1988

The Rand Strategy Assessment System: a new perspective on decision support systems.

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE RAND STRATEGY ASSESSMENT SYSTEM: A NEW PERSPECTIVE ON DECISION SUPPORT SYSTEMS

by

Philip Kemble Siddons

September 1988

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Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is umlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (If applicable) 56RT	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000	7b ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION Director Net Assessment 8b OFFICE SYMBOL (If applicable) OSD/NA	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MIPR DWAM 80078
8c ADDRESS (City, State, and ZIP Code) Office of the Secretary of Defense Washington, DC 20301	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification) THE RAND STRATEGY ASSESSMENT SYSTEM: A NEW PERSPECTIVE ON DECISION SUPPORT SYSTEMS

12 PERSONAL AUTHOR(S) Siddons, Philip K.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's Thesis	FROM ____ TO ____	September 1988	100

16 SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Wargaming, Decision Support, Decision Support Systems, Strategic Analysis, Rand Strategy Assessment System, RSAS, Net Assessment

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

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20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL James J. Tritten	22b TELEPHONE (Include Area Code) (408) 646-2521 22c OFFICE SYMBOL 56RT

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

Unclassified

U.S. Government Printing Office 1986—606-24

Approved for public release; distribution is unlimited

The Rand Strategy Assessment System:
A New Perspective on Decision Support Systems

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
September 1988

ABSTRACT

On-line strategic analysis and wargaming are experiencing increased growth within the national government, particularly the Department of Defense (DOD). A renewed emphasis on improved methods for net assessment has resulted in the advent of the Rand Strategy Assessment System (RSAS), a new strategic analysis tool which brings automated analysis and wargaming to the forefront of long-range strategic planning.

The ability of the RSAS to go beyond net assessment into the areas of decision support systems (DSS), group decision support systems (GDSS), and crisis management decision support systems (CMDSS) is the subject of this thesis. These areas are explored to provide recommendations for system modifications, upgrades, large-scale implementation, and proper utilization within the context of strategic planning and decision-making.

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ACKNOWLEDGMENTS

My heart-felt thanks to Commander James J. Tritten for his inspiration, guidance and friendship over the years; this thesis is as much his as it is mine.

My gratitude to Dr. Nancy Roberts for her advice and patience during this academic endeavor.

Finally, thanks to my loving wife, Carol, for her understanding and patience during the whole process.

I. INTRODUCTION

War has become a fact of life; world history is fraught with accounts of armed conflict between people, factions, and nations. One only has to pick up the newspaper to read of the fighting in Lebanon, Iran, Iraq, Ireland, South Africa, and Afghanistan, to mention a few. As such, preparations for war have become major line items (e.g., defense, education, and agriculture) in the budgets of the world's superpowers.[1] And like any subject which dominates our lives, man has sought to prepare for war using various qualitative and quantitative technologies. Such management techniques have included: operations research (OR); management science (MS); sensitivity analysis; role-playing; mock exercises; and gaming.

Of these techniques, gaming has become an integral part of our nation's defense analysis and training effort. This gaming for war has evolved over centuries, becoming a modern-day tool for strategic analysis and planning. It has come full circle from a rudimentary game known as Kriegspiel[2] to the complex military simulations gamed in

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[1] Superpower here denotes the worlds major economic and political countries e.g., U.S., USSR, Great Britain, etc.

[2] Kriegspiel is German for wargame and describes an 18th century manual game used to simulate military operations.

think tanks throughout the Department of Defense (DOD). Examples include the Naval War Game Simulation (NWGS) at the Naval War College and the Total Force Capability Analysis (TFCA) conducted by the Force Structure, Resource, and Assessment Directorate (J-8) under the Joint Chiefs of Staff (JCS). Modern gaming borrows from all the aforementioned disciplines, integrating them into a powerful analytic and educational tool.

Along with the growth of wargaming, there has been a modern parallel in the growth of computer technology, resulting in the development of management information systems (MIS), decision support systems (DSS), expert systems (ES), and artificial intelligence (AI). Such developments, particularly MIS, ES, and AI have been incorporated into strategic analysis through programming and war plan development.[3] MIS has provided the needed emphasis on data base management and reporting; ES has provided the framework for more complete and advanced models through a knowledge base; and AI has allowed automated systems to better emulate the human process for a more complete simulation. These factors allow for rapid dissemination of

[3]Programming is the process of determining the appropriate armed forces structure required to meet the nation's defense needs. It involves sensitivity analysis using simulations where the strategy invoked is held constant while the force structure is manipulated. In contrast, in developing war plans the force structure is held constant and the strategy is manipulated.

data, adequate modeling of real-world phenomenon, and high-speed simulation.

One of the newest computerized analysis tools in the DOD gaming arsenal is the Rand Strategy Assessment System (RSAS). This new tool provides the capabilities for in-depth analysis of political-military decision-making on a global scale--including thermo-nuclear war. Presently in its mid-phase of operational development, RSAS has the potential for having a profound impact on strategic policy, planning, and decision-making within the near future by: speeding up the process over manual methods; providing extensive on-line documentation; furnishing a global modeling approach; and utilizing stochastic modeling for sensitivity analysis.

As such, this thesis examines the use of RSAS as a decision support system (DSS), group decision support system (GDSS), and crisis management decision support system (CMDSS) with an emphasis toward implementation at the highest levels of defense decision making (e.g., JCS and CINCs). Chapter II provides an historical background of wargaming and strategic analysis with the RSAS being the current stage of the wargaming continuum. Chapter III addresses the specifics of RSAS including purpose, components, and functionality. Chapter IV examines the issue of DSS and associated topics including appropriate definitions, frameworks, and examples. By using the information on DSS/GDSS, Chapter V examines: (1) the RSAS as a decision support system; (2) the role of the RSAS beyond net assessment,[4] specifically at the highest levels of defense decision-making; (3) the RSAS strengths and weaknesses; and (4) areas of improvement or enhancement to the RSAS. The thesis concludes with an assessment of the RSAS as political-military game within the context of DSS, GDSS, and CMDSS with recommendations for future implementation.[5]

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[4]Net assessment compares competitors as dispassionately as possible to ascertain which side, alone or abetted by partners, is best able to achieve its objectives, despite opposition by the other. In the context of RSAS, this relates to net assessment of national defense and foreign policy.

[5]This thesis does not attempt to validate the RSAS; it is assumed that the RSAS is an adequate model that is utilized effectively. Improper use can only result in erroneous and invalid analysis.

II. WARGAMING AND STRATEGIC ANALYSIS

A. INTRODUCTION

With millions of dollars spent annually on wargaming and simulations throughout the private and public sector, inevitably the question is raised as to the purpose and benefit of such activities. The obvious answer is that gaming could improve the quality of decisions, providing insights otherwise missed and allowing the decision-maker to experience the environment, albeit simulated, without the commitment of resources--human or otherwise. Conversely, poorly designed games or the misuse of games could lead to worse decisions and no insight.

To understand the gaming phenomenon, this chapter reviews: the historical context of gaming; gaming terms and definitions; the benefits and pitfalls of gaming; the general mechanics of gaming; and strategy and strategic policy analysis.

B. WARGAMING

1. Wargaming: A Historical Perspective

The origins of wargaming and combat simulation can be traced back some 5000 years to the advent of Sun Tzu in China. This ancient game was played on special game boards using colored stones denoting opposing forces. The objective was simple--outflank your opponent. Yet wargaming did not gain wide-spread acceptance in military circles until the late 1700s. [Greenberg 1981:p. 93]

In 1780, Helwig developed a "war chess" game consisting of 118 pieces representing military units and a game board consisting of 1666 small colored squares denoting six different terrains. The games sophistication included troop and weapon capability and associated movement rates. [Perla 1987:p. 51]

The gaming evolution continued when Reisswitz took the wargame and moved it to a sand table to add realism not attained with the use of grid maps and chess-like boards. Additionally, he adopted a scale to represent the proportion, weight, and capability of all elements in a real situation. [Greenberg 1981:p. 94]

These early editions of the wargame led to the development of modern-day gaming. In the 1940s, Nazi Germany used Kriegspiel (Wargame) to game the invasion of Russia. Throughout World War Two, Germany continued to utilize gaming techniques to enhance the decision-making of the high command. For example, they gamed the Allied invasion on D-Day. Also, a real-time Kriegspiel was played utilizing actual front-line information as input which ultimately allowed the Germans to properly halt an Allied advance and launch the famous Battle of the Bulge counter-offensive.

