

AUTOMATED WAR GAMING FOR ENHANCING FLEET READINESS

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ABSTRACT

War Gaming at all levels has received increased attention as a result of DOD's emphasis on decreasing the use of fuel and travel. The Naval Warfare Gaming System is a sophisticated, flexible tool which provides a realistic decision-making environment for naval officers. The system provides multiple levels of models, automated doctrine control, and user-oriented features to support the four standard gaming phases: design, preparation, play, and analysis.

1. INTRODUCTION

The Dictionary of the U.S. Military Terms for Joint Usage defines a war game as "a simulation, by whatever means, of a military operation involving two or more opposing forces, conducted, using rules, data, and procedures designed to depict an actual or assumed real-life situation" (The Dictionary of United States Military Terms for Joint Usage 1964).

The purpose of such games can be educational, to provide the players with decision-making experiences, or analytical, conducted to obtain information and understand relationships that will help the responsible commander make decisions in the future.

War games have been played, in one form or another, since ancient times. For example, a form of chess was played in Iraq as early as 3000 B.C. War games have grown in complexity and in their attempt to mirror or simulate real-life situations.

In 1867, William McCarty Little, a retired Navy lieutenant who was living in Newport, RI delivered a series of six lectures on war gaming at the Naval War College. This series of lectures appears to have aroused the interest of the college in war gaming and led to the inclusion of war gaming as part of the college curriculum (Fundamentals of War Gaming 1966). Presently, war gaming is supported by the Center for War Gaming at the Naval War College and is used in various forms throughout the Navy as an educational aid and to provide insight into overall naval operations.

Manual, board-oriented war games provide an important part of the Navy's war gaming inventory. An example is the war game NAVTAG that is played on a chart representing the area of operations, with small ship models representing the participants in the battle being gamed. The rules of the game and the results of various tactical operations are expressed in a complex set of tables showing the results of engagement primarily in terms of the range of the various participants. A certain number of simulated environmental conditions are provided.

NAVTAG is played by two sides with an umpire. Each side may have multiple players and, because of the numerous calculations required during the game, multiple players are a considerable advantage. The difficulty with most manual board games is that more time is spent in calculation than for tactical decision-making, the objective of the game.

In order to enhance the value of such small tactical games, the Navy is presently automating NAVTAG as a micro-computerized tactical game. The motion calculations and table look ups which presently must be performed by the players or the umpire will be performed on a micro-computer and presented by means of CRT displays to the players. This will speed up the rate of play of the game considerably.

Although the manually-oriented games described above perform a useful educational function on-board ship and also serve to fill in available time with a learning experience, the complexities of modern warfare demand a system which provides multiple simulation models and multiple games,

each of which is considerably different from the others. Therefore, the personnel who prepare these games must have at their disposal a wide range of modeling capability and the facilities to introduce into the game all aspects of modern warfare. Such a system is presently being developed for installation at the Naval War College in Newport, R.I. The system is called the Naval Warfare Gaming System (NWGS).

2. WAR GAMING AND THE MISSION OF THE NAVAL WAR COLLEGE

The mission of the U.S. Naval War College is two-fold. The primary mission is to enhance professional development in management and command capability. The secondary mission is to conduct research into advanced strategic and tactical concepts. Both of these aspects of the War College mission will be supported by the Naval Warfare Gaming System. War gaming provides the officers at the War College a capability to extend the college's curriculum and further the decision-making experiences. Using the system, students at the War College can play war games as part of their course work and participate in game playing during off-hours by playing against the system or with other students as opponents.

In addition to the students at the War College, officers from the fleet can use NWGS on a scheduled basis for large-scale command games at the theatre or battle-group level. These games are conducted and prepared with the aid of War College personnel and provide an operational decision-making environment.

Research can be performed based on the system's extensive postgame analysis capability. This capability allows the user to replay games multiple times and investigate the different lines of operation that a game can take. Replay allows the user to observe the procedures used during a specific game and provides an extensive reporting capability based on reports preprogrammed into the system as well as reports provided on request after a game is played.

3. SYSTEM REQUIREMENTS

Various attributes of the war gaming environment at the Naval War College figured heavily in the specification of requirements for the war gaming system. Three critical parameters were identified: the system had to be reliable, provide flexibility, and meet a relatively short development schedule. Each of these requirements has been an important factor in the system design that led to the specification of the system.

The requirement for reliability and overall system availability stems from the game scheduling requirement at the Naval War College. Multiple users are scheduled to take part in large-scale command games, which frequently require over 100 participants. These war gaming participants are senior officers, varying from Commander through Vice Admiral. Naturally, the War College wants to keep the system on the air and continue games on schedule to avoid waste of personnel time caused

by system downtime. The need for flexibility stems from the varying requirements among the many games. Not only are various types of games played -- for example, command-level games, student one-on-one games, and student computer-opposed games -- but games of the same type change each time they are played. Changes in the game elements may be made in the platforms, command structures, rules of engagement, doctrine requirements, and so on. To provide the required flexibility, a war gaming utility was developed. This utility enables the War College to prepare games with different parameters without reprogramming the application software that supports each game, to change system parameters in the application software during the play of the game, and to replay and rerun previously played games.

The scheduling constraints ruled out the design and development of special computer hardware and precluded the inline development of specific system software. It was decided that the fastest development approach with the least risk and greatest up-front reliability would be provided by using existing, off-the-shelf commercial hardware and system software; this approach formed the basis for the system design. The primary mechanism by which this gaming flexibility is provided is the software architecture, which permits multiple levels of modeling detail to be used during different games, or even in a single game, and provides automated doctrinal control and computer-aided game preparation and analysis without reprogramming.

4. THE WAR COLLEGE

The environment for Navy war games, as shown in Fig. 1, is in the Sims Hall complex at the Naval War College. The Sims Hall facility includes three primary areas: the computer center, the game coordinator's area, and the command center.

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4.2 Computer Room

The computer room is located adjacent to the coordinator's area. It contains the large central processing units, mass storage devices, high speed printers, and two system control consoles.

