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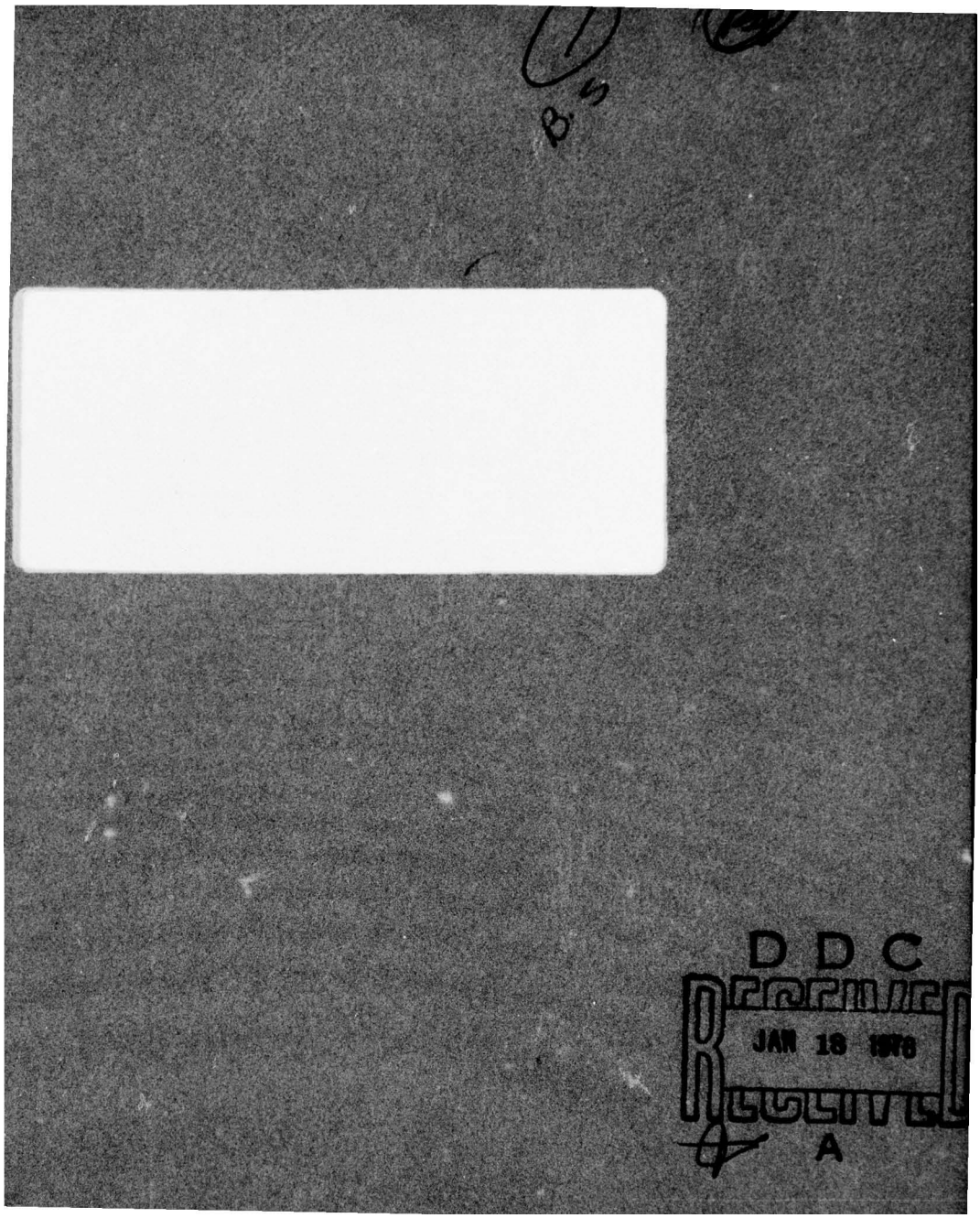

DEVELOPMENT CONCEPTS FOR THE NAVY WARFARE GAMING SYSTEM

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This report contains a series of ten monographs that summarize analyses conducted to support planning and concept development for the new generation Navy Warfare Gaming System (NWGS) to be developed at the Naval War College. Topics covered include: an analysis of the structure and applications of computer-assisted war games; an overview of the NWGS and other Navy war games and simulations; analyses of general development concepts for the NWGS; and analyses of issues to be considered in developing remote extensions of the NWGS.

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FOREWORD

This document constitutes the final report of analyses conducted by Ketron, Inc. to support planning and concept development for the new-generation Navy Warfare Gaming System (NWGS) to be developed at the Naval War College. For ease of reference, the material is presented as a series of monographs, each of which deals with a particular issue or concept. In some cases, the monograph format segments material that was originally contained in Ketron Report, KTR #22-76, "External Architecture for the Navy Warfare Gaming System," which dealt exclusively with the question of extending NWGS capabilities to remote users; it is felt, however, that the topical flavor achieved thereby will appeal to a wider audience.

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INTRODUCTION AND OVERVIEW

The Naval War College (NWC) plans to develop by the early 1980's a modern, digital Navy Warfare Gaming System (NWGS), which will provide the capacity, flexibility, and level of detail needed to support the full range of Navy applications of wargaming. To support planning and concept development for this system, Ketron, Inc. was engaged by the Office of Naval Research to examine several issues concerning design of the system, and, in a related effort, to organize a Navy Gaming Workshop to serve as a forum for examination and discussion of broader issues in developing war games and applying them to best effect.

This report summarizes the results of these efforts by presenting a series of monographs on the various NWGS development issues and concepts developed, often utilizing the ideas evolved in the Navy Gaming Workshop. The report is divided into three sections:

- Section I. Background. The three monographs in this section set the stage for the others by: examining computer-assisted war games and their applications; summarizing the broad plan for the NWGS; and describing the question of their management.
- Section II. General Design and Development Concepts. In this section are presented three monographs on specific questions and applications that might be profitably considered in evolving the design of the NWGS. Specifically:

  - "Expanded Usership" examines the question of security of information management in the NWGS from the viewpoint of possibilities that have not yet been explicitly considered, such as: use of SI*-like information, foreign participation in war games, and extra-Navy use of the NWGS, which may create needs for ensuring the privacy of information on Navy sub-systems.
  - "Perception of Situation and Objectives" examines the implications of psychological factors that tend to be overlooked in considering how computer-assisted war games are exercised and applied, and suggests thereby

*Special Intelligence

ways that the NWGS may be made even more useful.

- "Command Post Gaming" examines the NWGS in the context of emerging new developments in the Navy command and control arena and suggests a design concept that would enhance both the NWGS and the exercise capabilities of the Navy Command and Control System.

- Section III. Remote Extensions of the NWGS. Finally, in this section are presented four monographs on questions of possible extensions of the NWGS via remote interfaces. The first, "Feasibility and Consequences of Connecting the NWGS to Another Simulation Facility," examines the possibility of using existent facilities and programs outside of the Naval War College to support the NWGS and shows by analysis of an example that there would be much effort and little merit in trying to use other systems in this way. The other three examine, in turn, the probable demand, costs, and possible configurations for extensions of the NWGS in the opposite direction, i.e., by providing remote accesses to users outside of the Naval War College.

COMPUTER-ASSISTED WAR GAMES: STRUCTURE AND APPLICATIONS

Abstract: Computer-assisted war games are characterized in terms of the roles that the computer plays in supporting the game and structure of facilities provided the players. Types of computer-assisted war games are classified; ranges of applications are identified; and the types of game best suited for each application are described.

WAR GAMES -- DEFINITION AND IMPORTANCE

A war game is a dynamic simulation of military combat executed in such a way that one or more human participants can exercise control over the activities of the simulated forces. The essential elements of war games that distinguish them from other kinds of simulations of military activity are, then, that:

- Force command and control and/or combat direction for at least one of the opposing forces is supplied by human decision-makers, and
- These decision-makers must react to the evolution of the combat and exercise options that will affect its outcome.

These characteristics make war games perhaps the only medium short of actual warfare for examining command decision process and their effects. Additionally, the latter characteristic makes war games very useful in identifying and isolating problems and deficiencies as they arise. For example, a simulation may suggest that a force will have a logistics shortfall in some statically-structured scenario. In a war game, the point at which the effect of that shortfall is first felt, the constraints it imposes on conduct of the simulated operation, and the possible alternatives for circumventing those limitations are all surfaced during the interactive play of a war game. War games are thus the richest and most powerful tools available for analyzing military operations.

COMPUTER-ASSISTED WAR GAMES

The definition of a war game presented above is broad enough to encompass almost all simulations of military combat that utilize human command and control -- from force exercises (in which real personnel and equipment are used to simulate activity) to manual board games. Intermediate in this spectrum are computer-assisted wargames, in which some of the activities and status of forces are simulated and monitored by computers. Computer support for such war games may include:

- A game executive - a computer program module which maintains the

profile of the tactical situation by tracking: elapsed time and movement of forces; results of engagements; and status of forces with respect to number of units, remaining fuel and firepower, maneuverability, etc. The game executive may, in addition, track a tactical scenario, triggering simulated intelligence reports and automatically identifying critical decision points for the human players.

- System simulators - computer models that translate parameters describing environmental conditions and the technical characteristics of a weapons or support system into operational performance characteristics. Such a model for a radar system might, for example, accept inputs describing power, frequency, and environmental conditions and produce a detection probability curve as a function of height, range, and size of a target.

- Engagement assessment modules - computer simulation models that can be called up as necessary to translate actions into outcomes. One kind of engagement assessment module might, for example, use the detection probability curve produced for a radar by the system simulators to determine when various units in an incoming air raid will be detected by defenders. Other modules will presume the engagement of forces and/or units in combat and simulate combat losses and damages resulting from the engagement.

- Weapons characteristics and unit capabilities data files - which provide ready access to parameters needed for combat simulation in the engagement assessment modules and used to establish reasonable constraints on what can be accomplished by units in terms of movement, detection of enemy forces, etc. in the game execution.

In addition to these computer capabilities, the total computer-assisted gaming facility will generally provide:

- Physically separated input/output consoles and displays and communications links among these to enable simulation of dispersion of military commanders among and within platforms.

- A game umpiring system, so that disinterested observers can monitor game progress, resolve ambiguities when proposed actions or engagements exceed the interpretation capabilities of the game executive, and pace the game

to maximize its utility to the players (e.g., by increasing rate of play during maneuvering periods and slowing or freezing action during hot conflict phases of the evolution).

GAME TYPES

Within the broad spectrum of computer-assisted war games, there are a number of different types of games that can be distinguished by the kinds of program modules provided, structure of the opposition, and the number of sides that are played with limited intelligence. Briefly, the game types are distinguished in terms of these characteristics as follows:

- Computer modules - With respect to the modules provided (or employed), three types of games can be distinguished:

  - System level games - These provide only system simulators and possibly weapons capabilities data bases to enable players to specify units rather than the parameters needed in the simulation. These are really not games in the strict sense of the word, but are little more than interactive simulations. In larger computer-assisted games, however, provision for direct access to the system simulators through system games in an important consideration, because availability of system games will greatly enhance the utility of the total program.

  - Engagement level games - Engagement games provide a true gaming capability by providing engagement assessment modules and rudimentary game executives that enable players to specify limited scenarios involving combat between a few units and control unit actions as the scenario evolves. Because engagement games involve only one kind of engagement, their output can be much more detailed than larger-scale games which use a variety of engagement assessment modules.

  - Full-scale games - Full-scale games add to the engagement games a full game executive capable of tracking a number of different units, calling on a variety of different engagement assessment modules as necessary, and accepting combat control inputs from several sources.

• Structure of the opposition - The next major distinction among games is how the opposition that produces the simulated conflict is structured. This is determined by the nature of the opponent force against which the players play the game and the player structure.

- Opponent structure - For system games the players' "opponent" is the computer, which accepts the inputs and provides an answer. For engagement and full-scale games, there are three alternatives for the opponents, which create a further categorization of the game type. These are:

* Preprogrammed games, in which the operational environment and scenario are specified in advance, and the "opposition" allows only limited action selection by the player. In these games, engagements proceed according to a fixed scenario in which only a few major decisions by the players are called for.

* Computer-opposed games, in which the actions of the "opponents" are controlled by the computer in accordance with pre-structured decision/action tests that enable the computer to determine what actions and responses will be taken in given situations.

* Freely played games, in which all opposing forces are under the tactical control of human players, and the computer acts only as a monitor of the action and tabulator of results, force status, etc. Freely played games may be constrained (e.g., by not allowing for engagements outside of a fixed geographical region or actions that cannot be accommodated within the game executive), but force actions are otherwise totally specified by the players.

- Player structure - On the player side the primary distinction is between:

* Single-player games, in which command and control inputs are provided from only one source, which may be an individual playing alone, or a team of players constituted to simulate a single command node.

* Multi-player games, in which any number of different players or separate teams can individually react to a portion of the game and provide

force command and control inputs. Because play of these games simulates the coordinated responses of different command and control nodes, multi-player games generally must provide a means of communicating between the different players.

- Number of sides - Finally, a major distinction among freely played games is the number of sides in the game, as indicated by the number of opponents who play with limited intelligence. The basic game types with respect to number of sides are:

  - One-sided games, in which realistic conditions of limited intelligence are played only by one side in the simulated conflict and opposition is provided by game directors or umpires, who have access to complete information on both forces and are free to control parts of the game scenario as it evolves.

  - Two-sided games, in which two opposing forces with imperfect information are played against each other. Large-scale two-sided games usually require, in addition, presence of umpires who have access to complete information so that they can monitor the actions of both sides for violation of game constraints.

  - Multi-sided games, in which more than two major forces with conflicting objectives are played under realistic conditions of limited intelligence.

USES OF WAR GAMING

There are four commonly recognized areas of application of war gaming:

- Operational planning, which deals with questions of future force levels, deployment, or employment;
- Personnel and team training;
- Operational development, i.e., development of tactics, doctrine, and procedures to maximize effectiveness of weapons systems; and
- System development, i.e., design and development activities aimed at improving weapons systems and producing new items.

Each of these possible uses of the NWGS war gaming capabilities is examined below to identify specific applications and the kinds of war gaming capabilities needed to support those applications.

Operational Planning

The utility of war games in operational planning is that the game enables planners to analyze situations in which the outcome is sensitive to the quality of force command and control and limitations imposed by available resources and assets. Most war gaming applications that support operational planning therefore require the interactive play possible in full-scale games, so that the effects of human decision-making in the operational situation can be examined and analyzed, and deficiencies will surface as they occur.

Specific possible applications of war gaming in this area vary with the kind of planning involved. At least four distinct categories can be identified:

- Strategic/Force Level Planning. This kind of planning is aimed at anticipating the future world military situation and selecting U.S. force levels that will be great enough to adequately and clearly counter any threats, but not be so great as to be perceived as a threat or an unnecessarily large investment in national defense. Since the deterrent posture of general purpose forces depends both on numbers and on effectiveness of the forces, and force effectiveness is greatly affected by responsiveness of force command and control, a realistic war game is perhaps the only adequate medium for analyzing force level alternatives, and war games play a key role in force level planning. The kinds of games required are relatively aggregated global or theater-wide games that enable the players to confront a crisis situation, respond to needs for reenforcing indigenous troops, mobilizing reserves, etc., and see as the game progresses the consequences of delays and/or inadequate force levels. Most force level planning is predicated on scenarios and enemy responses that represent the best available intelligence at the time. One-sided full-scale games are therefore the most appropriate medium for this kind of planning, because they avoid the excursions that can be generated in freely played games.

- Contingency Planning. In contrast to force level planning, which focuses on questions of overall military posture, contingency planning focuses on a specific situation and attempts to formulate courses of action to be followed if the situation arises. That is, a contingency plan anticipates the possible need for action and attempts to abridge the action-selection process by deciding, in advance, and without the pressures of an emerging crisis, what our response ought to be. Since contingency plans are developed to be implemented, they must be carefully analyzed and tested to ensure that they are practicable and are not likely to lead us into an untenable tactical position. Sophisticated war games that enable the opposing force commanders to exercise both strategic and tactical decisions are well-suited to the problem of testing contingency plans -- so much so, in fact, that much of the impetus for improving war gaming techniques and capabilities comes from contingency planners. Since one of the primary objectives in testing contingency plans is verifying their reasonableness under a wide spectrum of opposition force options, full-scale, two-sided games that allow the opposition commander maximum freedom in selecting his course of action are most useful in this context.

- Exercise Planning. A step down from contingency planning is exercise planning, in which the objective is to design a tactical scenario to be carried out in the exercise which will confront the task force and unit commanders with a variety of realistic tactical problems. While larger-scale war games might be used to suggest design of exercises by surfacing the kinds of tactical situations about which more information is needed, engagement level games, which provide finer detail on tactical encounters, can be expected to be the most immediately useful capability for exercise planning. By "pre-exercising" the tactical situations planned for an exercise with an engagement level game, exercise planners can set reasonable bounds on raid sizes, etc. to ensure that the forces exercised are not confronted with problems that are too great to be managed or too easy to be of any practical use for training and developing operational readiness. Here, cleverness of the opposition is not as much of an issue as general size and structure of the opposition so computer-opposed games

are generally as useful in this context as the free play games.

- Threat Analysis. Finally, although it is not strictly a planning function, threat analysis aimed at estimating the probable difficulty in countering an enemy threat with a given force from what is known about enemy capabilities and tactics is a necessary element in all kinds of operational planning. Ready access to a computer-opposed engagement level gaming capability can therefore be expected to be of great use to all operational planners, by providing an alternate means of testing tactical hypotheses and sizing the threat posed by anticipated enemy force levels when other threat analyses are not readily available.

Training

By enabling players to exercise command and control and/or combat direction of simulated forces in an environment where consequences of the player decisions can be assessed and analyzed as they occur, war games provide a medium for some types of training that would otherwise be impossible or prohibitively expensive to acquire and not nearly so useful from the viewpoint of surfacing lessons learned. In particular, three kinds of training fall into this category:

- Command readiness training, which is designed to give flag rank commanders an opportunity to test and hone the command decision skills they must exercise, but are ordinarily exposed to, only in crisis situations. The traditional medium for this kind of training is the command post exercise, which does not provide realistic feedback on consequences of decisions and actions. Recently, however, computer-assisted war games with sufficient complexity to challenge flag rank commanders with realistic crises have been developed, and the success with these suggests that war games can be expected to achieve a prominent role in maintaining command readiness. As suggested by the years of operational experience possessed by the audience for this kind of training, any war game used for this purpose must achieve extraordinary complexity and realism,

or it will not sufficiently challenge the players. This means that command readiness training must be supported by large-scale games that will admit many higher-level commands and simulate the totality of assets in the operational environment, including communications, intelligence, and combat performance of weapons systems.

- Functional unit/team training, which is designed to exercise groups of people who must support a common operational function, to allow them the opportunity to test and streamline coordination. Since this kind of training focuses on one function, only the tactical activities that impinge on, or are supported by that function need to be simulated, and smaller-scale, multiple-player games played against standard, computer-generated opposition are best suited for this kind of training.

- Individual training, the objective of which is to expand the experience base of individuals by providing an opportunity to run through a variety of situations and observe the tactical impact of their decisions. Because they can provide in a short time exposure to problems that might take years to attain in a real-world environment, realistic tactical war games are an invaluable training tool for training of prospective CIC officers, deck officers, and other junior grade commanders whose position requires experience that will enable them to anticipate the probable impact and effects of their decisions. To be most efficiently used in this role, the war games should: pose relatively short-lived tactical problems; have good interactive input/display consoles that provide fine grained profiles of the evolution; and execute fast enough to enable the player(s) to run through several iterations of the problem in a few hours. The required capabilities are exemplified by the pre-programmed engagement level games.

Operational Development

To ensure that existing capabilities and resources are used to the best effect, force tactics, use doctrine, and standing operating procedures are constantly reviewed and tested for possible improvements. This activity, called here operational development, is a vital element in the management of military

forces that has always taken place to some extent, but is now receiving high-level attention and evolving into a formal activity. It comes in two forms: tactical development and evaluation (TAC D&E), aimed at optimizing force, platform, and weapons systems tactics; and similar activities, no so well formalized, directed toward development of the best ways to use support systems.