But probably the most well-known use and misuse of wargaming was prior to and during the war with Japan. The Japanese Naval War College conducted several gaming iterations of its proposed attack on Pearl Harbor. The results provided the planning staff with a breadth of insight into the proper approach route for the strike force and timing of the attack--the results are historic. On the other hand, gaming the Midway campaign was not as fruitful for the Japanese.[1] Rear Admiral Ugaki reversed the ruling of umpires on the sinking of two Japanese carriers (known as gaming the game) and ultimately ignored the problems the game had revealed. As a result (or contributing factor), Midway was a stunning defeat for the Japanese. [Perla 1987:p. 52]

During this time the United States was involved with gaming as well. The value of games was evident from a post-war comment by Fleet Admiral Chester Nimitz lecturing at the Naval War College:

> The war with Japan had been re-enacted in the game rooms here by so many people and in so many different ways that nothing that happened during the war was a surprise--absolutely nothing except the kamikaze tactics towards the end of the war; we had not visualized those.

[1]As with Japan's gaming of the Midway campaign, the United States also played down the results of its gaming the probable Japanese attack on Pearl Harbor.

Today wargaming flourishes at the Naval War College, the National Defense University (NDU), the Naval Postgraduate School, the Office of Net Assessment within the Office of the Secretary of Defense (OSD), the Joint Chiefs of Staff, and academic institutions and think tanks throughout the world.

2. Definition

The RAND Strategy Assessment System (RSAS) has been described as a political-military wargame--an automated global simulation of war designed to assist in strategic analysis and net assessment. Yet what is gaming? A wargame? What is a simulation? A model? These questions must be answered to comprehend the role of RSAS in the context of decision support systems.

a. Gaming

Brewer and Shubik define gaming as "...an exercise employing human beings acting as themselves or playing roles in an environment that is either actual or simulated." [Brewer and Shubik 1979:p. 7] Mobley contrasts gaming with analysis by stating "...while analysis focuses on physical phenomena, gaming emphasizes 'human' matters by considering phenomena that defy quantification." He goes on to say "Important perceptual and procedural matters surface in the play of manual scenario games; they almost never do in computer-based analysis." [Mobley 1987:p. 3]

Real-world gaming is exemplified by military exercises (e.g., UNITAS, Team Spirit, etc.) utilizing actual personnel and equipment in theaters throughout the world. Simulated gaming involves the use of manual, computer-assisted, or automated models to simulate the real world.

b. Simulations

The Defense Advance Research Projects Agency (DARPA) describes a simulation as the representation of a system or organism by another system or model designed to have a relevant behavioral similarity to the original [Brewer and Shubik 1979:p. 7]. The majority of wargames are simulations in contrast to the military exercise which, although not a bona fide conflict, utilizes real-world assets. Simulations are usually constructed utilizing a complex mathematical abstraction of reality--an area critics say is an inherent weakness of wargames. While many aspects of military conflict can lend themselves more readily to mathematical conversion (e.g., firepower, numeric strength, etc.), application is not universal. Qualitative factors such as human resolve, morale, and a willingness to take risks defy reduction to numeric terms. Additionally, it is impossible to identify all the variables that play in such social systems.

c. Models

A model, as defined by DARPA, is a representation of an entity or situation by something else that has the relevant features or properties of the original [Brewer and Shubik 1979:p. 10]. Models are the building blocks for simulations which lead to games and ultimately to wargames (See Figures 2.1 and 2.2). As Brewer and Shubik point out, "A model is a document or program containing all the rules, methodology, techniques, procedures, and logic required to simulate or approximate reality." [Brewer and Shubik 1979:p. 10] As with simulations, military models suffer from an inability to adequately emulate all aspects of the warfare environment.

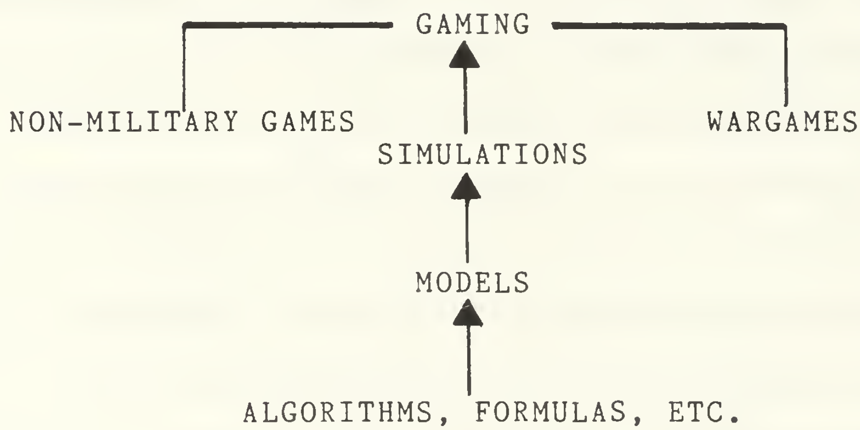

Figure 2.1 Hierarchy of Gaming Components

d. Wargaming

The Department of Defense (DOD) defines wargaming as a simulated military operation involving two or more opposing forces and using rules, data, and procedures designed to depict an actual or hypothetical real-life situation [Brewer and Shubik 1979:p. 83]. Perla describes

Gaming:

- incorporates the human element within a competitive environment;

- utilizes a simulation of reality in an aggregate sense; and

- composed of various models emulating the real world.

Simulations:

- composed of various models emulating the real world, usually on a smaller scale than a game;

- simulates environment, roles of players, or both; and

- all games are simulations; however, all simulations are not games.

Models:

- the basic building block for simulations and games;

- usually mathematical in digital or analog form;

- can be manual or automated; and

- represents the lowest form of an entity or situation as opposed to a global phenomena.

Figure 2.2 Gaming Definitions

wargaming as "...an experiment in human interaction and is best suited to investigate processes, not calculate outcomes." [Perla 1987:p. 51]

Within this context there are three basic types of wargames: the **training game**; the **operational game**; and the **research game**. The **training game** is designed to allow decision-makers the opportunity to experience situations they may encounter in combat (e.g., the NWG at the Naval War College). Operational games utilize present force levels and associated support elements to test proposed operational plans (e.g., military exercises). **Research games** are aimed toward the study of future strategic situations (e.g., the RSAS). [Brewer and Shubik 1979:p. 8]

Finally, there are two forms of the wargame in use today: the **free-form** and the **rigid game**. **Free-form games** utilize tactical freedom and are adjudicated by umpires, such as the Global War Game conducted at the Naval War College; **rigid games** function on rules and detail, such as the early versions of Kriegspiel. The RSAS appears to possess elements of both approaches, providing improved flexibility over traditional games. [Brewer and Shubik 1979:p. 8]

3. Wargaming: Pros and Cons

The advantages of gaming are numerous. Tritten and Masterson highlight the following attributes of wargames:

- allows the user to examine and focus more on issues than the outcome of an individual campaign or war;
- illuminates concepts that are difficult to grasp in the abstract;
- (through the use of models) stimulates innovative thought and, by doing so, educates sponsors and players; and
- forces players to consider what types of decisions have to be made, in what order, and by whom. [Tritten and Masterson 1987:p. 117]

McHugh goes on to say:

> Gaming provides a means of gaining useful experience and information in advance of an actual commitment, of experimenting with forces and situations that are too remote, too costly or too complicated to mobilize and manipulate, and of exploring and shaping the organizations and systems of the future. [McHugh 1966:p. 1-25]

On the down side, gaming suffers from two major weaknesses. The first is the tendency of users to accept the system's outcomes or recommendations as a reflection of reality, rather than the result of a simulation. This leads to the erroneous assumption that something has been proved. The second limitation is the temptation to "game the game"--purposely manipulating strategy and tactics to produce desired results from the game model(s).[2] [Tritten and Masterson 1987:p. 119]

Bracken also identifies three undesirable results of gaming: unintended learning; diverted attention; and suppressed possibilities. With unintended learning the results of gaming can foster the wrong conclusions and the wrong lessons. According to Bracken, "All to often these computer simulations are employed as black boxes by uncritical users who are unfamiliar with the peculiarities of data and structure contained within." [Bracken 1977:p. 313]

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[2]Gaming for advocacy is not necessarily bad; in fact, defense program sponsors use this technique frequently. Problems surface when such activities camouflage critical elements, producing erroneous results or suppressed possibilities.