4.3 Command Center

There are 22 command centers available for game players. Each command center (shown in Fig. 2) is equipped with an NWGS interactive console station, a teletype unit, voice communication equipment, and various maps and charts. The rooms are

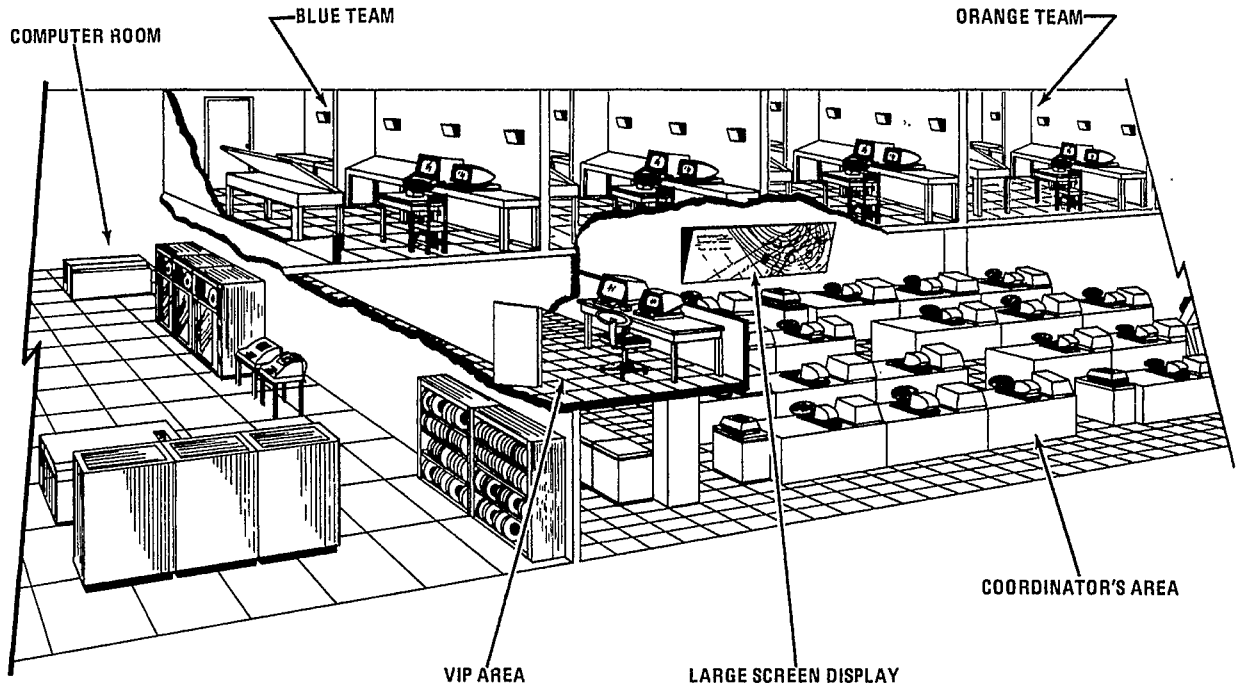


Figure 1. Naval War College Configuration

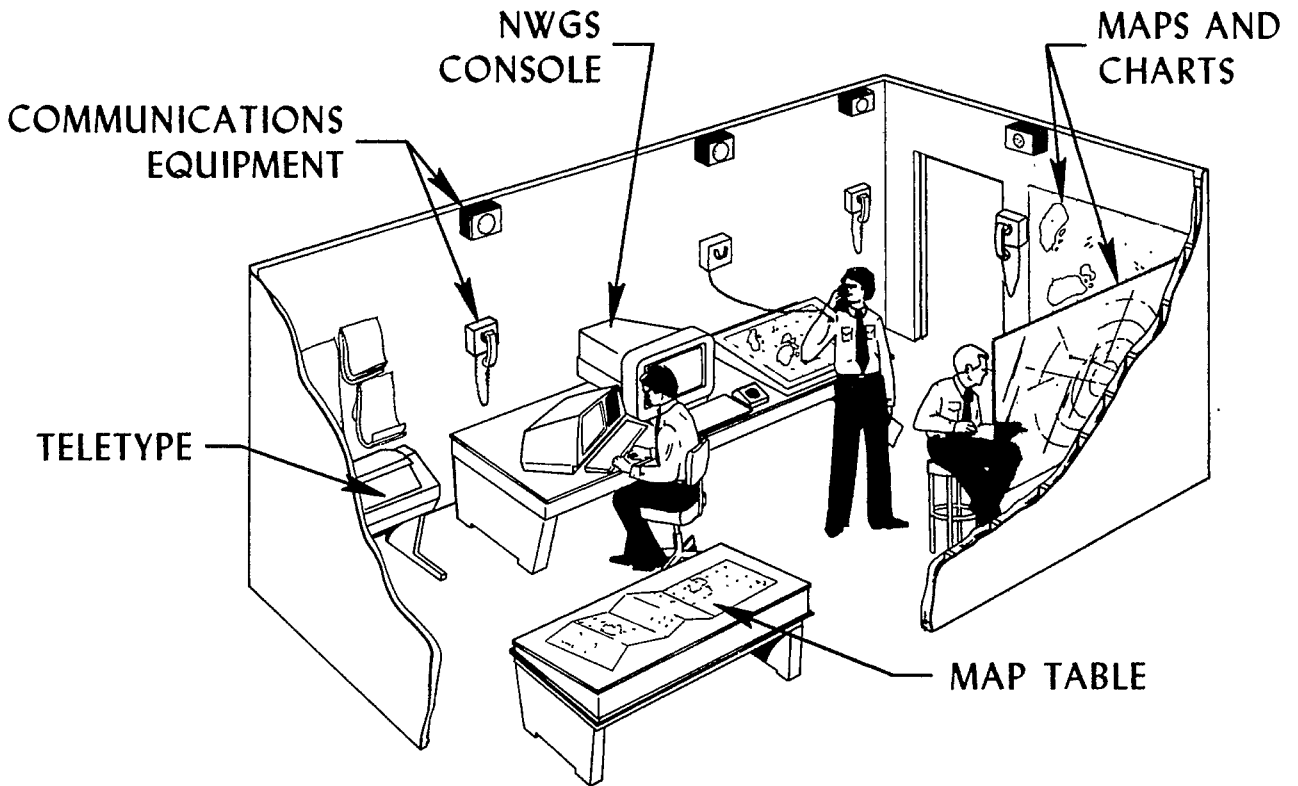


Figure 2. Typical Command Center

designed to provide an environment similar to a shipboard command center. Players use the command center consoles to monitor and control the status of their assigned forces and to monitor the enemy and neutral forces that they have detected. The console provides communication with the computer system and allows the player/participant to observe the results of operations as they are conducted.

