and in all scenarios from tactical to strategic. However, analysis tends to be carried out post event and training pre-event.

MYTHS ABOUT WARGAMING

9. Before I discuss wargaming in more detail, I wish to dispel some of the more common myths about wargaming:

a. MYTH 1 - WARGAMES ARE TOYS. As I mentioned at the start, the words "war game" suggest a trivial, even childish, pursuit. However, in 1824, when the Chief of the German General Staff, General von Muffling, was shown von Reisswitz's "Kriegsspiel" he said, "This is not a game, this is [training for] war!". Von Muffling quickly realised that wargaming could provide a vehicle for examining the [modern] principles of mobility and firepower as well as allowing an exploration of the problems created by the military and political situations of the time. In short, wargaming would assist staff in understanding the demands which would be imposed by a future war. Certainly not a trivial achievement, and still true today!

b. MYTH 2 - WARGAMES = COMPUTERS. When talking about wargaming it is usually assumed that computer-assisted wargames are being discussed. However, it is possible to have very successful manual wargaming. The "Global Wargame" (a strategic politico/military game played at 4* level annually at Newport, Rhode Island, USA) is a good example, where the use of computers would be both limiting and inappropriate. For "training" of this type, it is the conceptual fidelity in the players mind which is of paramount importance and computers are not introduced unless they assist in this process.

c. MYTH 3 - ANYONE CAN RUN A WARGAME. Anyone could, in theory, run a wargame, however, not everyone can run a wargame effectively. Successful interpretation of the results takes skill and experience, close knowledge of the "quirks" of the game (they all have them), a deep subject knowledge and appropriate experience. The old maxim "garbage-in-garbage-out" applies as much to the wargamers as it does to the game itself.

d. MYTH 4 - WARGAMES ARE PREDICTIVE. This is a difficult area. It is clearly possible to use wargames to aid in decision making, evaluation of tactics and strategies and assessment of equipment. However, it is not possible to use games to predict exact outcomes; at best relative values or probabilities can be evaluated. This was clear from the assessment of Gulf War casualties: where from 0.03% to > 25% was predicted. Even statistical analysis needs to be treated carefully. Assumptions, simplifications, limitations and exclusions must all be carefully noted.

e. MYTH 5 - WE'RE IN CONTROL. Well, we (the users of a game, especially a computer-assisted one) ARE NOT (really). We are at the "mercy" of the rules and probabilities "programmed" into the game. A big change in the results can be due to a small change in these rules introduced, say, in a software update. It is also possible to fall foul of data acquired from external sources which may contain generalisations. CAVEAT EMPTOR.

f. MYTH 6 - GOOD GRAPHICS MEANS A BETTER GAME. You can be sure that good graphics attracts purchasers. However, good graphics usually means more expensive hardware, not necessarily a better game. Good "user interfaces" are usually graphical, but if your users don't touch the computer, paying for this may be wasted money.

TYPES OF WARGAMES

10. So what types of wargames are available? The games available fall into many categories as follows:

a. BASED ON SCENARIOS. The games based on scenarios fall into three types:

(1) GENERIC. Generic games are set in mythical scenarios. Their value is that they home in on the procedures and strategies being used, without the distraction of arguments about the "reality" of, say, imaginary enemy actions. However, players can waste time becoming familiar with the generic scenario as they cannot use much of their general knowledge. In short, generic games are best for high level or novice training where a great deal of detail is not required.

(2) SPECIFIC. Conversely, specific wargames are based on reality. They study the effects of known doctrines in real politico/military contexts. Integrity of results can be taken for granted as real values for equipment performance are being used. Players can not only use their general knowledge to good effect, but can also have their knowledge improved through the wargaming process. However, arguments can develop about the validity of the scenario and about the actions taken by different countries. So, specific wargames are best suited to theatre level training downwards.