Care must be exercised to ensure the game, or model, is well designed, validated, and the results are adequately analyzed.

A contemporary example involved the Air Staff within the Air Ministry in Great Britain prior to and during World War Two. This virtually anonymous and secretive staff developed an erroneous analysis estimate of the casualties per ton of air delivered ordnance (i.e., bombing) from data of World War One and the Spanish Civil War. This "bad theory" led to the development of a wholly inadequate bomber force, devoid of fighter escort, designed to counter the mounting German threat through day-time attacks. The results were disastrous as the Luftwaffa shot down bombers so fast that continued raids were suspended. Additionally, this overly pessimistic estimate softened Britain's political and military negotiating position with Germany prior to the onset of hostilities as Germany was envisioned as having a stronger offensive bombing capability in terms of casualties than was the case. [Bracken 1977:pp. 32-49]

Since a game, especially an automated one, cannot address all the issues contained within a strategic problem, the results of a single game cannot be taken as having proved something--to do so can result in diverted attention. As Mobley points out:

> Wargames do not prove anything, but they do suggest how an idea might play out in a dynamic real-world setting. Gaming should engender questions and hypotheses, not answers and proofs. [Mobley 1987:p. 8]

A prime example was the development of the Maginot Line by the French in World War Two. Through their gaming and analysis, they focused on countering a German frontal assault while totally ignoring the possibility of an "end around" by an aggressor. The French chose to overemphasize the strengths (i.e., diverting attention away from the weaknesses) of the Maginot Line concept, resulting in a complete failure to stop the German advance. [Bracken 1977:pp. 6-17]

Finally, gaming can distort the reality it is attempting to emulate, resulting in suppressed possibilities. As Bracken attests "This might arise in coalition situations where an official game suppresses critical issues in the interest of coalition unity." [Bracken 1977:p. 55] Such was the case when Japan's Rear Admiral Ugaki resurrected a sunken carrier during the gaming of Midway which led to erroneous probable outcomes. Such suppression can result in the game participant or analyst failing to see all relevant alternatives.

These problems can be lessened by: educating game participants; ensuring "gaming the game" is not rewarded; encouraging free-form play; and validating models and simulations prior to acceptance.

C. GAME THEORY: A PRIMER

Modern wargaming is the result of an analytical framework developed by Von Neuman and Morgenstern for the study of decision-making in a competitive or conflicting situation. [Turban and Meredith 1985:p. 452] It has evolved as a mathematical process for deriving optimal solutions under competitive situations which could not be handled by nominal techniques such as linear programming. This section describes the basic attributes and classifications of gaming.

1. Gaming Attributes

Turban and Meredith describe the following format attributes for gaming:

- a game can consist of two or more opposing players; a player can be an individual or a group of individuals;
- simultaneous decisions are assumed in all game situations;
- each player is interested in maximizing his or her welfare at the expense of the other;
- one-time decisions are term plays; a series of repetitive decisions is called a game;
- the consequence of decisions within a game is called the payoff; and
- it is assumed that each player knows all possible courses of action open to the opponent(s) as well as all anticipated payoffs. [Turban and Meredith 1985:pp. 456-457]

2. Classifications of Games

Games are classified by the number of players and whether they are zero-sum or nonzero-sum. Additionally, they can be differentiated by their method of adjudication--deterministic, or probabilistic (stochastic).

Zero-sum games are characterized by the winner(s) receiving the entire amount of the payoff contributed by the loser(s); such games are purely competitive. In contrast, in the nonzero-sum game the gains of each player are different from the losses of the other. This points to the fact that other parties may share in the gains or losses of the situation. As a result, nonzero-sum games can involve cooperation in contrast to the purely competitive nature of zero-sum games. [Turban and Meredith 1985:p. 458]

A probabilistic or stochastic game is one whose execution involves a randomly determined sequence of processes based on a probability distribution producing varying results despite constant variable values. With well designed models, these games emulate the randomness of nature well. On the other hand, a deterministic[3] game is characterized by algorithms which produce identical results over numerous iterations when variables are held constant (e.g., an analyst determining adequate force levels for

[3]The RAND Strategy Assessment System is a deterministic simulation.

combat might hold strategy constant while varying troop strengths). Deterministic games are well suited for sensitivity analysis when the analyst wishes to test the impact of changing variables.

D. STRATEGY AND STRATEGIC ANALYSIS

The RAND Strategy Assessment System (RSAS) has been touted as a strategy assessment tool used for discovering the forces at play and the reasoning underlying potential political-military conflict. Its design and implementation are aimed at assisting the nation's net assessment capability. To come to grips with this concept requires an understanding of what strategy and strategic analysis are.

Random House defines strategy as "the utilization of all of a nation's forces through large-scale, long-range planning and development, to ensure security or victory." Strategic analysis can be described as the tools and methodologies used to acquire a deeper understanding of political-military issues involving strategy and to bring about better solutions. Quade amplifies on this by saying:

> Its (strategic analysis) major contribution may be to yield insights, particularly with regard to the dominance and severity of the parameters. It is no more than an adjunct, although a powerful one, to the judgment, intuition, and experience of decision-makers. [Quade 1982:p. 112]

The emphasis here is decision support rather than providing a solution; strategic analysis provides a method for investigating problems rather than solving them.

Strategic analysis is not, according to Quade, (1) an exact science, nor can it ever become one; (2) a panacea for the defects of public decisions; and (3) a tool for advocacy by the analyst for his own views. [Quade 1982:p. 25]

The RSAS utilizes its models to simulate reality and allow the user to perform strategic analysis and planning. Such a capability provides a manageable process designed to produce information about the consequences of a proposed action. This is the intent of the RSAS design--asking "What if...?" questions in the realm of political-military decision-making.

E. SUMMARY

It is obvious that wargaming has a rich history dating back some 5000 years and evolving to the present with manual and automated simulations and models. Although far from perfect, gaming provides a dynamic learning system that provides utility in the form of greater insight for decision-makers without the expense of actual conflict. This educational process, coupled with enhanced analytic ability, makes gaming an invaluable tool for the DOD in its strategic analysis effort.

With this introduction and background on wargaming, gaming theory, and strategy analysis, the discussion will shift its focus to the RAND Strategy Assessment System (RSAS) in the next chapter. In particular, the hardware, firmware, and software components will be described to orient the reader to the general architecture and capabilities of the RSAS.

III. THE RAND STRATEGY ASSESSMENT SYSTEM

A. INTRODUCTION

In the late 1970s Dr. Andrew Marshall, Director, Net Assessment, in the Office of the Secretary of Defense (OSD/NA) recognized the need for improved methods for strategic analysis to assist the national government in efficiently and effectively performing net assessment in the 1980s and beyond. To answer this need, a request for proposal (RFP) was issued with two contractors, the RAND Corporation and Science Applications, Inc. (SAI), given initial authority for system development competition. Ultimately RAND was awarded the full contract under the project title "Improving Methods of Strategic Analysis." The evolution of this project has resulted in development of the RAND Strategy Assessment System (RSAS) and the RAND Strategy Assessment Center (RSAC) concept.[1]

This chapter will discuss the hardware, firmware, and software constructs of the RSAS including discussions on the intricacies and complexity of the software component--the heart of the RSAS.

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[1]The RSAC is envisioned as a command post where modern wargaming would be linked directly to operational planning and policymaking at the highest levels of government.

B. OVERVIEW

The RSAS development effort is aimed at improving the ability of strategy analysts by combining political-military gaming and analytical modeling into a synergetic global analysis tool. The RSAS will simulate non-war crises, conventional war, conventional war subsequent to nuclear exchange, nuclear war, war at sea and the political environment surrounding armed conflict. With its deterministic models, the RSAS is adept at repeated plays where the analyst selects variables (e.g., political resolve, numeric troop strength, date and time of war onset, etc.) to be modified to perform "What if...?" or sensitivity analysis.

