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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

(U) The Falklands Wargame was conducted for the purposes of developing a maritime capability in the Contingency Force Analysis Wargame (CFAW) Model and comparing wargame results with history. During the conduct of wargame excursions, logistic constraint was used to increase realism and to provide an additional control mechanism in the wargame. Two excursions using the historical scenario and one additional free play excursion were conducted as part of the wargame effort.

(U) As a result of these wargames, a maritime capability was developed for the CFAW Model which is consistent in detail with the rest of the model. Although casualty assessments did not statistically match historical results, they appeared to be reasonable, based on subjective military judgement. The CFAW Model offers flexibility and robustness, which when combined with gamer imagination and innovation, provides a powerful wargaming tool.

(U) The CFAW Model is capable of portraying joint operations.

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STUDY REPORT
CAA-SR-86-21

THE FALKLANDS WARGAME

SEPTEMBER 1986

PREPARED BY
STRATEGY, CONCEPTS AND PLANS DIRECTORATE

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CAA
CONCEPTS ANALYSIS AGENCY

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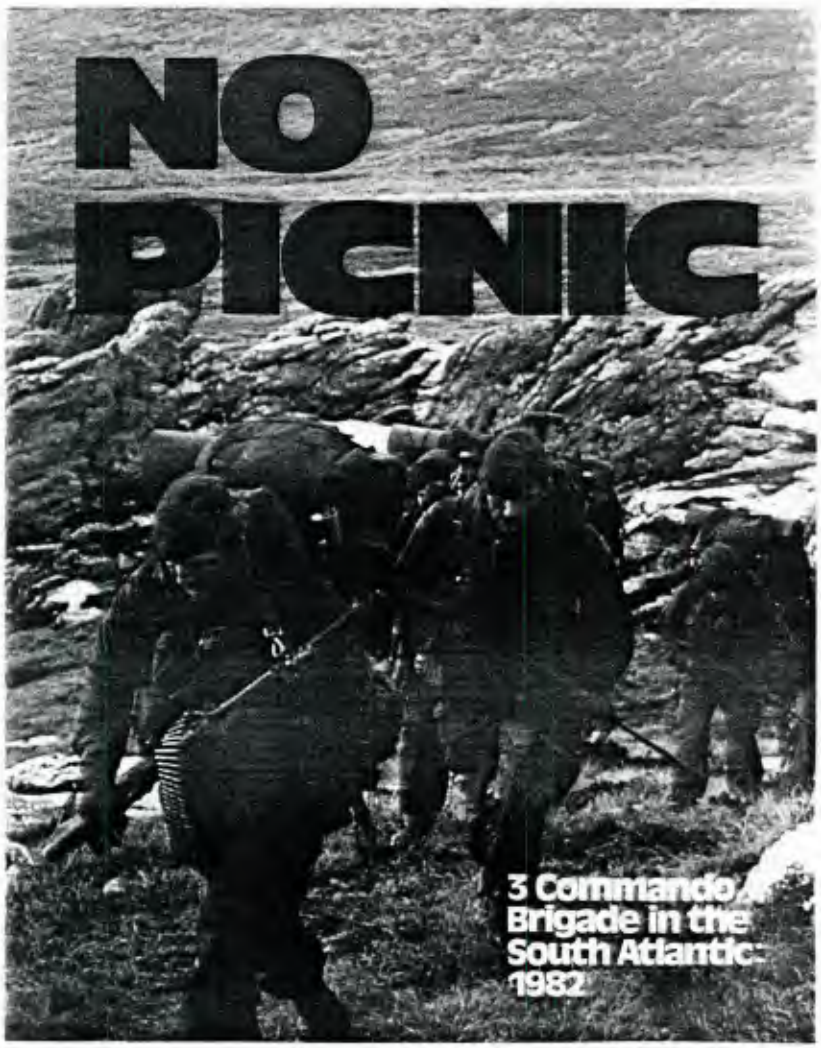
STUDY REPORT
CAA-SR-86-9

THE FALKLANDS WARGAME

September 1986



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The authors gratefully acknowledge the permission of Hippocrene Books, Inc. (New York) to copy the maps and photographs found on pages i, 2, 4, 12, 24, 32, 40, 44, 60 and 64 from No Picnic by Julian Thompson.

The authors gratefully acknowledge the permission of Harper-Row (New York) to copy the illustrations found on pages 20, 47, and 49 from War in the Falklands, The Full Story by the Sunday London Times Insight Team.

The maps on pages 14, 44, and 48 came from IDA Report R-271, "Lessons and Implications from the South Atlantic Conflict".

The photographs on page 24 came from page B1 of the July 13, 1986 issue of The Washington Post.

DEPARTMENT OF THE ARMY
US ARMY CONCEPTS ANALYSIS AGENCY
8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20814-2797

REPLY TO
ATTENTION OF:

CSCA-SPF

0 4 DEC 1986

SUBJECT: The Falklands Wargame

1. Reference memorandum, CSCA-SPF, 11 Apr 86, subject: Falklands Wargame Study Directive.

2. I requested that the Contingency Force Analysis Division conduct the Falklands Wargame for two specific reasons: to develop a maritime wargaming capability and to compare the results obtained through wargaming with historical results. This report documents the results.

3. I am particularly pleased to note that a maritime capability has been added to the Contingency Force Analysis Wargame (CFAW), providing the U.S. Army Concepts Analysis Agency with a means for analyzing joint operations.

4. Although comparing any model with history is extremely difficult for a variety of reasons, I believe it to be a worthy and necessary effort. In that regard, I am pleased with this wargame, even though the historical comparison met with more limited success.

5. I wish to acknowledge the superb assistance provided by Professor Wayne Hughes of the Naval Postgraduate School, who served as the Wargame Director and was instrumental in the successful development of the maritime modeling capability.

E. B. VANDIVER III
Director

CAA	THE FALKLANDS WARGAME	STUDY SUMMARY CAA-SR-86-21

THE REASONS FOR CONDUCTING THE WARGAME were to develop a maritime capability for the Contingency Force Analysis Wargame (CFAW) Model and to compare wargame results with history.

THE PRINCIPAL ACCOMPLISHMENT of the wargame was the development of a maritime gaming capability.

THE TIMEFRAME of the wargame was April-June 1982.

THE PRINCIPAL FINDINGS of this wargame were that:

(1) Sound play of most contingencies in an amphibious arena are now possible.

(2) Results reasonably comparable with history were portrayed.

(3) Wargamers are key to good gaming.

THE PRINCIPAL LIMITATIONS of this Wargame were that:

(1) Small unit tactics were not portrayed.

(2) The intangibles of combat could not be represented (e.g., Argentines did not attack many supply ships in the actual conflict).

(3) A single echelon of command and control was represented.

THE SCOPE OF THE WARGAME was to focus on the events directly associated with amphibious operations and the ground campaign in the Falkland Islands, excluding the earlier capture of South Georgia Island and the larger naval campaign beyond the immediate Falklands amphibious arena.

THE OBJECTIVES OF THE WARGAME were:

(1) To use Falklands maritime activities as a basis for designing a maritime capability in the CFAW Model.

(2) To conduct a quality assurance evaluation of CFAW wargaming by comparing its results with historical Falklands campaign results.

THE BASIC APPROACH was to:

(1) Review the campaign,

(2) Develop a maritime capability by defining the essential maritime requirements, making (or identifying) desired model improvements, and describing maritime gaming results,

(3) Apply logistic constraints, and

(4) Compare air, ground and amphibious campaign wargame results with history.

THE WARGAME SPONSOR was the Director, US Army Concepts Analysis Agency.

THE WARGAME was directed by Professor Wayne Hughes, CAA Adjunct Analyst, US Naval Postgraduate School, Monterey, CA.

COMMENTS AND QUESTIONS may be forwarded to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-SP, 8120 Woodmont Avenue, Bethesda, MD, 20814-2797.

Tear-out copies of this synopsis are at back cover.

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CAA-SR-86-21

THE FALKLANDS WARGAME

September 1986

Prepared by

Strategy, Concepts and Plans Directorate

US Army Concepts Analysis Agency
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CONCEPTS ANALYSIS AGENCY

INTRODUCTION

THE BATTLE FOR THE FALKLANDS

Section I. INTRODUCTION

PURPOSE AND BACKGROUND

The Falklands Wargame was conducted at the request of the Director, US Army Concepts Analysis Agency (CAA) in order to achieve two objectives:

- The comparison of wargame results with historical fact as a quality assurance evaluation of the Contingency Force Analysis Wargame (CFAW).
- The addition of a maritime capability to the CFAW Model.

The study directive which served as a guide for this wargame is at Appendix B. Terminology and study terms of reference changed as the study progressed:

- Although not explicitly stated in the study directive, addition of a maritime capability became the more important of the two objectives.
- It became evident that "addition of a capability" was a more appropriate description than "addition of a module". A new subroutine was not required; the existing model only needed to be modified.
- As the quality assurance evaluation unfolded, it was concluded that the measures of effectiveness (MOE) defined in the Study Directive were not good MOE. Air, artillery, and air defense were not significant elements of the ground campaign and that MOE was eliminated. Number of casualties was also not a good MOE to use (discussed futher on pages 43, 59, and Appendix F).
- The need to reflect tenuous logistical lines of communication (LOC) for both British and Argentine forces caused an additional objective to be identified: the development of a procedure whereby logistical constraint could be imposed on the forces fighting the Falklands Campaign.

SOURCES OF HISTORICAL INFORMATION

TIMEFRAME. May-June 1982.

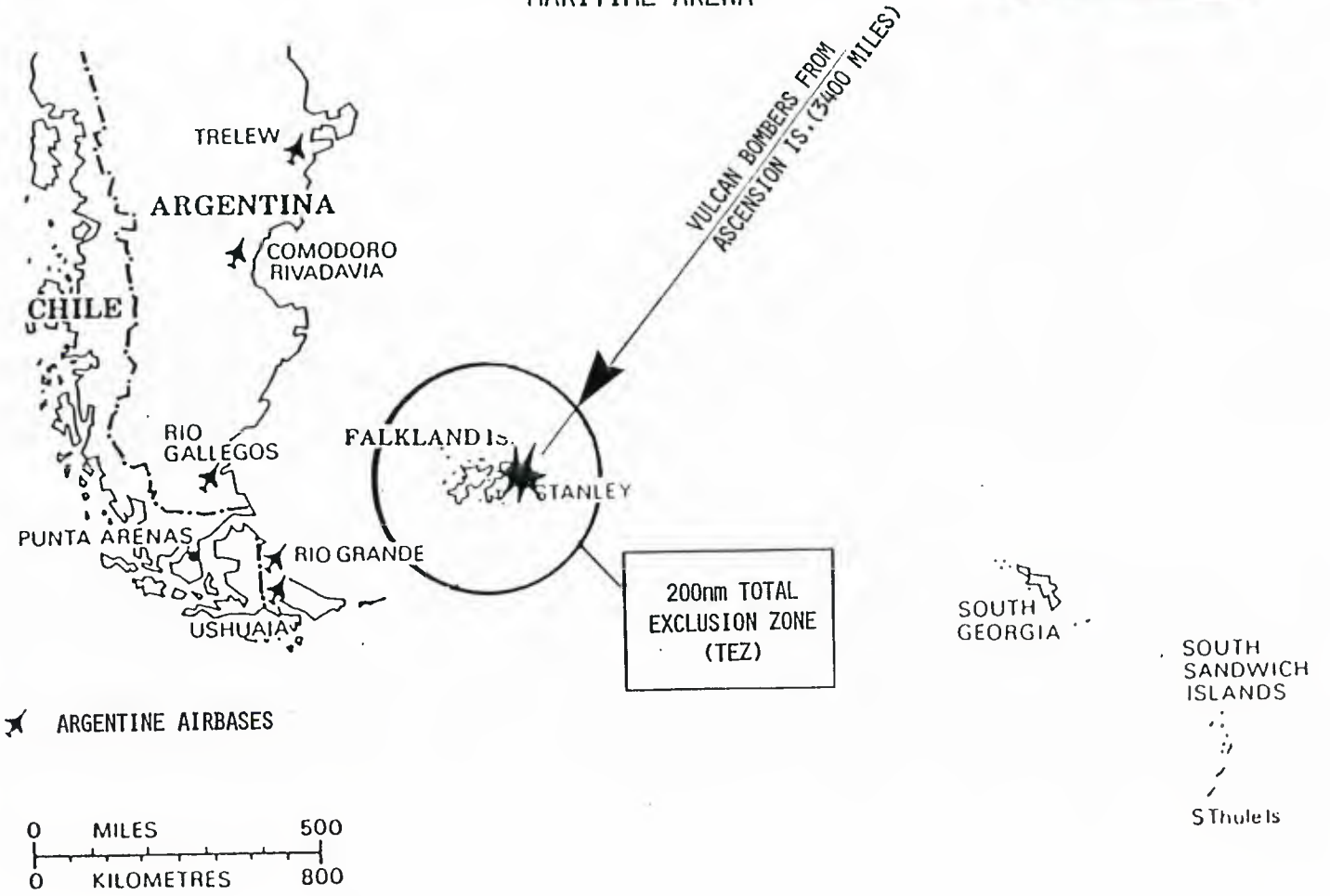
SCOPE. This wargame focused on the events directly associated with amphibious operations and the ground campaign in the Falklands. The earlier capture of South Georgia and the larger naval campaign beyond the immediate Falklands amphibious arena were not explicitly included; however, Appendix E discusses these events for the purpose of identifying candidate maritime capabilities for incorporation into the CFAW Model and documents the conclusions reached concerning each of these events.

APPROACH. This report documents the wargame study effort, the principal steps of which were to:

- Review the actual campaign (UNCLASSIFIED sources shown above),
- Develop a maritime capability (the considerations which helped define essential maritime capabilities, the improvements that have been made in the CFAW Model, the improvements yet to be completed, and the results of maritime gaming are included in the discussion of this step),
- Describe the application of logistic constraints, and
- Compare ground campaign wargame results with history.

CAA
CONCEPTS ANALYSIS AGENCY

MARITIME ARENA



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Section II. HISTORICAL CAMPAIGN OVERVIEW

MARITIME ARENA

This chart indicates the extent of the maritime arena in which the Falklands Campaign was fought. This arena was vast compared with the physical scene of operations ashore. The scale of British-Argentine naval operations in this war is often scorned by US planners as insignificant compared to the weight of US and Soviet naval forces. Nevertheless, the Falklands War probably corresponds with the upper end of the scale of complexity for contingency situations. Key events from 1 May, when the British Navy entered their self-proclaimed 200 nmi total exclusion zone (TEZ), until 20 May, the eve of the landings, were compiled in a chronology (Appendix E). The maritime issues these events raised were examined offline to determine if a modeling capability was required. Conclusions on how to game or analyze each of these events are included in Appendix E.

CONCEPTS ANALYSIS AGENCY

THE GROUND CAMPAIGN

THE GROUND CAMPAIGN

This chart shows East Falkland, that part of the Falkland Islands where the ground campaign actually took place. East Falkland is about 50 miles across. Key terrain in the campaign includes San Carlos Water on the west side of East Falkland and the series of "mountains" surrounding Stanley (the capital of the Falklands) on the east side. Roads exist only in the vicinity of Stanley, with a few tracks scattered across the remainder of East Falkland.

The cold, dismal weather was an added factor that influenced operations on both sides.

The ground campaign, starting with an amphibious landing in San Carlos Water on 21 May and concluding with the Argentine surrender at Stanley on 14 June, will be described in the next few pages in terms of an Operations Order from the British perspective using British data.

CAA CONCEPTS ANALYSIS AGENCY

MAJOR FORCES

BRITISH GRND TRPS ~10,000

GROUND

- 2 BDES
  - 3 MARINE BN
  - 2 AIRBORNE BN
  - 3 INFANTRY BN

  } ~5,200
- 5 ARTY BTRY
- 1 ADA BTRY
- 2 TANK PLTS
- 2 HELICOPTER SQNS (31 HELICOPTERS)

NAVAL

- 2 FIGHTER SQN (33 AIRCRAFT)
- 9 DESTROYERS
- 8 AMPHIBIOUS SHIPS
- 12 SUPPORT SHIPS
- 3 SUBMARINES (SSN)

ARGENTINE GRND TRPS ~13,000

GROUND

- 9 INFANTRY REGT
- 1 MARINE BN

} ~8,000

- 6 ARTY BTRY
- 1 ARMD CAV TROOP

NAVAL

- 1 LIGHT CARRIER
- 1 LIGHT CRUISER
- 8 DESTROYER/FRIGATES
- 3 SUBMARINES (SS)

AIR FORCE

- 3 FIGHTER/BOMBER SQN (60 AIRCRAFT)
- 5 FIGHTER SQN (60 AIRCRAFT)
- 1 COUNTER-INSURGENCY SQN (10 RECON AIRCRAFT)
- 1 HELICOPTER SQN (10 HELICOPTERS)
- 1 TRANSPORT. SQN (10 A/C)

MAJOR FORCES

Although there were about 10,000 British and 13,000 Argentine ground forces in the Falklands Campaign, only about 7,100 British and 10,000 Argentine soldiers are represented in the wargame. Of these, 5,200 British and 8,000 Argentine were infantry/marines (see also Appendix D) which belonged to the major combat forces shown in this chart.

The British marine battalions had about 645 personnel each, the airborne battalions 680, and the infantry battalions 650. The three marine and two airborne battalions were part of 3 Commando Brigade, the force which conducted the amphibious landing at San Carlos. During the period 4-8 June, 5 Infantry Brigade (with three infantry battalions) entered the conflict by landing at Fitzroy (see next chart). All of the remaining forces were in support of 3 Commando Bde from the outset.

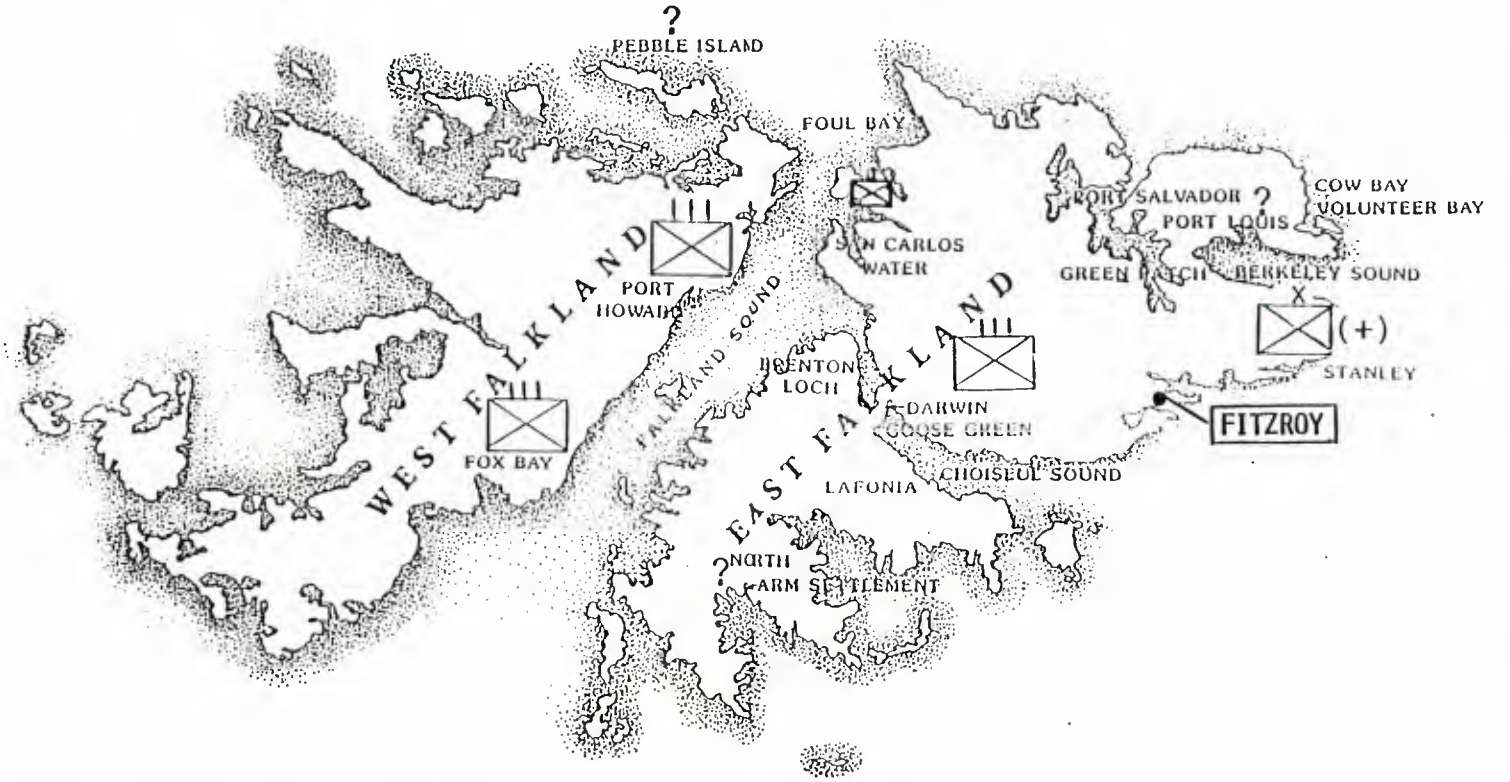
The Argentine infantry regiments each had about 830 personnel and the marine battalion had about 600; the brigade at Stanley (see next chart) totaled about 4,700. There were six 105mm guns in both Argentine and British artillery batteries, with the exception of one Argentine 155mm section. The Argentine armored cavalry troop had 12 Panhards, while the two British tank platoons consisted of a total of 8 Scimitar (30mm), 8 Scorpion (76mm), and 1 recovery vehicle. The British ADA battery consisted of 12 Rapiers.