TAC D&E

The importance of developing optimal tactics for applying new systems was formally recognized in OpNav Inst 5401.1, "Navy-Wide Intra-Type Tactical Development & Evaluation". Subsequently, TAC D&E as defined there has become an integral part of military system management, and Type and Numbered Fleet Commands have organized TAC D&E groups responsible for continuing major TAC D&E programs in their respective areas.

This kind of tactical development usually requires: extensive analysis of force performance data to determine possible weaknesses in existing tactics; further analysis to develop and evaluate proposed changes; and test of the proposed tactics in force exercises to verify the analytical results. Realistic war games can greatly facilitate these activities by providing a means of generating the data for analysis of tactics and by providing an alternate, more readily accessible test bed for evaluating proposed changes. In addition, much of the analytical effort in TAC D&E uses combat simulators similar to those used in engagement assessment in computer-assisted war games, so access to an appropriate war game may eliminate the need to develop simulation models locally.

The specific kind of war gaming that may be used to support TAC D&E varies with the level of the tactics being examined. There are three possibilities:

- Force level tactics. Development and evaluation of integrated force level tactics (also called inter-type TAC D&E) focuses on the problem of coordinating the large variety of force missions (e.g., AAW, ASW, etc.) and the use of weapons and platforms within a mission area. Since the objective is to evolve tactics that govern the concerted use of many different platforms and

weapons systems, this kind of TAC D&E requires large-scale war games that will admit different commanders for different platforms, supported by fine-grained engagement assessment modules that will accept weapons command and control supplied by the players. To be of most use in this application, such war games should be able to accommodate rigidly specified opposition force tactics, so that the game can be repeated with variations in own force tactics, and allow maximum free play by the individual players, to ensure that a wide range of tactical alternatives can be played. In terms of the types of games, these requirements suggest the need for one-sided full-scale games that can be computer-opposed and will display the detail attainable in engagement level games.

- Platform tactics. In contrast to force level TAC D&E, which focuses on heterogeneous groups of platforms, development and evaluation of platform tactics (also called intra-type TAC D&E) focuses only on questions of optimizing tactics for a given platform or homogenous group of platforms. Thus, either pre-programmed or computer-opposed engagement games in which several players can assume individual functional or platform command roles are ideally suited for this kind of TAC D&E.

- Weapon system tactics. At the lowest end of the spectrum of TAC D&E are efforts to develop optimal use doctrine for single weapons systems (e.g., an aircraft, missile system, Naval gun), or for a single platform engaged in one activity (e.g., a destroyer prosecuting a submarine contact). For this kind of TAC D&E, unit-on-unit engagement games with either a single player opposing a computer, or one player on either side in a free play mode are usually sufficient, because the focus is on single unit variations. To be most useful, such games must provide relatively fine-grained detail on the evolution of the game and results of engagements.

Other Operational Development

Another possibility for use of war games in support of operational development occurs in the area of developing command and control (C^2) system doctrine, organization, and information flow requirements. The potential here stems

from three features of a war game:

- Command and control is provided by the players.
- The impact of variations in that command and control can, if desired, be readily observed and analyzed.
- War games are conducted outside of the real-world environment, thereby safely allowing the assignment of command and control responsibilities, doctrine, and rules of engagement to be varied in order to test alternatives.

These features make war games perhaps the only practicable medium for conducting the kinds of analyses needed to support operational development of C^2 systems. This potential is only beginning to be recognized, but with the emergence of the Navy's new generation Navy Command and Control System (NCCS) and its subsystems, like the FCC and TFCC, demand for war gaming support in this area can be expected to increase radically.

There are two potential applications:

- Development of C^2 systems doctrine and organization. Here the regular war games might be played specifically to examine the impact of variations in C^2 system doctrine and/or organization, by conducting some game iterations with the existing C^2 system structure and others with variations of the structure. The kind of games required for this application will be ones that: (1) admit a large number of players to exercise simulated C^2 system nodes; and (2) can be conducted under fixed scenarios supplied by the computer or umpires, so that outcomes will vary only with the C^2 system structure and consequent responsiveness.
- Analysis of information requirements. A by-product from almost any war game (and not an unreasonable objective for specially-designed games) is the opportunity to use the war game as a medium for analyzing command and tactical information requirements. Data on information requirements can be derived from almost any war game by simply asking participants to note at critical decision points what information they would like to have had that was not available

to them. To the extent that the war game mirrors reality, such debriefing data may identify deficiencies and/or importance of information elements in the command decision process. To test indications from these or other analyses, specially-designed war games might then be used to conduct the same engagements with and without certain elements of information to provide a basis for assessing the contribution of those elements of information to force effectiveness.

System Development

Operational development accepts the constraints imposed by existing systems and attempts to optimize their use; the alternate approach to improving force capabilities is to evolve new systems or modify the technical performance characteristics of existing ones. This kind of system development ordinarily would not benefit too greatly from war gaming, but when war games are structured to provide direct access to the system simulators needed to support realistic games, the built-in system gaming capability represents a valuable asset to system developers. Such capability is useful in:

- Testing new system concepts. This traditional application of wargaming in support of system development utilizes somewhat rigidly structured war games to test the military utility of proposed new platforms and weapons systems by trying to determine the impact of a system with the proposed characteristics on force effectiveness in a variety of mission roles. Engagement games are sufficient to support extensive concept testing of this kind.

- Selecting new system parameters. One of the most difficult problems in developing a new system is that of ensuring that technical system improvements produce the desired operational improvements. The system games that provide direct access to the system simulators enable system developers to examine the effects of variations in system parameters on the operational measure of system effectiveness that must be fed into the war games. This is precisely the kind of capability needed to support the trade-off and impact analyses through which technical characteristics of new systems are selected.

Summary

Table I lists the possible uses of wargaming discussed above and shows for each the kind(s) of war games that appear to be most appropriate of the suggested use. Also indicated in that table, by asterisks, are the activities that might benefit from a natural by-product of accessibility of computer-assisted war games -- the ability to use the games' weapon capabilities data bases as a ready source of information on performance characteristics and performance parameters. Historically this convenient capability has been used informally and almost unconsciously by persons who, for example, keep a copy of war game documentation as a handy reference for parameters used by the game designers. It has more recently been explicitly recognized as a valuable by-product by the NWGS planners, and the NWGS will provide for direct query of the capabilities data bases.

TABLE I. POSSIBLE USES OF WAR GAMES
vs
TYPE OF GAME

	TYPE OF GAME						
	Full-Scale Games		Engagement Level Games			System Level Games	Data Base Query
	One-sided	Two-sided	Free Play	Computer-Opposed	Pre-programmed		
Operational Planning							
- Strategic/Force Level	●						*
- Contingency		●					*
- Exercise			o	o			*
- Threat Analysis				●			*
Training							
- Command Readiness	o[1]	o					
- Functional Unit/Team				●m			
- Individual					●		
Operational Development							
- Force Level TAC D&E	●[2]						*
- Platform TAC D&E				o	o		*
- Weapons System TAC D&E			o	o			*
- C^2 System	●[2]						
- Information Requirements	o	o	o				
System Development							
- Concept Testing			o	o	o		*
- System Parameters						●	
	Multiple-Player			Single or Multi-Player		Single Player	

● Best-suited for use
o Best-suited for some, but not all applications
* Can support activity

Notes:

[1] Careful structuring of scenario required.

[2] Requires iterations on the same scenario and therefore ought to be computer-opposed; fine grain detail on engagements required.

m multiple player games required; otherwise, single- or multiple-player games may be appropriate, depending on the specific question being addressed.

THE PLANNED NWGS: AN OVERVIEW

Abstract: Characteristics of the NWGS are described in terms of: planned capabilities of game executives; types of system simulators and engagement assessment modules; and planned characteristics data bases. Facility configuration and planned capabilities to extend the NWGS to remote sites are also briefly described.

The wargaming capabilities the Naval War College expects to have by the mid-1980's are described in a document entitled Detailed Statement of Requirements for a War Gaming Support System, 16 April 1975. This document calls for development of two independent, self-contained software systems:

- Student Gaming System (SGS), which will handle war games typical of those now used to support the NWC curriculum; and
- Command Gaming System (CGS), which will provide war gaming capabilities to meet the needs of operational commands and users outside the NWC.

Together these two systems will be capable of supporting the full spectrum of games described in Table I, ranging from weapon-system-level games, which will allow for direct access to the system simulators to enable examination of changes of system parameters, to large-scale command games that can simulate the actions of global forces being directed by a command and control system involving as many as 2000 commands. Although the current planning as described in the requirements document treats some game types shown in Table I as if they were appropriate only for the SGS, they are also potential capabilities of the CGS.

The scope of the capabilities that will be provided by the NWGS when current plans are realized is briefly summarized below to suggest the potential of this system. For further details the reader should consult the requirements document or its successors.

GAME EXECUTIVES

Game executives envisioned for the NWGS will be provided as required or appropriate for any of the types of game described in Table I. These executives will be capable of tracking and constraining operations in terms of:

- Geography. Game executives will be able to define and monitor play in an area of operations described at the same level of detail as standard nautical charts for the area showing: land masses and national boundaries; altitudes and water depths; and flight and movement restrictions. Over and under this area of operations the executive will, moreover, be able to track unit move-

TABLE I: SPECTRUM OF GAMING CAPABILITIES

Game Type	Description	Play Options
System Level*	Provides access to system simulators to enable examination of effects on performance of changes in parameters	None
Engagement Level	Small scale games that enable simulation of tactical engagements between units or small groups of homogenous units	Preprogrammed*- engagements proceed according to a fixed scanario with decision branches controlled by the computer Computer-Opposed*- command and control for one of the forces is provided by the computer in accordance with pre-structured decision/action tests Free Play - both opposing forces are under the tactical command of human players, and the scenario evolves
Full-Scale Games	Large scale games involving whole forces over wide areas under the command and control of human players	One-sided - Umpires control opposing force and/or parts of the game scenario for player controlled forces Two-sided (or Multi-sided) - All forces are controlled and directed by human players

* Capabilities of the SGS not currently planned for the CGS.

ments to an altitude of at least 150 nautical miles and a subsurface depth of at least 10,000 feet. Location and capabilities of fixed facilities such as radar sites, docks, storage depots, etc. can be specified for each game.

- Environmental Factors and Areas. Game executives will be able to define and monitor the operating environment, defining such conditions as cloud cover, light and darkness, weather and sea state, air and water temperatures, etc. for environmental areas within the area of operations.

- Mobile Units and Movement. Game executives will be able to distinguish and track reasonable movement of a wide variety of ships, submarines, aircraft, and spacecraft at rates consistent with capabilities and environmental conditions along prestructured or player-controlled paths. Tracking may be executed either on a unit-by-unit basis or maintained for groups of units presumed to be moving together in formation.

- Logistics. In addition to tracking motion, game executives will be able to simulate and record expenditures of ammunition, fuel, and consumables and maintain current status for participating units. In some game executives logistics status will be reflected as constraints on maneuverability and operational capability of the units simulated.

In addition to these functions, the game executives for some of the larger scale games will recognize a force command structure containing as many as 2000 commands, and may be designed to store and automatically generate at the appropriate time in the game play simulated intelligence and/or operational reports from these commands.

SYSTEM SIMULATORS

The NWGS will be provided with a large variety of sensor and weapons system simulators; the envisioned scope and variety of these is suggested by Table II, which shows the systems that have been mentioned as candidates in the requirements document.

ENGAGEMENT ASSESSMENT MODULES

The NWGS, considered as a whole, will provide a wide variety of engagement assessment modules that will realistically simulate combat losses and

TABLE II: REPRESENTATIVE SYSTEM SIMULATORS THAT MAY BE INCLUDED IN THE NWGS

SENSORS	PLATFORMS	WEAPONS
ESM/ECM/ECCM	Surface combat ships	Surface-to-surface missiles
Search Radars	Minecraft	Surface-to-subsurface missiles
Fire control radars	Landing craft	Subsurface-to-surface missiles
SIF/IFF equipment	Auxiliary ships	Subsurface-to-subsurface missiles
On-board active and passive sonars	Submarines	Surface-to-air missiles
Dipped sonars	Fixed wing aircraft	Air-to-surface missiles
Magnetic anomaly detectors	Rotary wing aircraft	Air-to-air missiles
Electronic warfare intercept receivers	Spacecraft	Subsurface-to-air missiles
Sonobuoys and processor	Landing vehicles	Antiradiation missiles
Visual reconnaissance		Torpedoes
Seismic sensors		Naval guns
Infrared sensors		Antiaircraft guns
Acoustic systems		Land-based guns
HF/DF		Aerial guns
Over-the-horizon radars		Bombs
Towed arrays		Cluster bombs
		Depth bombs
		Ahead-thrown antisubmarine weapons
		Mines

damages occurring when opposing forces engage. The kinds of modules available will range from very detailed one-on-one engagement models such as those provided in the SGS up to force-wide engagement models that combine one-on-one engagement assessments to simulate concerted attacks. As a minimum, larger scale engagement models will be provided for:

- Air warfare (ARW)
- Anti-air warfare (AAW)
- Submarine warfare (SBW)
- Anti-submarine warfare (ASW)
- Surface warfare (SUW)
- Mine warfare (MIW)
- Amphibious warfare (AMW)

CAPABILITIES AND CHARACTERISTICS DATA BASES

Two independent data bases containing data on capabilities and performance characteristics of platforms, weapons systems, and electronic systems will be assembled and maintained for the NWGS. These will have identical file structures, but one will be unclassified while the other will contain data classified up to SECRET. Within classification constraints each file will be comprehensive with respect to classes of units. Typical characteristics of units that will be contained in these data bases are summarized in Table III.

In addition to providing the parameters needed by engagement assessment modules and game executives, these data bases will be directly accessible by users who may want a print-out of selected portions. The data bases alone can therefore be expected to become a valuable, ready source of information needed for threat and requirements studies, exercise planning, and other modelling efforts.

COMMAND CENTERS AND COMMUNICATIONS

The NWGS wargaming facility will be configured to support game play among players in physically separated command centers, much as is done today. Each command center will have direct access to the NWGS computers via consoles that will handle inputs of tactical directives and intelligence

TABLE III: CAPABILITIES AND CHARACTERISTICS FOR PLATFORMS, WEAPONS SYSTEMS, AND ELECTRONIC SYSTEMS SPECIFIED FOR NWGS DATA BASES

PLATFORMS	WEAPONS SYSTEMS	ELECTRONIC SYSTEMS
Type and class	Type and class	Sensors
Physical dimensions	Ammunition	- Type
Motion capabilities	Burst radius	- Designation
Altitude/depth capabilities	Rate of fire	- Frequency band
Fuel consumption rates	Range	- Range capabilities
On-board electronic systems	Reliability	- Scan characteristics
On-board weapons systems	Hit probability	- Peak Electric Power
Logistics capabilities		Communications
Number of catapults		- Type
Aircraft loading capability		- Frequency Band

and provide alphanumeric and graphical displays of information available to each command. Umpire positions will have similar consoles with access to all game information. Initially, there will be at least 36 consoles of this kind at NWC, 22 for command centers and 14 for umpire positions.

The command centers and umpire positions will be provided with flexible voice and record communications accesses, so that the command centers can be linked with simulated communications networks and umpries will be able to coordinate game play or monitor communications to simulate intercepts. Though not explicitly called out in the requirements document, these communications links will probably be routed through computers, so that communications degradation, jamming, and delays can be realistically simulated to avoid the artificiality of near instantaneous, perfect communications now played in NWC war games.

EXTENSIONS TO REMOTE SITES

After the NWGS has been fully computerized in accordance with current planning, it will be possible to set up additional player command centers almost anywhere. To do this, a proposed site will need:

- A compatible input/display console to provide the player/computer interface;
- A high quality data communications link between the console and the NWGS computer for input and output of game information and record communications;
- Parallel voice communications links to provide access to the game voice networks; and
- As required, a separate, full-time voice or record communications link with the game floor in Newport to coordinate game play and computer operations.

Communications security in the form of on-line encryption, or (possibly) paper codes and physical security of messages will be required for the voice and record communications links used in the game play, and the computer data

links will require on-line encryption when SECRET data bases are used. Otherwise, a remote command center configured in this way will be no different from the command modules at Newport, and a remote player will be functionally indistinguishable from a player at the NWC.

THE NWGS CONTEXT: EXISTING NAVY WAR GAMES AND SIMULATIONS AND THEIR MANAGEMENT

Abstract: The existing Navy resources for large-scale wargaming and simulations are reviewed and questions of management of these assets are discussed.

INTRODUCTION

To examine the broader context in which the NWGS will be developed, ONR sponsored a Working Group on War Gaming and Simulation at the U.S. Naval Academy during 19-20 May 1976. Attending were representatives from: ONR; the Naval War College; Navy Research Laboratory; Center for Naval Analyses; Navy Weapons Laboratories at Washington and China Lake; OpNav; members of the Management Science Department of the U.S. Naval Academy; the Marine Corps Development Engineering Center; CNETS; Ketron, Inc.; and SRI.

Two of the primary objectives of this working group were to identify the wargaming and simulation resources in the Navy that might be used as a starting point for development of NWGS modules, and to address the broader question of management of war games and simulations within the Navy. The information relevant to these objectives generated in the working group and subsequent examinations is summarized here to display the context within which the NWGS will be developed.

EXISTING RESOURCES

There are in the Navy six war games with capabilities like those to be developed in the NWGS. Two of these -- the NEWS Control Engagement module and the WARS simulation and bookkeeping modules -- reside at the Naval War College, and will be supplanted by the NWGS. The other four are:

- TACDEWS - a tactical exercise game located at the Numbered Fleet Commands to provide realistic gaming of engagements. TACDEWS is largely a training game, played in mock-ups of shipboard CICs to allow operators and commanders an opportunity to get the feel of the CIC environment and handle typical tactical problems in that environment.
- Tri-Lab Game - a large, complex war game capable of handling a variety of war-at-sea scenarios. It is supported by Naval Weapons Center at China Lake, Navy Undersea Center, and the Navy Ocean Systems Center (NUSC)*

* Formerly the Navy Electronics Laboratory Center

to provide a medium of testing and evaluating system alternatives in tactical situations.

- LFWG - an amphibious operation war game maintained by the USMC, Marine Corps Development Engineering Center.
- TWAES - a data bank for field land war exercises maintained by NOSC.

Simulations

The significance of the war games described above is that they have built-in and running system simulators, engagement assessment modules, and capabilities data bases that might be lifted and modified for incorporation into the NWGS. Additionally, there are a number of computer simulations of various aspects of Navy warfare that might serve as a starting point for developing other engagement assessment modules for the NWGS. A listing is displayed in Table I. This list is not claimed to be complete, but it does suggest the richness of possibilities for adaptation that exist within the Navy community.

MANAGEMENT ISSUES

A broader issue suggested by the great variety and many different locations of existing Navy Warfare gaming and simulation resources is the question of how these diverse capabilities might be managed to ensure the widest application to Navy need.

At present, the management of war games within the Navy is decentralized, with the nominal center residing in the NWGS at the Naval War College (NWC). While the wargaming activities of the operational commands and other offices are usually coordinated and frequently conducted at the NWC, there is no central authority or control for the naval war games and simulations described above. Each user sees the game or simulation under his control as a product uniquely his own. In many cases, this is true, since simulation models are not easily transferred from the solution of one problem to another.