The RSAS is capable of operating in two distinct modes--semi-automatic with human intervention and fully automatic. This allows the user to tailor the system to the particular situation and perform multiple scenario assessment in a time-constrained environment. Its self-documentation feature, which is capable of numerous levels of detail, allows the user to perform post-game analysis and provides an on-line and hardcopy audit trail. With its deterministic models (see Chapter II) producing non-random results the analyst can gain deep insight into proposals and changes in the political and military campaign environment.

C. HARDWARE

1. Standard Configuration

The RSAS is currently programmed to run on the SUN-3 micro workstation which can be set up in numerous configurations depending upon user requirements. Typically, the system consists of a SUN Microsystem's 3/160 workstation with 12 megabytes[2] (the current minimum required) of random access memory (RAM)[3], one 575 megabyte Fujitsu hard disk (280 megabyte current required minimum), a 1/2" tape drive unit, and laser printer. The user interfaces with the RSAS via a multi-function keyboard and an optical mouse (described below). System presentation is facilitated through a high-resolution 19" color display.

The optical mouse is a hand-held device which relieves the user from exclusive use of the keyboard. The mouse uses an optical scanner to determine cursor position on the system display screen. As the user drags the mouse around the table-top optical grid pad, the cursor is positioned appropriately and is used to activate pull-down menus and indicate menu selection, similar to the Apple

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[2]A byte is a segment of computer memory (on magnetic disk or microchip) consisting of 8 bits of data (0s or 1s). Mega denotes or 1 million. i.e., megabyte denotes 1 million bytes of memory.

[3]Random access memory is internal computer memory (versus external floppy disk) capable of being accessed for the reading of contents or the storage of data.

Macintosh operating system interface. Although not eliminating the need for keyboard entry, this "point and click" operation greatly enhances the user interface, promoting ease of use and increased speed.

2. Networking

If a single monitor is used, simultaneous use of the system has a practical limit of 3 or 4 individuals (2 being ideal). To resolve this problem requires utilization of the RSAS network architecture which allows the RSAS to share its operating system among numerous users having independent central processing units, keyboards, monitors, and optical mouse.

Such a local area network (LAN) typically connects several stand-alone systems (i.e., the operating systems and central processing units (CPU) are not shared) for transfer of data and the sharing of applications software. An RSAS LAN would require multiple SUN workstations and associated hardware with a dedicated server system providing all the application software for network participants. The major advantage in such a configuration is the sharing of software and peripheral resources.

An RSAS LAN would typically consist of a SUN 3/180 workstation acting as a "server"[4] and several SUN 3/60

[4] A server is a central computer responsible for managing network functioning and the sharing of software resources.

diskless (i.e., lacking in hard disk capability) workstations. These diskless workstations would share the RSAS software providing the capability for multiple use for analytic work and two-sided gaming where each agent (Blue, Red, and Green explained in the next section) interfaces through an independent workstation.

D. SOFTWARE

1. Overview

The RSAS software (currently at version 3.1) operates under the Berkely UNIX operating system[5] and is written primarily in the "C" programming language. The decision models, in contrast, are written in RAND ABLE, a proprietary programming language which provides English-like syntax for building complex rule-based models.

As a political-military simulation, the RSAS software has been designed with two major components--decision models and analytic modeling. Decision models allow the RSAS to replicate the human factor, providing various levels of automation. As such, gamers can run wargaming exercises with human interaction allowing them to experience the decision-making environment and its complexities under simulated combat and stressful situations. In contrast, with analytic modeling the

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[5]An operating system is the software component responsible for managing routine system operation.

strategic analyst can run the RSAS in a fully automated mode while investigating the cause and effect of various variable values (e.g., troop strength, weapons capability, third world resolve, etc.) upon conflict outcome.

2. Modeling

The heart of the RSAS software is embedded in the modeling components which comprise the warfare simulation from pre-war political instability, to low intensity conflict, to thermo-nuclear war. Software architecture centers around the agent concept which embodies game adjudication into 5 major models: the Red, Blue, and Green political agents; the Force agent or CAMPAIGN; and the Control agent. Each of these models is discussed separately.

a. The Political Agents: Red, Blue, and Green

The Red, Blue, and Green political agents[6] (hereafter referred to as Red, Blue, and Green) represent the Warsaw Treaty Organization (WTO), the North Atlantic Treaty Organization (NATO), and other countries respectively. Within Red and Blue, command, control, and communication (C^3) sub-models have been designed to replicate the organization and operation of their real-world

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[6]Designed for non-public use, the RSAS software architecture is generally classified and beyond the scope of this thesis. Only a general description is provided for reader understanding.

counterparts (i.e., NATO/U.S. and WTO/USSR). Names and boundaries of NATO/U.S. Commanders-in-Chief (CINC) generally correspond to reality; WTO/USSR theaters of military operations (TVD) commands utilize actual names and boundaries. These characteristics are designed to imbue the simulation with not only realistic results, but a realistic feel for gamers, analysts, and decision makers (i.e., utilizing the language or "political-military speak" of the net assessment lexicon).

Additionally, Red and Blue each utilize a National Command Level (NCL) sub-model that emulates the highest command authority for each entity. These models are the National Command Authority (NCA) for Blue and the Defense Council for Red. These NCLs determine conflict escalation guidance, objectives, and strategies for each campaign theater after assessing various parameters including the threat, the urgency of decision-making, superpower relations, and the like.

To provide varying degrees of resolve at the NCL level, the RSAS software provides two distinct Red and Blue agents--one being more inclined to risk (e.g., more hawk-like). These are denoted as Ivan for the Red and Sam for the Blue. The NCL models can be selected, modified, and run on an automated basis.

Finally, a Global Command Authority (GCA) sub-model is integrated to represent the Joint Chiefs of Staff and NATO Military Committee for Blue and the Soviet General Staff (VGK) for Red. The GCA component implements NCL decisions through specific war plans to be run.

The Green Agent models non-superpower countries and their behavior in the midst of world crisis and warfare. These include all non-Warsaw Pact countries, all NATO countries other than the U.S., Japan, China, the U.K., and others. The model takes action after testing various conditions such as alliance, temperament, assertiveness, opportunism, orientation, and resolve. Such variables have a default value which can be modified to suit the individual game scenario.

b. The Force/CAMPAIGN Agent

The Force agent, also known as CAMPAIGN, is a global combat model which tracks military forces worldwide and adjudicates the results of force operations and warfare. It handles varying aspects of conflict including conventional, theater-nuclear, and intercontinental nuclear warfare. As such, it is composed of a collection of theater warfare, naval warfare, strategic warfare, air warfare, and other supporting sub-models. This substructure was designed to control the complexity of CAMPAIGN and allow for substitution of future iterations and upgrades to individual warfare models as needed.

c. Control Agent

The Control Agent, as its name implies, provides system control to the analyst allowing him to customize the system for various scenarios. As such, he can change system parameters (e.g., starting time of the war), select the level of internal documentation (known as logging), schedule the writing of information to the display, introduce exogenous events (e.g., chemical warfare), and specify key events. This is crucial to the analyst adapting the system for varying analytic research requirements.

3. Analytic War Plans

To adequately emulate the real world, the RSAS software incorporates analytic war plans (AWP) reflecting the base year of the system database. These AWPs are designed around present database force structure and are not identical to those currently in force within the NATO infrastructure. They are intended to simulate actual AWPs in a way that does not diminish their value as an analysis tool. AWPs are written to generally correspond to the architecture presently in use with the various CINCs; Red AWPs are written using national intelligence sources and experts in the field.

4. Software Tools

Several user-friendly software tools are available to facilitate smooth user interface and system access. They include:

- Data Editor (DE)--the primary means of viewing and changing data interactively. The DE utilizes displays known as tableaus which are logically arranged in sets according to function;

- Cross Referencing Tool (CRT)--utilized for using or building rule-based decision models. The CRT provides value ranges, location, and associated comments;

- Hierarchy Tool (HT)--depicts which entity (e.g., NCL, Blue Agent, Control Agent, etc.) is active at any one time; permits the game to be stopped for detailed analysis; and permits the execution of rules to be displayed for a specific actor/agent;

- "C" Menu Tool (CMENT)--provides interface into the Force Agent, providing faster "walking" menu access; and

- Interpreter--utilized for changing and debugging RAND-ABLE program code interactively.