British helicopters included 10 Lynx/Gazelle attack helicopters and 21 Sea King Mark V transport helicopters. The two fighter squadrons consisted of Sea Harriers. There were 60 Argentine A4 Skyhawk fighter/bombers; the fighters consisted of about 40 Mirage V and 20 Mirage III aircraft. The Counter-Insurgency (COIN) Squadron contained 10 Pucara aircraft. Argentine transport helicopters were half Puma and half Chinook and the transportation squadron contained 10 C-130 aircraft.

The tactical disposition of Argentine forces and the late employment of 5 Inf Bde created the tactical situation described on the next page.

CONCEPTS ANALYSIS AGENCY

ARGENTINE FORCE DISPOSITIONS
(BRITISH ESTIMATE PRIOR TO LANDING)



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ARGENTINE FORCE DISPOSITIONS

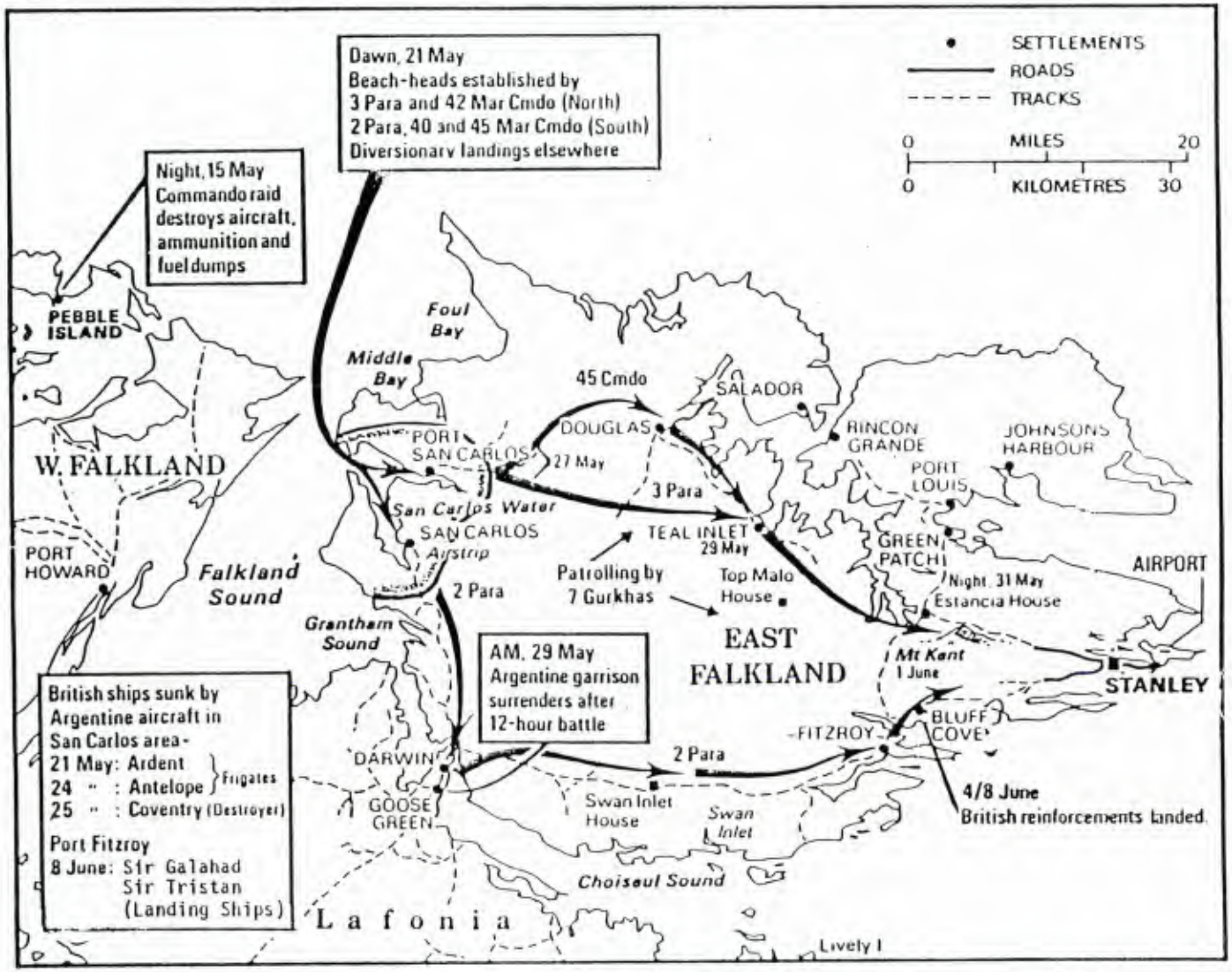
The requirement to defend many possible landing sites forced the Argentine commander to split his forces between West and East Falkland. About 70 percent of the Argentine infantry force was thought by the British to be located around Stanley, 10 percent in the vicinity of Darwin/Goose Green, and 20 percent on West Falkland.

From the British perspective, 80 percent of the Argentine infantry could be moved to confront 3 Commando Brigade, a potential attacker/defender ratio of 1:2. The addition of 5 Infantry Brigade would reduce the ratio to 1:1.2 but the British could not muster sufficient shipping in time to land both brigades at once. Movement of Argentine forces from West to East Falkland could also have altered the force ratios, but a lack of transportation prevented the Argentine Commander from doing that.

Faced with a potentially stronger defending force, it became paramount that British forces land away from Stanley, where the bulk of the Argentine force was located--this led to the choice of San Carlos.

CONCEPTS ANALYSIS AGENCY

EXECUTION



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MISSION AND EXECUTION

The mission assigned to Brigadier Thompson, Commander of 3 Commando Brigade--the initial assault force--is shown in the inset at the right. The ultimate goal was to seize Stanley, whose fall would politically end Argentine control of the Falklands.

The map above depicts the main events in the ground campaign.

Mission

"...Secure a bridgehead on East Falkland, into which reinforcements can be landed, in which an air strip can be established and from which operations to repossess the Falkland Islands can be achieved."

The Pebble Island raid on 15 May was designed to confuse the Argentine commander and prevent the removal of forces from West Falkland. On 21 May, 3 Commando Brigade landed unopposed at San Carlos. A beachhead (depicted on the map) was established and held until 26 May so that supplies could be built up ashore. During this period, 3 days of aggressive air attacks were mounted by the Argentine Air Force against the ships of the amphibious task force. After landing sufficient supplies and in the face of mounting political pressure, 2 Para (an airborne battalion) was dispatched on 27 May to secure Darwin and Goose Green (for the purpose of establishing a psychological British advantage over Argentine forces, securing an airstrip, and easing political pressure for results). At the same time, 45 Commando and 3 Para Battalions moved directly east to secure a potential supply base at Teal Inlet (reachable by sea).

By the night of 31 May-1 June, 3 Commando Brigade was along the line: Estancia House, MT Kent, and Fitzroy. During the period 4-8 June, 5 Infantry Brigade was landed at Fitzroy. The final assault on Stanley led to a series of battles in the mountains west of Stanley on the nights of 11/12 and 13/14 June. On 14 June, the Argentine Commander surrendered at Stanley.

CONCEPTS ANALYSIS AGENCY

LOGISTICS

LOGISTICS

Logistics were tenuous for both sides. Since British assault forces carried limited (3 days) food and ammunition, the British needed to build up supplies ashore before departing San Carlos. Once supplies were ashore, the lack of roads and limited helicopter support required the bulk of these supplies to be manpacked out of the beachhead. As forces moved farther from San Carlos, resupply was further strained. Helicopers were the primary means of sustainment. British forces were forced to carefully husband scarce supplies.

The Argentines were equally stressed. Although supplies were flown into Stanley airport right up to the end of hostilities, bad weather prevented sufficient helicopter resupply from reaching forces distant from Stanley, particularly those at Darwin/Goose Green. The road network out of Stanley allowed the Argentine forces surrounding it to receive adequate supplies. The lack of roads beyond Stanley may have been one of the reasons the Argentine commander kept a large part of his force near Stanley and did not station more force on the western side of East Falklands.

The strong influence of logistic constraint on the campaign prompted the exploration of representing such constraints within the wargame. This additional study objective will be discussed in greater detail later.

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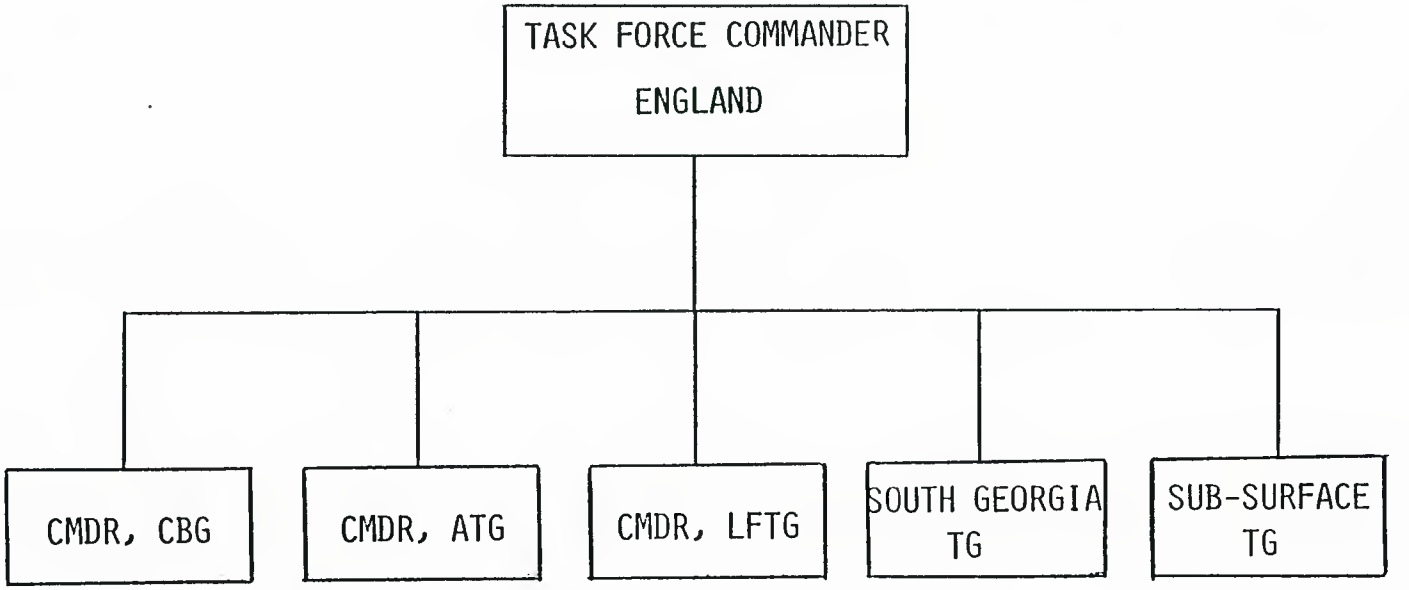
COMMAND AND CONTROL



CBG - CARRIER BATTLE GROUP
ATG - AMPHIBIOUS TASK GROUP
LFTG - LANDING FORCE TASK GROUP
TG - TASK GROUP

COMMAND AND CONTROL

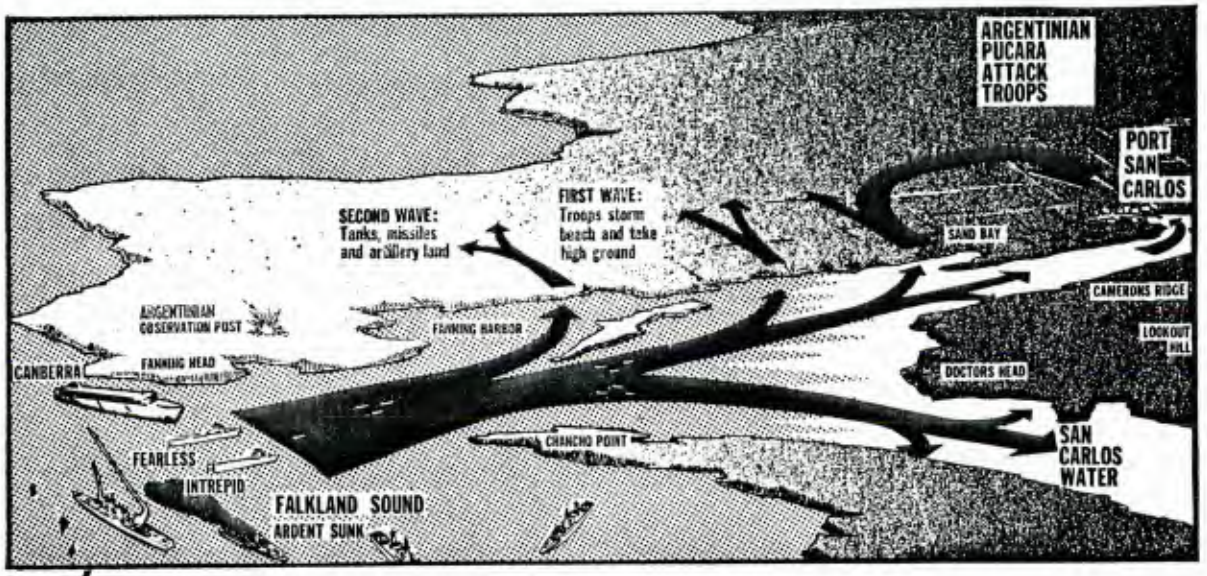
This chart shows the British command structure. Since command emanated from England, it cast political overtones on the operations undertaken by British forces in the Falklands. This was evident in the change of plans which resulted in the attack on Darwin/Goose Green. Originally, 3 Commando intended to move straight east to Teal Inlet and then Stanley. When the Task Force Commander directed that Darwin/Goose Green be secured first, the Carrier Battle Group, Amphibious Task Group, and Landing Force Task Group commanders were able to locally coordinate activities to accommodate this change in plans.

On the Argentine side, all Argentine ground forces were under control of the brigade commander located in Stanley. However, most of the Argentine air attack mounted against the British was directed from the Argentine mainland. Argentine naval forces were likewise controlled from Argentina. No possibility for local coordination existed.

On balance, then, the British had a command and control advantage. The British ground commander was able to influence the activities of naval forces in support of his campaign. The Argentine commander, however, could only hope that air and sea activities would support his plan of defense.

CONCEPTS ANALYSIS AGENCY

MARITIME GAMING CAPABILITY DEVELOPMENT



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Section III. MARITIME GAMING CAPABILITY DEVELOPMENT

The salient aspects of the historical campaign have been described in general terms. The campaign started with naval activities in the maritime arena (discussed in Appendix E). This was followed by the assault on the Falklands, which began with the critical amphibious landing at San Carlos. Developing a maritime capability in the wargame model to portray an amphibious assault was the next logical step in the study effort.

This section of the report documents the approach to the problem, identifies the maritime capabilities required, describes offline procedures for analyzing those maritime aspects not to be incorporated in the model, discusses model improvements (both completed and pending) and, finally, provides the results achieved in wargaming the amphibious landing at San Carlos.

CONCEPTS ANALYSIS AGENCY

WHY DESIGN NAVAL/MARITIME CAPABILITY BASED ON FALKLANDS CAMPAIGN?

BECAUSE...

- BEST EXAMPLE OF LITTORAL WARFARE SINCE OKINAWA
- FAST PACED AIR/SEA DECISIONS
- ENCOUNTER RATES DOMINATE: A FUNCTION OF SCOUTING
- ENGAGEMENT OUTCOMES LOOK LIKE:

  ΔF_1, NOT $\frac{dF_1}{dt}$

- CLASSICAL PHASES
  - PRIOR COMMAND OF THE SEA
  - AMPHIBIOUS LANDING
  - REINFORCEMENT, RESUPPLY, FIRE SUPPORT

EVEN THOUGH...

- SOME ATYPICAL CHARACTERISTICS (THERE ALWAYS ARE!)
- A COME-AS-YOU-ARE CAMPAIGN
- NO INTERDICTION OF SEA LINES
- NO CLOSE AIR SUPPORT ON EITHER SIDE
- NO COUNTERATTACK OF BEACH HEAD
- JURY-RIGGED SCOUTING ON BOTH SIDES
- NEITHER NAVY CONFIGURED NOR TRAINED FOR THE CAMPAIGN

WHY DESIGN A NAVAL/MARITIME CAPABILITY BASED ON THE FALKLANDS CAMPAIGN?

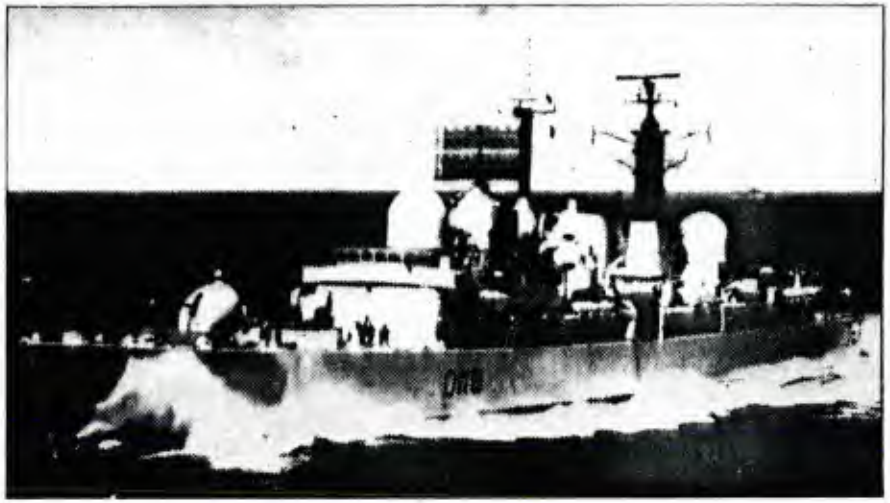
The Falklands Campaign provided an excellent basis for determining what a good maritime capability in CFAW should include because the naval actions and maritime operations in the Falklands were representative in the respects shown on the left side of the chart.

- **An Excellent Example.** The Falklands Campaign included amphibious landings, over-the-shore resupply activities, air attack of naval shipping, naval air attack of land targets, naval gun-fire support, scouting and antiscouting, naval engagements at sea, and submarine attacks--the significant aspects which should be considered in developing a naval/maritime model capability.

- **Fast Pace Decisions.** The pace of action at sea is much faster than action on land. The targeting problem for attacking aircraft is suitably difficult--available target information rapidly perishes with the fast movement of target ships (ground targets do not tend to evade air attack as quickly); however, once a target is identified, munitions are delivered against that target very quickly; thus, once targets are identified and attacked, the fight tends to be resolved very quickly. Ground battles do not occur in the same decisive manner. Ground forces withdraw and resume the fight later. The 5-day Argentine air campaign against the amphibious task force in San Carlos water is a good example of decisive air/naval battle--having failed to destroy the British fleet at this point, the Argentines were not again in a position to seriously challenge British naval forces.

- **Encounter Rates Driven by Scouting.** How quickly battle decisions transpire is normally determined by the scouting, surveillance, and pin-point targeting available to opposing forces. If the Argentines had had a better capability to target the British fleet at sea before the San Carlos landings, the war might have been over without a ground campaign. This again points out the critical value of intelligence (in a wargame as well as in actual conflict). Once intelligence is available, attacks are mounted, the battle develops rapidly, and a conclusive ending is quickly reached.

- **Discrete Outcomes.** Because of modern weapon lethality, ships which are hit suffer serious damage. The effect of this lethality is that one does not observe a change in force strength occurring as a function of time, but in quick, discrete, and often decisive steps.



FOUR YEARS AGO, my ship—the HMS Coventry—went to war in the Falkland Islands. The ship never returned; it now lies 300 feet down in the South Atlantic. The men who survived learned some fundamental things about themselves and about war.

CAPT. DAVID HART-DYKE AND THE LIFE AND DEATH OF HMS COVENTRY—ROYAL NAVY PHOTOS

Bombs straddle, from the left, RFA *Resource*, MV *Norland* and HMS *Intrepid*. The period 21–25 May saw the Amphibious Group under intense pressure.

(Courtesy of Hippocrene Books, Inc.)

- **Classical Naval Operations.** Although the Falklands Campaign demonstrated the classical phases of naval operations (command of the sea, amphibious landing, and naval support of forces ashore), it must also be pointed out that there rarely is an "average" war.