5. INTERACTIVE CONSOLE STATION

All interaction between NWGS users and the system takes place at the NWGS interactive console stations. The NWGS console equipment is shown in Fig. 3. Each console station has an alphanumeric display, a graphic display with a trackball unit, and a connection to a shared hardcopy unit. The units are physically arranged to permit maximum visibility of both displays and to enable a single operator to easily access both keyboards and the trackball unit. In addition, both units can be moved within the limits of their cable lengths to adjust their relative positions to suit various operational requirements.

6. NWGS MODELING CAPABILITIES

A primary advantage of automated war gaming is the capability to simulate activities that occur in real-world situations. With stimuli similar to those expected in actual confrontations, the player continually monitors activity, makes decisions on the basis of the stimuli, and enters all decisions into the computer. The computer model controls the simulated activity through complex mathematical routines, making modifications as determined by user inputs.

An important feature of NWGS is the capability for the user to specify the level of model to be used to meet game objectives within the constraints of the computer resources available. Different levels of detail can be used in different games or for different entities within the same game. Fig. 4 shows the NWGS simulation models.

A detailed model uses more parameters and more complex computational routines than a generalized model and provides more precise simulation. For example, the most detailed kinematics model takes into account acceleration, deceleration, turning,

- EACH CONSOLE STATION INCLUDES AN ALPHANUMERIC DISPLAY, A FOUR-COLOR GRAPHIC DISPLAY AND A TRACKBALL
 - HARDCOPY UNITS PROVIDE COPIES OF BOTH ALPHANUMERIC AND GRAPHIC DISPLAYS ON REQUEST
 - EACH HARDCOPY UNIT CAN SERVE SEVERAL CONSOLE STATIONS