E. ENHANCEMENTS AND UPGRADES

With the RSAS in the mid-phase of its operational development, there are areas in need of enhancement. Although detailed descriptions of the RSAS agents and models are beyond the scope of this thesis, an appreciation of their shortcomings will help the reader comprehend the ultimate thrust and utility of the RSAS design.[7]

According to Tritten and Channel, the following are some of the upgrades needed to bring one aspect of the RSAS, the naval warfare components, to full fruition:

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[7] For a detailed description of the RSAS models and agents refer to The RAND Strategy Assessment System at the Naval Postgraduate School, NPS-56-88-010, James J. Tritten and Ralph N. Channel, The Naval Postgraduate School, Monterey, CA, March 1988.

- nuclear capabilities reflected for all capable units from all nations that possess or might possess such a capability;

- convoy operations in all ocean areas;

- mine warfare improvement, including modern antisubmarine warfare (ASW) mines;

- amphibious warfare where the analyst might want to test its impact;

- database enhancement to include various maritime strategies for system to invoke including war originating in the Pacific; and

- space-based systems, communications intercept, and passive listening capability for ASW forces. [Tritten and Channel 1988:pp. 28-33]

These suggested improvements, and numerous others, are under consideration by the RAND Corporation, with several currently being implemented. Additionally, the OSD (Net Assessment) and the Department of National Security Affairs at the Naval Postgraduate School are continually evaluating the RSAS to discover problem areas and recommend solutions.

F. SUMMARY

The RAND Strategy Assessment System is a complex, political-military simulation which gives today's strategic analyst enhanced capabilities for supporting net assessment. Its modeling architecture provides a detailed representation of the NATO and Warsaw Pact infrastructure along with numerous supporting elements such as third-world powers, intelligence, logistics, and communications. With continued maintenance and upgrading, the RSAS will prove to be an invaluable tool for strategic analysis, research, and education. Its potential is only now beginning to be realized.

IV. DECISION SUPPORT SYSTEMS

A. INTRODUCTION

In order to adequately address the question "Is the RAND Strategy Assessment System (RSAS) a decision support system (DSS), a group decision support system (GDSS), or a crisis management decision support system (CMDSS)?" and "How would it best be utilized in these roles?", the theory of DSS and related areas (expert systems, artificial intelligence, etc.) must be fully explored. Unlike gaming and gaming theory, the idea of DSS is modern, having evolved from the early 70's to the present. This is mainly a result of its tie to the digital computer which has been instrumental in the evolution of on-line management tools. This chapter will survey current literature to establish a definition and conceptual framework of DSS in which to assess the RSAS.

B. DSS: A DEFINITION

The advent of the digital computer has revolutionized the way we manage data. Early in their development, computers were used for either scientific or **electronic** data **processing** (EDP) applications such as batch processing of payroll. Typically, this was in an effort to automate manual tasks. Its general characteristics were (and still are):

- a focus on data, storage, processing, and flows at the operational level;
- efficient transaction processing;
- schedule and optimized computer runs;
- integrated files for related jobs; and
- summary reports for management. [Sprague 1980:p. 9]

The next step in the evolution was to **management information systems** (MIS), which took EDP one step further up the management chain with an emphasis on integration and planning of the information systems function. [Sprague 1980:p. 9] Kennevan characterizes MIS as:

> ...an organized method of providing past, present and projection information relating to internal operations and external intelligence. It supports the planning, control, and operational function of an organization by furnishing uniform information in the proper time-frame to assist the decision-maker. [Kennevan 1970:p. 62]

MIS characteristics include:

- an information focus, aimed at middle managers;
- structured information flow;
- an integration of EDP jobs by business function, such as production, marketing, personnel, etc.; and
- inquiry and report generation, usually with a database.

From EDP and MIS the evolution has progressed to the **decision support system** (DSS)--a term that has been the subject of debate since the early 1970's. Keen and Scott-Morton state that a DSS "focuses on managers' decision-making activities and needs while extending their capabilities." [Naylor 1982:p. 92] They go on to say that DSS implies the use of computers to:

- assist managers in their decision processes in semi-structured tasks;
- support, rather than replace, managerial judgment; and
- improve the effectiveness of decision making rather than its efficiency. [Naylor 1982:p. 93]

According to Watson and Hill, a DSS is "...an interactive system that provides the user with easy access to decision models and data in order to support semi-structured and unstructured decision-making tasks." [Watson and Hill 1983:p. 82] Ford categorizes the DSS as a system that:

> ...helps decision-makers utilize data and models to solve unstructured or semi-structured problems. It incorporates features found in the area of management information systems and of management science and operations research. DSS do not provide answers to structured problems; rather, they emphasize direct support for decision-makers in order to enhance the professional judgments required in their decision making. To be effective, they require a symbiosis between the users and the system. As a result, there is an interplay between user and computer that produces a total effort greater than that attained by the user and the computer operating independently; this provides synergistic decision-making. [Ford 1985:pp. 21-22]

Reimann and Waren expand on these ideas by stating:

> An important characteristic of a DSS is an interactive, ad hoc analytical capability that permits managers to simulate or model their problems as completely and accurately as possible and test the impact of different assumptions or scenarios. [Reimann and Waren 1984:p. 166]

Finally, Sprague and Carlson summarize the essential elements of DSS. They define DSS as "computer-based systems that help decision makers confront ill-structured problems through direct interaction with data and analysis models." [Sprague and Carlson 1982:p. 97] These main points are highlighted in Figure 4.1 and elaborated on in the following section.

- computer-based systems
- help decision-makers confront ill-structured problems
- utilize direct interaction
- utilize data and analysis models
- support, rather than replace managerial judgment
- improve the effectiveness of decision-making in contrast to efficiency
- enhance decision-maker's judgment through support rather than providing an answer
- synergistic decision making

Figure 4.1 Primary DSS Characteristics

It should be noted that the definition of DSS explicitly implies the use of a computerized system (i.e., on-line). This does not mean that there cannot be a manual DSS, or "dss" as Huber points out. [Huber 1981:p. 4] In fact, each individual has their own dss that assists them in their daily work and activities. Examples include pocket calendars, filing cabinets, appointment books, and the like. Rudimentary, yes, but a dss none the less. A dss provides support for daily structured decision-making. In contrast, the computer provides the power and speed to tackle the ill-structured problems the human mind cannot assimilate because of data and information overload and time constraint. This is the arena that military decision-makers operate in--one in which RSAS may prove helpful.

C. DSS TERMINOLOGY

Several of the terms and concepts outlined in Figure 4.1 require elaboration: ill-structured problems; direct interaction; decision support; and effectiveness versus efficiency.

1. Ill-Structured Problems

Several of the authorities cited use the terms semi-structured, unstructured, and ill-structured to describe the type of decisions addressed by DSS (these terms are interchangeable; unstructured will be used throughout the remainder of this text). Simon defines unstructured as a "...decision-making process that cannot be described in detail before making the decision." [Simon 1960:p. 77] This lack of detail can stem from novelty, time constraints, lack of knowledge, large search space, need for quantifiable data, or other reasons [Sprague and Carlson 1982:p. 95].

This definition parallels the paradigm of programmed versus unprogrammed decisions espoused by Ivancevich and Matteson [Ivancevich and Matteson 1987:p. 584]. Additionally, this points to a problem of computerized decision support where software programs, based on strictly defined processes and sequences of instructions, are helping solve the ill-defined processes of unstructured decision-making [Sprague and Carlson 1982:p. 95].

2. Direct Interaction

Direct interaction requires that the decision-maker interface directly with the system (or at least understand what the DSS is capable of and be able to interpret its results), including the data and models. This is commonly accomplished with a computer keyboard and display. As such, the user interface design is critical as it must provide easy and efficient access to the DSS. Improper or poor design can severely hamper the effectiveness and usefulness of even the most sophisticated DSS.