- Some of the **atypical characteristics** of the Falklands War are shown on the right side of Chart 10.

- No unique training, equipment, or military organizations were used. The UK forces were hastily assembled and sailed with the forces available.

- The British had open sea lanes back to England throughout the campaign.

- Air attacks against land targets were primarily focused on installations.

- Although the Argentine Air Force attacked the amphibious task force viciously, it never hurt the British forces in the beachhead.

- Scouting on both sides was accomplished by makeshift reconnaissance forces.

- Although neither navy was prepared to engage in this campaign, none of these atypical characteristics was a handicap insofar as the development of a new maritime gaming capability was concerned.

CONCEPTS ANALYSIS AGENCY

MARITIME KEY DESIGN CAPABILITY REQUIREMENTS

VITAL CORE

SEA-TO-LAND

- ☐ AIR SUPPORT
  - CLOSE
  - DEEP
- ☐ NGFS (INCLUDES MISSILES)
- ☐ LANDING OF FORCES
  - ASSAULT
  - ADMINISTRATIVE
- ☐ RESUPPLY
- ☐ REINFORCEMENT

LAND-TO-SEA

- ☒ SCOUTING & ANTISCOUTING
- ☐ ATTACK & DEFENSE
  - ☒ AIR-TO-SURFACE
  - ■ AIR-TO-SUBSURFACE
  - ☐ SURFACE-TO-SURFACE

SUPPORTING

SEA-TO-SEA

- ☒ SCOUTING & ANTISCOUTING
- ■ ATTACK & DEFENSE
  - ■ AIR-TO-SURFACE
  - ■ AIR-TO-SUBSURFACE
  - ■ SURFACE-TO-SURFACE
  - ☒ SUB-TO-SURFACE
  - ■ SUB-TO-SUB

LEGEND

- ☐ GOOD CAPABILITY
- ☒ TO BE IMPROVED
- ■ TO BE ADDED OFF-LINE

MARITIME KEY DESIGN CAPABILITY REQUIREMENTS

In determining capability requirements, three key factors were considered: the level of detail in the model, the importance of specific maritime activities, and the interaction between maritime and land operations. Maritime capability was to be added at a level of detail commensurate with existing air and ground activities. No important maritime activity was to be excluded, but those activities which are intimately involved with operations on the ground were to be the focus for explicit portrayal in the game. The set of activities which met these conditions (sea-to-land and land-to-sea) is called the vital core on this chart. With this set, those essential aspects of maritime warfare which complement joint operations would be incorporated into the model. Although the maritime activities included under the supporting category (sea-to-sea) are very important, they will seldom need to be played explicitly in CFAW--offline analysis or the application of results provided by naval analytical agency studies are more appropriate.

The current capability of CFAW to portray these maritime activities is indicated.

Scouting and antiscouting improvement is not essential, since the CFAW Model's method of revealing intelligence about enemy positions and movements can be adjusted by the controller to indicate a realistic amount of scouting information. The improvement would be to automate these provisions in lieu of having the controller change parameter values.

For example, ships cannot now detect other ships, nor can ships be detected by land-based radar. In addition, the detection capability of aircraft at sea should be greater than on land; currently, it's the same. However, by increasing the detection parameters currently used in the model, the effect of better scouting can be represented in the aggregate. Once the battle moves ashore, the game parameters can be decreased to reflect more reasonable detection on land.

CONCEPTS ANALYSIS AGENCY

MARITIME CAPABILITY ACCOMPLISHMENTS

- GROUND UNITS AND SHIPS ATTRITED AT DIFFERENT RATES DURING MOVEMENT
- MINEFIELDS ATTRIT GROUND UNITS AND SHIPS DIFFERENTLY
- GROUND UNITS EMBARK ON SHIPS
- GROUND UNITS DO NOT SHOOT FROM SHIPS
- GROUND UNITS DEBARK FROM SHIPS
- AIR ATTACKS DAMAGE SHIPS IN HEXES ADJACENT TO THOSE TARGETED

MARITIME CAPABILITY ACCOMPLISHMENTS

In order to play maritime operations more realistically, these simple, but important changes were made to the CFAW Model:

- Separate movement attrition rates were established for sea and land. The model attrites ground units when they are moving to represent the noncombat attrition involved in movement (e.g., accidents, mechanical breakdowns). Ships, however, can repair mechanical/accidental failure while underway and normally suffer no effectiveness degradation as a result of movement, per se.

- Separate minefield attrition rates were established for sea and land. Ground units suffer a percentage attrition in minefields, but part of the unit continues on into combat. Ships, on the other hand, are usually rendered ineffective (sunk or crippled) by mine damage and normally drop out of a naval operation.

- Forces are moved onto, carried, and moved off appropriate transportation ships. Units and ships are collocated in adjacent hexes; ground units are embarked on ships after a suitable time delay has transpired in the model (representing shore-to-ship loading); at this point, ground units are superimposed on ship units so gamers know their location as ships transport these forces to their destination; upon arrival, ground units are debarked from ships after a suitable time delay has transpired in the model (representing ship-to-shore unloading).

- Ground forces aboard amphibious landing craft (very constrained in their ability to bring weapons to bear) are not permitted to engage opposing forces ashore.

- Ships in hexes adjacent to those being attacked by aircraft are attrited, but at a lower rate, to represent finding and attacking ships within a reasonable aircraft search area.

CONCEPTS ANALYSIS AGENCY

PENDING MARITIME CAPABILITY IMPROVEMENTS

- DIFFERENTIATE DAMAGE AGAINST INDIVIDUAL SHIPS IN A TASK FORCE
- DIFFERENTIATE DAMAGE AGAINST AN AIRCRAFT CARRIER
- MAKE OPPOSING MINEFIELDS INVISIBLE
- CONSIDER AUTOMATING SOME OF THE "GOOD CAPABILITIES" NOW AVAILABLE

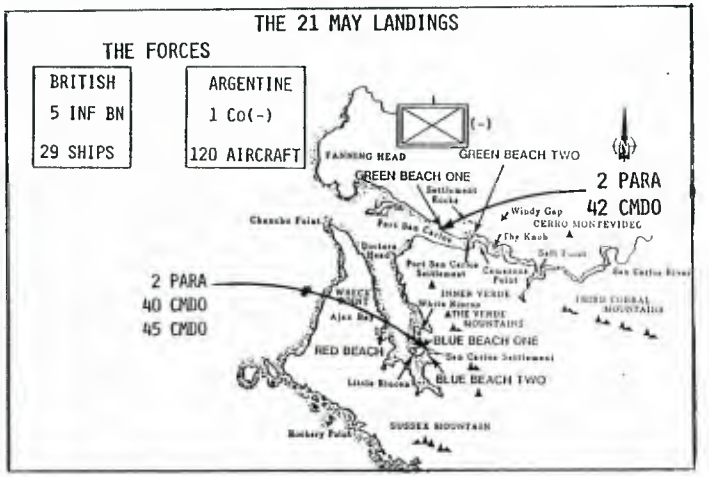
PENDING MARITIME CAPABILITY IMPROVEMENTS

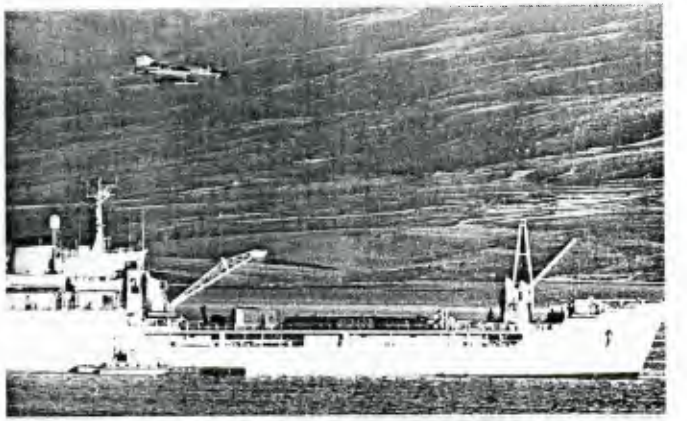
These changes to the CFAW Model have not yet been made:

- Ships are grouped together in task forces and represented as one "counter" in the model--this makes their movement by gamers significantly easier and faster. However, when aircraft attack the sea hex which contains the counter, damage ought to be assessed against individual ships grouped in that counter. Two requirements must be addressed:
  - A ship must be randomly selected from the group of ships in the counter, and
  - The air attack must produce ship damage commensurate with the ship randomly selected (i.e., damage which could sink a frigate-sized ship may only cripple a battleship or aircraft carrier). The type munition employed will also influence damage assessment.
- If an aircraft carrier is selected to receive damage from an air attack, the model must assess the damage against the ship itself, the aircraft carried on the carrier, and the degree of curtailment of air operations (e.g., half-rate for 24 hours).
- Minefields will be made visible only to the side emplacing the minefield. Although this was most important for sea mines, it is a desirable improvement in ground combat as well.
- The "good capabilities" now available (through manual actions by controllers or gamers) which could be built into the model at a later date include:
  - Steering sea forces around land masses automatically,
  - Adding a terrain code for sea hexes identifying shallow water and preventing ship movement in that type water, and
  - Providing ships with the radar capability available to aircraft in the model, giving them a detection capability (and perhaps concurrently providing ships with a passive electronic warfare capability to counter detection by opposing forces).
- A capability improvement not pending, nor presently planned, is the representation of nuclear, chemical, or biological war at sea.

CONCEPTS ANALYSIS AGENCY

THE BEACHHEAD





Mirages and Skyhawks come in low over the ships in San Carlos Water. In this picture a Mirage flies low over the LSL *Sir Bedivere*. Fortunately the bombs it dropped failed to explode.

AMPHIBIOUS LANDINGS ACCOMPLISHED ON TIME

SUPPLIES, SHIPS, AND AIRCRAFT LOST

HISTORY		GAME 1	GAME 2
0%	SUPPLIES IN SUNK SHIPPING	50%	0%
3/8	AMPHIBIOUS SHIPS	7/8	2/8
7/25	COMBAT SHIPS	9/9	4/13
2/36	SUPPORT SHIPS	9/12	3/12
46/133	ARGENTINE AIRCRAFT	7/120	24/120

THE BEACHHEAD

Having described the maritime capability development planned for the CFAW Model, its application in representing the amphibious operations undertaken in the Falklands Campaign will now be presented in the next several pages.

The amphibious landings in San Carlos water were unopposed. The British, in landing the 3 Commando Brigade at night, foiled Argentine attempts to detect and attack the British force before and during the landings. Surprise was achieved by the British. However, during the period 21-25 May, the Argentine Air Force conducted an extensive campaign to destroy the ships of the amphibious task force while 3 Commando Brigade built up its logistics base ashore.

The chart at the bottom right shows both historical and wargame results. Analysis of Game 1 results suggested that air-sea attrition rates were higher, and sea-based air defense attrition rates lower, than what should be expected in this type of naval engagement. In order to obtain results more in line with what might reasonably be expected (based on subjective naval judgment), these data were modified (Appendix F, paragraph F-2). Game 2 produced the results shown. (However, none of these results reflect the tenuous circumstances which existed in the actual situation--the British considered themselves very lucky to have lost only the ship, Atlantic Conveyor, which contained no ammunition or POL supplies but did contain a precious cargo of helicopters which were lost and never replaced during the campaign.) The number of combat and support ships used in the wargame were less than that historically available, but no fidelity in the close-in amphibious operation was lost by reducing the number of these ships available. The ships not represented were those which participated in actions outside the 200 nmi total exclusion zone (TEZ)--that part of the campaign was not included in this wargame.

In both games, amphibious landings were portrayed, resupply over the shore was conducted, naval gunfire support was provided, scouting was accomplished, both sea-to-land and land-to-sea attacks were conducted by aircraft, and ground weapons were fired against ships. Because these key activities (page 26) were demonstrated during the wargame, it was concluded that an amphibious capability had been developed in CFAW.

CONCEPTS ANALYSIS AGENCY

OBSERVATIONS REGARDING MARITIME GAMING

- SHIP AND AIRCRAFT ACTIVITIES AT SEA (HIDING/AVOIDING; HUNTING;ATTACKING) TAKE MUCH MANAGING BY PLAYERS
- SCOUTING IS CRUCIAL AND MUST BE PLAYED ARTFULLY
- COMPARED WITH LAND FORCES, NAVAL ENGAGEMENTS ARE FAST AND DECISIVE
- GOOD GAMERS ENHANCE MODEL CAPABILITIES

OBSERVATIONS REGARDING MARITIME GAMING

Gamers were able to effectively use air at sea. Aerial recon was fully adequate, but time consuming. Sorties were properly controlled: none were flown at night (no night capable aircraft available); a proper proportion was allocated against shipping (about 2:1, shipping versus counterair); and pulsed raids were conducted by large numbers of aircraft (reflecting actual Argentine tactics). Ship movement at sea was well executed by gamers. The constant movement required to avoid detection and subsequent attack was again a very consuming demand on gamer time.

Because scouting (and antiscouting) are crucial to ultimate success in the maritime arena, the tense "touch and go" atmosphere recorded by history was also observed in the game. Gamers quickly learned that artful scouting and antiscouting was essential in conserving naval resources.

Concurrent gaming of activites at sea and operations on the ground dramatically showed their differences. Compared with land operations, maritime engagments occurred very quickly and tended to be decisive. The concentrated Argentine air attacks on British ships in San Carlos water were an excellent example--if British supply ships had been sunk, ground operations could not have been conducted; since few ships were sunk, the British were able to build up supplies and forces ashore and eventually win the ground campaign. The major impact of these different degrees of combat intensity was to force gamers to continuously think and play both land and sea campaigns. Concurrent gaming at sea and on land will produce a lower game-to-real-time ratio than those games which have only ground forces.

Gamers very effectively produced the desired combat representations which were not explicitly modeled. For example, logistic buildup was made a tactical constraint: forces were not allowed to depart the beachhead until sufficient supplies were brought ashore. Troop unloading was made a time constraint; ships were vulnerable to air attack until unloading was completed. Shadow, or phony, escort aircraft were inserted into the game to allow single planes to attack shipping. Procedurally, the model checks the strength of opposing air combatants as its first step. If the defender is as strong, or stronger, than the attacker, the attacker is automatically turned back. If the attacker is stronger than the defender, both air combat and close air strikes are allowed to occur. Since the air-to-air combat involves phony escort aircraft, any aircraft lost due to air combat with phony escort aircraft are reinstated in the game.

CONCEPTS ANALYSIS AGENCY

MARITIME GAMING CONCLUSIONS

- SOUND PLAY OF MOST CONTINGENCY SITUATIONS POSSIBLE NOW

- KEY IS CFAW GAMERS

- WHEN MARITIME ASPECTS ARE VITAL AND COMPLICATED, TAP AN OUTSIDE EXPERT

MARITIME GAMING CONCLUSIONS

The three most important conclusions regarding maritime play in CFAW are shown on this chart.

Having made minor changes in the CFAW Model, it is now possible to incorporate all maritime elements that are considered to have a vital effect on the land war outcome. The granularity is similar and the amount of detail is compatible with the gaming of air-ground operations. Maritime play by itself, however, is not entirely realistic. For example, the scale of naval operations is artificially compressed, but the pace, effects, and general outcomes are quite suitable to reach sound conclusions regarding the contributions of naval forces and logistics (reinforcement/resupply shipping).

Consistent with other aspects of the CFAW game, good results and conclusions depend on good inputs, good players, and a sound umpire-controller team, not the model itself. There is sufficient flexibility in the model to permit effective gamers to create the combat representations most appropriate to the scenario being gamed. A hazard exists that the umpire-controller knowledge base will not be as comprehensive for maritime operations as for ground operations. An offsetting advantage is that maritime operations need not be played as comprehensively as ground operations. Indeed, essential operations at sea may often be reduced to only a few salient components. Appendix E (paragraph E-4) describes the use of branching techniques to determine when sea operations might be considered essential and when they might be safely reduced to a few basic considerations.

These conclusions are tempered by the caution that maritime aspects will, on occasion, be vital. For example, when amphibious assault or deep air strikes are observed to shift the outcome dramatically, then outside naval expertise should be consulted as a check. An important observation by the visiting naval analyst was that the CFAW gaming team is qualified to judge when such consultation is necessary.

CONCEPTS ANALYSIS AGENCY

USE OF LOGISTIC CONSTRAINTS

	BRITISH	ARGENTINE
• # OF SUPPLY DEPOTS	1	1
• LOCATION OF SUPPLY DEPOTS	SAN CARLOS	STANLEY
• O/H DAYS OF SUPPLIES	3	.75
• RESUPPLY CYCLE (DAYS)	1	1
• SUPPLY SHIP DISCHARGE RATE (TONS/HR)	200	---

Section IV. USE OF LOGISTIC CONSTRAINT

As stated in the introduction of this report, an implied objective was added after the Study Directive had been signed: the development of a procedure whereby logistic constraint could be imposed on the forces fighting the Falklands Campaign. This section briefly describes how logistic constraint was imposed, the rationale for imposing logistic constraint, and the impact logistic constraint had on the wargame. The actual results achieved in the wargames are described later.

Game play was intentionally constrained by logistics in the following manner:

- Britain's one supply depot (at San Carlos) received supplies from cargo ships in San Carlos Water. The amount received was determined by how long these supply ships remained close to the beachhead (vulnerable to air attack) offloading.

- Argentina's one supply depot (at Stanley) received supplies from C-130s flying in from the Argentine mainland. The amount received was determined by how many C-130s were flown into Stanley and how much supply each plane carried.

- British assault forces arrived onshore with 3 days of supply and no resupply available. Until resupplied to their basic load level from cargo ships offshore, these forces were not permitted to leave the San Carlos area.

- Resupply of British and Argentine forces was accomplished every 24 hours. However, while British forces received supplies at the rate of 1 day every 24 hours, Argentine forces received only three quarters of a day of supply every 24 hours (leaving them effectively without supplies for 6 hours each day). As units moved away from their supply point, the resupply interval was lengthened based on unit distance from the supply point.

Argentine prisoners are escorted down from Mount Harriet. Some 300 prisoners surrendered on 11 June.

- In the model, units that run out of ammo while in combat are automatically removed from the game. Hence, commanders had to be careful how long they committed their forces to combat. These logistic constraints created the desired relative isolation of Argentine forces at Goose Green, mainly because movement of supplies on land was very difficult and time-consuming. It also gave due pause to the British attack on Stanley, since these forces were at the end of extended supply lines.

In terms of the British attack, the primary objective in using logistics as a constraint was to preclude assault forces from moving inland prior to having an established supply depot on shore. The constraining factor was how long the British commander kept his supply ships in close to the beachhead and exposed to air attack while unloading sufficient supplies. Supply offloading occurred at night, since the Argentines did not have night capable aircraft. If a ship stayed near shore in daylight, it was very vulnerable to air attack. If the British had lost their supply ships during this crucial phase of the operation, the wargame would have been over. This phase of the campaign was portrayed very well, but it required significant attention by gamers to properly conduct.

In terms of the Argentine defense, the primary objective in constraining logistics was to reduce Argentine combat effectiveness. The Argentine commander could not ignore the fact that his forces would be periodically out of ammo (the time period between when onhand stocks were diminished and resupply arrived--in this game, at least 6 hours each day--but more if combat occurred during the day).

Logistic constraint produced another effect: the creation of POWs. The notion of logistic constraint, coupled with CFAW's automatic removal procedure (i.e., automatically removing from the game any unit caught in combat without ammunition), were used to represent the creation of POWs: the personnel strength of the unit at the time it was removed from the game equaled the number of POWs created. This procedure for creating POWs was an innovative addition to the wargaming process. Further work needs to be done in this area, but initial results are very encouraging. Obtaining logistical resupply data will be the biggest difficulty in applying this technique.

CONCEPTS ANALYSIS AGENCY

QUALITY ASSURANCE ASSESSMENT PLAN

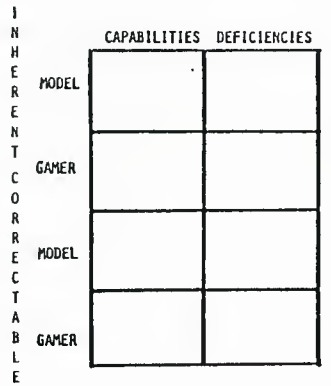
CONDUCT NORMAL WARGAME

- BUILD DATA BASES
- PRE-ANALYZE
- WARGAME
- POST-ANALYZE

PRODUCE REFINED OUTCOME

- MODIFY DATA BASES
- RE-WARGAME
- RE-ANALYZE

DESCRIBE RESULTS



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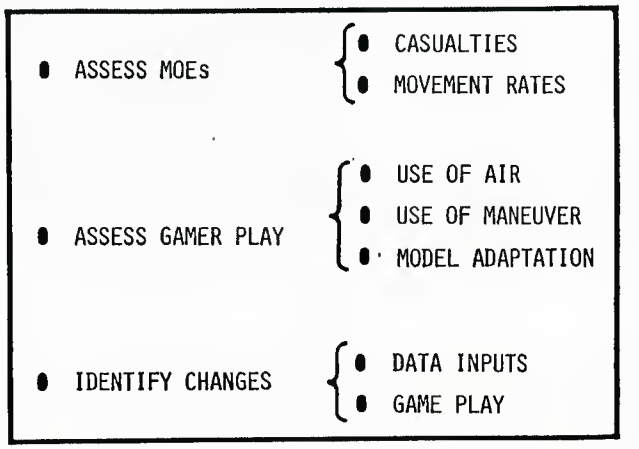
Section V. QUALITY ASSURANCE ASSESSMENT PLAN

Having described the development of a wargame maritime capability and explored, in general terms, the use of logistic constraint, the comparison of wargame and historical results will now be addressed.