To what extent this decentralization has led to inefficiencies or lack of

TABLE I.
Navy Warfare Simulations

Simulation	User	Purpose
BASD-MO	Bendix	AAW - aircraft and ship
CAM-SAAB	NADC/OPNAV	AAW - ASMD
FADM	NWC China Lake	AAW
STAB II	NADC	Air-to-Air Engagement
APAIR	OPNAV	ASW Air Engagement
APSURF	OPNAV	ASW Air Systems
LOTRAK II	OPNAV	ASW Localization
MIPES	NSWC Dahlgren	ASW Encounter
SEALIFT	OPNAV	Convoy Protection
SWIM II	APL	CV plus SSN
TESE	USMC-MCDEC	Tactical Exercise Simulator
CEM	OPNAV/JHU	Campaign Model
GENIE	VITRO	Fleet Defense
Mine Hunting	NSWC Dahlgren	Minesweeping Operations
C Base II	NAVAIR	TAC AIR Campaign
ACM Simulator	NASA/LTV/MCAIR	Air-to-Air Engagement

progress is problematical. There is a paucity of research and information on the needs, uses and capabilities of war games as they might be applied to the problems of the Navy. However, it will be necessary to develop a better understanding of the relationship in order to sensibly address the following issues:

- Is central management of gaming and simulation desirable? If so, which office should have responsibility for the centralized direction?
- What should be the relationship between groups using the same, or different war games?
- What should be the connectivities between the members of the wargaming and simulation community? Should they be tied into the operational communication links?
- Should priorities be established for new initiatives in wargaming and simulation? If so, what should be the basis for establishing these priorities?
- How should the costs for supporting the wargaming facilities be shared? Should users be charged on the basis of their participation?

Central to the resolution of these issues is the question of the centralization of authority in the management of Navy war games. Only by virtue of a strong central authority would it be possible to set priorities based on judgements of utility and costs and to direct the communications between support and user groups. In order to explore the issue of centralization, three alternative management concepts representative of the range of possibilities are briefly described here; the alternative ultimately selected may influence the way that the NWGS is evolved and developed.

Centralized Management

Under this scheme, an office would be established -- most likely in OPNAV -- to direct all Navy wargaming activities. It would control the allocation of funds and set priorities for these activities. If properly directed, such an office could assure an efficient, coherent wargaming program and be a central repository of data and information. Of course, the dangers of such centralization would be the loss of flexibility and independence of the users and operations.

A Centralized Support Activity

A more moderate approach would be to establish a Navy war game support activity, preferably located at the Naval War College. A mission sponsor could be located in OPNAV together with a steering committee consisting of representatives of the users, OPNAV, ONR and the support activity. While this concept would not provide strong, central direction to wargaming activities, it would promote greater coordination between the various offices. Centralization of wargaming support activities in one location should lead to greater efficiency in management and operation. Use of remote terminals, mini-computers, and/or traveling teams for specific war games would ease the problems of a centralized geographic location for the main activities.

Other problems could arise in this approach if some users did not believe that the war games and the support were responsive to their specific needs. Overcoming such concerns would be a major coordination task for the mission sponsor and steering committee.

A Decentralized Approach

As a general rule, users of war games believe that they should have control of the activity so it can be tailored to their special needs. A decentralized approach to management of the war games -- which closely parallels the present situation -- would permit each Navy organization to develop programs to satisfy individual organizational requirements. It would be desirable to have an office to disseminate information throughout the Navy; however, there would be no centralization of control. The penalties of such decentralization could well be duplication of effort and a lack of uniformity in the quality or applicability of the effort. On the other hand, diversity tends to stimulate creativity and responsiveness to particular needs. It would be a major challenge to ensure that new ideas, and techniques are communicated throughout the Navy.

EXPANDED USERSHIP: ADDITIONAL CONSTRAINTS ON INFORMATION FLOW AND DATA BASE ACCESS IN THE NWGS

Abstract: Possible requirements to constrain information flow and data base access in the NWGS beyond those needed to safeguard ordinary classified information are examined and discussed. Major requirements considered are those generated by: need to segregate game information at remote sites; use of special intelligence-like information in large-scale games; participation of foreign players; and participation of extra-Navy DoD and other government agency players, which may create needs to safeguard organizationally sensitive elements of the data bases.

INTRODUCTION

The Navy War Gaming System and its associated data bases will be a major training, planning, and analysis asset, with the potential to support not only Navy organizations, but many other agencies of the DoD, the national government, and allied staffs as well. If this asset is to be fully exploited, severe requirements will be placed on the executive element of the system to flexibly control access to both on-going games and the data bases. Since parts of the total requirement have not been explicitly recognized in other documents, this paper describes possible needs to control access to information in the system beyond those dictated by security classification. The principal classes of constraints on access considered are those needed to: separate the two sides of a game and the umpire staffs; safeguard classified material, when special intelligence is played or there are foreign participants in the game; and withhold organizationally sensitive materials from extra-Navy game participants.

SEPARATION OF PLAYERS AND OF GAME CONTROL/UMPIRING

During a game, each player should be furnished only the information that he would normally have in real situations, while the game control and umpiring teams should have access to all the information. The need for the separation of information along these lines at the central NWGS facility is universally recognized and much experience in providing this separation has been accumulated.

Care, however, must be taken to provide similar capabilities at the remote facilities envisioned for the larger NWGS.

In this context, it appears that as a minimum the NWGS should be able to segregate information furnished to the remote facilities into sets appropriate for:

- One player (e.g., Task Group commander)
- Commander of forces on one side (e.g., Commander ORANGE forces)

- Game Control Team (e.g., CINCLANTFLT may want to control the overall course of the game from his headquarters in Norfolk)

SAFEGUARDING OF CLASSIFIED INFORMATION

Clearly, in addition to the game-related restrictions on information flow, the various categories of classified information must be properly safeguarded, both at the central facility and at the remote installations. The need for this is universally recognized, and the experience in safeguarding classified information is abundant. However, two factors that may complicate the requirements for protecting classified information -- the need to increase the use of special intelligence and the likelihood of extensive foreign participation in future war games -- have not, perhaps, received full consideration. These two factors are briefly discussed below.

Need for Special Intelligence Information

Special intelligence, including deception techniques, have probably played a crucial role in every major naval engagement since 1940. Today's senior commanders have increasingly near real time access to evaluated intelligence from a variety of monitoring, surveillance, and reconnaissance systems. The flag officer player is no doubt well aware of this and should be further stimulated and given an opportunity to use special intelligence information in the NWGS games.

Clearly, the extent of special intelligence use in the war games should be dictated by the nature of the problems and the command-level of the players -- and not by the nature of facilities available.

Foreign Participation in Future War Games

It appears increasingly less likely that future maritime conflict situations will be restricted to exclusively bilateral US-Soviet naval interactions, even in an extra-NATO context. On the one hand, population growth, relative

scarcities of raw materials and food commodities, increasingly complex patterns of foreign investment and multi-national enterprise, and the inadequacy of the international monetary system all clearly point to greater interdependence among the advanced Western nations and therefore to a greater likelihood of joint action on the international scene. On the other hand, the potential for conflict involving emerging nations, particularly those that are rich in terms of scarce raw materials or strategic geographic circumstances is rising rapidly. This latter point, in particular, may benefit from some emphasis.

Small states and lesser powers can no longer be dismissed as insignificant, or nearly so, with their involvement in maritime conflict situations restricted to such essentially passive roles as:

- Granting permission for surface transit through straits, archipelagic seas, and or extended territorial seas
- Granting permission for, or merely ignoring, over-flights
- Providing transient use of air and port facilities
- Providing low-level intelligence
- Continuing contributions to and existing ocean surveillance arrangement.

In general, they now strive vigorously to establish and defend both their sovereignty and their economic interests with respect to continental shelves, the seabed, expanded fisheries zones and territorial seas, an increasing numbers of crucial straits, and other restricted waters.

Toward these ends, more and more of the small states and lesser powers are acquiring advanced weapons systems that were formerly available only to the industrialized nations. These advanced weapons systems, include the latest fighter/attack aircraft available, high speed anti-ship missile platforms, and new types of sea-control vessels. Even a short list of examples clearly shows that smaller states that can affort it have already acquired many of the most current non-nuclear weapons systems under production in advanced

Western countries and thus have or will soon have the capabilities to play a significant role in conflict situations:

- IRAN: F-14, Spruance DD, US PF-109s
- ARGENTINA: FRG Type 148 Fast Attack with Gabriel missiles
- BRAZIL: Vosper Thoneycraft MIC 10 frigates with Exocet and Seacat/Ikara
- CHILE: Leander frigates with Exocet and Seacat
- SOUTH KOREA: Asheville, PGM, Flagstaff PGM, and High Point PCH, all with Harpoon

In addition to such non-nuclear weapons, nuclear warfare options appear to be within the reach of such countries as India, Israel, Egypt, South Korea, Taiwan, Japan, Brazil, and Argentina.

Thus, both the disposition and the means to precipitate a conflict are there, and if the United States would become actively involved in any resultant conflict it most likely would be as an ally of a country or a team of allies. Therefore, if future conflicts are gamed, they should include realistic cooperation with third countries.

This leads to the problem of who should play the third country's roles in the gaming situations, and the problem is not readily solved. Thus far, for example, the scenarios for the CINCLANTFLT Tactical Command Readiness Program have not been designed to include foreign nationals, largely because the games are played at the SECRET/NOFORN level. For this reason, there has been no NATO officer participation, though NATO forces, command relationships, and other factors have been incorporated into the Norwegian Sea Game and played, in a naturally inadequate fashion, by umpires or exercise control.

It has been widely acknowledged that both for the enhanced realism of the United States side of the game and for the training value accruing to the other nations, the representatives of third activities or of international staffs of alliance headquarters should be involved in many future games. This would entail a further elaboration of the arrangements for safeguarding of classified information.

The final touch is given when it is considered that the many allied operations subject to gaming would involve several combinations of nations. With each of these combinations, different agreements relating to the exchange of intelligence and access to classified material will apply. It will be a nice point of systems design to achieve a good balance between systems complexity and cost versus the capability to conduct effective and efficient multi-national games.

MANAGEMENT OF DATA RELEASE TO U.S. ACTIVITIES

The NWGS, as currently proposed, is intended to serve several purposes. It is to furnish simultaneous games for class instruction in tactical command problems at the War College, and is also expected to support large-scale games for the training of present Flag Rank tactical commanders and their staffs. Besides serving as an instructional tool spanning these two levels, it is to constitute an analytic resource for studies of R&D strategy, future force structure, and the improved employment and support of existing naval assets. For all these applications, the system is to be able to place fleet operations in the context of appropriate surveillance, intelligence and C^3 systems, collateral US forces such as land-based air power and, as was indicated above, the complementary operations of allied and friendly nations.

If these objectives are achieved, the NWGS will incorporate a very comprehensive, up-to-date, and readily accessible body of data on US naval capabilities. The access to this body of data may need to be controlled for reasons of organizational sensitivity, in addition to any other controls. The potential usefulness of this body of data, the likely users, and the ensuing access control problems are briefly discussed below.

Potential of NWGS for Non-Navy Users

The body of information assembled in the NWGS data base could become an important aid in the generation and evaluation of operational plans not only on the level of a Naval task group (for which it is being designed) but also on

higher levels going up to the JCS. The NWGS thus has the potential for supporting the determination of national objectives and the organization of joint operations and campaigns.

This potential is considerable. A cursory examination of the assigned roles and missions of the USAF, for example, shows that both the strategic and tactical commands are charged with Coastal Defense, that SAC has Ocean Surveillance and Mining responsibilities, and that land-based Tactical Air Support of Maritime Operations (TASMO) is an increasingly important option in the Mediterranean and Baltic areas. When the land forces are added, as in the case of amphibious operations, it is clear that the effectiveness of traditional naval operations may be vitally influenced by and in turn may vitally influence the activities of the other services. Thus, the availability of naval war games and data base should constitute an important aid in the studies and planning done by the other services.

Candidate Non-Navy Users

Broadly, other-service candidates for access to the projected NWGS fall into three categories: Joint service schools, service analytic organizations, and the staffs that plan either joint or coordinated operations.

Schools. The joint service schools are the National War College, the Industrial College of the Armed Forces, and the Armed Forces Staff College. Of these, the utility of NWGS appears to be the greatest to the National War College, both in support of the instructional program and in the thesis research of the students. Perhaps the greatest value would be in having access to the NWGS data banks.

Analytic organizations. The analytic organizations would have two classes of use involving access to NWGS: the joint disinterested studies of combined-arms operations and the studies supporting positions in adversary proceedings. The joint disinterested class of use can, in turn, arise in two ways. The first of these is a reaction to the divergent results obtained when two services hold different policy views on a question which they both study. Higher authority

will then frequently direct a new study by a joint team or by a JCS agency. The second way in which a joint disinterested study may come into being is the need to generate realistic naval context for what are otherwise purely land- or air- force questions. The studies done in support of a position in adversary proceedings, such as an Air Force review of US carrier-based aviation, may lead very directly to difficulties in gaining access to the data base in NWGS. This, however, would be just an extreme manifestation of a general problem which is identified further below.

Staffs. The staffs of the commands of other services having cooperative or complementary responsibilities will have use for the widest access to NWGS. The functions to be served would include the gaming of joint operations, joint planning, and the development of tactics and procedures.

The Problem of Access to Data Base

The fact that the same non-Navy agencies may do both disinterested and adversary studies clearly raises the problems of providing variable access to external system users. The problem, however, is probably more pervasive. In any human organization, access to information is a source and symbol of power, and the possession of critical items of information can be of great value in the ever present struggle for more power. Since much of the business of the Department of Defense is conducted in the form of adversary proceedings, it is legitimate for the Navy to hold in confidence some data and to restrict release of plans and studies which are not yet complete or approved. In fact, some of the business transacted among major components of the Navy is also adversanal in nature. This means that the architecture of NWGS should have the dual function of giving agencies (both Navy and non-Navy) convenient access to gaming capabilities and a portion of the data banks while, at the same time, positively preventing access to some data and the on-going games sponsored by different agencies. The engineering of controls to accomplish this, both for the central system and for the remote installations, may be an important task for the NWGS designers.

SUMMARY

The main types of constraints on the flow of and access to information in the NWGS are those needed (1) to separate the various players and the teams that control or umpire the game, (2) to protect classified information, and (3) to protect organizationally sensitive information. While some of these needs are well recognized, the likelihood of demands for inclusion of special intelligence material to make large-scale games more realistic and the possibility of foreign participation in future war games suggest the need for more extensive controls than have been established in the past. In addition, possible extra-Navy use of the NWGS suggests a need to provide controls on organizationally sensitive portions of the weapons capabilities data bases, even when classification of the data is not a significant issue. Such possibilities should be carefully considered in designing the constraints on information flow and data base access in the NWGS.

PERCEPTION OF SITUATION AND OBJECTIVES: .
SOME IMPLICATIONS FOR DESIGN OF THE NWGS

Abstract: A frequently overlooked aspect of military command and control is the role played by the commanders' perception of the situation and objectives. The importance of these psychological aspects of command and control and their implications for the design and applications of the NWGS are discussed.

INTRODUCTION

This is one of several short papers which bring up selected subjects for possible considerations in the design of the NWGS. It briefly discusses two related topics -- the perception of military situations and the definition of objectives in a given situation -- and points out possible implications for the NWGS design.

PERCEPTION OF THE SITUATION

The Problem

It is a general human characteristic that people do not respond directly to observed "facts" but to their interpretation of these facts -- that is to their "definition of the situation". Although normally much care and experience goes into the making of these interpretations, errors can and at times do creep in.

Military decision-makers are not free of this aspect of the human nature, and, in spite of sustained efforts, they, too, are subject to error. In fact, recent history is studded with spectacular instances of wrong interpretations of "facts" -- even on the highest levels. In the summer of 1941, for example, the high-level decision-makers of the Soviet Union examined the signs of a massive build-up of German forces along the border in Eastern Europe and concluded that these signs were not an indication of an impending attack. In fact, the attack occurred shortly thereafter and pushed the Soviet army into a massive retreat. Later that year, radar indications of large numbers of unidentified aircraft approaching Hawaii were disregarded and the aircraft were allowed to reach Pearl Harbor unopposed, with consequences recorded in all history books. Just a few years ago, Israel failed to interpret correctly the signs of the Egyptian troop movements and concentrations and as a consequence experienced a surprise attack.

Similar but less spectacular misinterpretations occur much more frequently on various lower levels of military endeavors. There, however, such misinterpretations are more likely to be shielded from public view for reasons of security or simple human embarrassment.

The possibility of such misinterpretations on the enemy side is, of course, widely recognized and efforts both explicit and extensive -- usually referred to as "cover and deception" -- are made to bring these misinterpretations about. However, the problem of minimizing the occurrence of such misinterpretations on the friendly side, while implicit in many individual undertakings, seldom is recognized and pursued as a general subject. This relative neglect appears to persist, in spite of the fact that the trend in military situations has been toward a broader scope, greater complexity, and more uncertainty in the data on the basis of which decisions are made -- all of which make misinterpretations more likely.

Since the payoff from avoiding erroneous definitions of the situation is normally very high, it is of interest to ask whether war games -- which in large measure are precisely exercises in generating "definitions of situations" and in responding to them -- could not be tuned both to shed some light on this general problem and to provide for the decision makers some explicit experience in coping with it.

The answer appears to be affirmative. Clearly, scenarios can be designed with sufficient ambiguity to cause many erroneous definitions of the situation in the play of games, and attempts can then be made to identify the factors that either promote or impede errors. This would certainly provide for the players some experience in coping with the problem. However, since many of the variables that may have an influence on the extent of errors are not realistically represented in most war gaming systems, it is unlikely that an approach relying only on the use of ambiguous scenarios would yield significant insights into what does or does not affect the correctness of the definition of the situation.

To provide such insights, a new feature, it appears, would need to be incorporated in war gaming systems. Since the significance of this new feature is more readily seen when viewed in context of the command and control process, this process is briefly discussed next. Parenthetically, the discussion of the command and control process further indicates the relative absence of explicit concern with the general problems that arise in defining situations.

Command and Control Process

While the importance of the definition of the situation is usually recognized on the intuitive level, it is rarely incorporated in formalized treatment of the command and control problems. For example, while some details may differ from case to case, it is common to find the "command and control" process viewed basically as is shown in Figure 1. In this view, the command and control process is seen as consisting of three basic steps, triggered by the arrival of an input:

- Receiving the input,
- Selecting appropriate action,
- Issuing and communicating action orders (and providing for feedback, if not routinely available).

When an input arrives, suitable action is selected when deemed necessary, orders to carry out this action are issued and communicated to appropriate entities, and if necessary, arrangements are made to ensure feedback. Note that in this view, the entity exercising command and control (a single individual or a group of people) does not take or direct any command and control actions until an input arrives. Once an input does arrive, action may or may not be taken, but no action is ever taken without the arrival of an input. Action taken is always a reaction to an input.

This view of command and control fails to take fully into account the part of the process that involves interpreting the known "facts" -- i.e., defining the situation -- that is so characteristic of human activity and so important when ambiguities exist. It does not allow for action stemming, for example, from a "new" interpretation of "old" facts, from a desire to have more information, or from the fact that no inputs are coming in at all.