(3) HYPOTHETICAL. Hypothetical wargames deal with extrapolations of known situations and allow the exploitation of "what-ifs". New or experimental equipment, tactics or overall strategies can be evaluated. However, the danger of this type of game is that too much credence can be given to the outcomes. At best, trends and relative results (not absolutes) can be compared.

b. BASED ON TYPE OF PLAY. There are variations of games related to the type of play used as follows:

(1) FREE OR RIGID PLAY WITH SEMINAR OR SYSTEM RULES. In free play an umpire arbitrates the results of conflict based on their extensive military experience, whereas a rigid play system uses a (usually complex) set of rules to determine results. The play can be seminar (discursive) or "system" with structured moves.

(2) ONE, TWO OR MULTI-SIDED. One-sided games (against a fixed enemy or OPFOR team) allow control of the play to be retained. However, the "enemy" in a computer-based game is the programmer and it becomes too easy to "play the game" and not the war. In two- or multi-sided games the outcomes are more unpredictable, particularly if the teams involved are not closely matched.

(3) OPEN OR CLOSED. In an open game, all players can see all of the action. This format tends to be used for planning games where it is important to discuss enemy options as the play proceeds. Closed games (where one side sees no more of their opposition's moves than they would in reality) tend to be used for training.

(4) CYCLIC OR "REAL TIME". Most training games tend to be played cyclically where a "frozen midnight" is used. At the "game stops" players have time to assess the situation and make their decisions knowing that the enemy play is suspended too. This is unrealistic. Much better is to use a "live day" (where "moves" are made concurrently) to keep the players under pressure while they plan. Even in analysis, using the "live day" can give an insight into the time constraints of a situation.

(5) DETERMINISTIC OR PROBABILISTIC. Deterministic games tend to be "scripted", producing an unrealistic, unreactive form of play. Nevertheless, control of the outcomes is retained, usually at the expense of flexibility. Innovative thinking is not rewarded (or punished!). In a deterministic game, much more effort has to be expended in setting up, maintaining and retaining consistent rules as all eventualities must be programmed in. A probabilistic game produces slick, realistic and reactive play which can deal with unforseen actions by either side, where knock-on effects and interactions may have significant sway. A probabilistic game can automate many processes, for example: the selection of targets, based on a realistic assessment of the actual current threat.

11. All the types of games mentioned above can be executed in 2 main ways; either manually or automated in some way:

a. MANUAL. At the simplest, manual wargames have a fixed "pink" (an answer sheet), determined in advance, which dictates the outcomes. The lack of reactive feedback to inputs makes this kind of game of limited value. More sophistication can be added by dice throwing and the use of "tables of rules" based on previous outcomes. The main problem with a manual system is that determining outcomes for many engagements becomes time-consuming, especially for a large game. However, in a manual game control of results is maintained because the arbitration process is explicit and open.

b. AUTOMATED. Automation usually involves computer-assistance which improves wargaming by allowing faster production of results and increased consistency. Note however that, as yet, there is no such thing as a full computer wargame, only computer-assisted ones. The illusion of complexity is easily achieved in computer-assisted systems and then the danger arises of giving too much credence to the results.

SELECTING WARGAMES

12. So, assuming that wargames are considered to be of value, how are the right ones to be selected? Firstly, it is clear that more than one game will probably be required. Several games may be needed to provide the range of capabilities necessary to cover the different levels shown in Table 1 above. The games selected should be complementary, the strengths of one complementing the weaknesses of the others, with as much compatibility between the games as possible. Above all, there should be a clear need for wargames and the game selected should fulfil that need. However, that "need" (which will usually be to investigate "corporate" decision making processes) must be defined before wargame selection. Games should not be selected, say, just because it is available at little or no cost from another user. So, a number of points need to be considered as follows:

a. WHAT CHOICES ARE AVAILABLE. In choosing new games to meet future needs the question, "What choices are available" must be asked. Is there a definitive list of wargames, their suitability and effectiveness available? Unfortunately, the answer is not really. Many new developments in wargaming are underway, involving technologies such as so called "expert systems" and "artificial intelligence". Consequently capabilities are changing all the time. The Catalog of Wargaming and Military Simulation (1) is one source of information, but the best approach is by talking to existing wargaming users and by seeing games in action.