This chart highlights the plan for assessing the ability of the wargame to produce historically consistent ground combat results. **The first block** describes the normal process followed in conducting a wargame (see Appendix G for additional detail). Care was taken in this phase to avoid using historical information that would not be normally available to a wargaming study. The **post-analysis process, highlighted in the inset** on the right side of this page, was an exception to the normal process. Usually post-analysis involves analyzing and reporting the results which occur in a wargame. In this study, post-analysis involved comparing wargame results with history. The measure of effectiveness (MOE), casualties, proved to be a bad MOE on which to base a historical comparison. Although attrition results (i.e., casualties) are described in this section, the shortcomings of using this MOE are quickly apparent. Appendix H briefly describes alternative approaches (based on the insights gained from this wargame) to the development of MOE that might prove more useful in future quality assurance assessments.

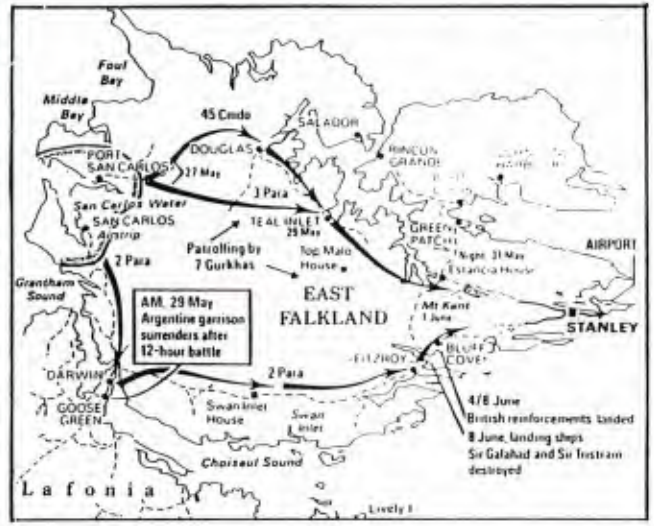
The next step was to refine data inputs and modify wargamer play in order to move closer to historical results. **An important caveat:** the purpose of this step was to evaluate the process of data preparation, not to determine if a "right" value could be found to produce observed historical results. This evaluation must also be tempered by conventional wisdom and military judgment. Actual conflicts tend to display atypical results more often than expected results. Expected results, however, are a fundamental premise of almost all computer simulations. This dichotomy must be recognized in judging a model credible, or not credible, in relation to historical conflict.

The third block represents how the results of attempting to recreate this historical battle will be described.

CONCEPTS ANALYSIS AGENCY

THE BRITISH CAMPAIGN PLAN

Men of 42 Commando dig in on the slopes behind Port San Carlos



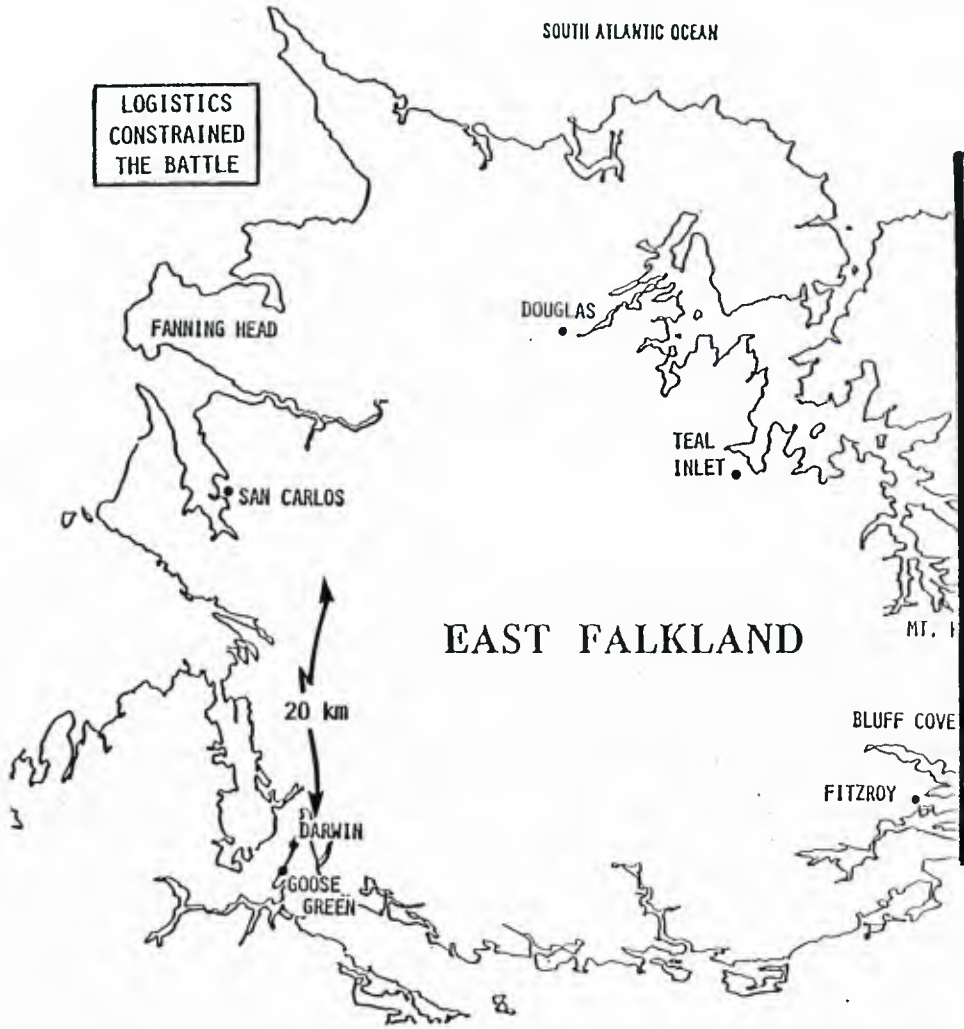
Members of 45 Commando 'yomp' across the desolate countryside of the Falklands

THE BRITISH CAMPAIGN PLAN

Although Stanley was the recognized objective for British forces once ashore, the British were faced with a two-fold dilemma: they needed to quickly assert their dominance over the opposing Argentine force and they needed to protect their only supply depot at San Carlos. Political pressure to take immediate action resulted in the decision to secure Darwin and Goose Green, the two settlements which contained the only sizable Argentine forces away from Stanley. Once Darwin/Goose Green were seized, the British would be free to focus on Stanley, the Falklands capital, and the key to eventual victory.

CONCEPTS ANALYSIS AGENCY

BATTLE OF DARWIN/GOOSE GREEN



GAME 1

CASUALTIES:
B: 0 (vs 17 KIA, 31-35 WIA)
A: 0 (vs 50-150 KIA)

POWS:
A:1600 (vs 1100-1400)

BATTLE TIME:
2 HOURS
(vs 12 HOURS)

MOVEMENT:
20 HOURS
(vs 20 HOURS)

GAME 2

CASUALTIES:
B: 3
A: 29

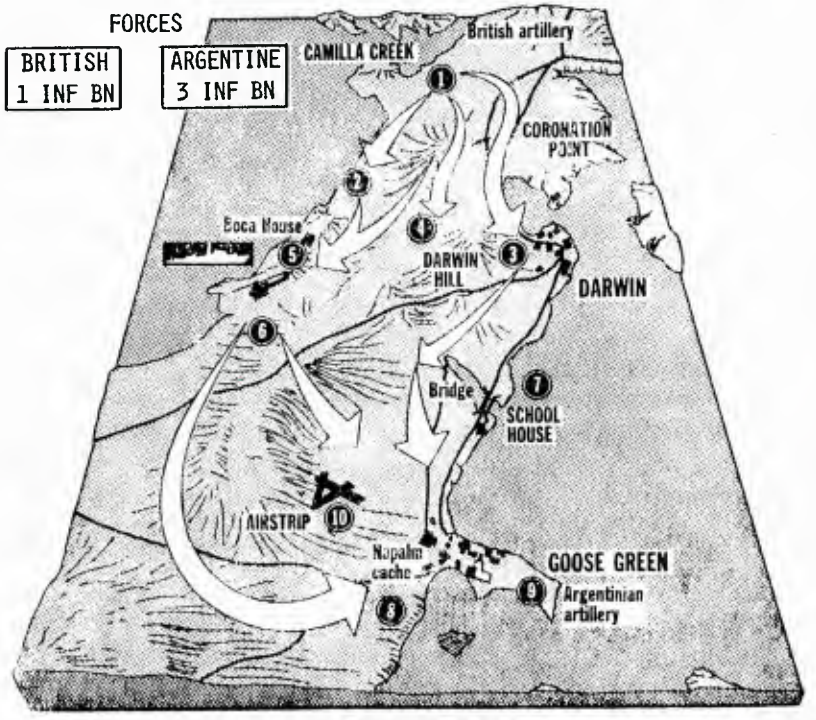
POWS:
A: 800

BATTLE TIME:
6 HOURS

NOTE: HISTORICAL DATA PROVIDED IN PARENTHESES

BATTLE OF DARWIN/GOOSE GREEN

The chart above portrays the results of both wargames: Game 1 resulted from normal preparation procedures; Game 2 reflects results after corrections were made to the initial input data. Although the British attacked in the face of 3:1 odds (see inset below left), two Argentine battalions were turned into POWs immediately in the wargame as a result of logistic constraint.

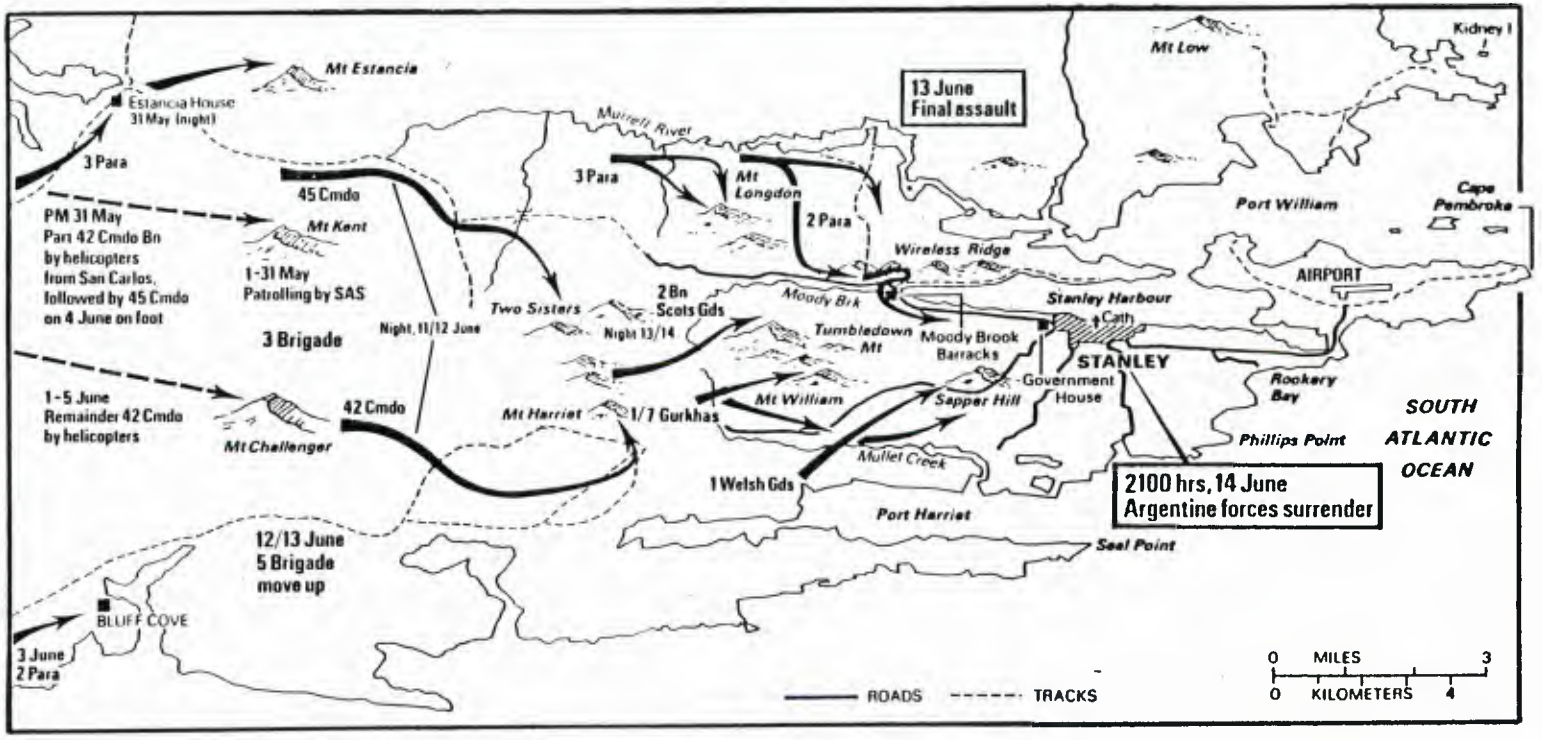


Movement rates were modeled very well in CFAW--British forces took about 20 hours to move from San Carlos to Darwin/Goose Green, about the same as in history.

In assessing combat casualties, however, the dilemma was to create proper input data as if the outcome were not known, while preserving the chance to compare results with history. An "infantry-only" battle had not been previously portrayed in CFAW--prior wargames had been dominated by big weapon systems such as the tank and the infantry fighting vehicle. In Game 1, no casualties were produced. There were two reasons: probabilities of acquisition and attrition were too low (discussed more in Appendix F) and logistic constraints were too tight. To ensure that attrition was properly accomplished, logistical constraint was not employed in Game 2. After modifying data inputs (Appendix F), more reasonable attrition results were observed in Game 2. The length of battle time was also closer to history. Although history was not statistically matched in the sense of staying within some range of the MOE--casualties--the results were subjectively assessed to be of about the right magnitude. Having wargamed and then followed the post-analysis plan (page 43) in an effort to improve the wargaming process, it was believed necessary to stop at this point. Any further modifications could rightfully be viewed as an attempt to force the model to duplicate history.

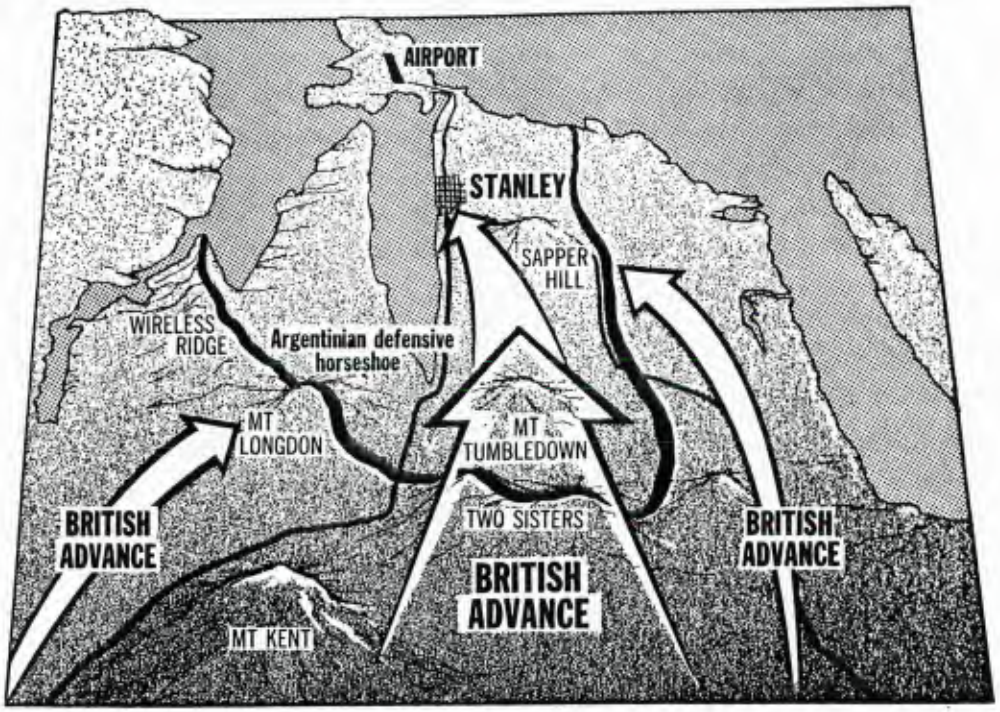
CONCEPTS ANALYSIS AGENCY

THE FINAL PUSH -- 11 - 14 JUNE



THE FINAL PUSH -- 11-14 JUNE

The battle for Stanley actually consisted of a series of battles on the nights of 11/12 and 13/14 June. Three battalions attacked the first night, one each against Mts Harriet, Two Sisters, and Longdon. Two nights later, four battalions assaulted Wireless Ridge, Tumbledown Mt, Mt William, and Sapper Hill. These battles were treated as one large battle in the wargame--the inability of CFAW to portray independent, small unit combat is a limitation in a campaign such as this. Nevertheless, the results achieved in both games are shown on the next page and are compared with actual campaign results.



The British advance on Stanley, June 12-14, 1982

US ARMY

CONCEPTS ANALYSIS AGENCY

FORCES

BRITISH	ARGENTINE
7 INF BN	7 INF BN

BATTLE FOR STANLEY

	MOVEMENT:	CASUALTIES:	POWS:	BATTLE TIME:
GAME 1	3 1/2 DAYS (vs 3 1/2 DAYS)	B: 0 (vs 42 KIA, 95 WIA) A. 240 (vs 600 KIA, 1025 WIA)	A:1170 (vs 1400)	50 HOURS (vs 57 HOURS)
GAME 2		B: 58 A: 2115		76 HOURS

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BATTLE FOR STANLEY

Since the Falklands terrain was evaluated to be between hilly and flat terrain (as represented in the model), infantry movement rates were reduced from 4 kph (flat terrain) to 2 kph (between flat and hilly terrain). The effective movement rate observed during the wargame (about 1 kph) seemed to be historically consistent. Battle time and the creation of POWs also seemed consistent.

However, in Game 1 of this battle, as in the battle of Darwin/Goose Green, no British casualties occurred--for the same reasons (data inputs and logistic constraint). Because these battle results were accumulated for 50 hours, some Argentine casualties occurred, but at too low a rate. Game 2 results were better, but still not an accurate reflection of history nor a precise estimate of the casualty MOE. However, the results were subjectively judged to be of reasonable magnitude. The motivation for this judgment was the recognition that real conflicts are often atypical while models tend to produce expected results. As stated in the discussion of the Darwin/Goose Green battle, further modifications would appear to be an attempt to force a duplication of history. Historically, British forces gained a foothold in the hills around Stanley as Argentine forces, low on supplies and morale, withdrew into Stanley. Surrender occurred later that same day. In Game 2, the Argentine gamer was faced with a similar dilemma--continued attrition of his forces or surrender. Knowledge of Argentine fighting esprit led to the decision to halt the game after 76 hours of battle.

CONCEPTS ANALYSIS AGENCY

DATA CHANGES

DATA INPUTS:

- ATTRITION--INCREASE:
  - RATES OF FIRE
  - P_k
  - P_a
- RESUPPLY--INCREASE RATE

DATA BASE:

- ADD 1 SUPPLY UNIT
- ADD TROOP TRANSPORTS

DATA CHANGES

Based on the results of the initial game (Game 1), the conclusion reached was that there had been a consistent tendency to use infantry weapon input data values too low for the model to produce noticeable results in a two-hour combat attrition cycle (i.e., the game produced zero casualties). In previous CFAW wargames, the effects of infantry weapons had been dominated by larger systems (e.g., tanks, HAWs). Since this wargame did not have these heavy systems in the force structure, infantry combat was the focus of attrition in CFAW for the first time. It is important to note that this would require correction independent of whether or not a historical comparison was being conducted. To correct the problem, rates of fire, probabilities of kill (Pk), and probabilities of acquisition (Pa) were adjusted upward. Appendix F discusses the procedures in greater detail.