A schematic representation of the command and control process that explicitly makes allowance for defining the situation is shown in Figure 2. In this view, the process consists not of three, as before, but of four basic steps:

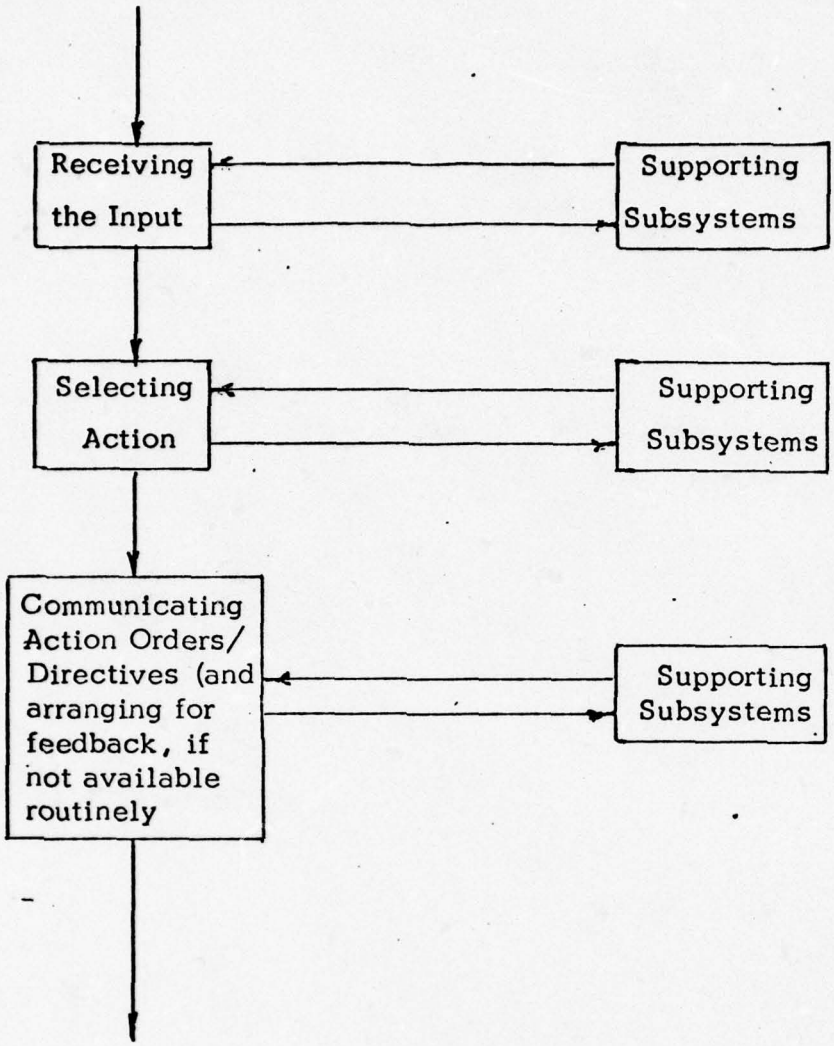

Figure 1: Mechanistic view of the command and control process.

- Receiving the input
- Defining the situation
- Selecting appropriate action
- Issuing and communicating action orders (and providing for feedback, if not routinely available)

Here, the inputs are received, incorporated into the definition of the situation, and then the whole situation is considered in the choice of any action. Importantly, however, opportunity is left open for re-defining the situation and possibly taking action even when no inputs arrive. The defining of the situation is seen as a continuing (and at times a truly dynamic) process that always takes into account the arriving inputs but also functions for some periods of time without any external inputs.

This latter view of the command and control process helps to direct attention to the sub-systems that support the defining of the situations. And what does affect the way a given situation is defined? Clearly, the inputs that come in and the people who combine these inputs with the knowledge, predispositions, and assumptions that are a part of their makeup. In addition, however, there are -- especially as military commands -- extensive and intricate arrangements for storing, collating, correlating, and displaying processed and unprocessed inputs. Without these supporting arrangements, no useful interpretations of the situation would be possible in modern warfare, and the nature of these arrangements is likely to exert a major influence on the way in which situations are defined. It is in these supporting arrangements that the implications for NWGS design lie.

Implications for the NWGS

The arrangements at military commands for supporting the interpretation of the situation affect the interpretation process in a number of complex ways, many of which are subtle and may depend strongly on details of particular implementation. The existing facilities of the War Gaming Center, that now simulate such supporting arrangements are, however, at most marginally adequate for some gaming purposes. These facilities do not represent, even in a most

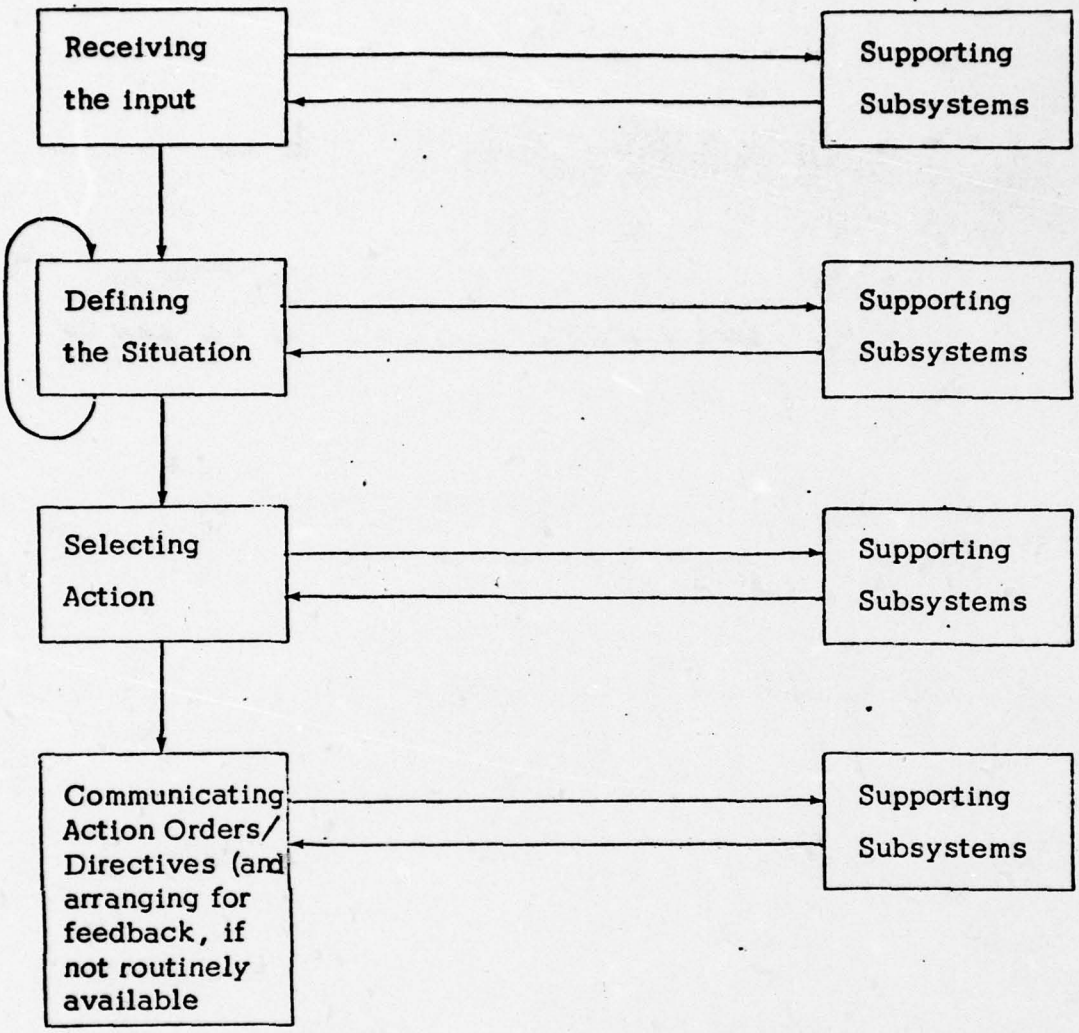

Figure 2. Humanistic view of the command and control process.

rudimentary manner, the information processing and display systems available on minor ships, not to speak of flag ships or shore-based command support centers. Thus, the existing facilities could not support any realistic investigation of the issues involved in interpreting tactical situations. Furthermore, even if a major effort were made to provide improved facilities of this nature in implementing the projected NWGS, it is doubtful that a sufficiently realistic replication of major command and control centers could be achieved in sufficient detail to provide a vehicle for studying the interpretation issues.

The solution to this problem appears to be not in the internal NWGS structure (i.e., not in providing facilities at the central war gaming site), but in reaching out to take advantage of capabilities existing elsewhere. Specifically, it appears possible to provide connections from the planned NWGS to functioning command and control centers that already possess some degree of automation (e.g., NTDS-equipped CIC, the Tactical Fleet Command Centers, etc.) and arrange for system compatibility. Some games could be then conducted with at least some of the players acting <u>in situ</u> in their normal decision making environment. Such an arrangement would certainly provide enough realism to make work on issues that arise in defining the situations worthwhile.

It is strongly recommended, therefore, that making provisions for using some selected operational command and control centers in certain war games be seriously considered in designing the NWGS. The general feasibility of making such provisions as well as additional reasons for having them are discussed in other monographs in this series.

DEFINITION OF OBJECTIVES

A conceptual companion to the "definition of the situation" is the "definition of objectives" -- that is, the definition of what one wishes to accomplish once one "understands" the situation. It is also a companion in neglect, for much like the definition of the situation, the definition of objectives is often recognized on the intuitive level but seldom properly incorporated in explicit considerations.

Nature of the Problem

Neglecting to take full account of the definitions of objectives may lead to errors in assessing human performance (e.g., in determining how well an individual decision maker did in a given game) and in attempting to determine the effect of "stimuli" (i.e., inputs) on human performance. Conceptually, these errors are easy to understand and easy to remedy. They are likely to arise when no effort is made to ascertain the objectives of the person performing the action.

To take a very simple example, a submarine moving toward an opponent's barrier may have as its objective either passing through unnoticed or attacking and destroying the unit (or units) manning the barrier. Clearly, to judge the performance of this submarine in a valid manner, one must know which of the two objectives it is pursuing. Similarly, to continue with this simple example, if one wanted to study the effect of supplying the submarine with certain information (e.g., negative response from sonobuoys dropped in a known location), one would need to know the objective to derive valid conclusions about the relationship between the availability of the information and the quality of the submarine's performance.

In principle, these issues are very clear. In practice, however, they not infrequently escape notice. This has happened not only in military investigations where methodological issues tend to be pushed back by the pressures and practicalities of the immediate situation, but also, as the example quoted below will indicate, in experimental psychology when problems of methodology are normally accorded front play.

The example uses the familiar case of feedback in target tracking to make the point:

> "A classical example...is the tracking experiment in which a subject manipulates a control lever to cause a cursor - say, a moving spot of light - to track a moving target...
>
> "From the subject's point of view...this is clearly a control task: He is trying to keep the spot and the moving target in a particular

relationship, namely, spot on target. If there is feedback it involves the position of the spot relative to the target and not in an absolute coordinate system.

"That there is feedback is easy to verify. If the spot drifts to the right of the target, the subject moves the control stick to the left and corrects the error; if the spot drifts left, the subject responds to the right...

"As this experiment stands, an important fact is still invisible. To make it visible, I shall whisper in the subject's ear, after which we observe that now the spot is off the target. In fact, it still moves with the target, but now remains always a few inches to the right. Another whisper, and it stays a few inches to the left. Another - a foot to the left.

"I have been telling the subject of course, to do exactly what was observed. How verbal instructions do this is beside the point here. What is important is that the subject is not simply responding to 'error' as we naively saw the situation at first. He is responding to an error, but the error is of a totally different kind. It is the difference between some condition of the situation as the subject sees it, and what we might call a reference condition [or objective] , as he understands it. The initial reference condition was spot on target. After the verbal instructions the reference condition [i.e., the objective] became successively spot a few inches right of target, a few inches left, and a foot left. A relationship which a moment before constituted an error became the no-error condition, and vice versa.

"The reference condition is not directly observable - in fact it is extremely easy to take for granted, and only demands attention when, as in the imaginary example, it suddenly changes to a new state. Once noticed, it is easy to define...

"The reference condition determines where the spot of light will be; the target does not. The motions of the target simply tend to cause a disturbance of the actual state of affairs away from the reference condition, and the subject moves the stick in any way that is required to cancel the effects of those disturbances before any large errors result...

"...We can [thus] see...why the stimulus-response concept of behaviorism has had to fail, and we can also see that the apparent randomness of the connections from specific stimuli to specific responses is no more than an unfortunate illusion."

-- Powers, William T., Behavior: The Control of Perception, Chicago; Aldine Publishing Co., 1973, pp. 44-55.

For an example closer to home, we need to reach only to the CINCLANTFLT Tactical Command Readiness Program. There, an early effort to assess players' performance focused on recording the "stimuli" (i.e., certain pre-programmed events in the game) and on the subsequent actions of the players - in an attempt to relate the actions to the stimuli. However, no explicit attempt was made to determine players' objectives. The objectives were assumed to be known.

Of course, if the assumed objectives coincide with those of the person performing the action, there is no problem. Experience seems to show, however, that it is not all that difficult to slip from a situation in which the assumed and actual objectives coincide to one in which they diverge.

Implication for the NWGS

What all this implies for the design of the NWGS is that it would be very desirable to "institutionalize" an explicit consideration of the player's definition of objectives by making provisions for routinely ascertaining what the player's objectives are. Specifically, it means that in any scheme for recording player performance -- and the NWGS should have such a scheme, be it manual, partly, or fully automated -- an explicit step should be the determination of player objectives.

COMMAND POST GAMING -- A CONCEPT FOR SYNERGISTIC DEVELOPMENT OF THE NWGS AND THE NAVY COMMAND AND CONTROL SYSTEM

Abstract: The possibility of using remote extensions of the NWGS to Fleet Command Centers and Tactical Flag Command Centers to provide more realistic Command Post Exercises is examined. It is observed that because of coincidence of the NWGS and FCC/TFCC development programs early development of a Command Post Gaming capability would: support operational development of the NCCS; enhance the utility and capabilities of the total NWGS; and capitalize on commonalities in the different development programs, in that:

- The NWGS could provide the required exercise and evaluation capabilities for the FCC and TFCC,
- Operational FCCs and TFCCs could serve as player positions in large-scale games,
- Display capabilities developed for the FCC and TFCC could be adopted to meet NWGS display requirements, and
- Weapons capabilities data bases common to both the NWGS and the FCC/TFCC could be jointly maintained and updated.

INTRODUCTION

During the same time period over which the NWGS is to be developed and installed, major development programs for the Navy Command and Control System (NCCS) will also be underway. Since a sophisticated wargaming capability like the NWGS represents perhaps the only practicable medium for realistically testing and exercising command and control systems in a benign environment, and many of the display capabilities to be developed for Fleet Command Centers (FCCs) and Tactical Flag Command Centers (TFCCs) are needed in running a full-scale, many player war game, the coincidence of these development programs creates a rare opportunity for mutually supporting development efforts.

The medium for merging these efforts would be an automated C^3 system exercise capability, called here Command Post Games, which would utilize the gaming capabilities of the NWGS together with direct interfaces between the NWGS and NCCS nodes to exercise and evaluate the NCCS. Development of such a capability would enhance the utility and design of the NWGS by providing a realistic context for playing large-scale war games and at the same time create a viable medium for continuous operational development of the NCCS with much greater capabilities than can be achieved with the exercise nodes planned for the NCCS.

This monograph explores the implications of Command Post Gaming from both viewpoints to show the benefits that would accrue. To provide the necessary background, it begins with a brief discussion of today's C^2 system exercise medium, command post exercises, and an overview of the NCCS concept.

BACKGROUND

Command Post Exercises

Today the principal vehicle for exercising and evaluating major nodes of command and control systems is the Command Post Exercises (CPX), in which message traffic describing a hypothetical situation and a postulated sequence

of events representing the development of the scenario is used to stimulate command decisions and action selection. To support crude evaluation, observers record significant events and note the situation assessments and decisions made by the participating commanders and their staffs. Upon conclusion of the exercise, the observers debrief the participants to show generally how the situation developed, what procedural and operational problems and deficiencies were observed, and why actions taken by the participants in response to exercise situations were appropriate or inappropriate.

As they are presently run, these exercises suffer from three deficiencies:

- Limited utility in analyzing the consequences of command decisions. Because it is necessary for the team of observers to provide the ongoing stimuli for the exercise and to record and evaluate the reactions of the participants, the observers must know in advance the significant events of the scenario and be prepared to measure system responses at specific times and locations. This requirement severely limits their ability to react to individual decisions and to demonstrate clearly in real time the consequences of these decisions. Similarly, the workload imposed on the observers to capture all relevant data and to reconstruct the unfolding situation from a number of viewpoints places limitations on a manual debrief. The difficulty in the reconstruction of the information available to each individual participant at the time of a given action often forces the observer to make an educated, but sometimes questionable, guess, with the result that the CPX evaluation suffers from inaccuracies and doubts.

- Lack of realism. Since today's CPXs are run manually by observer teams, there is very little opportunity for interpretation and realistic simulation of the effects of decision and communications delays. Thus, most CPXs evolve according to the original scenario with little or no adjustments for novel responses, lack of responses, or inordinate delays. The exercise events may therefore display to the participants little correlation with their responses, and there is little or no sense of urgency in responding to those events or incentive to adopt creative approaches to command problems.

- Lack of opportunities for fine-grained evaluation. Because it is so difficult to trace significant events and responses in a CPX, there is very little opportunity to use the results in well-structured analysis of causes for delays and problems, information requirements, and other detailed aspects of the C^2 system.

In short, then, today's manual CPXs are neither sufficiently flexible nor realistic enough to provide an adequate medium for training, operational development, or evaluation of performance. Since the CPX is the major evaluation tool, these limitations greatly inhibit system development, and alternatives are sorely needed.

Emerging Navy Command and Control System

The Navy Command and Control System (NCCS), scheduled for full operation in the early 1980's, will provide computer-based centers for information processing, display and dissemination to CNO, the FLTCINCs and afloat commanders, plus on-line communications for voice, digital message, display, and query/response traffic. It will interface with the WWMCCS (World-Wide Military Command and Control System) to provide a system by which the National Command Authority, Fleet Commanders in Chief, Numbered Fleet Commands, and officers in tactical command can exercise operational control over unit commanders with responsibilities for release of a weapon, control of a sensor, or control of a countermeasure system. Interfaces with sensor systems and specialized evaluation capabilities within the Fleet-Commanders-in-Chief (FLTCINC) Fleet Command Center (FCC) will enable him to monitor his entire area of responsibility and advise the tactical commander, supported by a Tactical Flag Command Center (TFCC), regarding situations developing beyond the range of his organic sensors.

Figure 1 illustrates the interface between the NCCS major nodes -- the FCC and TFCC -- and the interfaces with sensor systems at the respective centers. The functional design of the NCCS will be based upon data paths made available through these interfaces in addition to already defined major ADP equipment for the centers, but the final design will evolve through specifically tailored exer-

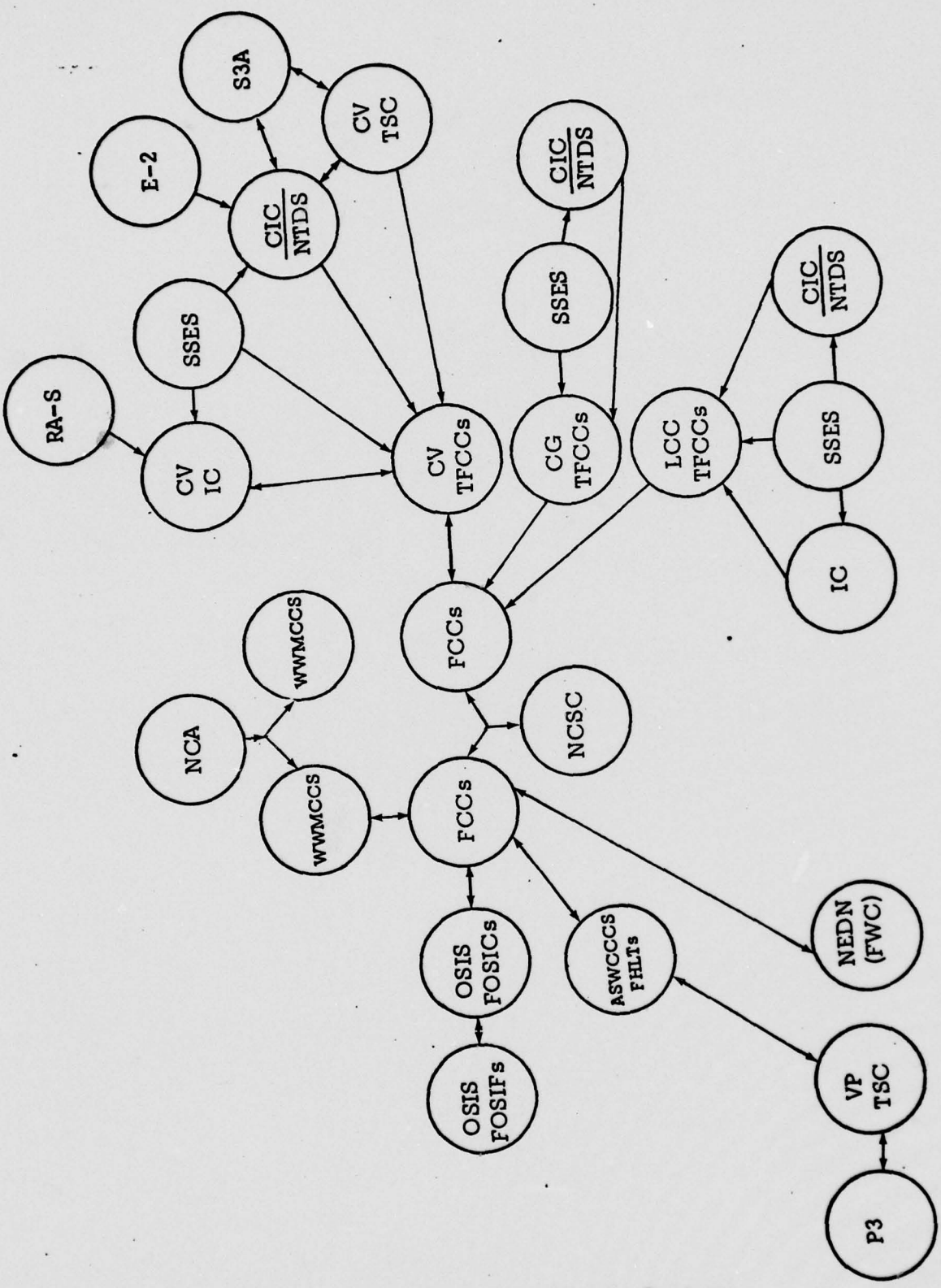

FIG. 1: NCCS and Interfacing Systems

cises and analyses that will explore the efficacy of alternate functional relationships. The major nodes shown there -- the FCC ashore and the TFCC afloat -- are described in detail below to illustrate the complexity of the systems which will be developed and must be adequately evaluated.