b. WHAT SELECTION CRITERIA SHOULD BE USED? There is also no established list of assessment criteria for wargames. An MPhil (2), published in the summer of 92, by Sqn Ldr Alan Burton (see also (3)), working at Edinburgh University under the internationally recognised expert Prof John Erickson, gives an up to date overview of some of the selection issues that should be considered. These points are expanded below:

(1) BASIC SELECTION Method. First, consider the type (training or analysis), level of task, scenario type and timescale of the game to be carried out using Table 1. Now consider all the selection issues mentioned in para 6, annotating those relevant to your selected task. Annotate the dependencies in a table. Consider carefully what would be "appropriate" uses. Now evaluate all the factors mentioned below. In this way you will home in on the games suitable for further investigation.

(2) THE OPERATION OF THE GAME. As discussed in paras 6 and 7 there are many types of game and obviously these issues should be considered when selecting a game. However, one of the most crucial issues to be considered when selecting games is how the game operates. This factor not only affects the data and equipment required, but also the quality, experience and number of staff needed. For example, most wargames contain no automatic planning (Thunder is a notable exception to this). Consequently, large teams of support personnel are required to issue orders to all the sea, ground and air units involved. If your aim is to involve many players and to employ them in their war roles (ie for mission or battle-staff rehearsal) then this would be OK. However, for a seminar game (particularly a strategic one) hands-on computer time would be a distraction from the important task of thinking and discussion.

(3) THE USER INTERFACE. For any game the "user-interface" is very important. Bluntly, is it easy to use?! This is especially important for computer-assisted games where the students have to get "hands-on". However, there is no point in the students having to waste time learning a computer interface which bears no relation to any they may have to use in reality. "Manual" interfaces such as the tactical floor" or "operational wall" are discussed below at para 14b

(4) DATA STRUCTURES. The data structures used to store information are important and will affect the cost of maintaining the database. Is the data accessed through an easy-to-use, easily available database management system or is proprietary software used which needs special maintenance and training? In addition, is the data commented well or do the data files consist of strings of "meaningless" numbers? Is the data "normalised" and compact or scattered around a number of files, duplicating data and making it hard to update? All these points need to be considered.

EXAMPLE WARGAMES

13. There are many games currently in use world-wide. Examples range from theatre-wide "exercise drivers" to the highly detailed models used by operational analysts. A notable gaming organization is the Warrior Preparation Centre near Ramstein in Germany. This US facility uses a "confederation" of games (each of which is stand-alone) connected together by the Aggregate Level Simulation Protocol (ALSP) explained at para 15c below.

14. In the UK, the Royal Navy use a large number of games at HMS Dryad for training staff from 4* commanders downwards. Games used by the Army range from IDAHEX/TAWS (used on the higher command and staff course at Camberley as an exercise driver) to Brigade and Battle group trainers. A tool called FLAMES (known in the USA as EADSIM or C³ISIM) is used mostly for analysis of air defence, C^2 and air tactics. There are many other analysis tools such as ESAMS (produces SAM p_k), TAM (theatre attack model for aircraft/weapons optimization), SABSEL (produces air to ground p_k) and others too many to name here.

15. There are two main wargames in use in the RAF, the "Thunder" wargame that is used on the Battle Staff Training Courses in the Air Warfare Centre and by the MOD Science Staffs and the "ACES" (Air Command Exercise System) wargame in use at the RAF Staff College at Bracknell. Thunder is the subject of continuous update and improvement, as is the "ACES" game from Maxwell Air Force Base, USA. Comparing Thunder and ACES illustrates perfectly the points raised above. Both games are very different and yet complementary:

a. THUNDER. The game uses a simulation written in a computer language called "Simscript" produced by a firm called CACI in the USA, and runs on "Sun SPARC" computer equipment. The game is theatre-level, where a theatre can be as small as a state or as big as a continent. Scenarios can be generic or specific. The software does not restrict scenario selection and there is total control over the data without having to involve computer programmers to make the changes. Thunder can be used for training or analysis, allowing either emphasis on true "reliability" of results or changes to produce "acceptable" results for training. The game works out the results using probability data and rules, although some element of determinism is possible by adding "orders" for commands, units and squadrons. Also, things like the timing and opening of air corridors can be set, and manual ATOs can be created, detailing targets and weapon configurations. The results that Thunder produces are classified and have been validated by the US Studies and Analysis Agency in the Pentagon.