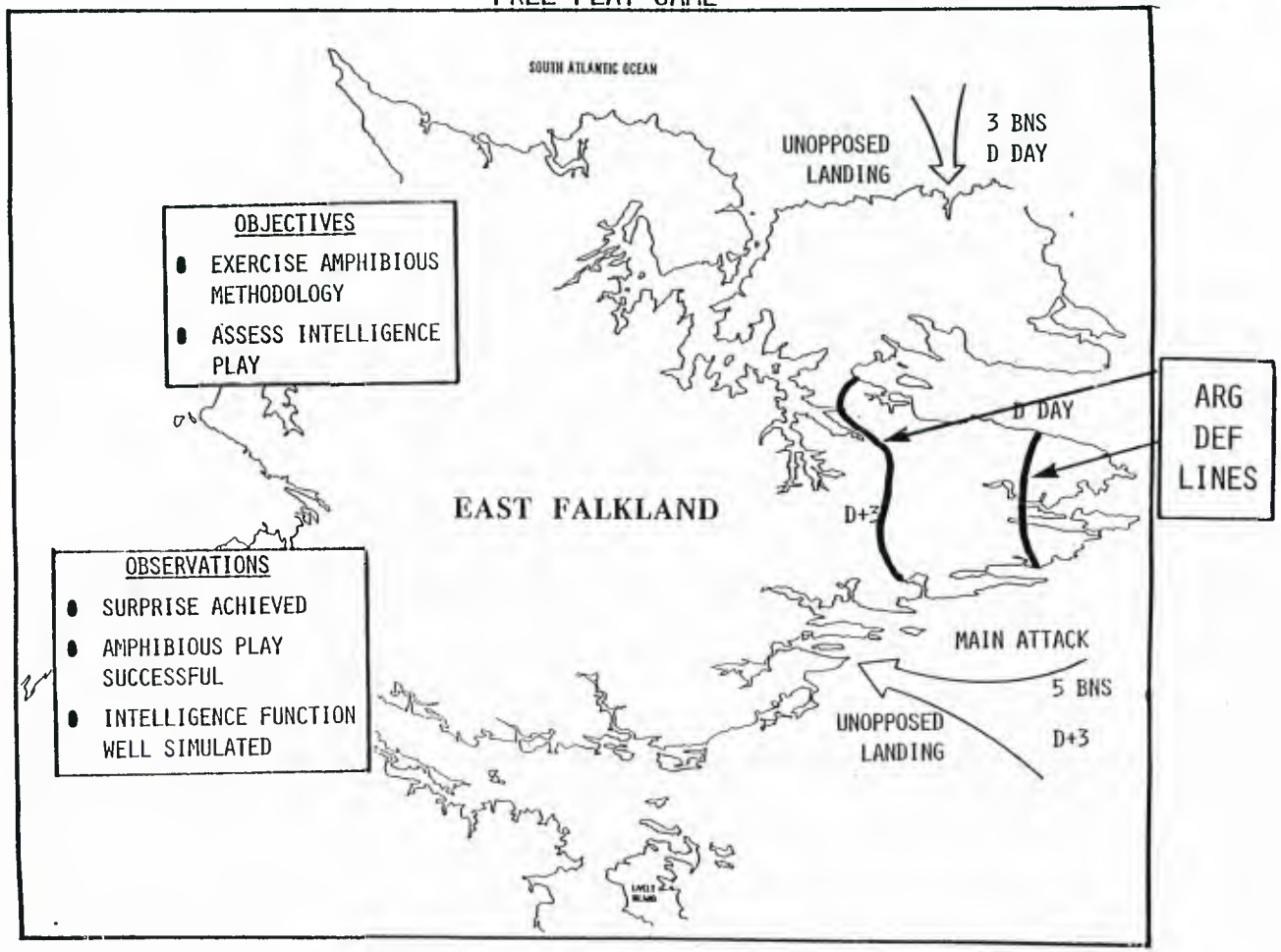
Resupply rates were also set too low. Consumption of supplies (an automated process within the model) caused Argentine units to run out of supplies too quickly. For example, an Argentine 18-hour resupply at the rate of once every 24 hours was used initially, commencing at 0600 hours. This effectively required Argentine forces to avoid combat after 2400 hours (if caught in combat they became POWs). By increasing the resupply rate to a 9-hour resupply once every 12 hours, then the periods 1500-1800 and 0300-0600 were the vulnerable times. Argentine forces could fight 3 additional hours at night before becoming vulnerable (i.e., out of supplies). These rates are subjectively developed inputs and must be finely tuned to represent reasonable logistic constraint. The key change necessary on the consumption side is to separate ammunition consumption from other types of consumption (e.g., food, POL, barrier materiels). If no combat occurs, units should not consume ammunition as they currently do in the model.

Resupply was also hampered by insufficient supply depots (represented as supply units).

In Game 1, insufficient shipping was played to carry all British units. The attempt to re-use the ships which transported 3 Commando Bde to transport 5 Infantry Bde, although done historically, created too many control problems to be straightened out by the umpire/controller team. In Game 2, more transports and support ships were played, but care was taken to ensure proper adjudication of British ship losses.

CONCEPTS ANALYSIS AGENCY

FREE PLAY GAME



FREE PLAY GAME

The third Falklands wargame was conducted with the objectives shown on this chart. The British commander was free to choose the time and place of his amphibious landings--in effect, a surprise assault. The Argentine commander had to deal with the uncertainties of the impending attack--in effect, he needed intelligence information. The controllers were forced to apply the amphibious methodology without prior knowledge of exactly where and when the landing would take place. This game also allowed an assessment of the intelligence functions in the game. Scouting, which was critical in the actual war, would now be played with imperfect prior knowledge.

The British commander's intent was to make a diversionary amphibious landing on the northeast side of the island with three battalions, moving due south toward Stanley. The main British body was to be landed at Fitzroy, on the southeast side of the island. Once ashore, this force of five battalions would move on Stanley.

The Argentine commander extended his perimeter around Stanley and conducted an aggressive intelligence collection effort to determine British plans. The Argentine commander was able to conduct intelligence gathering through human intelligence, aerial reconnaissance, and national intelligence. Although the British did achieve tactical surprise during their northern landing, the Argentine commander determined that the landing was diversionary and awaited a follow-on landing somewhere along the southern coast. The game was terminated on D+3 after the British landing in the South. The decision to terminate the game was made based on numerous factors: The objectives of the game had been met, only 2 working days had been allocated to conduct this scenario, and the participating players were only available for a short period of time.

During the game, CFAW demonstrated very acceptable intelligence play and an acceptable degree of battlefield surprise. The methodology for conducting an amphibious landing under different conditions than experienced in Games 1 and 2 was again successfully employed using a combination of online and offline processes.

Numerical results for this game were not collected because limited combat took place and the objectives of the game did not include evaluating attrition.

CONCEPTS ANALYSIS AGENCY

OBSERVATIONS REGARDING GROUND COMBAT GAMING

USE OF MANEUVER:

- REPRODUCED HISTORY
- MOVEMENT RATES ACCURATE
- STANLEY FOUGHT AS ONE BATTLE

MODEL ADAPTATION:

- LOGISTICS CONSTRAINED PROPERLY
- AT BEACHHEAD, REALISTIC:
  - TROOP UNLOADING TIME
  - LOGISTIC UNLOADING TIME
- INTEL PLAYED FOR FORWARD DEPLOYMENT OF UNITS
- AIR ATTACK IN SMALL NUMBERS POSSIBLE

OBSERVATIONS REGARDING GROUND COMBAT GAMING

Once the "no-casualty" problem of Game 1 had been corrected, the Falklands Wargame seemed to portray reasonable results with respect to history, even though wargame casualties did not statistically match with historical results. When relatively few casualties are assessed, it is very easy to observe variations in results which are 10:1 or greater. Gamers were able to reproduce force movements and initiate ground battles according to history through normal play of the game. The small unit maneuvers around Stanley, however, were beyond the capability of the model and these battles were represented as aggregated combat.

The influence of logistic constraint forced gamers, particularly the Argentine players, to avoid prolonged combat. When unable to do so, units were converted to POWs, a not unrealistic representation of real-world events. Delays in movement based on troop unloading and logistic buildup requirements in the San Carlos beachhead were realistically portrayed. The out-posting of British forces well forward of their main force was easily represented by allowing intell reporting from locations which would be occupied by them (an umpire-controlled function). Finally, single aircraft attacks were created by using "shadow" escort aircraft to offset the model requirement to achieve an air advantage before allowing close air support missions to be flown.

CONCEPTS ANALYSIS AGENCY

GROUND COMBAT GAMING CONCLUSIONS

- BETTER MEASURES OF EFFECTIVENESS SHOULD BE DEVELOPED FOR HISTORICAL COMPARISONS
- CFAW REPRESENTED KEY ASPECTS OF HISTORICAL CAMPAIGN
- LOGISTIC CONSTRAINT IS GOOD GAMING TOOL
- WARGAMERS ARE KEY TO GOOD GAMING

GROUND COMBAT GAMING CONCLUSIONS

Better (or more appropriate) measures of effectiveness (MOE) should be used in a historical comparison. Casualties, a key MOE in this wargame, should not have been used, as indicated earlier (page 43). Since the wargame does not attempt to model many facets of combat that affect the casualties produced in real conflict situations (e.g., morale and esprit, state of training), it is the wrong focus to expect a precise duplication of historical casualties (particularly when history may have recorded an atypical occurrence in the first place). Using casualties as an MOE becomes even more questionable when low levels of attrition occur, because relatively modest changes in the number of casualties can produce rather large changes in comparative results. At Goose Green, for example, 3 British casualties in the wargame, when compared to the 48 actually reported suggests that 16 times as many casualties occurred in history as in the wargame. However, if there had been 6 casualties in the wargame (instead of 3), only 8 times as many casualties would have occurred in history by comparison. As indicated on page 53, input values for infantry combat which were initially thought to be good had to be corrected in order to obtain any nonzero results from the model's 2-hour combat cycle. Once the model began producing combat results, those results were subjectively judged to be reasonable; no effort was made to achieve better (i.e., closer to historical) results.

The CFAW Model did permit the significant ground combat aspects which occurred on East Falkland to be reasonably represented. Specifically, ground weapon attack of close-in amphibious ships, the logistical buildup at San Carlos, the movement to (and battle of) Darwin/Goose Green, and the movement to (and battle around) Stanley were all portrayed in the wargame with sufficient fidelity to qualitatively assess the historical comparison as successful. The Darwin/Goose Green battle ended of its own accord in the wargame. The battle for Stanley, on the other hand, was allowed to continue beyond historical time limits and was finally terminated by gamers once they concluded attrition would continue indefinitely until one side had won. This battle highlights an inherent weakness of the CFAW Model: its inability to portray small unit battle. The tactical advantage achieved by individual British companies in the actual campaign forced Argentine withdrawal from their defensive positions--in the CFAW Model, withdrawal occurred only after attrition threshholds had been achieved. Since Argentine resupply was relatively close by and the British were able to marginally maintain their logistical resupply, logistic constraint could not be used to end the battle.

The Mortar Troop of 42 Commando gathers its equipment around it before it hops forward to the mortar position for the attack on Mount Harriet on 11 June. An LMG lies on the ground on the right as its owner helps to load ammunition into the Wessex.

During the wargame, experimentation with logistic constraint identified it as a potentially good gaming tool for the following reasons:

- It forced gamers to consider how long forces could/should be in combat.
- It provided a means of inducing time delays in the game for resupply activities.
- It provided a mechanism for creating POWs.

Finally, as observed in the maritime capability development section of this report, wargaming was ultimately constrained only by the innovation and imagination of the gamers. The model is flexible and robust enough to allow representation of many combat activities not explicitly defined in the model (e.g., attack by single aircraft, intell reporting by forward outposts).

CONCEPTS ANALYSIS AGENCY

QUALITY ASSURANCE ASSESSMENT

		CAPABILITIES	LIMITATIONS
INHERENT	MODEL	• MOVEMENT RATES • AIRBASES IN ARGENTINA • REPRESENTATION OF POWs • RESTRICTION OF INTELL. • PORTRAYAL OF MARITIME OPERATIONS	• SMALL UNIT TACTICS • REPRESENTATION OF INTANGIBLES (ARGENTINES DIDN'T ATTACK MANY SUPPLY SHIPS) • INABILITY TO COORDINATE UNIT ARRIVAL TIMES • SINGLE-ECHELON OF CONTROL
	GAMER	• LIMITED MANEUVER ACHIEVED • ASSUMED "ATTITUDES" OF PARTICIPANTS • SENSITIVITY CHECK OF INPUT DURING GAME	
CORRECTABLE	MODEL	• AUTOMATION OF UMPIRE/CONTROLLER ACTIVITIES • USE OF LOGISTIC CONSTRAINT • ATTACKS BY SINGLE AIRCRAFT	• ATTRITION TO INDIVIDUAL SHIPS IN A "ROLLED-UP" COUNTER • AIR & SEA & GROUND SUPPLY STOCKPILES NEED TO BE SEPARATED • DESIGN OF SCREEN OUTPUT (QUANTITY & QUALITY)
	GAMER	• IDENTIFICATION OF BATTLE SOFT SPOTS	• NUMBER OF NAVAL UNITS PORTRAYED

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QUALITY ASSURANCE ASSESSMENT

This chart describes the inherent and correctable capabilities and limitations of CFAW observed in this game in terms of those attributable to either the model or the gamers.

CAPABILITIES:

Movement rates, the location of airbases in Argentina (off the screen of play), the representation of POWs, and the restriction of intelligence available to gamers are all **inherently** portrayed in necessary detail by the model. As this wargame has demonstrated, the CFAW Model can now portray, maritime operations effectively. Gamers add the capability to achieve a limited amount of maneuver (but not small unit tactics) in spite of the model's built-in constraint against maneuver (i.e., when opposing forces occupy adjacent hexes, the model will automatically place them in combat with one another). Gamers also demonstrated a capability to assume the attitudes of British (aggressive, convinced of winning) and Argentine (tentative, not willing to fight aggressively on the ground, but very aggressive in the air) forces. Finally, gamers were capable of checking the sensitivity of data inputs during the game, particularly amphibious and infantry data, both of which had never been used in the model before.

The **correctable** model capabilities shown are those things which cannot be done automatically by the model at present, but which show good promise for future incorporation. Many of the capabilities achieved in CFAW result from actions taken by the umpire and controller. These actions normally require a significant amount of activity by the umpire and controller (e.g., changing unit positions to overcome a game artificiality, temporarily restraining some process within the model, or creating/deleting intelligence information to represent the desired situation to gamers); a specific example, discussed in this report, is an attack by a single aircraft (page 35). With a revised screen output format, it appears feasible to provide gamers with the capability to identify battle soft spots (i.e., the points in an aggregated battle where one side is weak relative to the opposing force, and therefore the point at which combat power, such as a reserve force, should be brought to bear).

A Wessex helicopter brings another load of ammunition to Blue Beach at San Carlos. Previous loads stand waiting on the ground. A LCU brings further stores to the beach which are then brought inland by Marine and civilian tractors. In the foreground are the Beach Armoured Recovery Vehicle (BARV) and a Gemini inflatable boat.

LIMITATIONS:

Representation of small unit tactics, many of the intangibles of combat (e.g., historically the Argentines did not attack many supply ships while, in the model, all shipping is equally likely to be attacked), a coordinated attack (when units must travel different distances to arrive at the point of battle), and communication of command and control decisions to subordinate elements are extremely difficult to include within the structure of CFAW without major alteration of the model's code.

The model limitations which may be alleviated are: the attrition to individual ships when they have been collected and represented as a task force in the game; the use of separate supply stockpiles to support air, sea, and ground forces (because these forces typically consume supplies at vastly different rates, causing unwanted problems during game play); and the portrayal of output information available to the gamers.

Because gamers are typically faced with severe "span of control" problems in a ground campaign, the addition of naval/amphibious forces in the form of task forces becomes a limitation--gamers can physically keep up with only so many units; therefore, the addition of naval units will generally require a reduction in the number of ground units being controlled (one way of doing this is to raise the level of aggregation, e.g., convert battalion units to brigade-size units).

SUMMARY

- PURPOSES: DEVELOP MARITIME CAPABILITY
  COMPARE RESULTS WITH HISTORY
  USE LOGISTIC CONSTRAINT

- CFAW MODEL IS FLEXIBLE AND ROBUST

- GAME PERMITTED BETTER UNDERSTANDING OF BOTH THE MODEL AND WARGAMING PROCESS

- CFAW CAN PORTRAY JOINT OPERATIONS

Section VI. SUMMARY

- The Falklands Wargame was conducted for the express purposes of developing a maritime capability in the Contingency Force Analysis Wargame (CFAW) Model and comparing wargame results with history. As the wargame progressed, the use of logistical constraint became an implied objective.

  - A maritime capability was developed for the CFAW Model which is consistent in detail with the rest of the model. Changes were made to the existing model to achieve this capability; a new module was not added.

  - Good MOE were not developed for comparing wargame results with history. The use of casualties created the wrong focus and would be hard to duplicate in any event. Additional thoughts on what MOE might be appropriate are provided in Appendix H. However, the wargame did permit the significant aspects of the Falklands Campaign to be reasonably portrayed. In observing this representation, the wargame was assessed to compare favorably with history on the basis of military judgment.

  - The use of logistic constraint, although not completely successful in this wargame, was an encouraging innovation. Movement delays due to troop unloading and logistic buildup requirements were realistic and the creation of POWs as a by-product of using logistics to constrain military operations offers interesting future possibilities.

- The flexibility and robustness of the CFAW Model were demonstrated in this wargame as gamers developed imaginative techniques such as the out-posting of forces and the use of shadow (or phony) aircraft to permit a single aircraft to attack a target.

- This wargame facilitated the identification, and better understanding of, the inherent and correctable limitations and capabilities of both model and gamers. The emerging matrix of limitations permits the development of a long-term model improvement program.

- The Falklands Wargame was, on balance, very successful. A reasonable representation of history was demonstrated and CFAW became a wargame capable of portraying joint operations.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Directors

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2. PRODUCT REVIEW BOARD

LTC Al Christensen, Chairman
MAJ Tom Shook
CPT George Spenser
Ms. Kim Hunt

APPENDIX B

STUDY DIRECTIVE

CSCA-SPF 11 April 1986

MEMORANDUM FOR ASSISTANT DIRECTOR, SP

SUBJECT: Falklands Wargame Study Directive

1. PURPOSE OF STUDY DIRECTIVE. This directive provides guidance for:

a. Conducting a quality assurance check of the Contingency Force Analysis Wargame, based on the Falklands campaign, and

b. designing a naval/maritime module for the Contingency Force Analysis Wargame (CFAW) model.

2. BACKGROUND. Models are frequently subjected to the criticism that they do not validly represent the "real world" and by extension, their results are not to be believed. To enhance the credibility of the wargaming being done in the Contingency Force Analysis Division, it is appropriate to compare results with historical battles. By using the Falklands campaign as a basis for comparison, a second initiative can be accomplished--exploration of the essential aspects required of a naval/maritime module for the CFAW model.

3. STUDY PROPONENT. Director, CAA.

4. STUDY AGENCY. Contingency Force Analysis Division, Strategy, Plans, and Policy Directorate.

5. TERMS OF REFERENCE.

a. Objectives:

(1) To conduct a quality assurance evaluation of CFAW wargaming by comparing its results with historical Falklands campaign results.

(2) To use Falklands maritime activities as a basis to begin designing a naval/maritime module for the CFAW model.

b. Scope:

(1) Only the Falklands land battle will be gamed for quality assurance purposes.

(2) Experimentation will be done with respect to maritime activities and naval actions.

(3) The quality assurance evaluation will include two aspects:

(a) the ability to recreate a historical battle using the model, and

(b) the ability to recreate historical results by altering model performance through appropriate wargame player and umpire/controller actions.

(4) Measures of effectiveness will be developed which address:

(a) Casualties.

(b) Percentage contribution of air power, artillery, air defense, and ground combat weapons.

(c) Movement rates.

c. Scenario: The historical campaign.

d. Timeframe: April-June 1982

6. RESPONSIBILITIES:

a. Management Support Directorate.

Assist the Contingency Force Analysis Division in developing necessary model data.

b. Research and Analysis Support Directorate.

Assist the Contingency Force Analysis Division in developing appropriate Measures of Effectiveness (MOE) and analyzing these MOE.

c. Contingency Force Analysis Division.

(1) Provide appropriate informal progress reports.

(2) Provide final results of quality assurance evaluation in annotated briefing format.

(3) Document naval/maritime module design.

CSCA-SPF 11 April 1986
SUBJECT: Falklands Wargame Study Directive

7. MILESTONES

Study Plan ARB	16 Apr 86
Study Directive coordinated	18 Apr 86
Data Base developed	25 Apr 86
Gaming completed	16 May 86
IPR	28 May 86
Naval/maritime module designed	13 Jun 86
Final ARB	18 June 86
Final evaluation report	15 Jul 86
Final design documentation	15 Jul 86

E. B. VANDIVER III
Director

APPENDIX C

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APPENDIX D

AVAILABLE FORCES AND EQUIPMENT

This appendix presents the forces and equipment modeled in the Falklands Wargame.