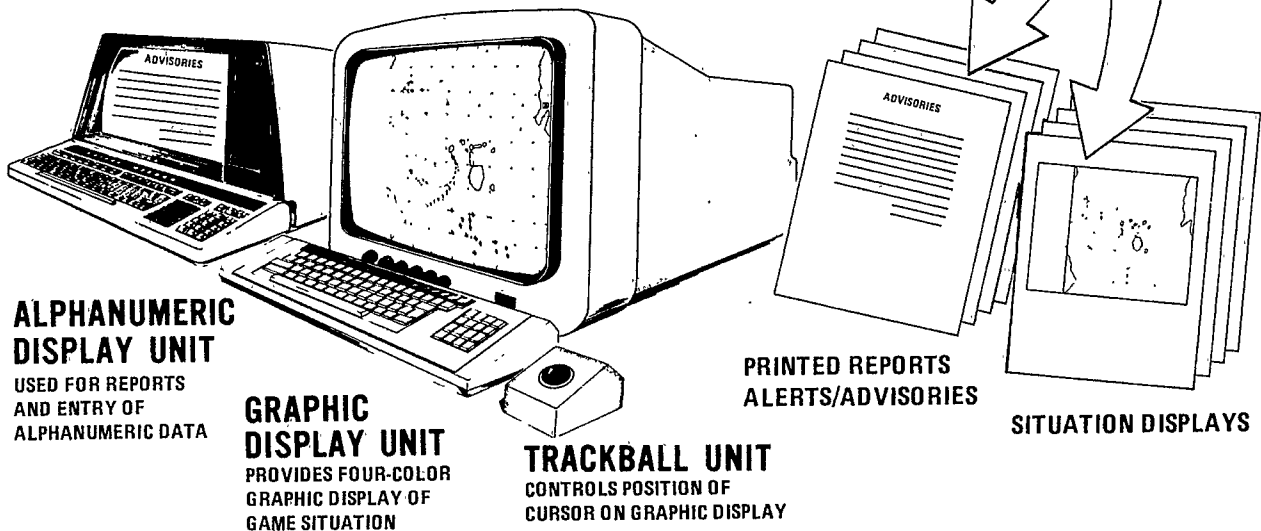


Figure 3. NWGS Console Equipment

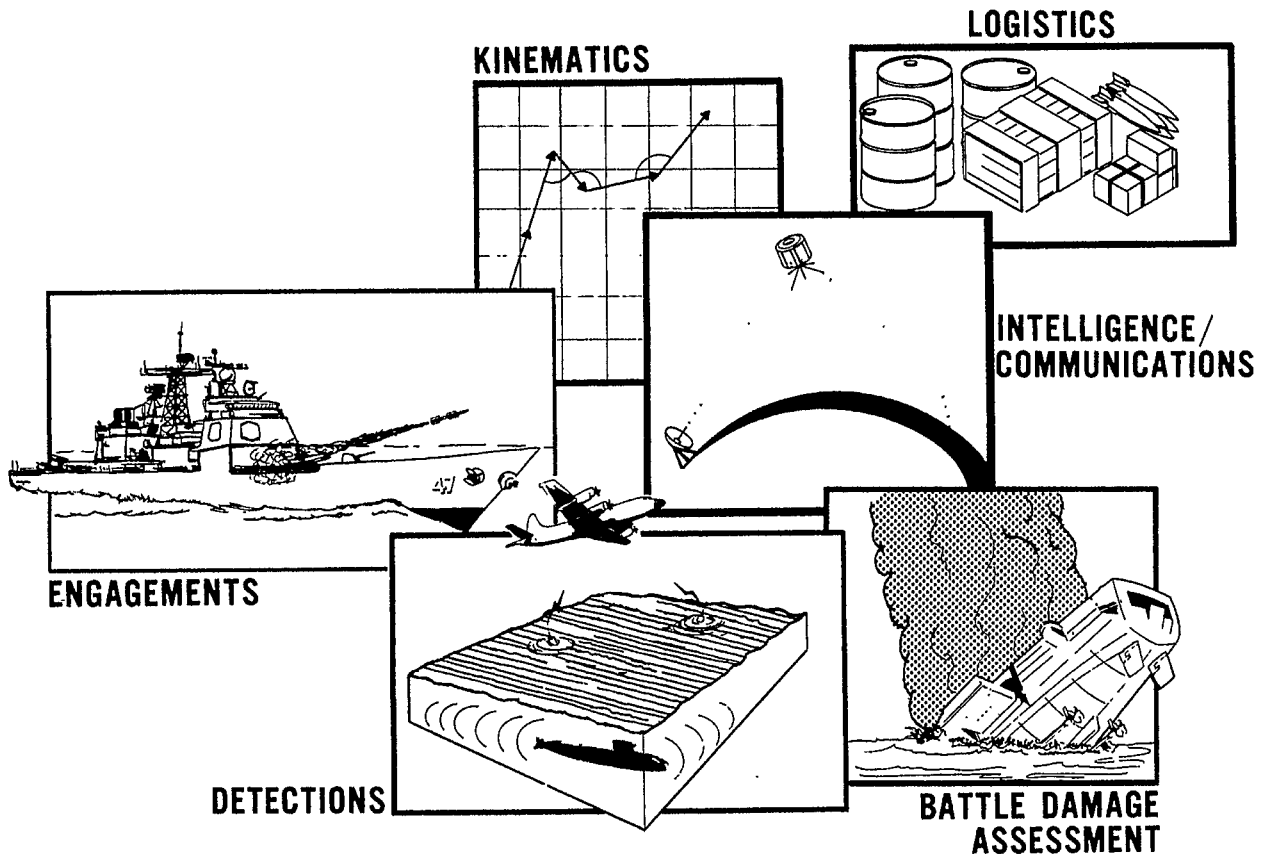


Figure 4. NWGS Simulation Models

and climb and dive rates in modeling aircraft motion, while the less detailed model simply immediately performs the requested kinematics change. The game preparator can select the degree of detail required for a specific game or for a particular event within that game on the basis of importance to the game objectives.

7. DOCTRINAL CONTROL OF FORCES

The NWGS Doctrinal Control of Forces feature enables a player to handle large-scale games and still concentrate on the overall situation and on decision making. It is described in Fig. 5. The doctrine is represented by a series of individual commands linked together to evoke a series of individual actions. Selecting and assigning the appropriate doctrine frees the player from having to enter numerous individual tactical commands, becoming immersed in detail, and losing the broad picture.

NWGS is capable of supporting a wide range of military tactics and doctrine within the naval warfare areas. Players can plan and implement specific tactical maneuvers for all platforms under their control with the commands provided in the NWGS user language. In games where players are controlling a small number of platforms, the player may wish to maintain close control of his forces by entering all commands directly. However, in games where players control a large num-

ber of platforms, the players will usually select and assign appropriate doctrine.

Doctrine representation generally contains one or more conditional commands that are evoked when a specified condition is met. Stimuli that can trigger a conditional command or doctrine might be detection of a hostile force within a specified range, a change in the rules of engagement, or a predefined logistics level for a given platform. The game preparator enters doctrine to be used in a particular game into the play file. He can combine standard naval doctrine with some game-specific doctrine that he has defined to meet game objectives. The game-specific doctrine can be new or a modification of doctrine used in other games. The game director or coordinator can also modify or create new doctrine during the game to meet unusual requirements that arise.

8. NWGS GAMING

The games that NWGS supports vary in scope and complexity according to the game objectives. Command games played at theater, battle group, or lower level of tactical combination are the most extensive in scope and duration and are often used for exercising real-world operational plans. Student games are played to support the curriculum of the War College and can vary from one on-one games, either free or computer opposed, to task-