b. ACES. This game consists of two parts: a wargame "engine" written in Fortran (which only runs on "Cyber" mainframes) and a "front end" (which the user sees) consisting of a graphical map and a text based "tote board" for input, which runs on "Sun SPARC" or "X_windows" computer systems. The game can be theatre level or more tactical, the nature of the scenario being determined by the front end, a new version of which has to be written

for each scenario. The current scenarios are optimised for training, though the "engine" is powerful and would be suitable for some analysis if a suitably "intelligent" front end was produced. The game produces its results by the use of embedded deterministic rule logic with some use of probabilities. Because of this, players must enter orders for every move an air or ground unit is to make. This can draw players "down into the weeds". Overall though, ACES is an excellent training game which is being vigorously improved.

16. This simple comparison illustrates quite clearly how the design of a game or analysis tool determines its suitability for different types of applications. The assumptions and simplifications embedded in the rules and data cannot be ignored, and so when comparing the suitability of games a thorough understanding of their strengths, limitations and methods of operation is essential. The glossy brochure view is not enough! The range of analysis tools and wargames available is, therefore, a vast and wide ranging resource.

SETTING UP A GAME

17. Setting up a game involves considering what is needed in addition to the game itself:

a. WHO WILL SUPPORT THE WARGAMES AND WHERE IS THE REQUIRED EXPERTISE? Some thought is required about who should support the wargaming. There is a shortage of wargaming professionals, especially for computer-assisted games. The formation of a suitable wargaming centre within your organisation could act as a focus for such support and assistance, where the wargamers would be centralised and so used most efficiently. Also, the wargaming centre could formalise the systems for exchange of experience and procedures between the current wargaming users.

b. WHO WILL TRAIN THE SEMINAR DIRECTORS? New wargaming seminar directors (SDs) need more than the standard "one week" handover normally used in the military. Wargaming SDs have specialist skills which are not in the main line of an officer's duties. Consequently, the handover should be during a wargame or analysis phase. So if there is only one wargame a year, then that is when the handover must be. If this is not done, the SDs will "muddle through" the next wargame, learning as they go, at the expense of the students/analysts. Of course, if there is a wargaming centre formed, then the SDs could go there at any time to acquire the appropriate skills.

c. WHAT EQUIPMENT IS AVAILABLE? Well established guidelines exist for selecting computer equipment, so this should be no problem. However, the issues of hardware compatibilities must be considered. It is also essential to establish what the peak load on the equipment may be. There is nothing that kills the credibility of a wargame faster than a slow and overloaded hardware system "cobbled" together from dissimilar elements.

d. WHERE WILL THE DATA COME FROM? Obtaining validated data is ostensibly not a problem. What will be a problem is getting it in the required format. Perversely, the most difficult data to get is information about NATO equipment performance because of commercial sensitivities. We really need access to our opponents "SECRET" books! However, when dealing with highly classified material, data exchange can become a nightmare. Which bit of data on a 500MByte disc is classified? Does anyone know?When was it last updated and from which source? Configuration control of data is essential and requires dedicated staff.

e. RULES. Rules embody doctrine, strategy, tactics and standard operating procedures (SOPs). Acquiring "correct" rules is vital to the success of the game. Rules though,

especially once "hidden" in a computer, can have a perfidious effect on outcomes and their role should not be underestimated. Rules too need configuration control.

f. SCENARIOS. The development of credible scenarios is an art in itself. The scenarios must be consistent and "sensible" and they must be designed to meet and exercise the analysis or training problem.

g. WHO WILL MONITOR EFFECTIVENESS? Lastly, who is going to monitor the effectiveness and standards of the systems. If you are going to rely on the results of wargaming or trust the training of our commanders to these systems (including using them to assist the commanders in their decision making) then maybe you should know which systems you can trust and which you can't!