Table D-1. Force Comparison

Equipment and personnel	British	Argentine
Lt tanks/IFVs	16	12
APCs	15	0
Antitank wpns	379	0
Transport helos	21 (SRA King Mark V)	10 (PUMA/CHINOOK)
Attack helos	10 (Lynx/Gazelle)	0
Fixed wing aircraft	33 (Sea Harriers)	140[c]
ADA wpns	54[a]	45
Artillery tubes	71[b]	38[d]
Total personnel	14,665	11,690
Navy	7,320	0
Air Force	250	1,690
Army	7,095	10,000
Infantry	5,245	8,040
ADA, arty, helo	1,850	1,960

[a]Includes 18 ADA weapons located on ships.

[b]Includes 35 Naval guns.

[c]Includes 60 A4 Skyhawk, 40 Mirage V, 20 Mirage III, 10 C-130, and 10 Pucara aircraft.

[d]Includes 2 ground launched EXOCET missile systems.

Note: Approximately 2,900 British and 3,000 Argentine Army forces (signal, engineer, etc.) are not represented in the model, even though they participated in the actual campaign.

APPENDIX E

OFFLINE ANALYSES

E-1. NAVAL/MARITIME EVENTS, ISSUES, AND CONCLUSIONS

The following is a record of the significant historical events that took place at sea during the Falklands War, with emphasis on those that predated (1 May to 20 May) the period of the Contingency Force Analysis Wargame (CFAW). These events nicely cover most kinds of naval and maritime operations of interest in contingency analysis.

The ISSUES appear as they were originally posed before the wargames were conducted. The CONCLUSIONS are the postgame resolutions of each issue.

I. **BACKGROUND:** Initial Conditions, 1 May

United Kingdom (UK): Carrier Battle Force (CBF) enters total exclusion zone (TEZ), 200 nmi from Falklands.

Invincible + 10 Harriers
Hermes + 12 Harriers
About 9 escorts
2 SSNs

Argentine (Arg): 1 Carrier Battle Group (CBG), 1 Surface Action Group (SAG) at sea.

About 12,000 troops, small numbers of small jets, helicopters, and light planes occupy the Falklands.

II. **EVENTS PRIOR TO 21 MAY**

EVENT

1 (26 April - 2 May) Search by two UK submarines (SSN) for Argentine Fleet. Two stations at limits of TEZ; 50 nmi detection radius. HMS Conqueror detected General Balgrano on 1 May, attacked at 1600 2 May with torpedoes. Two hits sank cruiser General Balgrano.

ISSUE. The extent of modeling necessary for submarine encounters and engagements (the attack itself is too simple to play).

CONCLUSION. The critical questions are whether the SSNs could find the Argentine forces (carrier group and cruiser group) before they posed a threat, and the outcome of the action. A cursory analysis would conclude that, with their passive sensors, the SSNs would gain an early detection and the British fleet, especially the SSNs, would engage and defeat the obsolescent Argentine fleet. This

EVENT (continued)

reinforces the study conclusion that a full-scale fleet-on-fleet wargame will often not be necessary. One side (the Argentine ships) can be eliminated from further consideration by a simple net assessment.

2 (2 May) Arg aircraft search and attack. Long-range (Boeing 707) search. UK CTF on station 30-40 nm east of Stanley, steams N-S. Of two pickets N and S of Falklands, HMS Sheffield attacked and destroyed on 4 May.

ISSUE. How to play "targeting." (Detection should have been easy, but localization and attack was tricky.)

CONCLUSION. Detection and targeting can be played when necessary, with the modification that has been built into CFAW. The pace of the action at sea (information revealed to the attacker versus fast movement of ships at sea) results in a suitably difficult targeting problem for the attacker.

3 (3 May to 20 May) UK CTF on station usually 30-40 nmi east of Stanley. Argentine Navy outside their 12-mile limit, stalked by subs. Harriers conduct ineffective land strikes.

ISSUE. Test adequacy of sea-to-land air attack model. (UK submarine action was a significant "nonevent.")

CONCLUSION. The CFAW Model tests out well for the play of air attacks against land targets.

4 (unknown dates) The only operational Argentine sub is at sea during an unknown part of the war. Submarine search and attack (SSN, SSGN, SSG, or SS) is a required capability to incorporate offline.

ISSUE. Decide ways to compute submarine engagement rates and results.

CONCLUSION. When submarines are significant participants in the maritime action, the two vital ingredients are engagement rates (how long it will take for the submarines to do their damage) and engagement results (in surface ships lost per submarines sunk). These two pieces of information can be used in the model by imposing appropriate "movement attrition" on sea counters (which is a different rate from movement attrition for ground counters).

In the Falklands War, the Argentine submarine was a major nuisance, but our analysis (or anyone else's) would have concluded that the Argentine submarine order of battle (OB) was too small (in both quantity and quality) to cause significant British losses, which was also the historical result.

EVENT (continued)

5 (9 May) HMS Coventry and her escort establish a "missile trap" 12 nmi from Stanley, shoot down three Argentine aircraft: two Skyhawks escorting Hercules airlift aircraft, and one Puma helicopter.

ISSUE. How to represent air interdiction.

CONCLUSION. With proper inputs, the model will represent naval surface-to-air missile (SAM) effectiveness adequately.

6 (9 May) Harrier bombs and strafes the trawler Narwhal which was following, tracking, and reporting the British CVBF.

ISSUE. How to represent scouting at sea in general and tattletales in particular.

CONCLUSION. CAA contingency wargames need not play the details of scouting and tracking (e.g., with tattletales) explicitly. When results are found to be sensitive to these activities, they should be analyzed offline.

7 (10 May) While HMS Alacrity is in Falkland Sound (conducting harassing fire and scouting landing sites, mines, shore batteries, etc.), she finds a 4,000-ton tanker and sinks it.

ISSUE. This and other incidents raise the need to model or estimate effects of a naval blockade.

CONCLUSION. In the Falklands game, it was satisfactory to assume that a generally effective naval blockade by the British Navy was imposed. In most games, the rough effect can be approximated without explicit play.

8 (from about 10 May onward) UK shore bombardment. Details unknown. A secondary purpose is to draw air attacks before the amphibious operation. One "22-42" team (a Type 42 ship with area defense missiles (e.g., HMS Glasgow and Sea Dart)) is teamed with a Type 22 ship with point defense (e.g., HMS Broadsword and Sea Wolf)) attacked by two waves of four Skyhawks each. Three aircraft shot down. HMS Glasgow hit.

ISSUE. How to model sea-air warfare.

CONCLUSION. The model has now been adapted so that, with proper inputs, sea-air actions can be played for all activities vital to the wargame.

EVENT (continued)

9 (about 12 May) Two UK SSNs change from antiwarship role to early warning against air attacks, stationing off Argentine airfields.

ISSUE. How to treat scouting and early warning. Solution (?): assign forces and assume you have it.

CONCLUSION. With the normal amount of pregame planning of missions for naval and air units, assets can be apportioned in such a way to set aside forces to be dedicated to scouting and early warning. The strategic intelligence aspect of the CFAW Model will appropriately represent the intelligence gained and display it to the Red and Blue players.

10 (16 May) Sea King(s) conduct "reconnaissance" on Argentine mainland. These may have been special forces trying to destroy aircraft on the ground.

ISSUE. If play of such details is contemplated, forces must be allocated (where did the Sea King helicopters fly in from?) and the operation (and play) consumes significant resources.

CONCLUSION. Conclusion 9 applies.

11 (15-20 May) Accelerated naval gunfire support (NGFS), including in Falklands Sound and a diversionary landing site.

ISSUE. How to play effects of fire support not associated with an amphibious assault itself. (Effects are principally harassment and interdiction of movement; little attrition.)

CONCLUSION. With proper inputs, NGFS, including that conducted by ships in support of amphibious operations, can be played explicitly. In general, NGFS effectiveness per gun tube will be several times greater than ground artillery.

III. POST LANDING MARITIME EVENT

12 (25 May) Attack on the UK CBF by Super Etendard with Exocet.

ISSUE 1. The general problem is resolving air attacks by air-to-sea missiles (ASM) with an offline model. A particular problem is treatment of atypical incidents, such as this sneak attack with one snooper aircraft and two ASM-equipped aircraft. (Two aircraft launched two Exocets. One had no effect. Second was reported variously as heading for an escort or a carrier. It was diverted, probably by chaff, sought a new target, and hit the Atlantic Conveyor. The aircraft had, in effect, tracking but not targeting information on the force.)

EVENT (continued)

CONCLUSION. In instances when the contingency game results are sensitive to the results of major clashes between naval forces, the results should be determined offline.

ISSUE 2. The Atlantic Conveyor had a concentration of important materiel (all tents and three or four heavy lift helicopters). What relationship should be assumed between percent of resupply tonnage lost and percent of ground combat capability lost?

CONCLUSION. Damage to troop and support ship counters per attack by guns, missiles, or aircraft can be calibrated with enough accuracy to approximate the loss of ground combat capability. It is preferable not to add the complication of a nonlinear relationship between ship counter losses and associated ground combat effectiveness lost to the embarked troops or supplies.

IV. OTHER MARITIME EVENTS TO BE GAMED EXPLICITLY

21-25 May: The UK landing, establishment of beachhead perimeter, and defense against Argentine air attacks which slowed the landing of combat support materiel.

21 May-13 June: NGFS.

5-8 June: Amphibious lift of 5 Inf Bde to Fitzroy and daytime air attacks.

11-12 June: "Shore battery" attacks by land-based Exocets against ships (the actual incident was a hit on HMS Glamorgan on 12 June. She had given NGFS to 45 Commando assaulting Two Sisters and overstayed into daylight hours).

CONCLUSION. All of the above kinds of events for the period 21 May to 12 June can now be played explicitly.

E-2. UNDERSEA BATTLE ANALYSIS

- AIM: Inject loss rates (ships lost per transit mile steamed)
- Include losses to amphibious, reinforcement, and resupply ships
- Method: Estimate engagement rates

  Then estimate losses/engagement for warships, protected ships, and enemy subs

Figure E-1. Undersea Battle Analysis

When a submarine order of battle (OB) for one or both sides is large enough, in the opinion of the study director, to strongly influence the outcome of the conflict being studied, then a considerable amount of analysis may be required (the Navy has done exhaustive studies on submarine warfare). Otherwise, for the purpose of wargaming in the Contingency Force Analysis Wargame (CFAW), the loss rates will probably be small due to submarine-antisubmarine operations and can be handled by injecting a suitable movement loss rate for opposing ships.

E-3. SURFACE BATTLE ANALYSIS

- AIM: Project result of Blue attempt to gain sea control as: Yes/no/too-close-to-call
- Examples:
  - "Yes indicates O.K. for Blue to attempt sea-to-land operations (harassment and interdiction by Red) (US in Vietnam)
  - "No" indicates no sea-to-land operations possible. (Blue and Red may attempt hit-and-run attacks) (Libya-Egypt)
  - "Too-close-to-call" indicates need to play two ways (when important) (Falklands)
- In many contingencies detailed offline play of big sea battle not necessary. Static force comparison sufficient.

Figure E-2. Surface Battle Analysis

Surface sea control operations and battles (and associated air operations) would be handled differently than submarine-antisubmarine operations. In most contingency situations, a simple net assessment of warships will lead to a conclusion as to whether sufficient sea control can be gained by either side to conduct sea-to-land operations.

For example, a clear "yes" was indicated on the US side for the duration of both the Korean and Vietnam Wars. In future games, US naval operations **not** involving the Soviet Union will probably fall into the "yes" category, albeit with a growing land-to-sea threat necessarily considered.

A clear "no" would be the case in a war between Libya and Egypt. Neither side has the naval preponderance of force at sea nor the amphibious capability to make such naval operations interesting.

Sometimes the competition for sea control should be categorized as "too-close-to-call," an indication that the game may need to be played two ways.

Even with skillful naval analysis and gaming, the conclusion may be that the outcome hangs on a knife's edge. It was easy to reach the conclusion that Argentine ships were outclassed and would not affect the outcome. But Argentine aviation was a serious threat before, during, and after the landing.

Had the campaign been wargamed before it actually occurred, it would have been possible to reach a "too-close-to-call" conclusion about the feasibility of a British landing on the Falklands. The outcome hangs on a tenuous chain of curcumstances that could go either way. Even if the landing looked infeasible (a "no" to the sea control question) after this wargaming, the branching approach would require that a "yes" to sea control be assumed and the ground operations be gamed anyway.

Since this wargame is a ex post facto historical comparison, the situation on the 20th of May (i.e., tenuous British sea control) was known and the wargame proceeded to play the landing operation as it occurred, with the subsequent events afloat and ashore.

E-4. DISCUSSION OF GAMING WITH BRANCHES

- A branching mode
- One game assumes Blue must conduct a ground campaign without maritime control (e.g., no Inchon landing)
- Second game allows Blue to supplement actions on the ground (e.g., naval blockade)
- All results presented two ways (Red vs Blue in both possible postures) with risk analysis
- More than two branches conceivable (e.g., Inchon, Wonsan, and Hungnam) but should be avoided

Figure E-3. "Play Two Ways" Explained

Branching may be used to explore two or more variations to reach independent conclusions derived from two or more alternative "inputs." For example:

If A then X and if B then Y (e.g., A = sea control achieved, X = amphibious landing can occur, B = sea control not achieved, Y = no landing).

The understanding that A and B are both significant, mutually exclusive possibilities ("too-close-to-call") is of itself as important for the study customer as A⟶X or B⟶Y relationships.

Then what? If results X = you win and Y = you lose, then the customer knows that enormous effort is warranted to create A (e.g., commit more naval forces) or if that's impossible, avoid B (e.g., make more political concessions).

Before telling him that, however, under these circumstances of extreme sensitivity, close study of the A - B dichotomy is called for. There is some antecedant which causes A or B, call it α : if α then A, if $\overline{\alpha}$ then B. (Of course α is a complicated vector of inputs, or we would already know as much as we can about the probabilities of A and B occurring--e.g., if "outcome" A depends on α = (cleverly done first detection and quick, effective attack), then can α be improved by changes to the scouting plan? (Is α driven by the weather, such that we may have A if we can pick the time of attack?)

But there is no point in doing much work to analyze the $\alpha \longrightarrow$ A relationship, much less study ways to achieve α (e.g., by intense training or new operational plans) if it turns out, as it often will, that for either X (amphibious landing made) or Y (none is made) the "ultimate" results are undesirable. If, either way, you lose the war, then α loses importance.

In the context of the Falklands Wargame, without much explicit gaming it was possible to forecast that achieving sea control sufficient for a landing (condition A) would be a closely run thing. We can even say why: it depends on Argentine decisions regarding air operations, over which the British have no control. So we assume A and hence X (landing is made).* If now the Argentines are so strong ashore that X doesn't lead to victory, then A and B both result ultimately in outcome Y, a loss for the UK. By having pressed on and played the A-case, we would have learned:

a. We don't need a big analytical effort to understand α and the probabilities associated with A and B. They're irrelevant.

b. We shouldn't tell Mrs. Thatcher to beg, borrow, or steal more ships to create situation A by brute force, because the outcome will still be Y.

In the play of the ground war, however, we actually reached the opposite conclusion: that if the UK could secure a beachhead and a force buildup without great losses, then the UK could win on the ground. That led to the prominent conclusion that sea control was vital; that winning the air battle was critical and that it would be closely run; and searching for ways to win the air battle required the most intensive thought, whether viewing the problem through British or Argentine eyes.

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*To assume B leads to a new strategy, probably one of accommodation.

APPENDIX F

DATA MODIFICATION

F-1. GROUND FORCE DIRECT FIRE ATTRITION

a. CFAW's **direct fire attrition algorithm** is designed to attrit equipment. To do this, it requires the input of five variables: single shot probability of kill (Pk), probability of acquisition (Pa), rate of fire, target priority, and number of shooters per side per weapon category. These input values are designed to simulate all postures, engagement ranges and lighting conditions for shooter and target that are expected in a particular scenario. The algorithm is based on a 2-hour combat cycle.

b. **Pk data**, as used in the model, is a weighted average of expected range, target exposure, and type and number of shooters in the weapon category. An expected engagement range profile, and a target exposure profile is developed for each wargame. In the Falklands Wargame, the expected engagement range was 500-1,000 m for MGs and targets were assumed to be in defilade positions.

c. **Rate of fire** (the number of shots taken by a single weapon in a 2-hour combat cycle) treats all weapons as single shot weapons (to include MGs), and was obtained from FM 101-10-1, using "protracted period" data.

d. **Target priority** (a military judgment utility value assigned to each target in relation to each shooter) allows the model's attrition algorithm to maximize the expected value of killed targets given a set number of rounds.

e. **Pa data** (the probability a shooter acquires and can engage a target) is a function of terrain, weapon configuration, tactics, target range and exposure, and shooter exposure. Since this type of data is not readily available, military judgment is used to develop appropriate data by adjusting values up or down from previous games to meet the conditions of the current game.

f. **The number of shooters per weapon category** is obtained from the TOE of forces used in the wargame.

g. Game 1 input data

(1) Small arms were represented in the model as MGs per battalion or regiment. The types are shown in Table F-1.

Table F-1. Weapon Types

British	Argentine	Weapon
X	X	7.62 MG
	X	.50 Cal MG

(2) Game 1 input data, taken from earlier CFAW wargames, are shown in Table F-2.

Table F-2. Game 1 Input Data

Shooter	PK	Rate of fire	TGT priority	PA	Number wpns
British	.04	1.25	1	.01	32
Argentine	.01	.71	1	.01	13

NOTE: Number wpns is per battalion or regiment.

(3) Using this data in Game 1 produced no casualties in the first battle simulated (Darwin/Goose Green). Post-game analysis revealed the model to be insensitive to the combination of small arms input data and the small number of combat forces (i.e., weapons) involved.

h. Sensitivity analysis:

(1) To investigate sensitivity, this data was input into the CFAW Standalone Attrition Algorithm. One weapon kill on each side for a 2-hour combat cycle resulted (not equal to 1 personnel kill). New Pk data, obtained from CAA's MICAF-85 Study, are shown in Table F-3.

Table F-3. Machine Gun Pk Data

PK against opposing MG				
Weapon	**250 m**	**500 m**	**1000 m**	**1500 m**
British				
7.62 MG	.631 (.300)	.224 (.140)	.049 (0)	0
Argentine				
7.62 MG	.455 (.300)	.310 (.207)	.070 (.046)	0
.50 Cal MG	.290 (.097)	.250 (.083)	.125 (.042)	.070 (.023)

NOTE: Data is for targets fully exposed and in defilade (in parentheses).

(2) A second sensitivity run was conducted using the standalone attrition algorithm. The objective was to vary Pa, Pk, and Rate of Fire in sequential steps to observe the sensitivity of the algorithm to changes in the variables and to produce an expected attrition ratio (Argentine/British) of 3:1 by finding the proper Pk, Pa, and Rate of Fire combination. An attrition ratio of 3:1 seemed reasonable, based on a British to Argentine weapons ratio of almost 3:1 (32:13).

(3) The new input data resulting from this sensitivity analysis are shown in Table F-4. The British Pk value represents a range just slightly under 500m.

Table F-4. Refined Input Data

Shooter	Pk	Rate of fire	Tgt priority	Pa	Number weapons
British	.15	1.50	1	.10	32
Argentine	.10	2.00	1	.30	13

i. Game 2 input data:

(1) The stand-alone algorithm, based on the new input values shown in Table F-4, produced 7 (of 13) kills of Argentine weapons and 5 (of 32) kills of British weapons, 58.8 percent and 15.5 percent, respectively, an approximate 3:1 ratio in percentage attrition.

(2) Based on these observed results, input data for Game 2 were changed to incorporate these new values, producing attrition on both side during a 2-hour combat cycle, overcoming the zero attrition problem which occurred in Game 1.

j. Input Analysis. Figure F-1 summarizes the results of the input analysis conducted as part of the Falklands Wargame.

WARGAME 1 (CFAW MODEL)	PRIOR RUN (Pk = .01 -.04)	NO ATTRITION
SENSITIVITY ANALYSIS (ATTRITION MODEL)	NEW (Pk = .10 - .15)	WEAPONS ATTRITION 1:1 (ARG:UK)
WARGAME 2 (CFAW MODEL)	NEW (Pk = .10 - .15)	PERSONNEL ATTRITION 10:1 (ARG:UK)
HISTORICAL RESULTS		3:1 ◄► 9:1 (ARG:UK)

Figure F-1. Input Analysis

(1) As stated in the main report (page 51), the initial wargame produced no attrition.

(2) Subsequent sensitivity analysis resulted in the selection of new Pk values which would produce a weapons attrition ratio of 1:1.

(3) Figure F-2 demonstrates how the weapons attrition ratio interacts with weapon values (based on weapon density) and number of soldiers to yield a personnel casualty ratio of about 12:1 in favor of the British.