Fleet Command Center Systems

The Fleet Command Center System (FCCS), encompassing the FLTCINC centers and CNO's Naval Command Support Center (NCSC), will function as the key interface between the WWMCCS and the NCCS. Each FCC consists of three subsystems: the headquarters operations; intelligence facilities; and communications facilities. Associated with each subsystem are the equipments, procedures, and personnel required to provide the CNO, CINCUSNAVEUR, CINCLANTFLT, and CINCPACFLT with the capability to plan, command, and control the operations of assigned forces. The NCSC includes the CNO's flag plot, intelligence plot, and associated areas with their supporting communications centers, Automatic Data Processing (ADP) and non-ADP equipment, procedures, and personnel. For each FLTCINC, the FCC includes the FLTCINC decision area, the fleet watch area, the Fleet Ocean Surveillance Information Center (FOSIC), and associated staff areas with their supporting communications centers, ADP and non-ADP equipment, procedures and personnel.

The information processing and storage requirements for the FCC will be met in part by the existing systems at the FLTCINC sites (e.g., WWMCCS, OSIS (Ocean Surveillance Information System)). The FCC-unique processing capability is the Integrated Information Display (IID), which will extract data from these interfacing systems and perform the necessary processing, storage, display, and dissemination to integrate this data with that obtained through dedicated FCC facilities and to present the information in a form useful to the decision maker. The extent to which FCC capabilities will be provided through interfacing systems, including such considerations as the nature and capacities of communication links, the kinds and amounts of data extracted continuously or on an ad hoc basis, and the requirements for data processing, storage, and update

through the IID facilities, has not yet been defined. Such factors will be analyzed in the exercises previously mentioned.

Built-in training and operations analysis capabilities that will utilize simulation and exercise data bases are planned for the FCC. With these, the system will be able to switch resources between the real and the exercise world on demand, and utilize message stimuli generated internal to the system or input via the communications facilities of the FCC. The latter mode of operation (herein referred to as "exercise mode") will allow the FCC to participate in Fleet or Command Post Exercises.

Tactical Flag Command Center

The TFCC will be developed to integrate processed data from its supporting FCC with data from information sources organic to the task force, thereby providing the tactical flag commander the capability to correlate, summarize and display, in near-real time, tactical data and information required for effective accomplishment of missions and tasks. The availability of a TFCC/FCC computer-to-computer data link will provide the afloat commander more timely intelligence and permit him to more readily keep seniors advised of the status of forces, resource requirements, and the tactical situation. TFCC facilities are planned for CV, CG and LCC class flagships. Figure 1 illustrates the varying availability of interfacing on-board systems, and the consequent reliance on outside sources such as FCC, with ship type.

Unlike the FCC, which conceptually incorporates facilities of its interfacing systems, the TFCC concept is based on a self-contained system that draws on its interfacing systems for data only. However, as in the case of the overall NCCS and the FCC, the functional design of the TFCC and its interfaces -- nature of the links, resolution among multiple data sources, etc. -- will be examined through exercise and analyses.

TFCC functions will include operations analysis and the ability to accept and maintain simulated data to support training. The extent of these

capabilities and the means of their accomplishment have not yet been determined, but remote inputs as might be supplied through a satellite link with the FCC and/or NWGS are a distinct possibility.

COMMAND POST GAME CONCEPT AND DESCRIPTION

The Command Post Game (CPG) is an extension of the NWGS which provides for the interfacing of operational TFCCs and FCCs, thereby combining the facilities of the NCCS with those of the NWGS. This arrangement would enable use of the extensive NWGS game facilities, including large-scale simulation, game construction, monitoring, and umpiring, to support and upgrade C^2 system exercise capabilities, thereby reducing the burden on fleet personnel and requirements for equipment to conduct and reconstruct exercises. Besides offering support to the C^2 system, the CPG would also add to the NWGS. By incorporating physical facilities (hardware and displays) into the system, an actual operational environment could be simulated as part of gaming and training activities.

THE COMMAND POST GAMING SYSTEM

A notional CPG configuration, including representative communications links, is depicted in Figure 2. This configuration would make use of on-line communication links to operational FCCs and TFCCs, which would participate in the game in the exercise mode. The figure also shows the installation of hardware at CWG to provide "exercise FCC/TFCCs". While not essential to the CGP, this installation would greatly increase its flexibility and could provide the CWG and NCCS programs additional benefits which are discussed below.

Operational Concept

With the CPG the traditional CPX would be replaced by a game driven by the NWGS. The environment generated for the FCCs and TFCCs would be that currently conceived for NWGS games with the data content and communications

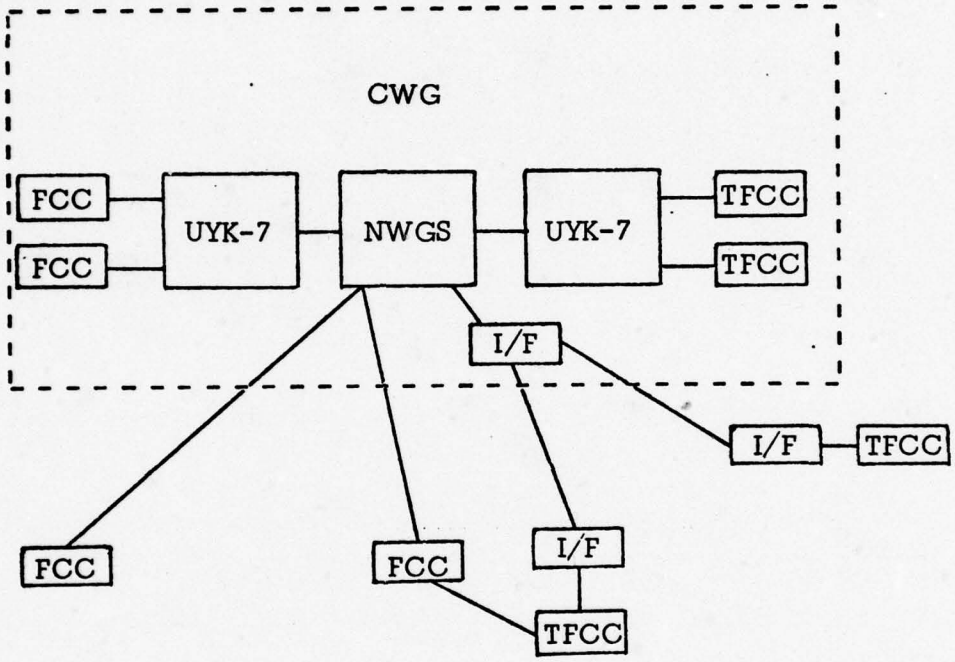

FIG. 2: CPG Configurations

formatted in accordance with the appropriate NCCS definitions. Game participants at the designated exercise consoles would have access to the full powers of the respective centers with the system automatically ensuring that the messages they receive or release, the data bases they access and update, the displays they are presented, and related characteristics of the center operation are those pertaining to the exercise. Communication facilities would automatically perform the internal and external routing of operational and exercise traffic. Insofar as feasible, all aspects of the man/system interface would be tailored to emulate actual operations, to make transparent to the participants any differences between operational and exercise modes.

The CPG would be managed by umpires who would use the game consturction capabilities of the NWGS to define the forces and to input the elements of the OPORDER, and who would continue to monitor the game, supplying necessary amplifying information and formatting responses to any queries beyond the scope of game data bases. With the configuration shown in Figure 2, a full-scale game could include real and exercise command centers in addition to a mix of real and simulated naval forces; the NWGS would update kinematics and supply weapon and sensor interactions among units.

The NWGS would transmit to the FCC simulated external sensor and source input and the message traffic from the exercise TFCC, other FCCs, and NCA. It would receive FCC traffic for the exercise TFCCs, FCCs, and NCA, and tasking for the game's fixed sensors. NWGS would also: supply the TFCC on-board and external system data and traffic from exercise FCCs and TFCCs; receive the traffic for the exercise FCCs and TFCCs and directives to unit commanders; and maneuver the tactical commander's game forces in accordance with directives from the commander. Appropriate extracts from traffic between operational FCCs and TFCCs would be forwarded to the NWGS as needed to monitor and update game conditions.

The participating centers would continue to be netted for debrief, utilizing the NCCS communications and display capabilities to allow personnel to be

debriefed on station. Data normally recorded by the respective FCCs and TFCCs would afford reconstruction and playback from the local viewpoint, while a master record and display commands would be broadcast from CWG (Center for War Gaming) to effect the game-wide debrief.

Potential Benefits

By making use of the automated facilities of the CWG and the next generation command centers, the Command Post Game would provide a powerful and versatile tool for operational development of the NCCS, test and evaluation of NCCS performance, and NCCS readiness training. In contrast to today's CPX, the participants would experience a realistic sense of operations resulting from the system's real time response to their actions, and reconstruction would be rapid and accurate, featuring continuous play group display that could be frozen at any point to permit complete and credible situation critique. Additionally, six specific improvements in exercise capability would be produced:

(1) The CPG would afford the full flexibility of the NWGS in the play of the game, rather than following a pre-programmed sequence of events. The range of options normally available through the NCCS would be presented to the commander and his staff, and the consequences of their actions would be fed back in the progress of the game. The game could readily be stopped, started, or recycled to respond to operational exigencies or to permit examination of variations in situation or alternate courses of action.

(2) The availability of the group displays for debrief would give all participants a clear picture of the overall operation at all times to help them develop better insight into their own contributions and responsibilities. In addition, the data captured by the system would make possible the reconstruction of the viewpoint of any operator station at any point and its comparison with the game situation to assess communications, processing, or retrieval capabilities or to help refine operating procedures.

(3) With the capabilities of the NWGS to conduct a game and of the NCCS to capture data and play back the exercise, the workload associated with exercises should be greatly reduced. Such reduction would occur both in the amount of time and the number of control group personnel required for pre- and post-game activities and data recording, and in the total man-hours required for game brief and debrief.

(4) The CWG could serve as a theater for observers not engaged in the conduct of the game. These observers would receive all of the reports and information they need, while the operational facilities would be fully dedicated to the command center personnel engaged in operations or the exercise.

(5) The optional installation of FCC and TFCC equipments at CWG would afford the CPG full flexibility in the makeup of forces and command structures. FCC or TFCC suites utilizing the exercise capabilities of their operational counterparts could be configured to represent multiple centers or various stations within a single center. Available operational centers could then be augmented by exercise centers playing hypothetical roles or the roles of centers unavailable by virtue of operating schedules or personnel availability.

(6) Installation of the CPG communication links would make feasible the exchange of static data common to FCC and NWGS files, such as ship characteristics or sensor performance parameters. This would permit consolidation of the maintenance efforts, effecting a savings that could be shared between the programs.

On the other hand, the utility of the CWG as a tool for investigation and analysis of proposed concepts, tactics and/or systems would be increased by the on-line accessibility of operational command centers, and the optional installation of FCC/TFCC suites could provide additional command and student gaming enhancements. Specifically:

(1) FCC equipment could satisfy some, and possibly all, remote NWGS access requirements at the CNO and CINCFLT sites.

(2) The CPG would add a dimension of reality to CWG games. In those situations where the outcome might be affected by human factors such as operator level of proficiency and motivation, efficacy of the man/machine dialog, physical layout of the center, etc., the CPG would reduce the necessity to approximate or simulate these factors, with a corresponding increase in confidence in the outcome. Similarly, incorporation of actual inter-center communications into the game would enhance the realism of game communications.

(3) Incorporation of FCC and TFCC equipment into the CWG would bring command gaming the versatility described above as an exercise enhancement and would contribute to the NWC curriculum by promoting familiarity with real, rather than representative centers. The resulting facility could, in fact, become an educational center for training for command center officers.

(4) The TFCC and/or FCC suite installation would provide the CWG with additional display capabilities. This would probably reduce NWGS initial development cost and the cost of modifications to keep abreast of the upgrades to the decision aids in the operational centers. If this equipment were found to satisfy completely the CWG display requirements, NWGS hardware and software could be optimized to the gaming requirement.

Finally, a phased program of sharing and interconnecting facilities with the CWG could provide powerful analytical tools to the NCCS programs. The value of such an approach is particularly evident with regard to the TFCC evaluation and the previously mentioned NCCS architecture definition. Specifically, three benefits would accrue:

(1) The connection of a prototype TFCC to the NWGS could be used to perform analyses for an early assessment of the contribution of the TFCC to the decision process. These analyses would ideally commence prior to the on-board tests of OPEVAL and would continue as needed to maximize effective utilization of at-sea time. This configuration could then serve as a continuing test bed for the evaluation of proposed follow-on decision aids.

(2) The CPG could be used as a supplement to fleet exercises to simulate alternate NCCS architectures under a variety of operating conditions

and missions to assist in the ongoing NCCS functional design.

(3) The exercise capabilities intended for the FCC and TFCC are not yet well defined and bounded; however, to begin to approach the level of capability that is available through the NWGS would entail considerable development cost and would impose severe strain upon NCCS resources for execution. Implementation of the CPG would reduce demand for indigenous NCCS simulations to a minimum required for system operator proficiency training and to perform operational analysis when the availability of CWG resources could not be guaranteed.

PROPOSED DEVELOPMENT APPROACH

The NCCS development program, together with the NWGS requirements, suggest a phased implementation of the CPG that would provide a significant increase in capabilities over those of the independent systems without a commensurate increment of cost and risk. Although the two programs appear to allow considerable latitude in the establishment of CPG milestones, the TFCC prototype evaluation is schedule to begin mid FY 79; for maximum benefit from a connection to the NWGS, the required interface should be available near this date.

A four phase program attuned to both the NCCS and NWGS programs is presented here, providing a progression of capabilities that culminates in the full CPG. The Phase I-III configurations are illustrated in Figure 3; Phase IV has been previously presented in Figure 2. Certain overall assumptions and observations, in addition to those addressed specifically in the program phases, follow:

- The definition of special communications identifiers (e.g., content indicator codes) and handling procedures for exercise traffic is assumed. The advent of the NCCS, with its inherent ability to support fleet exercises, makes such a development likely, regardless of a CPG development.
- On-line connection of the NWGS to processors like those in the FCC and TFCC, will require prior existence or development of suitable interfacing hardware or software in the NWGS internal architecture; requirements for

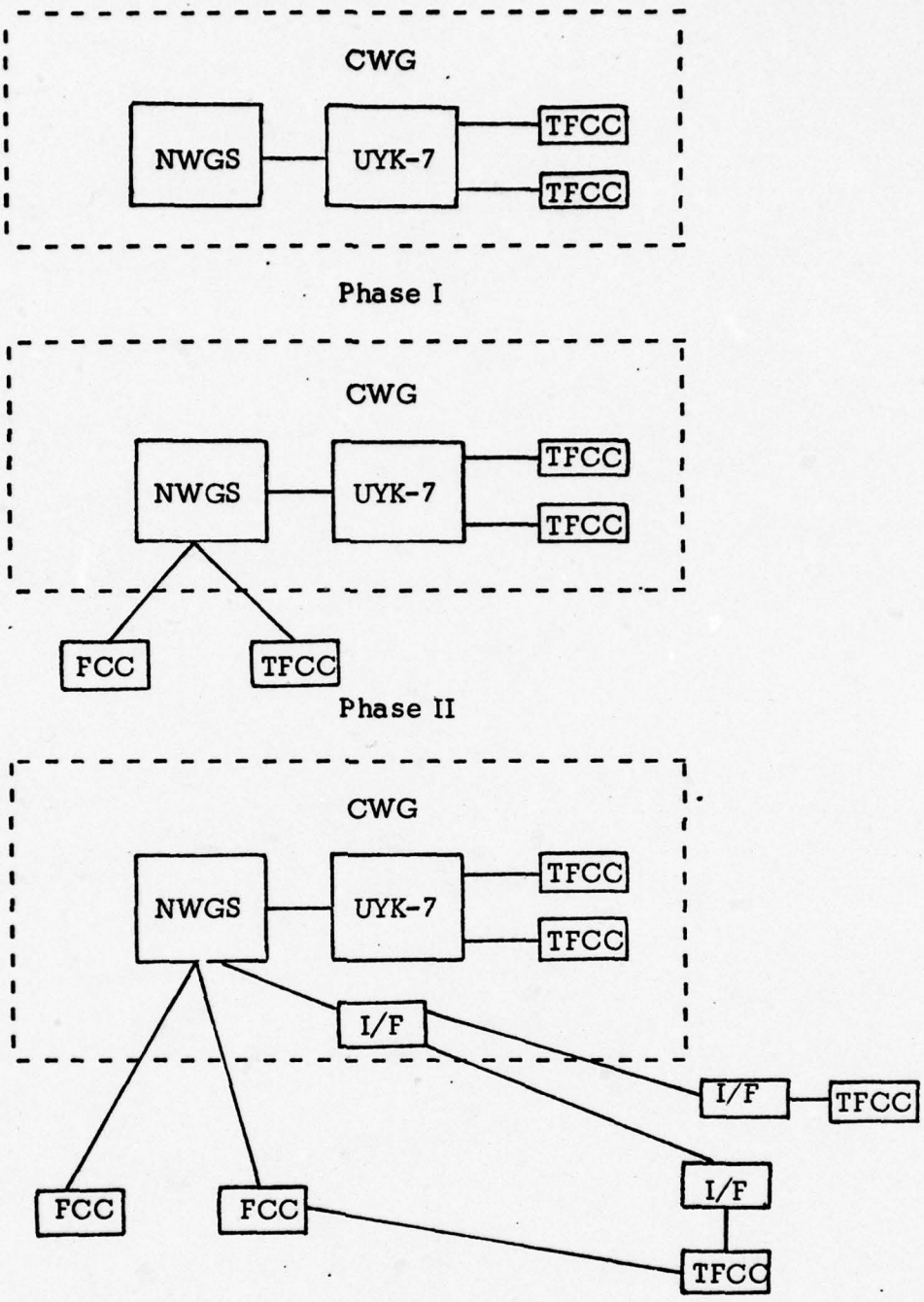

FIG. 3: CPS Development Configurations

these interfaces are not further enumerated in the discussion of the implementation phases.

- Interoperability between the NWGS and the command center units should be effected by matching the appropriate NCCS interface specifications in the NWGS rather than by augmenting the TFCC/FCC, to avoid the difficulties in upgrading the more numerous TFCC and FCC modules if changes are made.