The final stage of the setting up procedure is the accreditation of the game. Who does this, and how it is done is not easy to solve. Issues of internal and external validation must be considered. Whether the game meets the objectives set is one issue. Just as importantly (and often ignored) is considering whether the objectives meet the requirements in the wider world. In wargaming, those wider world issues will literally mean the difference between life and death.

USING A GAME

18. Once a game is provided, using the game effectively (as has already been mentioned) involves further effort. How the game is to be used will affect decisions at this point.

a. THE ROLE OF THE STAFF. Whether the game is to be used for training or analysis, SDs, ie subject experts, are needed to interface with the users, be they students or analysts as follows:

(1) STUDENTS. SDs are obviously needed to interface between the game and the students, but how they do this is contentious. Many wargames are used as "exercise drivers" to stimulate interaction between opposing players. Here the wargame is merely an interface and the SDs act as umpires. In other situations the students "play" against the wargame and so its "behaviour" must be much more credible. The role of the SDs is now to act as the interface between the opponent (the computer) and the students. Note, however, that when evaluating the student's performance, the SDs will play a passive role by observing the group dynamics. In any case, unless the students need to get "hands-on" for a specific reason, there is little point in exposing them to the workings of the game and the full complexity of its results.

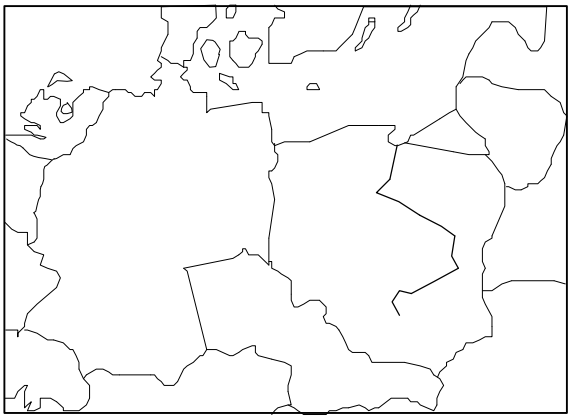
(2) ANALYSTS. SDs, ie subject experts, are also needed to co-operate with the analysts. Once a "question" has been posed, interpreting the question and the results produced is important. As an example, in an investigation of attacks on "strategic targets" the attacks were deemed to have little or no affect on the war at the "front". In fact, the attacks would probably have little effect other than to absorb air effort. The analyst concerned concluded that attacking strategic targets was of no value (as it did not directly affect the battle) and therefore obtaining aircraft for this role was not a priority. This conclusion was entirely an artefact of the criteria used which judged success or failure by FLOT (forward-line-of-own-troops) movement and force levels. Subject experts can point out the problems with such a conclusion and prevent misunderstandings.

Thus, in both the above cases, management of the results is one of the most vital tasks. Even more important is what conclusions are drawn from the games. Interpretation is a tricky business and needs to be done with care, as is deciding on the criteria by which "success" or "failure" is to be judged. Certainly, as Desert Storm experience showed, better military training of (UK) analysts is required, so that "analyst's judgement" becomes "military judgement".

b. THE GAMING ROOM. In Naval wargaming the "Tactical Floor" (or a variation thereof) is often used. This represents an appropriate way to present the "game world" to the students/analysts. Considering what is the "appropriate way" to present the data from your wargame is vital. At the Air Warfare Centre we use the "Operational Wall" approach (see Figure 1 below), where, as the scenario is theatre (operational) level, a system for summarising the mass of data from our game is required. The Operational wall does this well. An essential part of the wargaming experience is for the students to concentrate on theatre-wide issues (with which they are unfamiliar) and ignore detail (which would be handled by staff lower down the system).