- DOCTRINE PROVIDES FOR CONTROL OF FORCES NOT UNDER DIRECT CONTROL OF PLAYERS

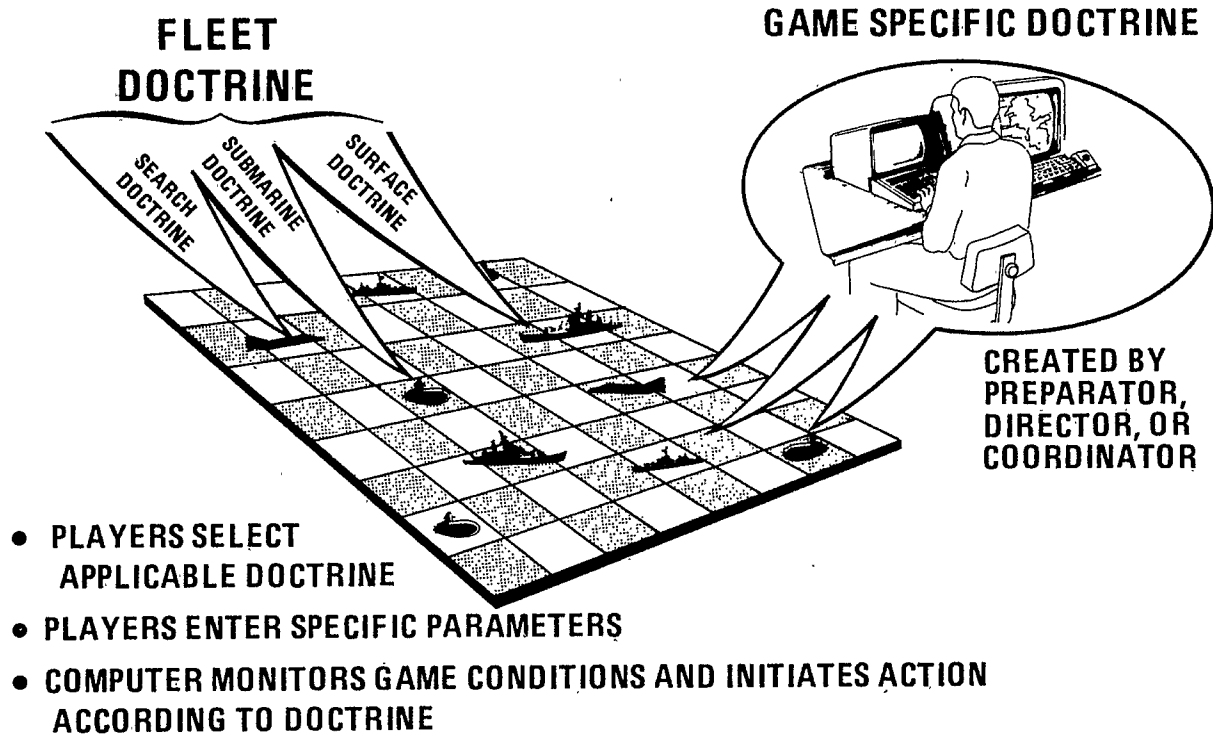


Figure 5. Doctrinal Control of Forces

force level games in which the student takes the role of a task force commander and the system plays the role of his subordinates.

The game play phase of NWGS is supported by pre-game phases -- design and preparation -- and a post-game analysis phase. The following paragraphs highlight the NWGS operational phases, the interaction of which is supported by the concept of a gaming utility, shown in Fig. 6.

9. GAME DESIGN

The game design phase entails development of a detailed game specification. The inputs of the design phase are obtained from the game sponsor and incorporated into the game design. (See Fig. 7.) The NWGS application utility program (AUP) provides support tools to aid the designer in translating the sponsor's requirements into a game-oriented specification. AUP permits the designer to scan the master data base file and incorporate data from prior game design files. The outputs of the game design are (1) a design file which can be saved on the machine and (2) a printed game specification. The sponsor reviews the printed game specification, which can be revised easily by using the system's AUP update capability. The game specification is the primary input to the preparation phase.

10. GAME PREPARATION

Game preparation is a process that molds the game design specification requirements into a computerized play file. The play file includes data on all platforms, weapons, sensors, command organization, formations, and movement plans to be employed in the game.

A game preparator, working at an interactive console station and using a specific set of user-oriented commands and menus, creates the play file. Fig. 8 illustrates game preparation. The game specification may require the creation of an entirely new play file or revision of a previously prepared play file. The preparator's commands permit retrieving NWGS master file data and data from previous games for use in constructing the play file. In addition to this capability to transfer and incorporate, the preparator can modify data before entering it in the new play file and thus tailor the characteristics of platforms, weapons, and sensors to meet the requirements of a specific game.

In constructing a play file, the preparator uses a hierarchy of selection and fill-in menus. These menus guide the preparator through the file creation process, in the entry of new data, and in the retrieval of existing data.