3. Decision Support

Decision support is a broad term encompassing several ideas. In essence, it involves assisting the decision-maker in all phases of the decision process. Using Simon's paradigm, these would be the **intelligence**, **design**, and **choice** phases. **Intelligence** is searching the environment for conditions calling for a decision; **design** is inventing, developing and analyzing possible courses of action; and choice is the selection of a particular course of action from those available. [Sprague and Carlson 1982: p. 95]

4. Efficiency

Many of today's software products are aimed at increasing efficiency. From word processors to accounting packages, the objective is to automate a routine, mundane task and increase the productivity level. DSS, on the other hand, are designed primarily to increase the quality of decisions by leveraging the mental skills of the decision maker. This distinction is critical to differentiating DSS from MIS and EDP.

D. DSS FRAMEWORK

Presently there are two complementary frameworks for DSS: the data, dialog, and models (DDM) paradigm; and the representations, operations, memory, control (ROMC) approach. These frameworks will be discussed to better understand the functioning of DSS now that a broad definition has been attained.

1. Data, Dialog, Model (DDM) Paradigm

Sprague has defined the basic elements required for a successful DSS: data, dialog, and models (See Figure 4.2) [Sprague 1987:p. 199]. Obviously, the decision-maker must have access to relevant **data** which the DSS can manipulate to provide meaningful information for making a decision. The dialog component is crucial for ease of access and to help frame the problem and its varied complexities in graphical form for better understanding. Finally, adequate modeling must be present to draw the data together into meaningful output for the decision-maker.

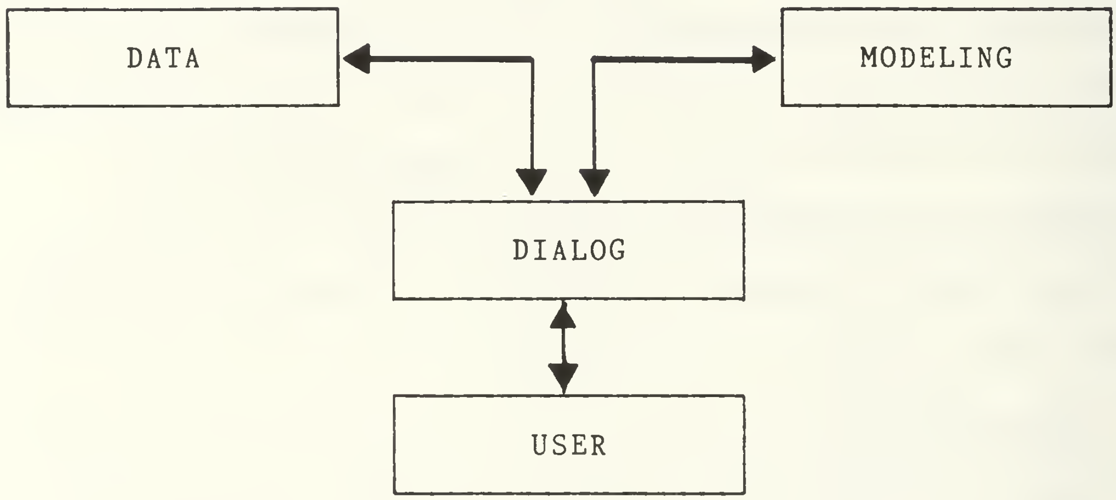

Figure 4.2 The Data, Dialog, and Models Paradigm

2. ROMC Process Model

As pointed out, DSS must satisfy the three major areas of the DDM paradigm. As such, an approach for appropriate DSS design is needed; Sprague and Carlson developed the complimentary ROMC approach to answer this need [Sprague and Carlson 1982:p. 101]. Figure 4.3 graphically depicts the ROMC relationship.

a. Representations (ROMC)

The decision-making process for unstructured problems requires that the decision-maker conceptualize the problem and its complex interrelationships. This is often accomplished with charts, graphs, blackboards, scratch paper, GNATT charts, PERT charts, histograms, scatterplots, maps, charts, etc. These aids help in making the decision

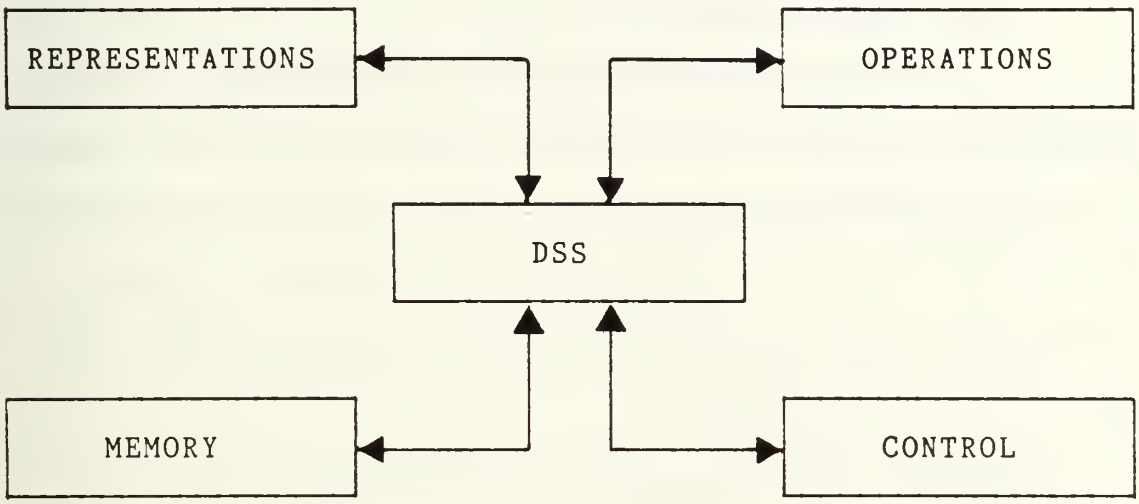

Figure 4.3 DSS Requirements Under ROMC

and communicating aspects of the problem [Sprague and Carlson 1982:pp. 105-106]. Accordingly, DSS must provide such representations to support the intelligence, design, and choice paradigm of decision-making espoused by Simon.

b. Operations (ROMC)

The term operations describes the actual manipulation of data input to the DSS to produce information output that is useful to the decision-maker in making a more informed (better quality) decision. Examples include: collecting data; validating data; manipulating the data through models; generating statistics; simulating alternatives; assigning risks to alternatives; and generating reports. A well-designed DSS provides a wide range of operations that provide the flexibility for data manipulation and simulation in numerous ways. [Sprague and Carlson 1982:p. 106]

c. Memory (ROMC)

To adequately support the representations and operations aspects of DSS memory aids are required. These aids, though mostly transparent to the user, are vital to DSS functionality. Examples include databases, views, workspaces, libraries, links, triggers and profiles. These terms are defined below:

- database--memory for data compiled from sources the decision-maker thinks may be relevant to the decision;

- views--memory aids for specifications for groupings, subsets, or aggregations of data in the extracted database which may be relevant to the decision alternatives;

- workspace--transient memory aids providing results of operations and representations;

- library--associated with workspaces to provide long-term memory for intermediate and final results created in the workspace;

- links--memory aids for information across workspaces and libraries;

- triggers--memory aids used to invoke operations automatically or prompt the user for action; and

- profiles--memory aids used to store initial or default values for the DSS; user "log files" are considered profiles. [Sprague and Carlson 1982:pp. 105-106]

d. Control (ROMC)

The control mechanism provides the decision-maker with the capability to manipulate the representations, operations and memory of the DSS to suit his particular method of decision-making. Examples include on-line help functions; on-line tutorial facilities for operator training; functions for varying variable values for sensitivity analysis; and functions for editing models for dynamic environments. [Sprague and Carlson 1982:p. 106]

E. DSS TODAY

The DSS phenomenon is firmly entrenched throughout public and private industry, including the military. Examples include the Deployable Mobility Execution System (DMES) and Southern Railway's computer-aided train dispatching system. DMES is a microcomputer-based system used to optimize the Military Airlift Command's (MAC) aircraft utilization and cargo loading. During the 1983 invasion of Grenada, use of this system saved in excess of $2.5 million in flying-hour costs; experts predict annual peace-time savings at greater than $20 million. Typically, load planning is reduced by 90% over conventional methods and aircraft utilization is boosted by 10%. [Cochard and Yost 1985:p. 53]

In late 1980, Southern Railway placed into production an automated train dispatching system which yielded spectacular results. In the system's first two years of operation Southern realized an overall 32.1% reduction in train delays and a corresponding 37.8% drop in weekly meet delays despite increases in traffic. [Sauder and Westerman 1983:p. 32]

From these examples it is evident that decision support systems are making significant improvements on decision-making in numerous application environments.