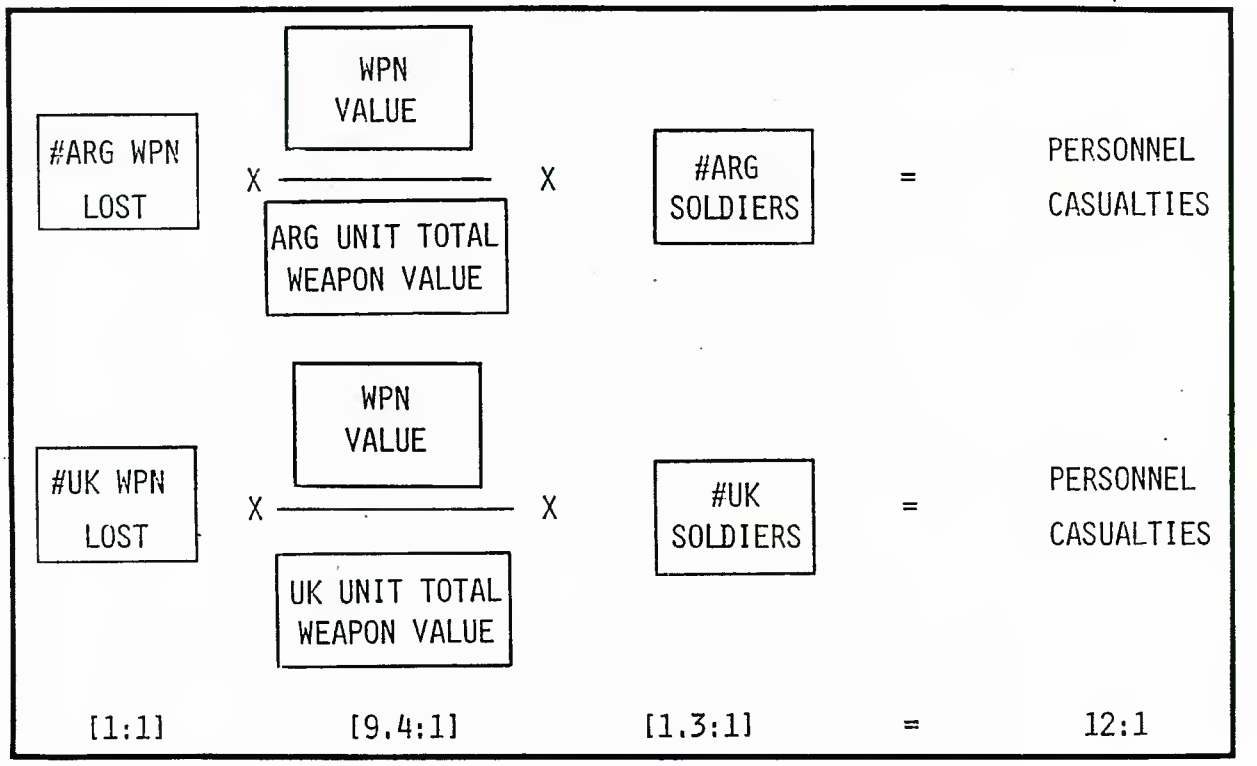

Figure F-2. Personnel Attrition

(4) As noted on Figure F-1, historical results between 3 and 9:1 were reported in the sources cited in the bibliography.

F-2. NAVAL ATTRITION

a. Table F-5 shows the naval attrition input values used in Games 1 and 2. Game 2 introduced additional combat ship **counters** (a counter was used in the game to represent one or more ships of the same type) and increased the effective range of antiair weapons. Experimentation with ship speed, number of ships controlled with one counter, and attrition against a counter containing more than one ship was necessary to produce results which, based on naval judgment, were reasonable. Game 2 input values were based on 10 experimental trials done offline with the model.

Table F-5. Naval Attrition Input Data

Counter type	Number of counters	Speed	Naval gunfire		Antiair weapons			Number of events[a]
			Range	DAMVOL	Range	Pa	Pk	
Destroyer (1 ship)	3/4[b]	20/35 kph	10/16	.05/.05	2/4 km	.5/.5	1.0/1.0	2/2
Destroyer (3 ships)	2/3	20/35 kph	10/16	.1/.1	5/12 km	.5/.5	.5/1.0	6/6
Amphibious (1 ship)	2/2	15/35 kph	-	-	2/4 km	.5/.5	1.0/1.0	2/2
Amphibious (3 ships)	2/2	15/35 kph	-	-	2/4 km	.5/.5	1.0/1.0	4/4
Reinforcement ships (3 each)	2/2	15/35 kph	-	-	-	-	-	-
Support ships (6/3[b] ships)	1/2	15/35 kph	-	-	-	-	-	-

[a]An event is a single attack by one or more aircraft against a ship. Each ship can fire the indicated number of times against that attack.

[b]Game 1/Game 2.

b. Table F-6 shows air attrition input values against naval targets for Games 1 and 2. In Game 2 (based on the 10 experimental trials mentioned), the percent damage per sortie was reduced to offset the very large amount of attrition observed in Game 1.

Table F-6. Air Attrition Input Data (against naval targets)

Aircraft type	Number of sqdn	Aircraft per sqdn	Total aircraft	Damage per sortie (%)
A-4	3/3[a]	20/20	60/60	10/8
Mirage 5 (DAGGER)	2/2	12/12	24/24	10/8

[a]Game 1/Game 2.

APPENDIX G

CONTINGENCY FORCE ANALYSIS WARGAMING

G-1. INTRODUCTION. The US Army Concepts Analysis Agency (CAA) has developed a capability to conduct wargames involving joint forces. The purposes for establishing this capability are shown in Figure G-1. CAA's philosophy has been to develop an economical wargaming process that supports wargame players with a computer model that allows a rapid accumulation of combat days and maximum flexibility in analyzing specified scenarios.

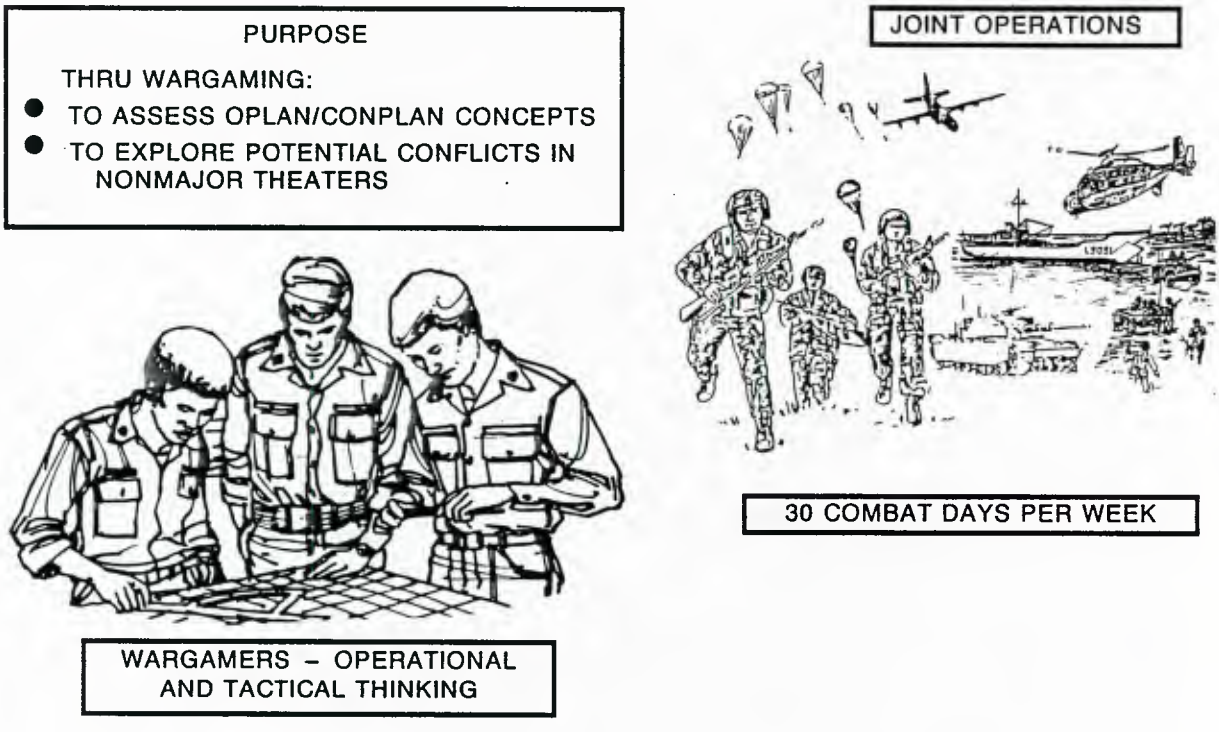

Figure G-1. Contingency Force Analysis Wargame (CFAW)

G-2. THE MODEL. The Contingency Force Analysis Wargame (CFAW) Model is an enhanced version of an original model developed by Mr. Fred McClintic for the US Army War College. It is a two-sided, player-interactive model designed to simulate one or more corps in a theater-level wargame played on a hexagonal map network (Figure G-2). The model contains five major programs: data preprocessing, combat simulation, player-model interface (input/output), graphics (for display of units and real time locations), and data postprocessing. The Information Graphics Retrieval System (INGRES), a relational data base management system, has been incorporated into CFAW to increase the ease and flexibility of preparing data bases for new games and of obtaining desired output reports at the end of game runs. The model aggregates combat assessment at battalion, brigade, or division level, depending on how the variables used in the model are initially defined. This enhanced model provides the analytic capability necessary for CAA to produce decision-assisting information for the Department of Army Staff or other major Army commands (MACOMs)/agencies concerning the guidance, assumptions, executability, and supportability of OPLANs and CONPLANs. It also allows exploration of potential conflict in non-major theaters worldwide.

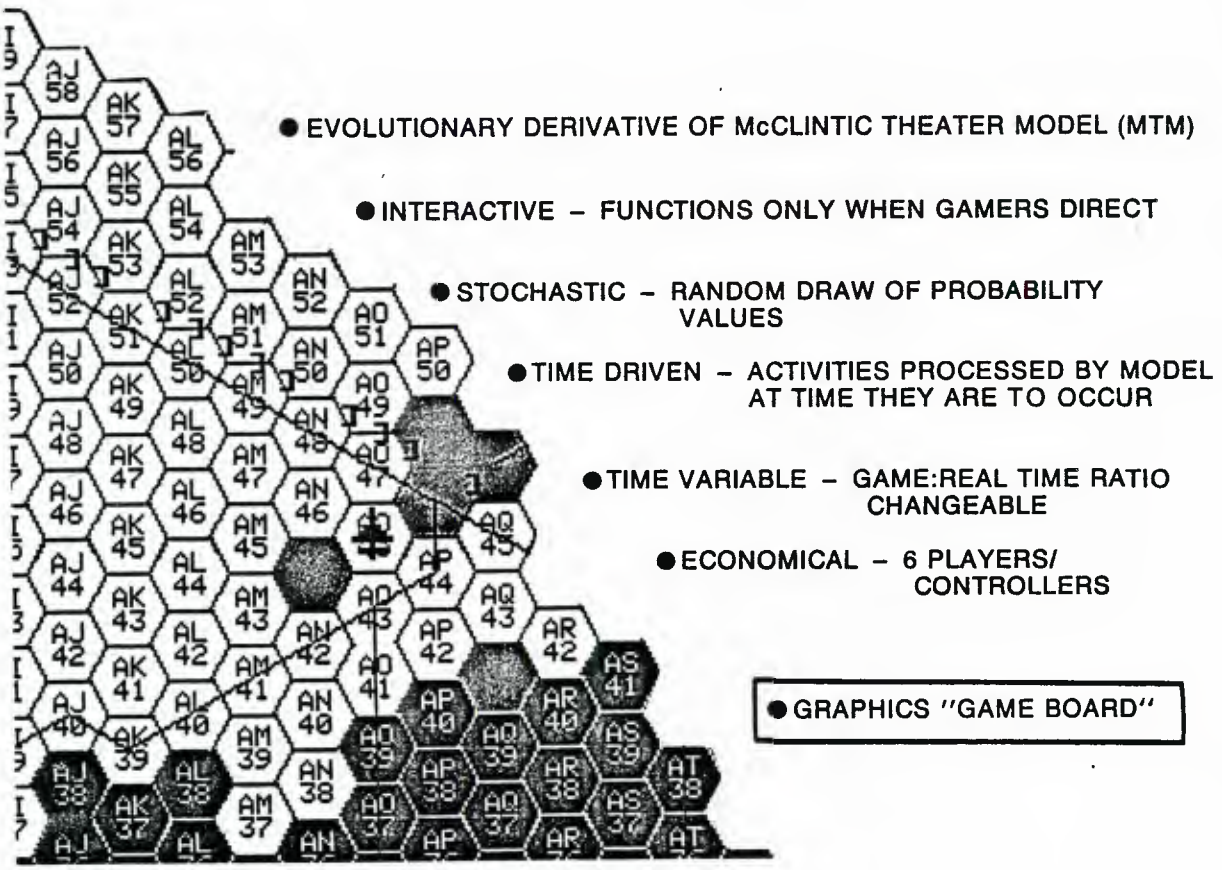

Figure G-2. The CFAW Model

a. **Combat Processes.** The 12 activities represented in CFAW (Figure G-3) are air movement and combat, effects of chemical and nuclear weapon use, intelligence reporting, employment of Army aviation, ground movement and combat, engineering, airborne/airmobile employment, electronic warfare, amphibious operations, artillery and naval fire, air defense, and aggregate logistical functioning.

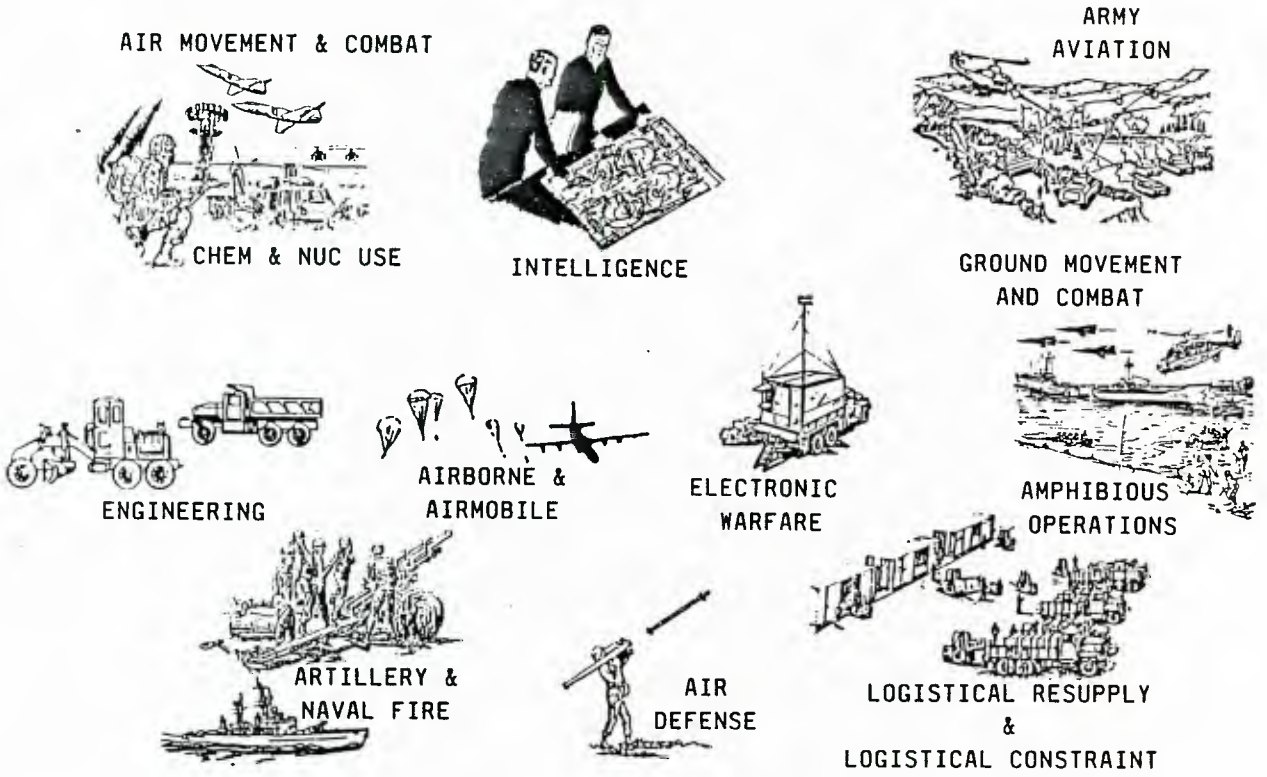

Figure G-3. Combat Processes

b. **Close Combat**

(1) The strength of ground units is represented in CFAW by a weapon array dimensioned by a variable number of weapon categories. Allocation of fire and calculation of attrition is based on preset inputs of target value, probability of acquisition, probability of kill, and sustained fire rates. Changes in combat postures (attack, defend, delay, and withdraw) are not modeled. Termination of combat occurs when a unit has been attrited to a preset strength threshold or below 25 percent of the original strength. The preset strength threshold is set by the player and can be set (and altered during game play) at any level from 26 percent to 99 percent. Attrition to the preset strength threshold triggers automatic withdrawal from combat. Attrition below 25 percent of original strength equates to combat ineffectiveness, and the unit is removed from the game.

(2) Ground units maneuver in discrete steps on a hexagonal grid game board. Movement rates are based on maximum unit speed and preset multiplicative coefficients which reduce movement speed to account for terrain, barriers, and contamination.

c. **Fire Support.** Player control of fire support units is restricted to the number of volleys fired and target location. Attrition is assessed against a randomly selected unit within the target hexagon. Naval gunfire is treated identically to land artillery fire.

d. **Air Defense.** Air defense calculations are based on slant range and probabilities of detection, acquisition, and kill as aircraft fly routes over hexes. Coordination of fire and fratricide are not played.

e. **Combat Support**

(1) **Engineering.** Engineer units are not explicitly modeled. However, units can destroy roads and bridges if sufficient demolition supplies are onhand. Repair of roads is automatically played. Combat construction and general engineering support are not played automatically in the model, but can be manually effected through input changes made by the controller.

(2) **Mine Warfare.** Hexagon sides can be mined. All units entering mined areas must automatically perform clearing operations. The time to breech minefields, both opposed and unopposed, is played. The rate of attrition of units doing the breeching depends on whether the minefield is opposed or not.

(3) **NBC.** Nuclear and chemical contamination can be delivered by both air and artillery units on a side as long as permission has been granted to that side. Entire hexagons are contaminated. The effects modeled are delay and attrition to units currently present in the hex.

f. **Command, Control, and Communications.** Players must directly and explicitly command each unit in the game. Communication systems are not specifically modeled.

g. **Combat Service Support.** Logistics is modeled both by automatic resupply and by player-issued orders. Arrival of units and supplies in theater is also modeled. There are designated supply points and implicit supply routes; however, such supply routes can only be disrupted by destroying the supply points. Resupply by helicopter is modeled. CFAW keeps track of the total tons of supplies held by every unit for seven classes of supply as well as aircraft fuel and aircraft ammunition. Consumption rates, based on individual unit strength, are input for unit type, side, and activity (combat, noncombat). Personnel and medical service support are not modeled, nor is maintenance.

h. **Air Interdiction Strikes.** Strikes are ordered by target location (hexagon). Generic bomb loads are simulated, and damage is assessed against a randomly selected unit within the target hexagon.

i. Counterair. Counterair is calculated as a closed-form, probabilistic expression based on number of attacking and escorting aircraft, number of alerted interceptors, and quality of the attacking, escorting, and interceptor aircraft.

j. Defense Suppression. Not modeled.

k. Airlift. Air and ground units must be collocated at time of order. If a unit has organic or dedicated aircraft, it can alternatively be modeled as fly-capable at all times.

l. Sealift. Navy and ground units must be adjacent and have a hexagon edge designated as a shoreline between them at the time of the order.

m. Electronic Warfare. Jamming and interception of players' orders, at fixed probabilities and indexed by side, are modeled.

n. Amphibious Warfare. Naval air strikes, naval gunfire support, assault and administrative landing of forces, resupply, air and surface fire against ships, and aerial scouting are portrayed.

o. Surface Warfare. Not explicitly played (depends on analysis done offline).

p. Subsurface Warfare. Not explicitly played (depends on analysis done offline).

q. Tactical Surveillance, Reconnaissance, and Target Acquisition. National intelligence summary reports are automatically generated at fixed probabilities and indexed by side, providing information on randomly selected enemy positions and activities. Gamers can order reconnaissance flights and request human intelligence on a specific hexagon.

r. Resolution of Detail. Units are modeled as independent, point-located entities that can accomplish one task at a time. They see and hit targets with fixed probabilities, consume supplies at standard rates, and maneuver from hexagon center to hexagon center. Friendly units interact with one another to the extent required by multi-unit activities, such as resupply, escort, airlift, and sealift. Friendly units can be collocated, but opposing units cannot occupy the same hex.

s. Model Adaptation. Each wargame seems to require unique representation of one or more activities which occur in the conflict being explored, of which attack by a single aircraft and logistic constraint induced time-delays are two examples. The CFAW Model can be quickly adapted to provide such representations by the CAA controller/umpire team.

t. Game Control and Information. Since CFAW is a single-echeloned model, command and control of maneuver units, artillery fire, air sorties, and amphibious forces must be exercised simultaneously. Players interactively direct activities through an input terminal. Results are returned to players through an output terminal, with unit movements and current locations depicted on a graphics terminal. The game information available to players is shown in Figure G-4.