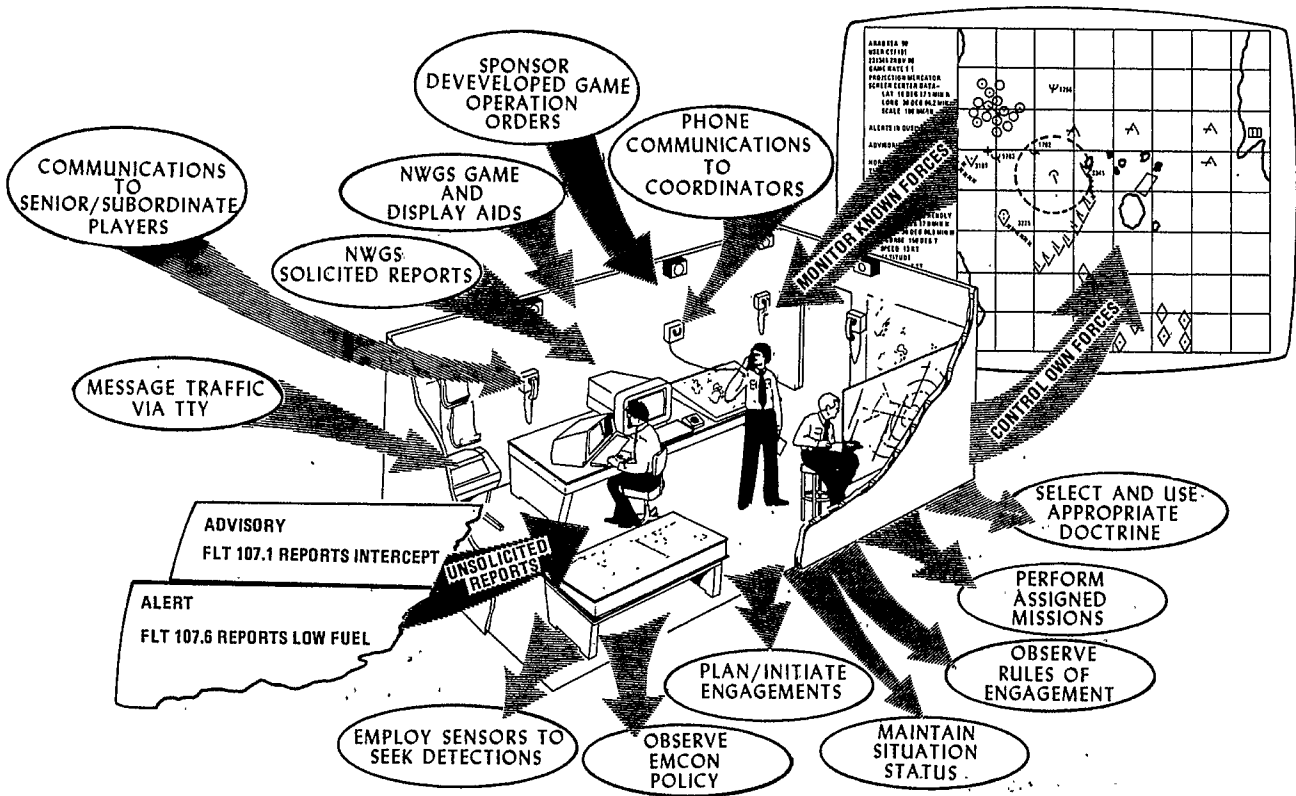


Figure 6. Player Interaction

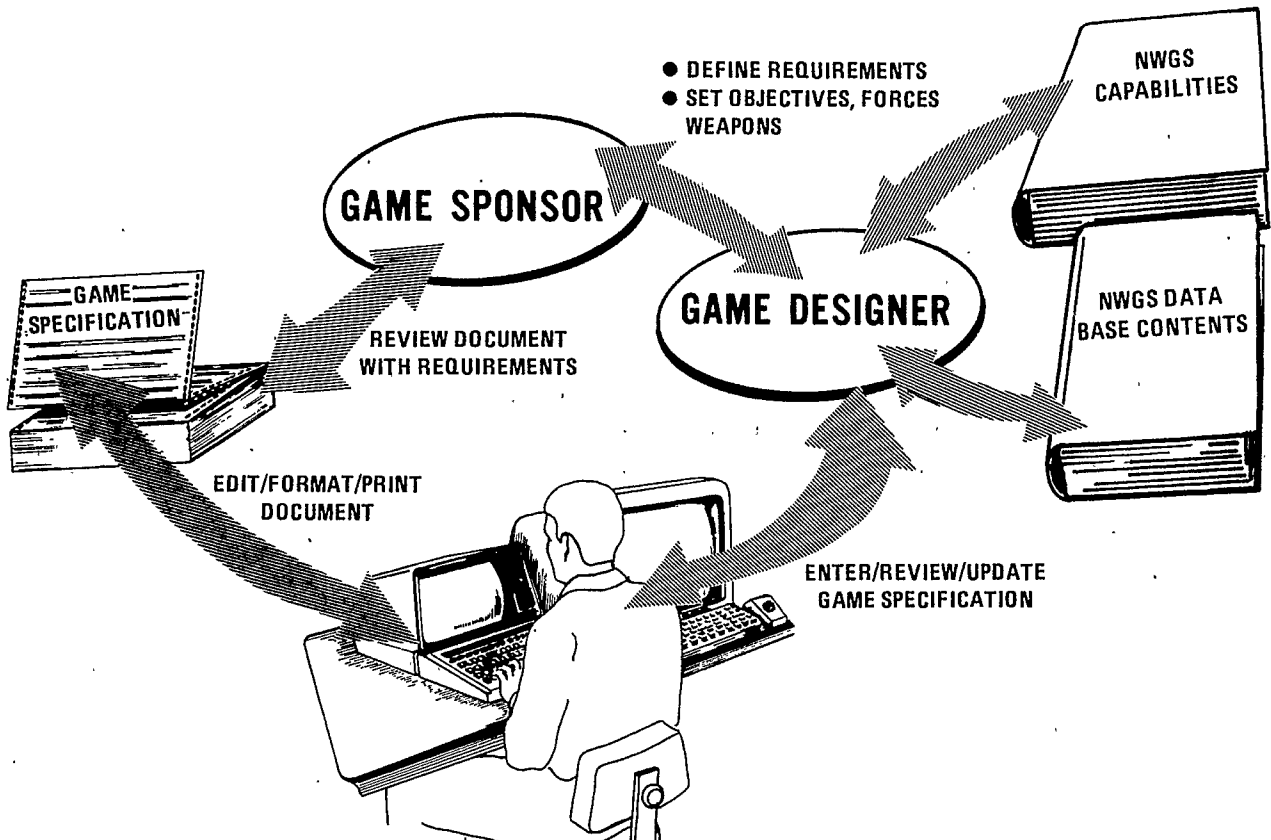


Figure 7. Game Design

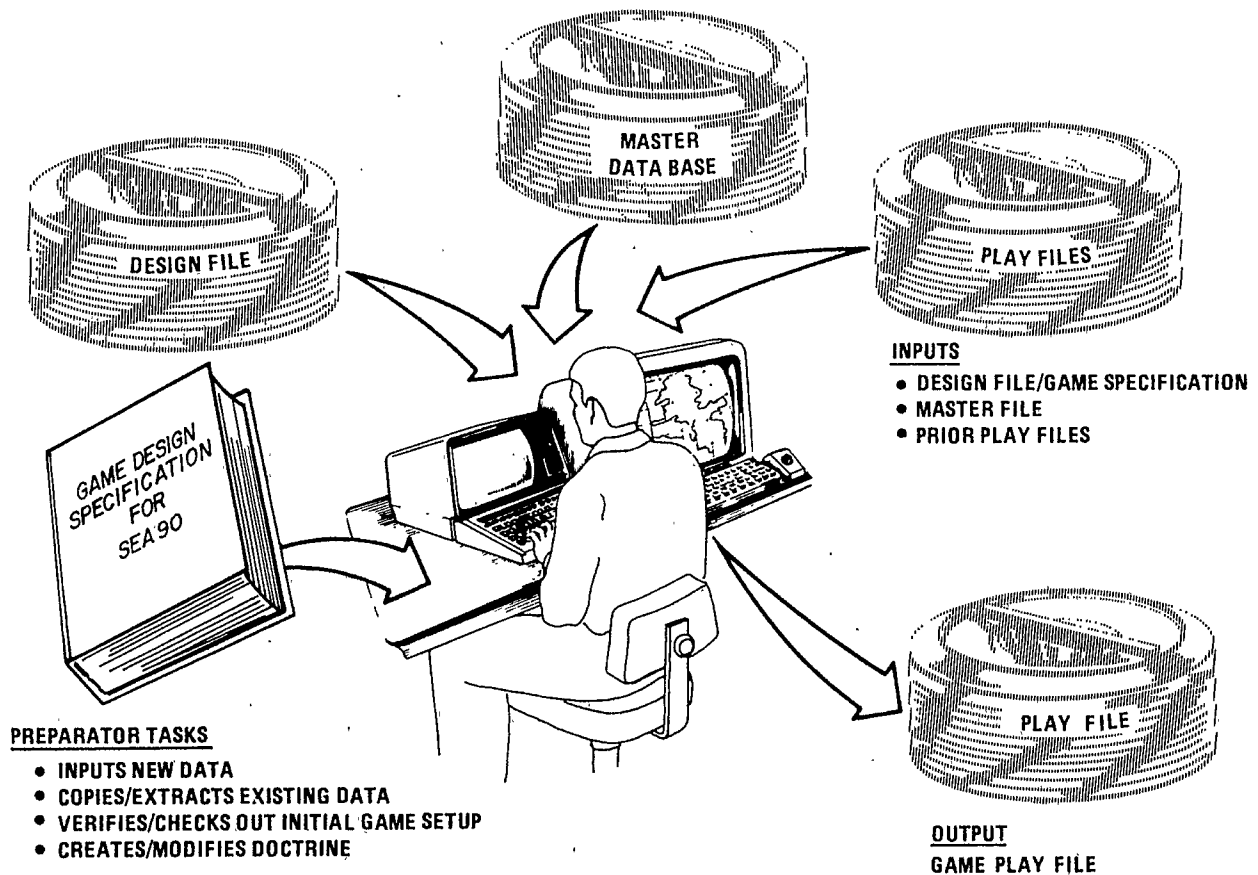


Figure 8. Game Preparation

11. GAME PLAY

The game play phase is initialized by loading a play file into the system. The NWGS command and student gaming system performs three primary functions: (1) conducting the simulations, (2) providing information, and (3) processing user requests. During game play, participants continually interact with the system, performing the functions appropriate to their position in the command structure. The original game data is updated continually on the basis of user inputs and game events. As the game progresses, data is recorded in the history file. The system master data base is offline during play and cannot be inadvertently modified by any user entries.

12. POSTGAME ANALYSIS

An important feature for war gaming is the NWGS postgame analysis capability. System reports, game reruns, and game replay allow game participants to evaluate decisions made during the game by:

1. Examining results on a hardcopy printout
2. Observing a game segment from any point to the end
3. Entering alternative strategic and tactical decisions to alter the game results.

Fig. 9 illustrates the postgame report functions. The postgame activities enhance the game participants' decision-making ability, allowing more comprehensive self-evaluation of original decisions and the opportunity to modify those decisions and re-examine results. Each postgame analysis option supports game evaluation in a unique manner.