F. EXPERT SYSTEMS

Expert systems (ES) are the present-day extension of the DSS revolution. As their name indicates, they are computerized systems that "capture" the knowledge and expertise of an individual or group for use in solving complex problems requiring extensive inference and data handling. In essence, an ES models the cognitive processes of the human expert and automates it. Typical applications include medical diagnosis, mineral exploration, computer configuration, and combat planning. Successful examples include MYCIN--a medical diagnosis ES; TATR (Tactical Air Targeting)--an Air Force ES used for planning air strikes that maximize target destruction within given constraints [Callero, et al 1986:p. 189]; CRITTER--an ES used to verify digital circuit designs for correctness and robustness; and DART (Diagnostic Assistance Reference Tool)--a framework to trouble shoot IBM series teleprocessing systems as well as the cooling system of a nuclear reactor [Keravnou and Johnson 1986:pp. 71-73].

ES are differentiated from DSS in that the former provides a solution which the decision-maker can accept or reject (computers still cannot replace the human element entirely); a DSS provides no suggested solution--only assistance in evaluating and choosing among alternative courses of action. The debate continues as to whether ES is a subset of DSS or an entity in and of itself.

Another difference involves the computer language used for system coding. With DSS the majority of applications are programmed in third generation languages (3GL) such as PASCAL, FORTRAN, and COBOL.[1] These 3GLs are primarily procedural, executing in a sequence of functions and modules. ES are coded in fourth generation languages (4GL) utilizing artificial intelligence (AI). Examples include LISP and PROLOG[2] which have non-procedural capabilities allowing the software to infer and move beyond the IF-THEN-ELSE constraint of procedural languages. AI is discussed in a subsequent section.

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[1]PASCAL (1968) is named after mathematician Blaine Pascal; FORTRAN is an acronym for FORmula TRANslation (1953); COBOL is an acronym for COmmon Business Oriented Language (1959).

[2]PROLOG is an acronym for PROgramming LOGic (1970); LISP is an acronym for LISt Processing (1958).

1. Expert System Components

Harmon and King have identified the basic components of the ES (see Figure 4.4) that help distinguish the architectural differences between DSS and ES [Harmon and King 1985:p. 49].

a. The Knowledge Base

The **knowledge base** contains the rules, assumptions, and facts that the inference engine analyzes or "fires" to trace numerous logic paths to make an inference.

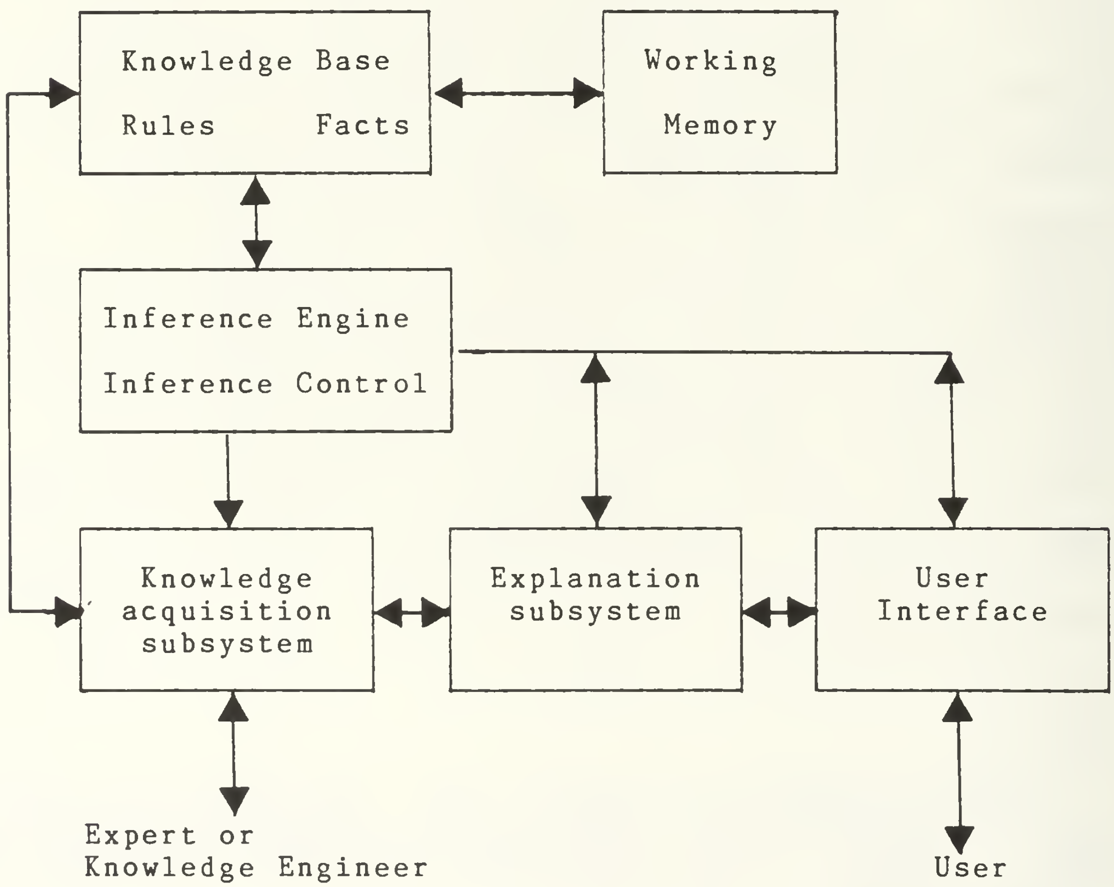

Figure 4.4 Knowledge-based Expert System Architecture

This process is rarely automatic; external stimulus is required to put the system into gear. Stimulus can be in the form of user supplied input after query from the system (e.g., patient vital signs for a medical diagnostic ES), or automatic input from environmental sensors in the case of automated processes such as control of a nuclear reactor (coolant temperature, radiation level, etc.).

Within the knowledge base, there are two basic types of data the ES uses. According to Arcidiacono:

> One describes the problem and comprises the information that has been concluded, assumed, or provided during the inference process. This information is contained in an assertion base, or world model. The other type has knowledge about how to use the assertion base to reason about the problem domain. [Arcidiacono 1988:p. 47]

The types of data structures used within an ES are varied too. They include rules, frames, semantic networks, logic, procedures, and relational databases.

b. The Inference Engine

The inference engine is the heart of any expert system. Its function is to provide the mechanism to systematically "fire" the knowledge base to reach an inference, or conclusion. Two methods are utilized to this end--forward and backward chaining.

In backward chaining systems, the domain of possible outcomes is relatively small, allowing the ES to work backward from conclusion to inference. This is very common in diagnostic expert systems where the user provides an educated guess at the problem and the system asks for pertinent information to prove or disprove the assumption(s). Backward chaining systems are often called **goal-directed systems**. [Harmon and King 1985:p. 55]

In **forward chaining** systems, the solution domain is usually so large that backward chaining would be inefficient and too costly. In this instance, the solution must be constructed. The inference engine takes the data provided by the environment (user) and searches the knowledge base to find those rules whose premises are satisfied. It then adds the conclusions from the rules just fired to the list of data or facts known to be true and re-examines the knowledge base until a conclusion is reached. Forward chaining systems are also known as **data-driven systems**. [Harmon and King 1985:p. 55]

2. <u>ES Subsystems</u>

a. Working Memory

Working memory is that segment of memory containing the facts that result from consultation with the user or environment. When the inference engine is checking rule premises, it references working memory. When a rule fires, its conclusions are placed in working memory for further evaluation as the inference process progresses. [Harmon and King 1985:p. 55]

b. Knowledge Acquisition

The **knowledge acquisition subsystem** provides the means for accessing and storing the data provided by an expert or knowledge engineer.

c. Explanation Subsystem

The **explanation subsystem** provides the user with the logic used by the system to reach a conclusion or inference. ES are developed to supplement the expertise and experience of the user, not replace it. As such, detailed explanations are necessary for the user to properly analyze and validate system results and learn from it at the same time.

d. User Interface

The user interface is the link between the environment and the expert system, providing for input of data and output of inferences and associated explanations. Proper interface design ensures adequate system operation and use. As mentioned before, a poor design can severely hamper the effectiveness and usefulness of even the most sophisticated DSS.