<table>
<tr>
<td>Game control data

Blue Current Ops

Blue sorties/losses by aircraft by day</td>
<td colspan="2"> 
Error! Switch argument not specified.</td>
<td>OPFOR current Ops (Estimated)

OPFOR Sortie Generation Capability (Estimated)</td>
</tr>
<tr>
<td>Blue Air Orbat by aircraft mission type (eg CAS) by day</td>
<td>Blue Airbase Status and assigned squadrons</td>
<td>OPFOR Airbase Status (Estimated) and aircraft</td>
<td>OPFOR Air Orbat (Estimated)</td>
</tr>
</table>

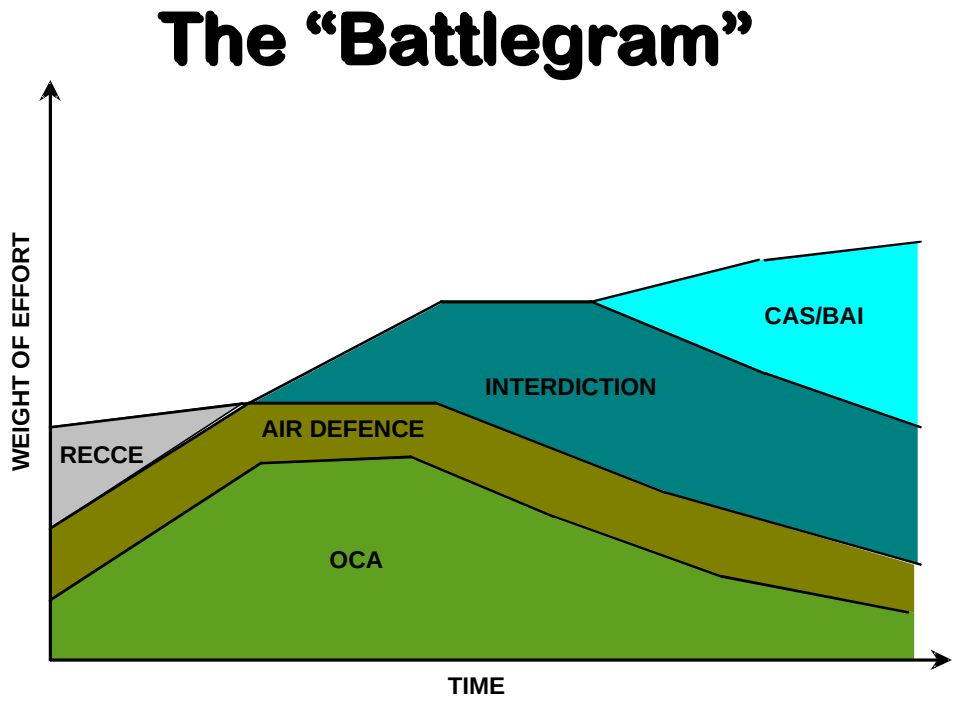
Figure 1 - Example "Operational Wall"

c. THE STAGES OF A GAME. Before a game starts good preparation is required. An appropriate scenario must be chosen and SDs briefed and trained in their roles. The SDs (umpires) are important in keeping the flow of information moving. The scope of the game in terms of geography, forces, command and control, team constitution and players must be decided. Also, the relationship of the game to real time (ie is the game historical) and the "clock speed" must be set. The playing strategy and game objectives must be clear too. How "success" or "failure" is to be assessed (if at all) must be considered. The stages of the game are then as follows:

(1) PLANNING PHASE. The players must put on paper **their** strategic goals, their estimate of the situation and their appreciation of how the wargame may unfold. I would suggest the construction of a campaign profile using a battlegram (see Figure 2 below) to assist with this process. They must also set objectives and/or criteria to be used to assess whether or not they are achieving their goals (measures of effectivesness[MOEs]). For example: a goal such as "achieving air superiority" may

be considered to be achieved when the enemy is no longer flying offensive sorties. This should be noted and the enemy's offensive sortie rate tracked.

(2) IMPLEMENTATION PHASE. In this phase the gamers have to apply and assess the progress of their plan, re-assessing and re-setting goals as necessary. It is crucial that the gamers "get inside" the enemy's "decision cycle" and take control. Learning to plan ahead and out-think the enemy's options is crucial to "success". This phase is essentially an iterative process and in wargaming occurs in the minds of the students, but in analysis has to be coded into some sort of analysis tool.