- The command consoles of the NWGS are analogous in function to the command centers of the FLTCINC, and afloat commanders. The type of data derived from the game for presentation via these consoles and the game inputs from the consoles is presumed similar to that interchanged between the command centers and their operational environment. Hence, the incremental requirements NWGS interface with FCC and TFCC appears to be one more of format than of unique data generation.

- A meaningful statement of CPG impact on communications, such as loading, will be possible only when NCCS communications requirements analysis is available.

The implied four-phase CPG development program is outlined below.

PHASE I

The first phase in the CPG development would consist of a physical link between the NWGS and a prototype TFCC. A step in the development, rather than a distinct CPG capability, this phase would provide the test bed for TFCC evaluation and for development of the NWGS-TFCC interface. The TFCC prototype could be located at NWC or interfaced remotely, although in the latter case, certain of the advantages of the exercise TFCC would not be realized. This link would be effected through the interface management system that governs exchanges of data between TFCC and the various onboard systems, since the NWGS outputs to the TFCC would provide data similar to that available from the on-board system. FCC-TFCC communications could also be simulated utilizing this link, by positioning an umpire to respond to TFCC queries for FCC data not held in the TFCC.

PHASE II

The second phase would entail on-line communications between the NWGS and operational FCCs to permit CNO and the FLTCINC to conduct a basic CPG. These links would support the exchange of data among the FCCs and with the exercise TFCCs. With FCCs in the network, it would no longer be necessary for the NWGS to emulate FCC interaction with TFCCs.

This phase would require NWGS sensor simulators to feed the FCC with contact reports and responses to tasking messages. A basic communications network control capability would be needed at the CWG to effect switching among the FCCs, TFCCs, and the NWGS for this and succeeding phases.

PHASE III

Phase III would incorporate a communications link to the operational TFCCs to permit their participation in CPGs. At this point, most of the capabilities previously described for the full CPG would be available; only the exercise FCC would remain to be added.

This phase would require the installation of an interface device incorporating the Operational Test Environment function in TFCC-equipped ships to receive the simulated on-board system data and input it to the TFCC. A corresponding device would be required in CWG to format this data for transmission. To accommodate participation of TFC's and other actual forces in the game, it would be necessary for the NWGS to be able to accept actual force movements and status to determine interactions with simulated forces.

PHASE IV

With the installation of the FCC Integrated Information Display suite at CWG, the full CPG capabilities would be achieved. This installation would utilize the software previously developed for functional interface with operational FCCs. The only new requirement on NWGS would be the umpire-augmented

emulation of the processing support given the IID by collateral systems at the FLTCINC site. As has been previously explained, the extent of this support is yet to be determined.

FEASIBILITY AND CONSEQUENCES OF CONNECTING THE NWGS TO ANOTHER SIMULATION FACILITY IN A SUPPORTING ROLE

Abstract: An existing wargaming facility, TACDEWS is examined to assess the feasibility of using this system to provide inputs to support large-scale games played on the NWGS. The limitations discussed highlight the inherent difficulties in trying to absorb an existing wargaming facility into the NWGS and show that this kind of external interface is probably not a viable development option for the NWGS.

INTRODUCTION

Other monographs in this series show the potential benefits that would accrue from designing the NWGS from the outset to be directly interfaceable with major computer-assisted real-world command centers. This monograph addresses the question of whether direct interfaces with existing wargaming facilities would similarly offer significant extension/absorption potential in developing the NWGS.

As a basis for assessing the utility of such interfaces with existing systems, a simulation facility which appears to offer many capabilities that would be useful in the NWGS -- the TACDEWS and Master Simulation Program (MSP) -- is examined to determine the feasibility and consequences of using outputs from this system to feed larger-scale games played at the NWGS.

TACDEW SYSTEM CAPABILITIES

The TACDEWS MSP system is designed to function primarily as an adjunct to the overall training program for shipboard CIC and Flag Plot personnel. It provides computer-simulated sensor inputs from systems such as radar, sonar, sonobuoy, MAD, IFF, etc., to realistic mock-ups of NTDS-equipped CG, DDG, and CVA CIC and Flag Plot areas. These inputs are processed and displayed in the same manner and on the same equipment as found aboard the ship type represented. In addition to computer-generated data, problem-control personnel supply information appropriate to the exercise over simulated radio nets. The MSP is theoretically capable of simultaneously conducting up to eight separate exercises involving a total of 335 tracks. It can be programmed to depict with high accuracy the characteristics of up to ten different aircraft types and eight different ship types. The system can account for winds, ocean currents, and magnetic variation between 45° north and south latitudes.

GENERAL SYSTEM LIMITATIONS

As indicated above, the MSP has sufficient capability and versatility to achieve the purpose for which it was designed, i.e., to train personnel through detailed simulation of tactical battle conditions. However, it does have its

limitations, some of the most significant of which are:

- Game Size Limitations. Only one CVA can be simulated during an exercise, thus precluding a multi-carrier exercise.
- Execution Rate Constraints. Although the system is capable of running at up to 4 to 1 time, it is normally limited to real-time (1 to 1) by the detailed nature of the exercises usually presented.
- Personnel Limitations. Manning of the TACDEWS at the Fleet Combat Direction Systems Training Center is limited to essential capabilities needed to manage the smaller-scale games played in the TACDEWS. Thus, while greater capabilities are provided in the MSP, these cannot easily be realized because there are not enough trained personnel to operate the various equipments.
- Equipment Problems. This goes hand-in-hand with the preceding problem. There are only seven consoles available for communicating with the system during an exercise. This limits the number of ships and aircraft that can be controlled by human players while an exercise is running, and as a result, severely restricts the amount of action-reaction play that can be simulated. This is discussed in more detail further below. Thus, even were more players provided, the Free Play capability in TACDEWS could not be expanded without an investment in more consoles and/or larger programs.
- Game Executive Limitations. The system has no land mass simulation and, therefore, lacks the capability to portray realistically anything but an open ocean scenario.

FREE PLAY CAPABILITIES

As indicated above, the ability of the TACDEWS MSP to handle an action-reaction interplay in freely played war games is restricted by the number of units (ships and aircraft) that can be manually controlled. When used as a training device, the system can handle a large number of tracks and present a very complex multi-threat environment to the various ship mock-ups, because practically all of the hostile (and often many of the friendly) actions can be pre-programmed. Under these training conditions, it is necessary to provide

manual control only to those friendly units that are actually reacting to some pre-programmed threat, and the number of problem-control operators and computer consoles available is usually sufficient to cope with this level of activity. However, in a Free Play situation the actions of ships and aircraft are unknown before the actual play of the problem, and therefore relatively little can be programmed ahead of time. This means that in Free Play all units must be controlled manually for the duration of the game.

Within these limitations, capabilities of the TACDEWS MSP for the various types of freely played games are:

- AAW Free Play Game. The "Blue" and "Orange" players are limited to an AAW-type exercise. Because of equipment limitations in Problem Control, the maximum numbers of tracks that can be entered and controlled are fourteen friendly and nine hostile aircraft. Jamming and Electronic Warfare information is available to each group of players.

- Surface Free Play Game. The scope of this exercise is limited to the locating and reporting of surface forces. The number of Free Play targets is again restricted by the equipment available in Problem Control. Jamming and Electronic Warfare information is available to each group of players. A maximum of two P3s can be exercised, but a few additional aircraft may be employed in search roles.

- ASW Free Play Game. This type of exercise is the most difficult to implement, because submarine expertise is limited at this center and submarine simulation would require additional hardware similar to that needed for surface Free Play. A submarine might be pre-programmed for certain ASW missions, such as a submarine transit or a submarine on-station, but this submarine target could not be dynamically controlled after initial detection. The Master Simulation Program (MSP) is capable of handling simultaneously only five active sonar contacts. There are no automated means of reporting sonobuoy information, but reference points can be entered at the desired position of the sonobuoys and information manually generated by problem-control operators. Sonar information is limited to range-of-day information; the MSP does not contain structured ocean data.

FREE PLAY LIMITATIONS

If used as a vehicle for freely played games, the limitations of the TACDEW MSP would be severe:

- The number of players for any game type described above is limited to a total of eight, e.g., four "Orange" and four "Blue".
- Unmanned units or pre-programmed forces would be nothing more than video displayed to both groups of players. Problem-control personnel could not control unmanned units because of the amount of on-line functions required.
- "Orange" tactics may not provide the realism required for the "Blue" players because of the limitations on the number of Free Play targets that can be controlled. Through pre-programming, TACDEWs can provide hostile raids in excess of eight aircraft. Missile profiles from on-line vehicles are unrealistic during Free Play. Air-launched ASCMs are limited to 95 miles.
- Visual sighting reports from aircraft can only be resolved by participation of pilots/crews of aircraft types included in the scenarios. Crews or pilots are not attached to the command but could be made available through inter-type cooperation. Pre-written scripts for Free Play are not practical.
- Ships crews to support controlled Free Play exercises would receive limited training due to the limitation placed on Free Play alternatives and the loss of pre-programmed capability. Training presently received during the LANTFLT Tactical Command Readiness Program (TCRP) includes pre-programmed high density multi-threat environment. Possible boredom of the crews could adversely affect the success of a Free Play exercise.

DISCUSSION

Clearly, the TACDEWs MSP performs credibly in cases where most of the exercise proceedings can be stipulated in advance, but was not designed (and lacks the flexibility) to handle large-scale, real-time, action-response exercises. Obviously, then, it is not suited in its present form to be used in conjunction with a large-scale war game, at least not in a real-time sense, since the action in the such games is singularly unpredictable.

The next question to consider, then, is whether the TACDEWS facility could be modified to make it more amenable to Free Play exercise, and then connected with the Newport wargaming facility to enhance the war game play there. At present, the two systems are designed to achieve completely different aims, they function in totally different ways, and they don't even talk the same language. There is no doubt that, given enough time and money, the equipment of the two sites could be altered and linked together. It would mean, however, starting from scratch with new systems and, probably, new hardware as well.

It therefore appears that it would not be worth the attempt. Even if the means were available to enlarge sufficiently and modify the TACDEWS MSP system to make it reasonably compatible with the Newport system, it is difficult to see how this would contribute significantly to the play of a large-scale war game. It seems that as long as the TACDEWS facility retains its basically tactical character (enlarged or not), its utility for a larger-scale war game will be limited to a considerable extent to merely providing a different way of evaluating the outcome of an engagement. In other words, it would constitute a very complex and expensive engagement assessment model. Granted, tactical training would be received by those actually playing in the TACDEWS mock-ups, but that could be accomplished as well in an exercise without the larger war game backdrop and without the associated coordination problems. On the other hand, training in campaing-level decision-making requires only that some means of generating the results of tactical interactions be available to provide feedback to the players for continued play of the game. Players at this level accept damage assessment generated by any reasonable method, for they are interested primarily in the information itself. Thus, using the TACDEWS MSP system (even if modified and expanded) would be only a very expensive (and difficult to coordinate) means of obtaining battle results, and hardly worth it when there are other comparatively inexpensive and easier-to-implement alternatives, such as improving the Newport wargaming facility itself.

CONCLUSIONS

As seen from the preceding discussions, the TACDEWS MSP system as it stands provides limited capabilities for pre-programmed and freely played engagement-level games in a single threat environment. Any direct interface with the planned NWGS in its present form would at best provide inputs to engagement-level games played at the NWGS on what will probably be incompatible hardware with unnecessarily costly and complex engagement assessments. Given the inherent limitations in what can be played in the free play mode with TACDEWS and the difficulties in matching program languages, rates of play, output formats, etc., any attempt to use TACDEWS to provide inputs to larger-scale games controlled by the NWGS is, then, presently not cost-effective, and the cost of modifying TACDEWS to play such a role makes this alternative even less attractive.

This is not to say, however, that the opposite kind of interface -- one which would enable the NWGS game executives and weapons simulators to drive and manage a wider variety of games played at the TACDEWS facility -- would not be beneficial. This kind of interface is examined in other monographs in this series.

PROBABLE DEMAND FOR REMOTE ACCESS TO THE NWGS

Abstract: Current planning for the NWGS calls for provision of remote access capabilities so that NWGS game consoles can be located outside of the Naval War College and used as additional command centers for large-scale games or as a means of tapping the NWGS system simulators or capabilities data bases. This monograph describes classes of possible Navy users of such remote accesses, examines the wargaming applications each class of users will be most likely to support with remote access, and estimates the total demand for remote access that might be generated.

INTRODUCTION

One of the features planned for the NWGS is a remote access capability that will enable users outside of the Naval War College to use local game consoles and telecommunications links with Newport to participate in large-scale war games, use the NWGS system simulators, and/or query the NWGS weapons capabilities data bases. Since this feature is likely to be attractive to many potential users of wargaming and simulations throughout the Navy, the initial design of the NWGS must recognize and accommodate a large demand for remote use. Specifically, system designers will need early answers to questions of who the possible remote users will be, what NWGS capabilities they will be most likely to use, and how often will they require access. This monograph provides a basis for answering these questions by identifying classes of potential users of remote access whose needs are similar, defining for each user class the type of access that may be desired, and estimating the frequency with which a member of the user class might be expected to use the NWGS for different kinds of applications.

The characterization of user class needs is based on the characterization of possible applications of war games described in the first monograph in this series, "Computer-Assisted War Games: Structure and Applications." For ease of reference, the applications described there are summarized in Table I. In addition to the applications in Table I, frequent reference will be made to data base access, which will involve simple query of the NWGS weapons capabilities data bases. Because of the flexibility desired for the NWGS, the automated capabilities and characteristics of data bases in this system will be the most extensive and comprehensive ones of their kind. Since the information they will contain is useful through the Navy in answering day-to-day questions, operational planning, and developing long-range programs, the capability to query these data bases can be expected to be a very valuable byproduct of the remote access provided any user.

TABLE I.
APPLICATIONS OF WARGAMING

APPLICATION AREA	APPLICATION	OBJECTIVE
Operational Planning	Strategic/Force Level Planning Contingency Planning	Selection of U.S. force levels Formulation of courses of action if some event requiring military action occurs
	Exercise Planning	Selection of reasonable exercise objectives
	Threat Analysis	Estimation of difficulty in countering enemy systems and tactics
Training	Command Readiness Training Functional Unit/Team Training	Exercise of Flag level decision skills Test and streamlining of team coordination
	Individual Training	Expansion of experience base of junior officers
Operational Development	TAC D&E - Force level tactics - Platform tactics - Weapons system tactics	Development and evaluation of: - Multi-force, multi-mission tactics - Tactics for a given platform or heterogenous groups of platforms - Single weapons systems (e.g., an aircraft)
	C^2 System Development	Development and evaluation of operational procedures and doctrine for C^2 systems
	Analysis of Information Requirements	Clarification of command and tactical information requirements
System Development	New System Concepts	Determination of the impact of a new system on force effectiveness
	New System Parameters	Selection of technical parameters on the basis of operational requirements

USER CLASSES

One major possible class of users of the NWGS -- automated modes of the Navy Command and Control System -- has already been described in the earlier monograph and will not be considered here. To develop other classes of possible users of remote access to the NWGS, each of the activities outlined in Table I was examined to determine at what commands each is typically carried out and the extent to which each command was also involved in other activities on the list. This process suggested seven distinct, major user classes characterized primarily by the combination of activities they support:

- Fleet Commands. As the major operational commands for management of Navy forces, Fleet Commanders-in-Chief and the Numbered Fleet Commands are naturally involved in all kinds of operational planning on a continuing basis. In addition, they have responsibilities for force level TAC D&E, and, if the CINCLANTFLT experience with Command Readiness Training is a harbinger, other Fleet Commands will begin to use this kind of training for their flag rank commanders. Finally, nearly all of the staff and command functions would profit from access to the NWGS data bases as a source of information on capabilities of forces and systems.

- Type Commands. Type commands are also typically involved in operational planning, particularly for fleet exercises. They may also run training schools and courses for teams and officers, and, when platform level TAC D&E is not tasked to designated development groups, they may maintain continuing TAC D&E programs.

- Warfare Training Centers. Any Navy training centers, such as FCDSTC, which provide team and officer training designed to improve coordination and command skills in warfare areas are primary candidates for use of remote access to the NWGS in the training role, and might profitably use the smaller-scale gaming capabilities of the NWGS as an adjunct or supplement to existing facilities. To be most useful in this role, the NWGS would interface directly with the displays in the training center mock-ups to provide tactical training

problems. However, even if this were not done, remote NWGS consoles would still be a useful medium for supplementary instruction.

- Development Groups. Some Navy development groups are tasked to provide TAC D&E by their respective type commands, and nearly all development groups are involved in systems analysis. They are, therefore, potential users of smaller-scale games and NWGS system simulators in their respective areas of responsibility.

- Navy Laboratories. Although Navy laboratories are usually well-supported with computer capabilities and are able to develop and use their own simulation models, they generally have neither the flexible wargaming capabilities of the kind needed to analyze threats and tactical constraints nor the extensive capabilities data bases needed to provide ready access to information on existing weapons and support system characteristics. In addition, where possible, access to quality system simulators in the NWGS would eliminate the need to develop such simulators at the labs when study efforts generate requirements.

- Major Development Agencies. In the material arena, standing major development agencies for Navy systems, such as the Naval Electronic Systems Command, Naval Ship Systems Command, etc., are continually involved in evolving development concepts and specifications. They are, therefore, potential users of remote access to the NWGS for system development applications. In addition, like the Navy laboratories, they would profit from ready access to the capabilities data bases to ascertain existing system capabilities.

- CNO. Finally, as a single member class, CNO is a natural candidate for access to the NWGS, if only because ready access to the capabilities data bases and system simulators would greatly facilitate budgeting and program development, which often generate specific questions as to force capabilities that require fast answers. In addition, access to the NWGS would provide CNO force level planners with ready access to a tool which could be used to resolve ambiguities or inconsistencies in planning inputs received from the field.

Table II summarizes the user classes identified here and shows for each one the activities in Table I in which members of the class are engaged that justify their consideration as potential major users. In addition, with the possible exception of warfare training centers, all of these users would benefit from the ability to readily query NWGS weapons capabilities data bases.

TYPE OF ACCESS

The preceding section identifies possible users of remote access to the NWGS. To identify the kind of access that they might require, it is useful to think in terms of a three-level hierarchy of types of remote access within which different capabilities can be accommodated:

- Full facility access, capable of supporting multiple-player, full-scale games. This kind of remote access would require convenient location of a wargaming facility at which were positioned physically separated input/output consoles with the internal communication links and umpiring capabilities necessary to assemble and conduct games equal in complexity to those conducted at the Naval War College. Such an arrangement might also accommodate multiple-site games in which both the Naval War College Gaming Center and one or more remote facilities were used.
- Multiple console access, capable of supporting smaller-scale, engagement level games that can be conducted in the free play mode against player opposition or in a computer-opposed mode with more than one player, to simulate coordination. Included in this level of access would be the capability also to support simultaneous play of a number of single-player games.
- Single console access, through which single player games or data base queries could be accommodated. Single console access would not preclude the user from distributing more than one console within the command as a matter of convenience; it would, however, preclude use of more than one console at a time.

In this hierarchy, any higher-level access automatically provides all of the

TABLE II

MAJOR USER CLASSES AND THEIR POSSIBLE USES OF REMOTE ACCESS TO THE NWGS

	OPERATIONAL PLANNING				TRAINING			TAC D&E			SYS DEV	
USER CLASSES:	Strategic/Force Level	Contingency	Exercise	Threat Analysis	Command Readiness	Unit/Team	Individual	Force Level	Platform	Weapons System	Concept Testing	System Parameters
Fleet Commands	●	●	●	●	o			o				
Type Commands			●			●	●		o	o		
Warfare Training Centers						●	●					
Development Groups									o	●	o	●
Navy Laboratories				●						o	o	●
Development Agencies										o	●	●
CNO	●	●										

● - Major activity, common to all members in the class.

o - Possible activity, supported by some, but not necessarily all members of the class.

capabilities offered by a lower one, so the type of access needed for the most demanding game that might be played by a user will support the full spectrum of his activities.