13. REPORT GENERATION

Reports enhance the detailed evaluation of war games by producing hardcopies of the game events and the results of strategies and tactics used during game play. Through report generation, the analyst receives a chronological listing of events related to a game activity or a summary report with totals, statistics, or percentages.

14. RERUN

This feature enables the user to review the entire original game or any particular segment of it. During rerun, the player has access to the total picture, his own actions as well as those of other players. To produce a game rerun, the system processes data that was recorded in the game history file and repeats all the events (interactions and outputs) just as they occurred during game play (see Fig. 10). The clock rate and the display outputs can be changed during the rerun process at the request of the analyst.

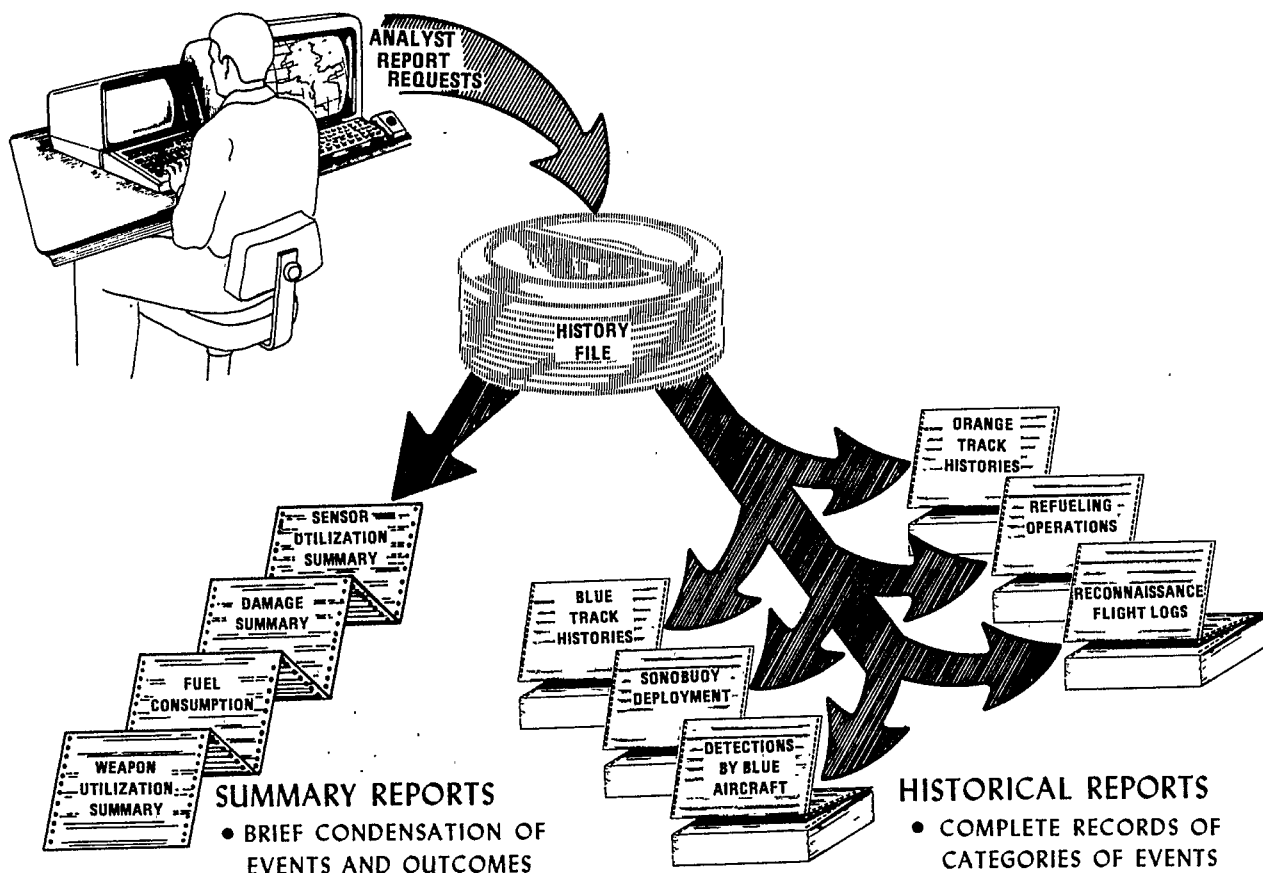


Figure 9. Postgame Reports

15. REPLAY

NWGS replay provides a facility for investigating the effects of alternative decisions at some point during game play. The game player, coordinator, or director selects the particular time for restart and resets system conditions to exactly as they were at a specific point in the original game. The game can then be replayed as a new game from that point. The system creates a new history file from the point of restart.