Error! Switch argument not specified.
Figure 2 - Example Battlegram

(3) THE DE-BRIEFING PHASE. The most decisive insights often occur during the de-briefing phase. The de-briefing (or results analysis) must be given adequate time and should be conducted skilfully by the SDs. The aim of this phase is to stand back and to detect the patterns of events and analyze the interplay of friendly and enemy decisions. This phase may well force gamers to drop "reality assumptions" or "received wisdom" which they have, up to this moment, held to be true. An open-minded approach must be encouraged.

TECHNOLOGY ISSUES

19. There are new technologies on the scene which may well impact on future wargaming such as:

a. NEURAL NETWORKS. Neural networks are excellent at recognizing patterns such as the "common features in a large number of alternative military options" mentioned by Gavin Lidderdale (4) in his March 92 Air Clues article. However, while such techniques would enhance the performance of wargames, they would not make wargames a panacea for all our decision and analysis problems. Their role could be to be trained to recognise (and "advise" on) trends which are indicators of likely enemy action or of friendly crisis.

b. SYNTHETIC ENVIRONMENTS. The phrase "synthetic environments" has been coined to refer to systems of simulations and models connected across a network. Currently, only models at agreed levels of resolution can be connected, but once Tools For Aggregation and Dissaggregation (TFADS) are developed the potential is for high-level games to automatically draw their data from lower-level simulations or to be used to "drive" a confederation of lower-level models.

c. AGGREGATE LEVEL SIMULATION PROTOCOL. A notable gaming organization is the Warrior Preparation Centre near Ramstein in Germany (5). This US facility uses a "confederation" of games (each of which is stand-alone) connected together by the Aggregate Level Simulation Protocol (ALSP). ALSP gets round the problem of having to produce monolithic models which do everything for every one and instead allows a network of models to communicate. The models can be added/removed as required depending on the situation and so this mix-and-match approach gives flexibility. Consequently, the software maintenance task is smaller. ALSP allows models to exchange information about the entities they control, with other models entities appearing as "ghosts" in the "host" model. The protocol has to consider who has control over entities. To achieve this, each model has to have a bespoke "translator" which interfaces between it and the rest of the network. There is also a generic ALSP common module which passes the data out onto the net for consideration by other models and a generic ALSP broadcast emulator which manages network traffic, especially between "clusters" of models at a site. However, any new game has to conform to the existing ALSP protocol if it is to be allowed to join the"club".

d. VIRTUAL INTERFACES. A full discussion of virtual reality and its possible impact on wargaming is beyond the scope of this paper. However, it is worth noting my comments in para 14b above about providing "appropriate" data interfaces for students. Virtual interfaces for simulators? Yes. For wargames? Probably not, but as the tools and methods for data fusion inprove it may be possible to allow the Commander a "gods-eye" view of the battlefield via a virtual interface.

e. SCENARIO COMPILERS. As has been mentioned, database "population" and maintenance is a considerable task. Moves to develop "scenario compilers" are underway. A scenario compiler collects and integrates data in the same way that a software compiler does. Across networks, a generic database formatting language is used to issue requests for information. Included in the request is information about how the data is to be formatted. This process needs the services of "agents" (see below) and would allow games to "self populate" and keep up to date.

f. "AGENTS". "Agents" are similar to Unix "Daemons" (and also to "viruses") in that they are self-sustaining pieces of software which can be used to "hunt" for information. They could use some of the "a-life" (6, 7 & 8) methods to maintain their identity in the network. Agents could "work" for scenario compilers, asynchronously acquiring data and formatting it as required.

THE FUTURE OF WARGAMING

20. The future of wargaming seems assured. Even though the basic wargaming activity is likely to change little, I expect to see wargaming used in more diverse areas as follows:

a. FROM TRAINING MODE TO ACTION MODE. Over recent years "embedded training" systems have been developed which allow a piece of equipment to "toggle" between training mode and real use mode. In future, we may see wargames used in the same way, with pre-prepared likely scenarios being used to study possible conflicts and then switched into reality mode to act as the basis for decision making in crisis.

b. AS AN EXPERIENCE GATHERER. The developments in technology mentioned above in para 15 may allow wargames to accumulate "experience" which can be used to help predict outcomes. In any case, such "learning" would allow the games to suggest alternative courses of actions to students based on the game's "experience" of previous failed or weak strategies.

c. AS AN ADVISOR. Currently, decision makers may use wargames to assist their staffs with planning options, but it is possible to foresee a time when wargames have acquired enough "experience" to directly advise the decision makers on their courses of action. How such a tool would be "accountable" is an interesting point.