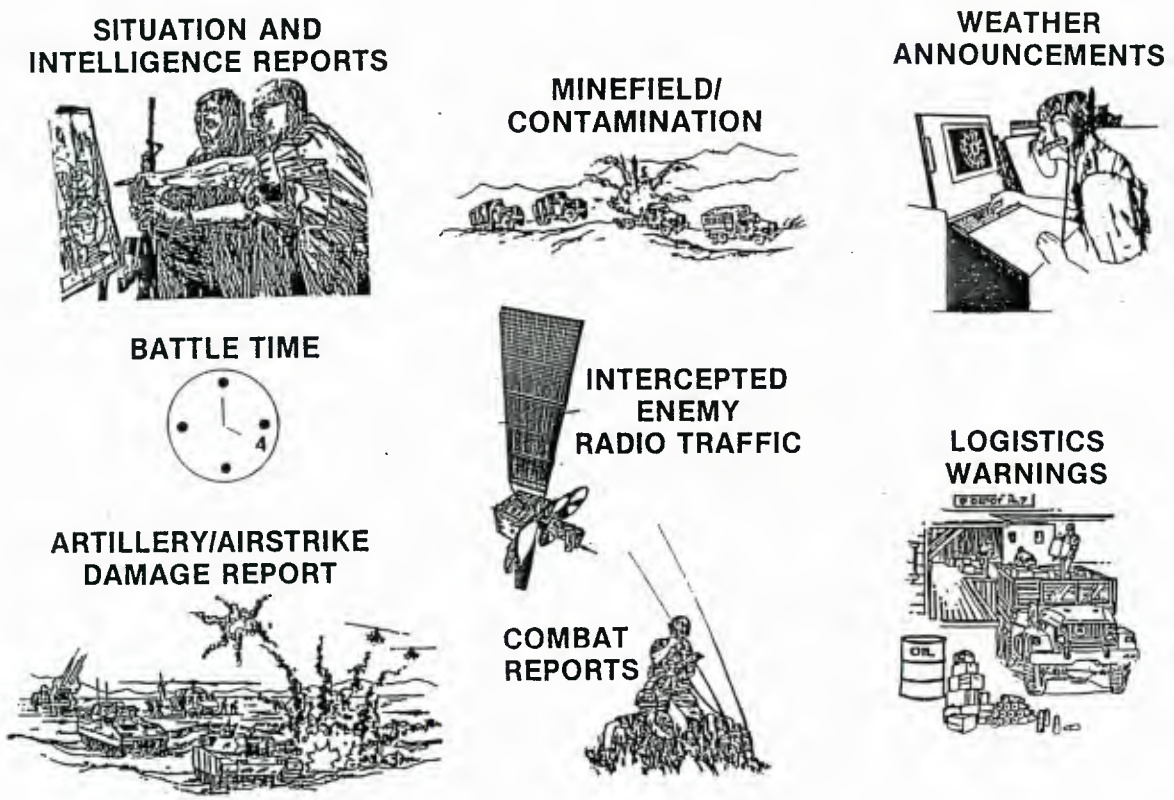

Figure G-4. Game Information

G-3. METHODOLOGY. The methodology employed in Contingency Force Analysis is a combination of online, interactive, computer wargaming coupled with offline analysis. Figure G-5 illustrates the sequence of events.

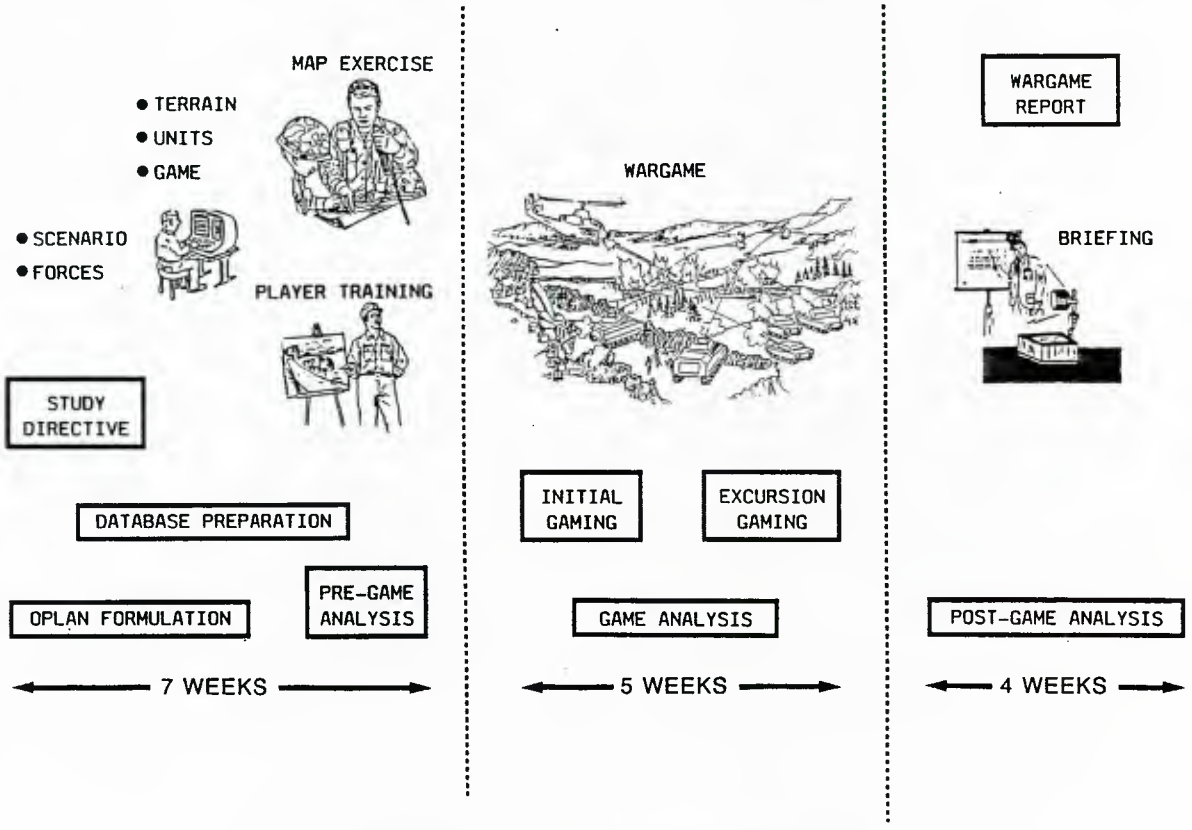

Figure G-5. Methodology

a. OPLAN Formulation

(1) Area of Conflict/Scenario. An area of potential conflict is identified by the wargame sponsor and research begins into the scenario and force employment that describe the conflict. In some cases, a US OPLAN or CONPLAN exists and is used to build the scenario. In other cases, the scenario is built from existing intelligence estimates gathered from the Defense Intelligence Agency (DIA) and the Office of the Assistant Chief of Staff (Army) for Intelligence (ACSI).

(2) Study Directive. Concurrent with scenario and forces research, a study directive (Appendix B) is prepared which describes what the study sponsor desires to accomplish in the study.

b. Data Base Preparation

(1) Terrain Data Base. Once the geographic area of interest and the scenario have been identified, the terrain data base must be built for the model. CFAW is played on a map that consists of hexagonal shaped grids which represent terrain. CFAW's graphic capability limits the grid to 49 (east-west) hexagons by 48 (north-south) hexagons. The hexagons can be any size that is desired; however, the gamer must take into consideration: 1) the 49 x 48 grid limitation, 2) the amount of terrain that needs to be represented, and 3) the level of unit resolution (battalion, brigade, etc.) that is to be played in the game. Typically, in gaming units at brigade level, a hexagon around 7 kilometers in diameter will be used. Once the size of the hexagons is determined, the terrain is coded and placed into the terrain data base. Terrain coding is done by assigning a numerical value (1-6) to the interior of each hexagon which represents the type terrain found within the hexagon and then assigning numerical values (1-10) to each of the sides of the hexagon. The side or "border" values represent the trafficability in moving from one hexagon to the next across a specified "border."

HEX INTERIOR	
1 - FLAT	dark green
2 - HILLS	light green
3 - URBAN	gray
4 - SWAMP	sand
5 - MOUNTAINS	brown-orange
6 - OCEAN	blue

HEX EDGES	
1 - GOOD HIGHWAY/OPEN	dark green
2 - SECONDARY HIGHWAY/OPEN	dark green
3 - GOOD HIGHWAY/NO OFF ROAD	light green
4 - SECONDARY HIGHWAY/NO OFF ROAD	light green
5 - POOR HIGHWAY/OPEN	sand
6 - POOR HIGHWAY/NO OFF ROAD/RR	gray
7 - CROSS-COUNTRY FOR VEHICLES	yellow
8 - CROSS-COUNTRY FOR FOOT TROOPS	brown-orange
9 - NONPASSABLE (MOUNTAINS/SWAMPS)	dark red
10 - COASTLINE	dark red

(2) Unit Characteristics Data Base. The unit characteristics data base consists of the numerical values which describe each unit played in the wargame. Inputs include the:

(a) Number of weapons in each weapon category.

(b) Movement speed of the unit.

(c) Effective range of the unit (if applicable).

(d) Number of personnel.

(e) Damage per volley/sortie (if applicable).

(f) Capacity, basic load and reorder point for supply classes.

(g) Air defense capability of the unit.

(h) Unit arrival time in theater.

(i) Unit type.

(3) **Game Characteristics Data Base.** Game characteristics are determined for each wargame based on the scenario, forces available, and equipment types within the units. This is the largest of the data bases needed to play the wargame. It consists of 15 separate files and includes:

(a) Ground-to-air weapons characteristics.

(b) Weapon rates of fire.

(c) Probabilities of acquisition for the Red side weapons.

(d) Probabilities of acquisition for the Blue side weapons.

(e) Probabilities of kill for the Red side weapons.

(f) Probabilities of kill for the Blue side weapons.

(g) Target values for each of the Blue side weapons.

(h) Target values for each of the Red side weapons.

(i) Game control variables (weather data, light data).

(j) Cutoff values which limit the amount of effective firepower that can be brought to bear in specific terrain (6 files).

c. Pregame Analysis

(1) **Map Exercise/Concept of the Operations.** In addition to building the computer data base, a "data base" for players must be built. This "data base" consists of translating the scenario into a concept of operations that will be portrayed in the wargame. A major strength of CFAW is the "man-in-the-loop." By utilizing a wargame that requires interactive input, CFAW permits the identification of critical decision points that occur during the simulated combat. To prepare the player for this role, it is imperative that an offline map exercise be conducted. The map exercise forces wargamers to think through the scenario, using the factors of METT-T. By overlapping the map exercise with data base preparation, it is possible to alter the computer input, as necessary, based on the results of the map exercise.

(2) **Player Training.** Players from outside CAA are provided training on how to interact with the model using the input/output terminals.

d. **Conduct of the Wargame**

(1) **General.** The wargame is played by two Red players, two Blue players, one umpire, and one computer controller. Personnel from the US Army Concepts Analysis Agency will always perform the duties of umpire and controller.

(2) **Game Speed.** Although virtually any time ratio is possible, 24:1 has been the highest realistic ratio to use. Experience has shown that a 6-hour gaming day works best. Beyond 6 hours, player fatigue degrades wargame quality. At 24:1, gaming 6 hours per day allows 30 days of combat to be completed in 1 week; 15:1 allows 15 days of combat.

(3) **Gaming Time.** One-half the available gaming time is usually devoted to gaming the initial scenario and one-half allocated to gaming excursions to that initial scenario.

e. **Analysis**

(1) **Analysis** is conducted before, during, and after gaming.

(2) **Pregame analysis,** accomplished prior to wargaming, must address the following questions:

- **what military factors will be most significant in this wargame?**
- **what is the function(s) for the "man-in-the-loop" in this wargame?**
- **what model limitations will affect this effort?**
- **what questions is the sponsor really asking with this wargame?**
- **what questions are we capable of answering?**
- **what form of output will be needed to answer the questions?**

(3) **Game analysis** is accomplished during wargaming. The potential for "gamesmanship" always exists when utilizing an interactive wargame. It is imperative that the umpire and controller continually assess the progress of the game and intervene as necessary to ensure the operational/tactical credibility of the wargame. Additionally, it is imperative that players document the thoughts and timing that represent critical decision points. This documentation can be as valuable as any computer output that may result, since it represents the human dimension of the wargame. Questions addressed during the conduct of the wargame include:

- **Are the initial assumptions still valid?**
  If not, then have players adjusted accordingly.
- **Is the 'man-in-the-loop' performing his expected functions?**
- **What excursions to the initial game should be considered?**
- **Is the combat reasonable?**

Based on the answers to the above type of questions, game analysis provides a critical look at the conduct of the ongoing game. If the wargame is unsatisfactory, a number of options exist. The game can be restarted from a number of stopping points, the players can adjust their predetermined concept of operations, or input variables can be adjusted to ensure a more realistic portrayal of combat.

(4) **Post-game analysis** occurs after the wargame has been completed. Since the wargame only represents one trial, player observations are as important as the computer-produced numerical results. Post-game analysis includes:

- an evaluation of the realism of the combat,
- a description of the conflict which occurred in the wargame,
- identification and analysis of the critical decision points in the conflict,
- a comparison of the computer wargame results with the **a priori** map exercise,
- offline analysis of important aspects of the scenario (e.g., transportation sufficiency), and
- an analysis which provides the answers to the questions posed in the study directive.

f. **Reports/Briefings.** At conclusion of the post-game analysis, an appropriate briefing is developed and a final report, in annotated briefing format, is prepared.

c. Limitations. Although the wargame model is a powerful tool, there are obviously limitations implied by the "delicate balance" figure. The more significant are highlighted in Figure G-8.

INHERENT

- Does not portray echelons of command
- Unreproducible results (probability and player variabilities)
- Small unit combat not explicitly represented

CORRECTABLE

- Changes in combat postures are not modeled
- Portrayal of maneuver is limited

Figure G-8. Limitations of CFAW

APPENDIX H

ALTERNATIVE APPROACHES TO MEASURE OF EFFECTIVENESS (MOE) DEVELOPMENT

H-1. GENERAL. The MOEs used in this wargame were narrowly focused and essentially evaluated attrition and movement rates. This appendix offers two alternative frameworks for evaluating wargaming at CAA:

a. An assessment of the model preparation process based on considerations of input, design, output and overall (or face) model validity.

b. An assessment of the wargaming process based on either a portrayal of the tenets of AirLand Battle or the principles of war.

H-2. MODEL PREPARATION VALIDITY

a. General. This assessment approach is based on the framework described in "Military Applications of Modeling: Selected Case Studies," written by Mr. Francis P. Hoeber. The assessment is conducted in terms of input validity, design validity, output validity, and what could be called face validity. The focus is on preparation of the CFAW Model.

b. Input Validity. Input validity is defined as the accuracy, currency, consistency and authority of the force structure and the system performance data base. Simply said, data must be aggregated properly in the model.

c. Design Validity. Design validity (for the purpose of this MOE development approach) is limitedly defined as the degree to which the logical structure of the model and its algorithms reflect the dynamics of combat in a reasonable fashion.

d. Output Validity. Output validity is defined as the degree to which the model's output is sensitive to the model's input. The CFAW Model has both quantitative (e.g., attrition, logistic consumption, movement rates) and qualitative (e.g., major decision points, subjective evaluation of an operational concept) outputs to be considered.

e. Face Validity. Face validity is defined as the willingness of the decisionmaker to make decisions based (at least in part) on wargame results. (Another term for this validity check might be subjective military judgment.) Once face validity is considered, other potential assessment approaches suggest themselves--two such approaches are described below.

H-3. PORTRAYAL OF AIRLAND BATTLE TENETS

a. General. This approach is based on ideas described by Cadet Dan Evans in his unpublished 1986 paper, A Different Approach to the Validation of the CFAW Model. The doctrine of AirLand Battle, which describes how the US Army should fight at the **operational level**, might be described in terms of four tenets: initiative, depth, agility, and synchronization. How well these tenets can be demonstrated and explored in a wargame offers a possible approach to the development of good measures of effectiveness (MOE). Each of these tenets is described in sufficient detail to permit their consideration as one (or a set of) MOE to be used in comparing future CFAW results with history.

b. Initiative. Initiative means acting first, applying offensive spirit, and capitalizing on opportunities presented by human factors problems.

(1) Offensive spirit incorporates five concepts--concentration, surprise, speed, flexibility, and audacity:

- Concentrate sufficient force at the right place and time.
- Create strategic and/or tactical surprise to gain advantage over an opponent.
- Use speed: move forces quickly to where they are needed; react to new situations before an opponent does.
- Be flexible in adapting plans and orders to the situation presented.
- Be audacious - execute boldly and violently; take calculated risks when appropriate.

(2) Enemy soldiers who are ill-trained, fatigued, or low morale, or improperly supported logistically will make serious mistakes which can be turned into an advantage.

c. Depth. The dimensions of depth which are important on the battlefield are: time, distance, terrain, and resources (personnel, equipment, logistical).

d. Agility. Battlefield agility requires flexible units that act more quickly and more decisively than their enemy. A thorough understanding of the factors of METT-T (Mission, Enemy, Terrain, Troops available, and Time available) and good Task Organization permit units to achieve agility on the battlefield.

e. Synchronization. Use all available assets in order to conduct a joint operation which coordinates the effective and efficient use of the right asset at the right place and time.

H-4. PORTRAYAL OF PRINCIPLES OF WAR

a. **General.** How well the principles of war can be demonstrated and explored in a wargame offers another possible approach to the development of good MOE.

b. **Objective.** Accomplish assigned mission(s).

c. **Offensive.** Exercise initiative and impose your will on the enemy.

d. **Mass.** Concentrate superior combat power at the critical time and place for a decisive purpose.

e. **Economy of Force.** Use minimum force at appropriate places so that mass can be achieved.

f. **Maneuver.** Move forces to place the enemy at a relative disadvantage.

g. **Unity of Command.** One commander in charge!

h. **Security.** Prevent surprise, preserve freedom of action, and deny information about friendly forces to the enemy.

i. **Surprise.** Strike the enemy at a time, place, and in a manner for which he is not prepared.

j. **Simplicity.** Use direct, simple plans and clear, concise orders to minimize misunderstanding and confusion.

H-5. **SUMMARY.** Two different methods for assessing the performance of CFAW in relation to history have been described in this appendix. One method essentially looks at model preparation to ensure it is valid. The other approach tries to look at militarily significant considerations and assess how well CFAW demonstrates and/or permits exploration of those considerations. Whatever the method ultimately chosen, the comparison of CFAW results with history must proceed with caution. If the historical campaign is not a fair and objective representation of military conflict, the comparison will have little meaning. More importantly, perhaps, all aspects of the comparison must be considered before conclusions are reached. To do otherwise builds in unacceptable bias.

APPENDIX I

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CAA	THE FALKLANDS WARGAME	STUDY SUMMARY CAA-SR-86-21

THE REASONS FOR CONDUCTING THE WARGAME were to develop a maritime capability for the Contingency Force Analysis Wargame (CFAW) Model and to compare wargame results with history.

THE PRINCIPAL ACCOMPLISHMENT of the wargame was the development of a maritime gaming capability.

THE TIMEFRAME of the wargame was April-June 1982.

THE PRINCIPAL FINDINGS of this wargame were that:

(1) Sound play of most contingencies in an amphibious arena are now possible.

(2) Results reasonably comparable with history were portrayed.

(3) Wargamers are key to good gaming.

THE PRINCIPAL LIMITATIONS of this Wargame were that:

(1) Small unit tactics were not portrayed.

(2) The intangibles of combat could not be represented (e.g., Argentines did not attack many supply ships in the actual conflict).

(3) A single echelon of command and control was represented.

THE SCOPE OF THE WARGAME was to focus on the events directly associated with amphibious operations and the ground campaign in the Falkland Islands, excluding the earlier capture of South Georgia Island and the larger naval campaign beyond the immediate Falklands amphibious arena.

THE OBJECTIVES OF THE WARGAME were:

(1) To use Falklands maritime activities as a basis for designing a maritime capability in the CFAW Model.

(2) To conduct a quality assurance evaluation of CFAW wargaming by comparing its results with historical Falklands campaign results.

THE BASIC APPROACH was to:

(1) Review the campaign,

(2) Develop a maritime capability by defining the essential maritime requirements, making (or identifying) desired model improvements, and describing maritime gaming results,

(3) Apply logistic constraints, and

(4) Compare air, ground and amphibious campaign wargame results with history.

THE WARGAME SPONSOR was the Director, US Army Concepts Analysis Agency.

THE WARGAME was directed by Professor Wayne Hughes, CAA Adjunct Analyst, US Naval Postgraduate School, Monterey, CA.

COMMENTS AND QUESTIONS may be forwarded to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-SP, 8120 Woodmont Avenue, Bethesda, MD, 20814-2797.