To determine the kind of access most appropriate for each user class, Table II was compared with Table III, reproduced here from Table I of the first monograph in this series, to determine the most demanding type of war game that might be used. The implied access requirements for classes of users in terms of the types of access identified above are summarized in Table IV. In constructing Table IV, when a user's activities were shown in Table III as possibly utilizing either single- or multiple-player games the choice of the most appropriate game was based on an estimate of the relative utility of multiple-player games to the user. Thus, development groups have been assigned multi-console access, because their involvement in platform and weapon system TAC D&E will often focus on questions of coordination of activities, which require the ability to handle separate inputs to force control. The Navy labs and development agencies, however, have been assigned single-console access because their involvement in weapons system and platform TAC D&E will be exploratory and not aimed at formulating procedures, so multiple-console access will be of lesser significance to their total activities.

FREQUENCY OF USE

The remaining question in developing a profile of demand for remote access to the NWGS is one of how often various capabilities might be used by potential users in each class. Specific estimates of this nature are very difficult to generate, because such estimation requires determination of the use which might be made of convenient, readily accessible capabilities that are not now offered the potential users that have been identified. However, by examining the nature of the activity and taking into account the relative difficulty in setting up and playing different kinds of games, it is possible to develop order of magnitude estimates represented by the codes:

TABLE III. POSSIBLE USES OF WAR GAMES
vs
TYPE OF GAME

USE	TYPE OF GAME						
	Full-Scale Games		Engagement Level Games			System Level Games	Data Base Query
	One-sided	Two-sided	Free Play	Computer-Opposed	Pre-programmed		
Operational Planning							
• Strategic/Force Level	●						*
• Contingency		●					*
• Exercise			o	o			*
• Threat Analysis				●			*
Training							
• Command Readiness	o[1]	o					
• Functional Unit/Team				●m			
• Individual					●		
Operational Development							
• Force Level TAC D&E	●[2]						*
• Platform TAC D&E				o	o		*
• Weapons System TAC D&E			o	o			*
• C^2 System	●[2]						
• Information Requirements	o	o	o				
System Development							
• Concept Testing			o	o	o		*
• System Parameters						●	
	Multiple-Player			Single or Multi-Player		Single Player	

● Best-suited for use
o Best-suited for some, but not all applications
* Can support activity

Notes:

[1] Careful structuring of scenario required.

[2] Requires iterations on the same scenario and therefore ought to be computer-opposed; fine grain detail on engagements required.

m multiple player games required; otherwise, single- or multiple-player games may be appropriate, depending on the specific question being addressed.

TABLE IV

APPROPRIATE ACCESS TYPE FOR POTENTIAL USERS
DERIVED FROM EXAMINATION OF THEIR ACTIVITIES

USER CLASSES:	ACCESS TYPE		
	Full Facility Access	Multiple Console Access	Single Console Access
Fleet Command	●		
Type Commands		●	
Warfare Training Centers		●	
Development Groups		●	
Navy Laboratories			●
Development Agencies			●
CNO	●		

- I - infrequent, less than one application per year on the average
- Y - yearly, 0-3 applications per year
- S - semi-monthly, 4-9 applications per year
- M - monthly, on the order of one per month, 10-14 applications per year
- MM - multi-monthly, 15-35 applications per year
- W - weekly, on the order of one application per week, 36-70 applications per year
- MW - multi-weekly, more than once a week, 71-100 applications per year
- D - daily, 3-5 applications per week, 101-150 applications per year
- P - as possible, very frequent application, in excess of 150 per year

Here, an application of a war game includes set-up of a particular game and its use with as many iterations as are necessary to solve a specific problem. Thus, for example, one user's setting up and running a system level game several times to test a range of parameters would represent but one application.

Tentative estimates of frequency of use expressed in terms of these magnitudes are displayed in Table V. These are not claimed to be precise, and might change under more detailed analysis. However, their reasonableness can be justified as follows:

- Force Level Planning - Force level planning is nominally carried out on a yearly cycle, so even allowing for pre- and post-input applications by CNO, demand for support of this activity by wargaming is not expected to exceed the yearly rate of use.
- Contingency Planning - Contingency planning is a continuing activity, but major contingency plans are evolved slowly and usually in response to some apparent change in the world situation or directives from higher authority. Hence, the relatively infrequent use of wargaming in support of contingency planning shown in Table V is reasonable.

TABLE VII
ESTIMATED ACCESS REQUIREMENTS FOR POTENTIAL USERS BY USE

	Full Facility Access	Multi-Console Access	Single Console Access
Fleet Commands			
- Strategic/Force Level Planning	Y		
- Contingency Planning	Y		
- Exercise Planning		Y	
- Threat Analysis		S	
- Command Readiness Training	S		
- Force Level TAC D&E	Y		
- Data Base Query			M
Type Commands			
- Exercise Planning			S
- Unit/Team Training		W	
- Individual Training		W	
- Platform TAC D&E			S
- Data Base Query			M
Warfare Training Centers			
- Unit/Team Training		MW	
- Individual Training		MW	
Development Groups			
- Platform TAC D&E		Y	
- Weapons System TAC D&E		Y	Y
- System Concept Testing		I	Y
- Parametric System Analysis			P
- Data Base Query			S
Navy Laboratories			
- Threat Analysis		[I]	
- Weapons System TAC D&E		[Y]	S
- System Concept Testing		[I]	Y
- Parametric System Analysis			P
- Data Base Query			S
Development Agencies			
- Weapons System TAC D&E		[I]	Y
- System Concept Testing		[Y]	Y
- Parametric System Analysis			P
- Data Base Query			M
CNO			
- Force Level Planning	Y		
- Contingency Planning	S		
- Data Base Query			D

[ ] - use that might be made of a nearby facility, but not sufficient to justify provision of higher level access.

- Exercise Planning - The estimated use rate shown in Table V is based on requirements for one or two major fleet exercises per year, for which free play games might be used to support planning, and quarterly smaller-scale exercises, usually managed by the type commands.

- Threat Analysis - In the case of the Fleet Commands, the semi-monthly estimate is notional only, based on an experiential estimate of the frequency with which they are called upon to respond to "what if..." queries from higher authority. In the case of Navy laboratories the small value is included to indicate that there is a possible demand for wargaming applications in the course of concept studies for new systems.

- Training - The semi-monthly estimate of command readiness training games replicates the present CINCLANTFLT Command Readiness Training Program, which supports 3-4 games per year. For other training, the daily use rate is consonant with a continuing curriculum in which the NWGS access is used as an adjunct to existing capabilities and/or multiple console access to perhaps several available consoles is used to support individual training. But use rates will, however, be lower when the schools are not continuously attended.

- Force Level TAC D&E - The use rate estimate is based on a 1 or 2 topic program and assumes each topic will inevitably be supported by a war game.

- Platform TAC D&E - The use rate estimate is based on a typical TAC D&E program of 5 to 10 topics, for which it is estimated only half the topics will require some sort of wargaming support, and only half of that support will involve multiple-player games.

- Weapons System TAC D&E - In the case of development groups the estimate picks up the rest of the estimated total wargaming support that will be generated by a 5-10 topic program. For the Navy labs and development agencies, possible applications will vary with the number of development programs, and the figures represent educated guesses as to numbers of systems in progress that may be in the concept development and engineering development

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phases at a given location. The greater use rate for Navy labs is based on the difference in applications: the Navy labs use Weapons System TAC D&E in an analysis role, to test for tactical constraints implied by notional systems, while development agencies use Weapons System TAC D&E to check out an emerging new system.

- System Concept Testing - The small figure for development groups merely suggests that these command may be called upon to analyze new system concepts emerging from the Fleet. For Navy labs and development agencies the estimates are again educated guesses. The inversion in relative frequency of application is based on the development agencies' greater responsibility in evolving and specifying development objectives.

- Parametric System Analysis - For development groups, Navy labs and development agencies, access to the NWGS system simulators can be expected to evolve into a tool much like a calculator, used on-call for obtaining quick answers. Demand for this kind of quick query access may, therefore, expand to absorb almost all available time after other, higher priority requirements are met.

- Data Base Query - The opportunities for quick read-out of information on force capabilities and system characteristics can similarly be expected to become a high-use item to remote users of the NWGS. Although bounds are indicated in Table V, if the query capability is easy to use and responsive, almost any estimate of query frequency is apt to be exceeded, unless its use is carefully controlled.

COMMENTS AND RECOMMENDATIONS

Remote Extensions of Smaller-Scale Gaming Capabilities

Implicit in the preceding analysis of possible demand for remote extensions of the NWGS is the assumption that such access will be provided for all types of games planned for the NWGS. In fact, current planning appears to consider only remote extensions for data base query and large-scale war games, while the system

level and engagement level games have been called out as requirements for the student gaming system (SGS) which, according to current plans:

> "... shall be designed to meet the requirements of the department and constituent colleges of the NWC for simultaneous student war games." 1/

As suggested by the potential uses and users of remote access described here, this system dichotomy in the current planning is unnecessarily restrictive. Nine of fourteen possible uses of remote access considered here are best handled by smaller-scale games against well-structured tactical opposition or by direct remote access to the NWGS system simulators. Since there is no technical impediment to extending these capabilities to suitably equipped remote users, the overall utility and value of the NWGS will be greatly enhanced if the planning for remote extensions is expanded to include system level and engagement level games. It is therefore recommended that:

- The remote access system for the NWGS offer users access to the full spectrum of games that will be developed.

Expansion of Planned Gaming Capabilities

One of the types of war games that has not yet been considered in planning for the NWGS is what would essentially be a computer-opposed large-scale game, i.e., a multi-player, large force game in which the "enemy" force would always pursue well-structured decision logics in the conduct of its operations. Omission of this alternative is natural enough if only Naval War College applications of the NWGS are considered, because considerable effort is required to structure a computer-implemented scenario and opposition for human players, and presence of umpiring facilities at the Naval War College enables a close approximation of such opposition in one-sided games. However, the ability to control and replicate opposition tactics is very important when the NWGS is used for force level planning, force level TAC D&E, and operational development of C^2 systems, and

1/ Detailed Statement of Requirements for a War Gaming Support System, 16 April 1975, p. 13

the preceding analysis of possible demand suggests that remote extensions will make the NWGS available to a large body of potential users of wargaming in these applications. Thus, development of this capability will further enhance the utility and value of the NWGS to possible remote users, and it is recommended that:

- Computer-opposed, full-scale games be considered as a possibility in the development of the NWGS.

A PROFILE OF COST FACTORS AND COST OFF-SETS TO BE CONSIDERED IN ASSESSING REMOTE ACCESS TO THE NWGS

Abstract: Cost elements, benefits, and possible cost off-sets for developing remote accesses to the NWGS are highlighted and discussed. No rigorous cost/benefit analysis is attempted, but the qualitative comparison of costs and benefits amply demonstrates the possible value of remote accesses.

INTRODUCTION

The preceding monograph displays a profile of possible demands for remote accesses to the NWGS that suggest there is potentially great utility and value in developing an extensive remote access system. However, there will naturally be possibly large costs in developing such a system, and one of the greatest near-term planning problems will be to decide how much of that demand should or can reasonably be met. To provide a basis for this effort, this monograph structures the associated cost factors that must be considered and examines the benefits and possible cost off-sets against which the related costs must be weighed.

COST FACTORS

The major costs of developing a remote access system for the NWGS will be incurred in five categories:

- Softward development
- Facilities construction and modification
- Console and computer procurement
- Communications costs
- Continuing operation and maintenance costs.

The specific cost elements in each category associated with each of the three type accesses -- full facility, multiple console, and single console, discussed in the previous monograph and re-defined here in Table I -- are summarized in Table II and discussed below.

Full Facility Accesses

Costs associated with developing and maintaining full facility accesses include in each category:

- Software development. Creation of full facility access capabilities would require development and implementation of four classes of software:
  - Communications protocols to manage the flow of information between

TABLE I.
TYPES OF REMOTE ACCESS TO THE NWGS

- Full Facility Access - capable of supporting multi-player, full-scale games, using remote access to NWGS game executives and program modules, requires convenient location of a wargaming facility at which are positioned physically separated input/output consoles, internal communications links among these, and umpiring capabilities. Can support games on-site or on-site participation in large-scale games run at the Naval War College.
- Multiple-Console Access - capable of supporting smaller-scale, engagement level games and/or simultaneous play of single-player games; when provided with the necessary auxiliary communications capabilities can serve as a command node for large-scale games played and managed at the Naval War College.
- Single Console Access - capable only of supporting access to the NWGS for single-player games, access to the system simulators, or data base query; display capabilities for the console are optional.

TABLE II

MAJOR COST ELEMENTS FOR REMOTE ACCESSES TO THE NWGS

Type of Access	COST ELEMENTS: Software Development	Facilities Construction & Modification	Console and Computer Procurement	Communications	Continuing Operation & Maintenance
Full Facility	- Communications protocols - Local game management & display - NWGS access routines - Interface management	- Remodelling and equipping of player spaces and game center - Site preparation for major computer facility	- Large size computer - Full capability	- Leased lines for data links, and voice and/or teletype coordination - Data, voice, and TTY cryptographic devices	- Full complement of operator and maintenance personnel - Expenses associated with major computer facility
Stand Alone Multiple-Console	- Communications protocols - Adaptation of some RWC software to minicomputers - Special software for interfacing existing displays	Minor remodelling as required to create space.	- Minicomputer - Full capability consoles	- Leased lines for data links with NWGS - Cryptographic devices for data link	- Few operator and maintenance personnel - Expenses associated with minicomputer operations
Stand Alone Single Console	- Communications protocols and controls for on-call system	None	Console only; various possible	- Voice-grade cryptographic devices for telephone & commercial costs OR - AUTOSEVOCOM or similar terminal	Negligible

the facility and the control facility at the NWGS.

- Local game management and display software for the facility to manage local variations in game play and segregate and construct displays from incoming data from the NWGS. An additional option here would be locally implemented communications simulator packages to queue and simulate disruption to and delays in the messages exchanged between the physically separated consoles
- NWGS access routines to enable remote call-up and use of the NWGS game subroutines to support conduct of the games played at the remote facility.
- Interface management software to establish and manage interfaces between consoles and the NWGS when local off-site consoles are used as player positions in full-scale games and when the facility is used as a concentrator for multi- and single-console accesses to the NWGS. Of these four classes of software, only the interface management packages represent a possibly substantial development effort, because: standard communications protocols are readily available; the local game management and display software can be tailored from the corresponding NWGS software; and the access routines will have already been developed for the NWGS executive.

- Construction and modification of facilities. Some costs may be incurred in setting up spaces for a full facility. These can, however, be held to a minimum, because any game consoles distributed among commands in the immediate vicinity of the facility for single console access may be used to achieve the necessary physical separation, while common user or special user telephone lines can be used to simulate inter-force voice communications.
- Consoles and computer procurement. A full facility will require a relatively large computer and some full capability game consoles.
- Communications. A full remote facility will require a secure, high-quality, high data rate communications line from the facility site to Newport, plus parallel secure voice and teletype coordination links. The costs will, however, be nominal since most candidate sites for such facilities will be close to Naval communications facilities, and should therefore be able to obtain lines and ac-

cesses on a shared-use basis through the Navy's leased line network. As with any of the higher level accesses, there will be a major initial investment to procure the required cryptographic devices.

- Operation and maintenance. A full remote facility will have a full computer facility and will, therefore, require personnel support and funding for continuing operation and maintenance. However, since the computer need not be continuously and exclusively used for wargaming, these costs can be distributed among the NWGS and a variety of general-purpose users in the area.

Multiple-Console Accesses

The majority of multi-console accesses will either be obtained through full facilities or located at Warfare Training Centers that can provide much of the needed support. The marginal costs of stand-alone facilities will therefore be nominal. Specific additional costs in each category are seen as follows:

- Software development. Most of the required software will have been developed for full facility accesses so the only additional development costs will be incurred in adapting the existing software to smaller computers that will be used to coordinate multiple-console games and in developing software for interfacing NWGS with the displays and mock-ups already installed at Warfare Training Centers.

- Construction and modification of facilities. Since multiple-console accesses do not require the physical separation of consoles, umpire support, or large computers needed for a full remote facility, construction and modification of spaces will be minimal, requiring only such remodelling as might be required to create a large enough space for accommodating a small computer and the necessary consoles.

- Consoles and computer procurement. Several full capability consoles will be required, along with a minicomputer to handle protocols and accesses.

- Communications. A stand alone multiple-console access will require the same data communications capabilities as a full facility, but the additional

costs of voice and teletype coordination circuits will not be incurred. Instead, long distance telephone should be adequate. Costs of the leased data line may be greater than for smaller, multiple-console facilities, since shared access to Navy leased lines may not be obtainable.

- Continuing operation and maintenance. At Warfare Training Centers these costs can probably be absorbed, because computer personnel will already be available and the demands will not be great. At other stand-alone, multiple-console facilities, one or two additional billets for operation and maintenance may be required. Other expenses will be negligible.

Single-Console Accesses

Stand-alone, single-console accesses will be obtained either through a nearby full facility or through a common-user, single-console access system. The additional costs for the single-console will, therefore, be limited to the cost of the console and either:

- Costs of secure lines to a nearby remote, full facility which may utilize small, on-line, voice-grade cryptographic devices and telephone lines; or
- Costs for developing a communications protocol and management software for a common-user, single-console access network that would use AUTOSEVOCOM or a similar common-user secure voice capability.

COST OFFSETS

While the software development and communications costs for remote accesses to the NWGS cannot be avoided, the costs for other items shown in Table II may be partially offset by savings in other areas. Possible cost offsets of this include:

- Direct savings from shared use of equipment. The computers and consoles procured to establish remote accesses may be used to support other functions, thereby reducing the proportion of their cost attributable to the NWGS remote access program. Possibilities for each kind of access are seen as follows:

- Full Facility Accesses. While the full capabilities of the computers at full remote facilities will be needed for large-scale games, their support will account for only a small fraction of the available computer time, and use of the computers for the single- and multiple-console accesses will require neither all of the remaining time available nor the full capacity of the computer when it is used. The computers at such facilities can therefore be expected to have appreciable capacity for dedicated or time-shared general-purpose applications. Conversely, if an adequate machine and facility is available in an area chosen for full facility installation, that facility might be developed around existing capabilities at a reduced cost.

- Multiple-Console Accesses. Since NWGS access is not likely to be demanded or even possible around the clock or at all times, the smaller computers needed to support multiple-console accesses can similarly be expected to have time available for general-purpose applications.

- Single-Consoles. Stand-alone, single-console accesses might be established through sophisticated calculator systems (HP 9525, IBM 5100, Tektronix 4051 and the like) or "smart" computer terminals. If this is possible, access consoles may be developed at little cost by users that already possess such systems, and when they are purchased as NWGS access consoles, they will be available for other uses. Actual cost of single-console accesses may, therefore, be but a fraction of the total cost of the console.

- Off-setting manpower savings. If the system is responsive, access to the NWGS force and system capabilities and system simulators will provide users with information and analysis support as good as can be found anywhere else. Thus, remote accesses can eliminate the need to maintain similar data bases and develop similar simulation models locally. When integrated across the wide spectrum of potential users of single-console accesses throughout the Navy, the NWGS substitute might save literally thousands of man-hours annually.

- Direct savings in TAD costs. Finally, for any users of remote access to the NWGS who would otherwise use the facility at Newport, availability of

nearby full- or multiple-console facilities would reduce or eliminate the TAD costs associated with such use. If Command Readiness Training Programs similar to that developed by CINCLANTFLT begin to be used by other commands, the dollar savings here would be substantial.

In addition to these more or less direct cost offsets, it should also be noted that establishment of NWGS remote accesses will in many cases require allowance of on-line voice or data grade cryptographic devices that might not otherwise be justified. While not strictly a cost offset, the resultant secure voice or teletype capability will be a definite asset to such users.

BENEFITS

In the many possible specific applications of the NWGS that have been discussed, the role of the NWGS has invariably been one of providing:

- Training and/or exercise capabilities that would be impossible or prohibitively expensive to obtain in any other way;
- Analysis and evaluation tools that may not be readily available elsewhere; or
- Ready access to information on force and system capabilities that may not be easily obtainable from other sources.