SUMMARY

21. Much money and time is spent using wargaming and analysis tools. However, the range available is vast, with little or no standardisation. As our use of wargaming increases, certainly within the RAF, there are considerable time and financial savings to be made if wargaming is effectively used and if wargaming professional's advice, training and support is co-ordinated and preferably centralised. The future uses of wargames in the military are still wide open. The recent establishment of the UK Defence Wargaming Policy Working Group (which aims to set standards and provide guidance on the selection, suitability and use of wargames tri-service) will help remove some of the uncertainty about the future of wargaming in the UK. However, it will be interesting to see how the other problems associated with wargaming will be tackled.

22. Certainly our requirement for wargaming in the future is likely to increase, not decrease, as cost constraints on "live" exercises and trials continue. Nevertheless, the justification of wargaming on the grounds of cost savings or increased efficiency raises the spectre of how effectiveness is calculated. Funding for analysis has been extensive, but for training has been small by comparison. Its interesting to ask why. Finally, whatever task it is that you have in mind for wargaming, before you start, be aware of the mistakes made by others (and avoid them) and of the lessons learned (and consider them). As a last point, remember that:

"The analysis of outcomes is just the beginning of wisdom, not the end product" (9).

REFERENCES

1. The Pentagon. *Catalog of Wargaming and Military Simulation Models.* 11th Edition. Defense Technical Information Center, Alexandria, Virginia.

2. Alan J. Burton. *Computer Simulation (Some considerations on the relevance and the applicability of military modelling techniques)*. MSc Thesis, Edinburgh University, 1992. Also

published by the RAF under the title: *Military Wargaming (An investigation into the Applicability and Validity of the Military use of Computer-assisted Wargames).* 1992.

3. Gavin Lidderdale. *The Analysis of Operation Granby.* Air Clues, Vol 46, N^{o} 3, March 1992. UK MOD DT(F) RAF.

4. Alan J. Burton. *The Computer Wargame - Tool or Toy?* Air Clues, Vol 46, N^{o} 4, April 1992.

5. Warrior Preparation Centre. *Computer-assisted Exercises and the Warrior Preparation Centre.* WPC, June 1991.

6. All TFADs, Agents, Neural Net and A-life research courtesy of TBT, Fulbeck, England, 1993-4, patrick@patb-tbt.demon.co.uk

7. Rodney A Brooks, "A Robust Layered Control System for Mobile Robots", IEEE Journal of Robotics and Automation, March 1986, p14-23.

8. Luc Steels, "Cooperation Between Distributed Agents Through Self-Organization", University of Brussels, AI Memo 89-5, June 1989.

9. Peter P. Perla. *The Art of Wargaming.* Naval Institute Press 1990, Airlife Publishing Ltd.

10. *Various.* Simulation and Gaming Journal, University of Lille, France.

11. Peter J. McCarry. *This is not a Game (Wargaming for the Royal Australian Airforce).* RAAF Air Power Studies Centre, 1991.

12. Daniel B. Fox. *A Conceptual Design for a Model to meet the Wargaming needs of the United States Air Force.* Report N^{o}: AU-ARI-84-8. Air University Press, Maxwell Air Force Base, Alabama, USA. July 1985.

13. Thomas A. Cardwell. *Wizard Warriors of Desert Storm.* Military Review, Vol LVXXII, September 1992, N^{o} 9. Published by US Army Fort Levenworth.

14. John L. Krueger. *Pitfalls in Combat Simulations.* Military Review, Vol LVXXII, September 1992, N^{o} 9. Published by US Army Fort Levenworth.