16. SUMMARY

The Naval Warfare Gaming System supports the development and enhancement of fleet readiness by providing a controllable decision-making environment for fleet officers. Both command and student games range from one-on-one platform conflicts to global, multiple-task-force engagements. NWGS simulates existing platforms and weapons and accommodates future advances. NWGS is designed for the military user and puts no language barrier between computer and participant. The well-defined four-phase operation leads participants from the design of specific games through analysis of tactical decisions.

The current NWGS includes 44 consoles and redundant data processing equipment. The use of stan-

dard components and off-the-shelf commercial hardware and software facilitates system expansion or reduction according to user needs.

NWGS is expandable in terms of consoles, computing power, memory, and remote capabilities. Without software changes, the system is expandable to four times the processing power and more than ten times the virtual memory capacity provided. Up to 128 consoles can be used. Smaller consoles, fewer game entities, and less detailed models can be mixed and matched for decreased computer power requirements.

System usefulness can be enhanced considerably by eliminating the need for game participants to travel to a central location. Since specific gaming functions are not dedicated to particular consoles but are dynamically allocated in accordance with pass-words and log-on procedures, console location does not affect system operation. The full spectrum of game playing capabilities as well as support for the design, preparation, and analysis phases can be provided from remote locations.

Full security is provided during remote operations by encrypted communications processed in an NWGS secure environment. The remotely-located user can communicate either through the standard NWGS communications lines with the inherent high-speed response time, or via standard telephone lines.

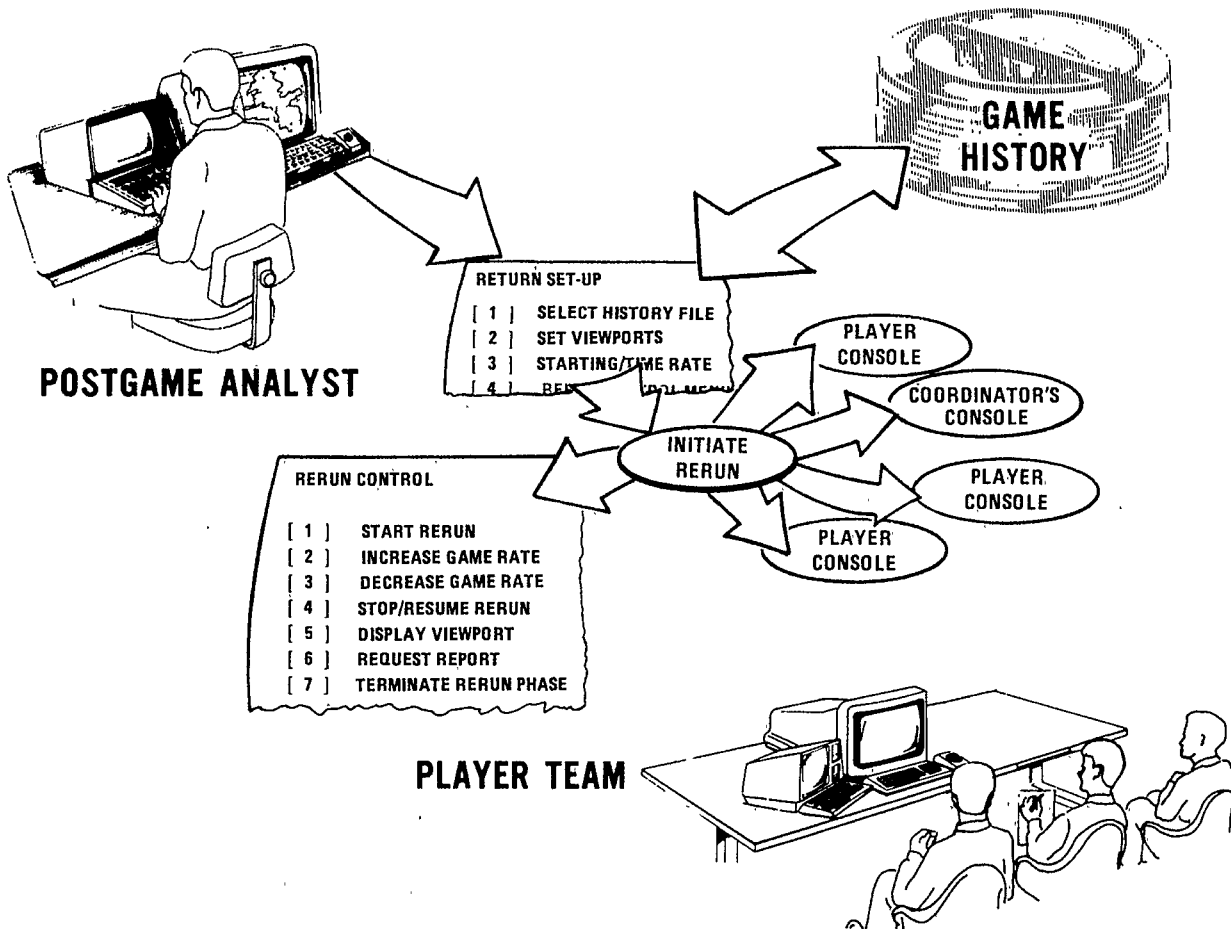


Figure 10. Game Rerun

REFERENCES

The Dictionary of United States Military Terms for Joint Usage (1964), 1 December.

Fundamentals of War Gaming (1966), Defense Documentation Center, Cameron Station, Alexandria, VA, p 2-1.

Birns, M.L. (1980), NWGS, Conflict Without Crisis, Proceedings 1980 Summer Computer Simulation Conference, August.