By eliminating time and distance impediments that might otherwise keep potential users from actually using these capabilities, the remote access system will ensure that they can be used to the maximum extent consonant with the needs of the users.

The benefits from remote access are therefore reflected in the value and utility of these capabilities to the individual users. Any assessment of such value and utility will necessarily be qualitative and subjective, because the capabilities provided by the NWGS are not now available to the potential users, and there is no generally accepted way to estimate the impact of training, analytical activities, and access to information on force effectiveness. Within these constraints, however, the capabilities that might be provided through remote access must be

estimated to offer substantial, unique benefits. The reasoning that supports this conclusion is briefly seen as follows:

- Full facility accesses. The full facility accesses would extend to the higher level commands the opportunity for frequent application of wargaming in improving: command readiness, operational plans, and C^2 system performance. These are three of the most sensitive and critical elements in a viable military posture and their adequacy is a matter of continuing high-level concern. Since there is virtually no other viable medium for the necessary training, analysis, and system exercise, remote access must be considered invaluable.

- Multi-console accesses. When used to support TAC D&E, multi-console access would provide a unique capability to test and validate hypotheses in a competitive environment to ensure that proposed tactics cannot be defeated by an intelligent enemy. As with any analytic effort, the ultimate value of TAC D&E cannot be measured directly. However, the capability to validate proposed tactics is essential to many projects, and multi-console access must therefore be considered as valuable as the activity itself. The use of multiple-console accesses to upgrade training capabilities at warfare training centers must similarly be considered to be as valuable as training itself, since access to the NWGS war games will automatically expand the base of situations for which specific experience can be gained by trainees.

- Single-console accesses. Finally, the ready access to analytical tools and information offered by single-console accesses to the NWGS must be recognized as a benefit whose value is virtually unbounded. Ready access to models and system simulators already developed for the NWGS will simultaneously encourage wider use of such tools and eliminate needs for local development where they are not frequently used.

Finally, the capability to query the NWGS data bases provided in any type of access will in many instances provide users with access to information that is sometimes so difficult to obtain otherwise that it is just not used to support decisions. Moreover, at places where such information is already available, remote

access to the NWGS data bases can eliminate the need to maintain the local data base.

ASSESSMENT

While no formal cost/benefit analysis has been attempted here, even a cursory comparison of costs, as modified by possible cost offsets, with benefits clearly suggests that development of substantial remote access capabilities may be warranted by the needs of the potential Navy users of wargaming. Moreover, in view of the extent and magnitude of the possible benefits and relatively minor associated cost, single-console accesses that would enable a large number of users to use the system simulators and query the NWGS capabilities data bases is clearly warranted. Such accesses could be: established relatively easily by providing for telephonic interfaces through AUTOVON, utilizing AUTOSEVOCOM terminals as necessary for security; managed on an on-call basis much as time-shared computers are managed today; and obtained by users through use of relatively inexpensive terminals. This kind of on-call, single-console access subsystem should be treated as a separate entity in the planning and development of the NWGS, regardless of the decisions made with respect to providing other, more elaborate remote access capabilities.

AN ARCHITECTURE FOR NWGS REMOTE ACCESS SUBSYSTEMS

Abstract: System, operational, and management concepts for three possible types of remote access to the NWGS are developed to show how the capabilities described in the preceding monographs might be developed and managed.

INTRODUCTION

To illustrate what might be involved in developing remote access capabilities for potential users of the NWGS, this monograph describes:

- The extent and type of equipment needed to establish full facility, multi-console, and single-console remote accesses to the NWGS, and
- The supporting administrative structure that would be necessary to organize, schedule, and coordinate use of each kind of access.

FULL FACILITY ACCESS

Operational Concept

Establishment of remote, full facility accesses to the NWGS requires creation of Remote Wargaming Centers (RWCs) modelled after the center at Newport. These RWCs would serve the two-fold purpose of providing convenient sites for remote play of large-scale, multi-player games that might be played by some users, and providing centers that could be used by nearby local commands for lower-level access, thereby eliminating the need for separate equipment and administrative support for each user.

For NWGS-controlled remote games the RWCs would serve as sub-control centers where remote player inputs would be queued for transmission to the NWGS and outputs would be separated and routed to the appropriate local consoles. Although control for many remote games would be exercised at the Center for Wargaming (CWG) in Newport, the complete system would allow for at least some umpiring functions to be exercised at the RWC, before the inputs were transmitted to the NWGS. Further, maintenance of a total force display would be provided, either at umpire consoles or on a larger display . Because of the flexibility and convenience they would offer, the RWCs would be expected to greatly increase the usage of wargaming in the Navy analytic community without putting a burden on the CWG it could not handle. Savings would be realized in travel expenses and man-hours over the current system and land line cost would be less than a remote system in which all remote players interacted directly with the NWGS.

Candidate locations for Remote Wargaming Centers would be areas in which a large number of potential users are concentrated, such as: Norfolk; Washington, D.C.; San Diego; and Honolulu.

Physical System

Each RWC would necessarily have its own computer system, which would not be nearly so extensive as the NWGS, but would have the basic characteristics of a CDC [1/] 6000 or UNIVAC 1100 series system. It would necessarily have tape and disk storage capabilities, software for game control and large screen and hard copy display capabilities. The center would also have several physically separated remote consoles on-site and the capability of interfacing with off-site remote terminals. It would therefore need remote terminal interface software, and software for queuing and transmitting inputs to NWGS and separating and distributing outputs from the NWGS. Finally, it would require a dedicated, encrypted, two-way, multi-channel land-line connection to the NWGS computer to support the required data and coordinating communications links.

Remote sites feeding into the RWC would require a terminal facility allowing on-line interface with the RWC or NWGS, CRT and hard copy display capabilities, and provisions for an encrypted connection to the RWC. A locally programmable terminal would give added flexibility. For instance, many of the highly sophisticated calculator systems (HP [2/] 9830, HP 9525, IBM 5100, Tektronix 4051) which the Navy is now buying might be used as remote terminals when equipped with the necessary peripherals.

Administrative System

The management chain for the operation of RWCs would begin at the Center for Wargaming (CWG) in Newport, where overall supervision would rest with a

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1/ Control Data Corporation
2/ Hewlett-Packard

member of the CWG with a title such as "Director of Remote Wargaming". It would be his job to approve and schedule wargaming activities involving the NWGS. At the Remote Wargame Centers activities will be overseen by a member of the staff of the senior area commander (CINCLANTFLT in Norfole, CINCPACFLT in San Diego and Hawaii, and OPNAV (probably OP-96) in Washington). All requests to use wargaming facilities by major subordinate commands would be channelled through the wargaming officer on the staff of the appropriate RWC. He would screen and schedule requests to use the RWC and, in turn, request the necessary time on the NWGS from the CWG Director of Remote Wargaming. Finally, each major subordinate staff (C2F, C3F, SURFLANT, SURFPAC, AIRLANT, AIRPAC, etc.) would designate a wargaming officer to handle requests from its staff and from its subordinate commands. To illustrate the administrative structure described above, Figure 1 displays the chain of command for forwarding a request to conduct a small-scale war game by the TAC D&E officer at Helicopter Sea Control Wing, Atlantic.

In light of the large potential demand for this kind of service, it is expected that significant use would be made of RWCs and that control would need to be exercised at several levels to: minimize duplication, cull unnecessary requests, keep usage within budgets, and determine what requests could be combined into one game. Further, it is expected that funding for the RWCs would be partly by direct, partly provided by users, and partly obtained from cost offsets from shared use of computers.

MULTI-CONSOLE ACCESS

Operational Concept

For users that require multi-console access, but would not be conveniently served by a nearby RWC, on-site or shared multiple-console access would be provided by a medium level facility (MLF), the main function of which would be to act as a focal point for remote play, with little or no control capability. The medium level facility centers would, however, provide a location for several remote players and would still queue inputs to NWGS and separate and distribute

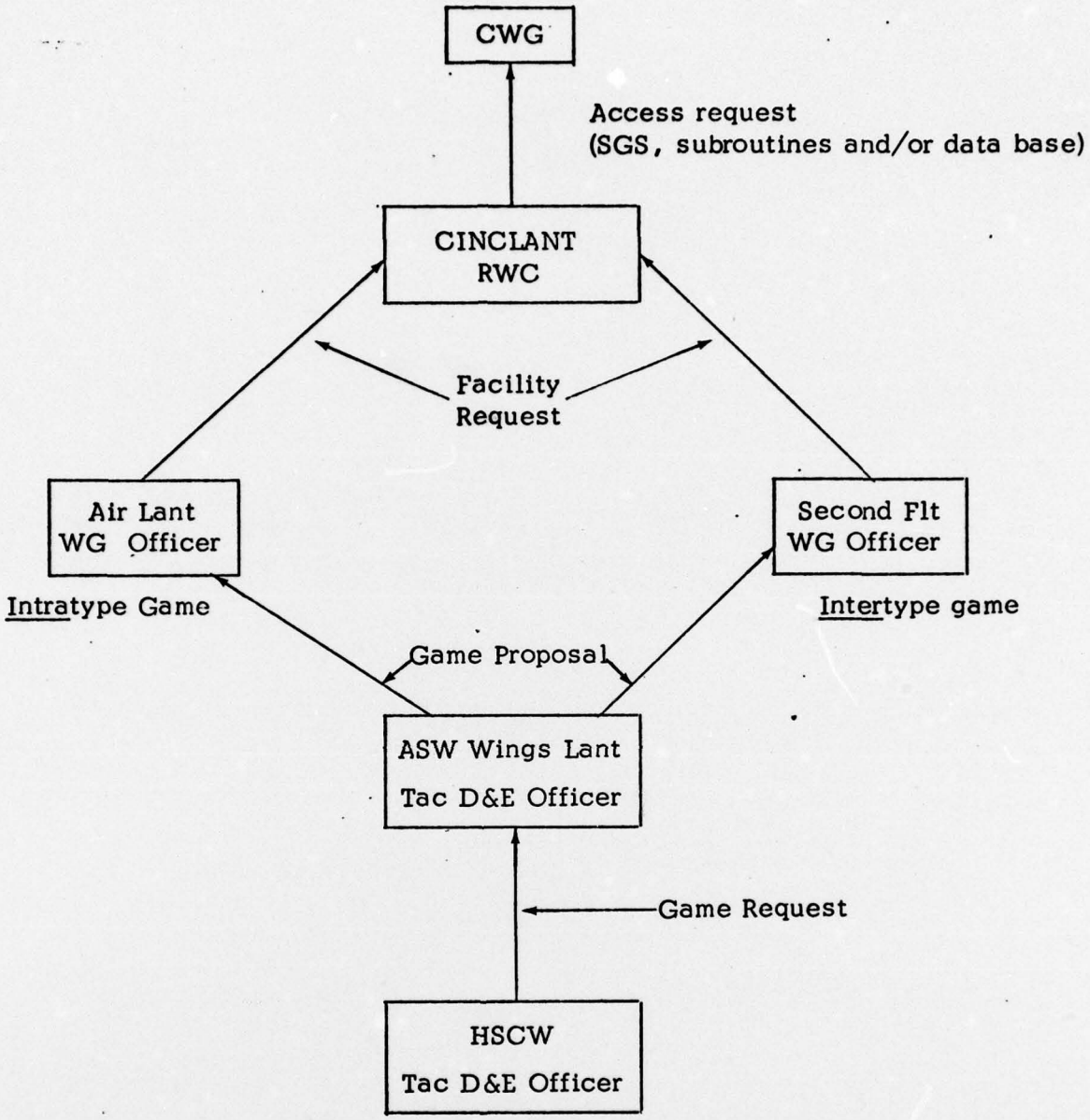

Figure 1:

Flow of Game Requests for War Games
Played through a Remote Wargaming Center

outputs from the NWGS. Depending on location, they would interface with an RWC or directly with the NWGS, and would be capable of supporting small-scale, multi-player games and directly accessing the NWGS capabilities data bases.

Physical System

Each MLF would contain a small (IBM 360/20, CDC 1700) computer or mini-computer system (DEC, PDP, HONEYWELL) which could interface with the NWGS over a dedicated, encrypted, two-way land-line. These systems would have software to queue inputs from remote sites feeding into the NWGS or RWC and transmit them sequentially. They would also have complementary software to translate outputs from the NWGS and distribute them to the appropriate consoles. In-house game control capability and software would be limited because of computer memory and storage size constraints, but an MLF feeding into an RWC would have the ability to become a node in a larger-scale game.

Administrative System

The same basic system as presented for the RWC would be needed except the wargaming officer at the MLF would have less responsibility and would act primarily as a go-between for users and the CWG Director of Remote Wargaming. He would therefore not need to be as senior as the RWC officer, need not be on the staff of the senior area command present, and, probably, need not dedicate all his time to that job, since there would be more direct liaison between the CWG and fleet commander representatives. To illustrate the administrative structure required to manage and coordinate use of MLFs, Figure 2 shows the change in command flow for the same Atlantic Fleet HSCW request for conduct of a war game through an MLF.

SINGLE-CONSOLE ACCESS

Operational Concept

Access to either a RWC or a MLF would simultaneously provide single-console access capabilities for most of the potential users of remote access to the

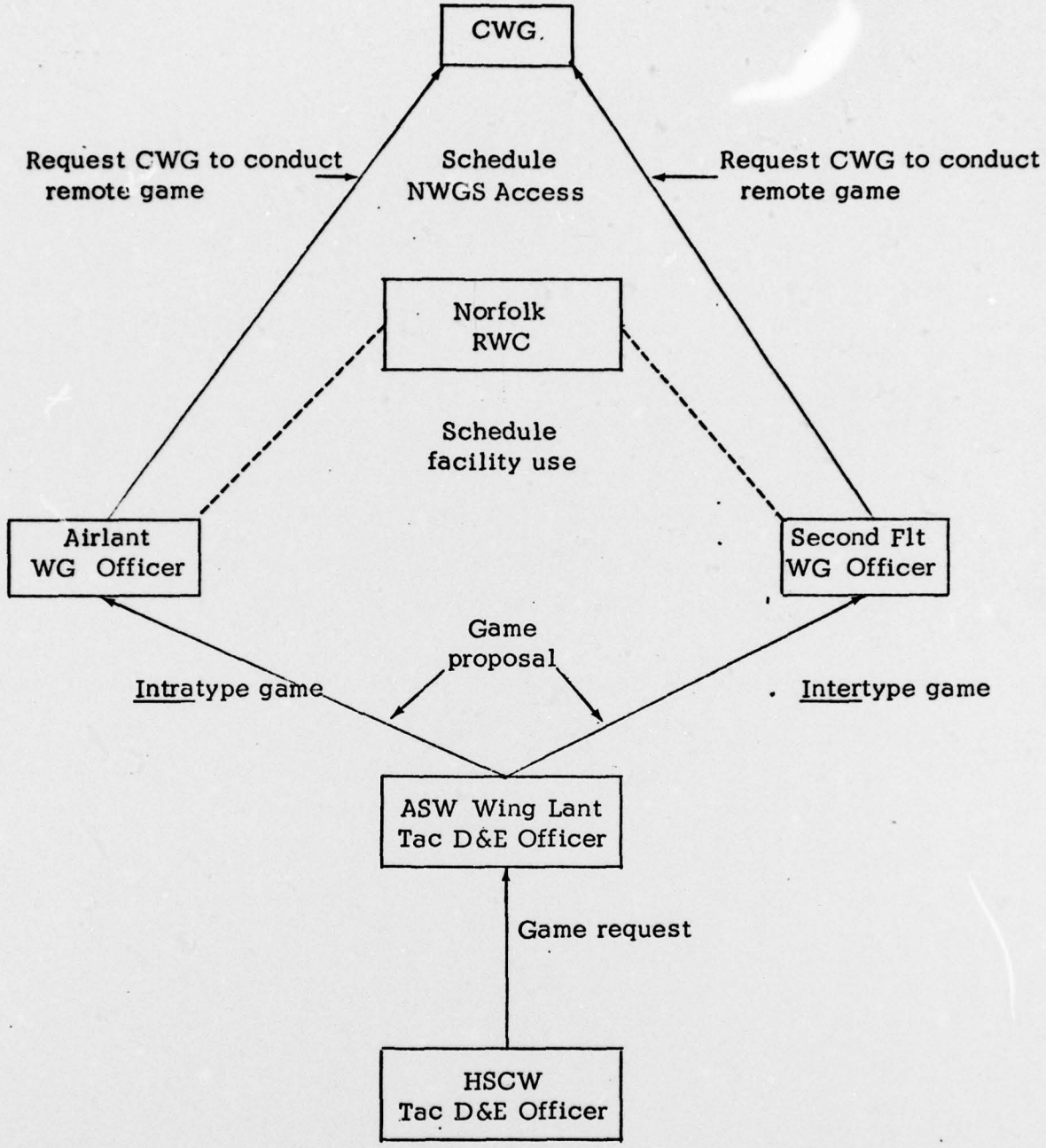

Figure 2:

Flow of Game Requests for War Games
Played through a Medium Level Facility

NWGS. However, for users requiring single-console access that are too far removed from either an RWC or MLF, and for some frequent users of system level games and/or data base query, a minimal remote access system might be provided. Such a system would consist of a console or small terminal that could be interfaced with the NWGS via AUTOSEVOCOM or a similar on-call common-user communications system to enable access to the NWGS system simulators and capabilities data bases.

Physical System

The consoles would essentially be remote computer terminals with the capabilities to respond to protocols and call-up routines for system level games and data base queries provided by the NWGS, together with minimal CRT and/or hard copy displays.

Administrative Structure

Management and scheduling of these single-console accesses would be under the purview of the NWC Director for Remote Wargaming. The magnitude of the demand for this kind of access, both through single-console systems and through MLFs and RWCs, can be expected to be so great that item-by-item approval of requests will not be practicable. Accordingly, overall management will probably best be handled by establishing schedules of periods during which the NWGS will be up and available for such access on an on-call, first-come-first-served basis.

OVERVIEW

The NWGS remote access system concept implied here essentially utilizes two networks: a teleprocessing network with concentrators and individual accesses at the RWCs and MLFs; and a parallel remote, on-call network for accessing system simulators and capabilities data bases. Illustrative node characteristics for these networks are displayed in Table I, to suggest the magnitude of the notional system.

TABLE I

PHYSICAL SYSTEMS FOR DIFFERENT LEVELS OF ACCESS

Structure Features	Access System RWC	MLF	Single-Console
Local Game Control	Yes	No	No (1)
Computer	Medium-Large	Small or Mini	None
Dedicated land-lines to Newport	4 2-way	4 2-way	None
Computer Peripherals			
Random Access Mass Storage	Disk	Disk or Floppy Disk	
Tape Storage	7 Track Tape	7 Track Tape or Cartridge	
Game Control Console	Yes	No	
Player Consoles	Several	Several	(1)
Large Screen Display	Yes	No	
CRT and Hardcopy Display	Each Console	Each Console	(1)
Several I/O Ports	Yes	Yes	
Software Requirements			
Higher Level Languages	FORTRAN	BASIC	None
Game Control Access	Yes	No	No
NWGS System Simulator Access	Yes	Yes	Yes
NWGS Data Base Access	Yes	Yes	Yes
Terminal Interface	Yes	Yes	Yes
Queue and Distribute	Yes	Yes	No
Communications Protocol	Yes	Yes	No
NWGS			
I/O Port Requirements	4	4	Many
Game Control Responsibility	Large Games	Most Games	All Games
Software Requirements			
Terminal Interface	Yes	Yes	Yes
Queue and Distribute	Yes	Yes	No
Allow Subroutine Access	Yes	No	No
Allow System Simulator Access	Yes	Yes	Yes
Allow Data Base Access	Yes	Yes	Yes
Remote Site Requirements			
Smart Terminals	Yes	Yes	No
CRT and Hardcopy Display	Yes	Yes	Yes

(1) Remote centers containing several consoles may be established, but these would not operate in concert, unless they were remoted to an RWC for large-scale game play.