G. CRISIS MANAGEMENT DECISION SUPPORT SYSTEMS

A relatively new application for DSS is **crisis management**, especially within the military. The U.S. Navy's commitment to the AEGIS weapon system on Ticonderoga class (CG-47) cruisers is a contemporary example of the sea service employing DSS-like systems.[3] Application of DSS techniques to crisis management is a direct result of information overload and time constraints imposed on the decision-maker in an emergency or crisis.

Yet what constitutes a crisis? Elam and Isett describe crises as events that have "no identical precedent on which to base a routine decision, and their precise characterization is difficult." [Elam and Isett 1987:p. 4] Crises are characteristically non-recurring, while emergencies not only reoccur, but are anticipated with contingency plans. These definitions adequately describe the situations military managers (e.g., tactical action officer (TAO) aboard ship) will face in combat. According to Smart and Vertinsky:

> Designs for crisis decision making attempt to: (1) prevent certain biases that are specific to stressful situations; (2) increase flexibility and sensitivity of line units; and (3) develop computational and processing capabilities in the organization to meet sudden increasing demands imposed on the decision units. [Smart and Vertinsky 1977:p. 655]

Yet can such a system actually help the decision-maker? In an experiment with U.S. Air Force officers, Elam and Isett discovered some interesting relationships. Using a simulated air attack, decision-makers were tasked with

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[3]AEGIS integrates the ships sensors with the weapons systems to provide a manual, semi-automatic, or fully automated mode of threat engagement in the time-constrained combat environment.

defending an air station with the assistance of a prototype crisis decision support system (CMDSS) which provided recommendations based on queries by the system. Their overriding conclusion was that decision quality can be dramatically improved with the use of a CMDSS. Additionally, the use of a straightforward chauffeur-driven (directed) interface allows the user to concentrate on solving the problem and not on how to use the system. [Elam and Isett 1987:p. 37]

There was insufficient evidence from the experiment to support the ideas that: (1) use of a CMDSS will lower perceived stress; (2) use of a CMDSS will reduce information overload over a conventional dss; and (3) use of CMDSS will reduce time pressure over a conventional dss. [Elam and Isett 1987:pp. 31-36]

The stressful and time-constrained combat environment requires split-second decision-making as evidenced by the tragedy of the USS STARK in the Persian Gulf in 1987 and most recently with the downing of an Iranian airliner by USS Vincennes in 1988. With continued advances in computer technology, artificial intelligence techniques, and a better understanding of crisis management, the military can benefit greatly from CMDSS applications.

H. GROUP DECISION SUPPORT SYSTEMS

The advent of DSS has spawned the development of computer-based systems aimed at improving the quality and timeliness of decisions with an emphasis on the individual. However, as organizations have become increasingly complex, fewer decisions are made by individuals; rather groups are dominating decision-making, especially at the executive level. As such, a new outcrop of DSS has evolved--the group decision support system (GDSS). [DeSanctis and Gallupe 1985:p. 190]

According to Huber "The purpose of a GDSS is to increase the effectiveness of decision groups by facilitating the interactive sharing and use of information among group members and also between the group and the computer." [Huber 1984:p. 192] He goes on to point out the group activities that a GDSS supports:

- <u>information retrieval</u>--selection of data values from an existing database, as well as simple retrieval of information (including attitudes, opinions, and informal observations

- <u>information sharing</u>--display of data to the total group on a viewing screen, or sending of data to selected group members terminal sites for viewing

- <u>information use</u>--application of software technology (such as modeling packages or specific application programs), procedures, and group problem-solving techniques to data for the purpose of reaching a group decision. [Desanctis and Gallupe 1985:p. 192]

The basic components and group features of a GDSS are summarized in Figure 4.5. [DeSanctis and Gallupe 1985:p. 194]

- text and data file creation, modification, and storage for group members;
- word processing for text editing and formatting;
- learning facilities for naive GDSS users;
- on-line help facilities;
- worksheets, spreadsheets, decision trees, and other means of graphically displaying numbers and text;
- database management to handle queries from all participants, control access to public, or corporate databases, etc.;
- numerical and graphical summarization of group member's ideas and votes;
- menus to prompt for input of text, data, or votes by group members;
- programs for specialized procedures such as calculation of weights for alternatives; anonymous recording of ideas; formal selection of a leader; or progressive rounds of voting for consensus-building;
- method of analyzing prior group interactions and judgments; and
- text and data transmission among group members; between group members and facilitator; and between group members and the central processor.

Figure 4.5 GDSS Components

Such activities and the use of a GDSS can apply to several group scenarios: committees, review panels, task forces, executive board meetings and so on. Therefore, use of a GDSS could be generalized or specific depending on the situation. Generally, there are three architectures prevalent in GDSS design; the **decision room**; the **local decision network**; and the **teleconference**. [DeSanctis and Gallupe 1985:pp. 196-197]

The decision room is a GDSS design supporting group meeting in one primary location (e.g., the boardroom). A typical layout would consist of a main computer and associated GDSS software tied into a large display monitor to facilitate group viewing of data. Additionally, each participant would have an individual terminal in front of them. Decision-making sessions would be run by a facilitator who would interface directly with the main computer and run the meeting. Information and graphics would be displayed to the group; individuals could perform sensitivity analysis and problem solving on an aggregate basis as well at their individual terminal. [DeSanctis and Gallupe 1985:p. 196]

The **local decision network** is an extension of the decision room where the participants are not centrally located in a single room. Instead, each individual has a workstation at their desk which is tied to the GDSS network through a central processor. They can view a "public screen" or work independently on the problem for input to the decision process. This eliminates the need for a dedicated facility, yet does not allow for direct, face-to-face interaction among participants. [DeSanctis and Gallupe 1985:p. 196]

Teleconferencing is a GDSS methodology where participants who are geographically dispersed are tied into a wide-area network of software and hardware. Communication is via computer terminal or video display thereby reducing the need for travel and providing flexibility in timing and duration of meetings. [DeSanctis and Gallupe 1985:p. 197]

The idea of GDSS is in its infancy stage. Experiments at Southern Methodist University and other academic institutions are testing the viability of such DSS hybrids. AT&T and other telecommunications organizations have developed or are developing prototype Teleconferencing systems for business. Further research is needed to better understand the usefulness and impact of GDSS for group decision-making.

I. ARTIFICIAL INTELLIGENCE

Within the areas of electronic data processing(EDP) and management information systems (MIS), computer software consists of programs which generally execute code in a sequential fashion. Program code is rigid and finite in that it is limited in the number of possible execution paths.

With the advent of DSS and ES it was evident that the usefulness of such "standard" software was questionable. A new generation of computer logic and associated software was needed--one that would allow the system to infer and learn; one that could emulate the human cognitive process. That requirement has evolved into what is known today as artificial intelligence or AI.

1. Artificial Intelligence: A Definition

What is meant by the term artificial intelligence? Is it intelligence in the human sense--the ability to reason, infer, and learn? Is it the ability of a computer to think as a human does? Can a computer ever emulate the human cognitive process?

To answer these questions one must understand what characterizes intelligence. Hofstadter suggests that the essential abilities for intelligence are:

- to respond to situations very flexibly;
- to make sense out of ambiguous or contradictory messages;
- to recognize the relative importance of different elements of a situation;
- to find similarities between situations despite differences which may separate them; and
- to draw distinctions between situations despite similarities which may link them. [Mishkoff 1985:p. 5]

Ideally then, AI should provide the computer with these capabilities. But the concept of AI is still vague. Barr and Feigenbaum define AI as "...the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior." [Mishkoff 1985:p. 4] Buchanan and Shortliffe describe AI as "...that branch of computer science dealing with symbolic, non-algorithmic methods of problem solving." [Mishkoff 1985:p. 10] Buchanan elaborates further by stating that AI "deals with ways of representing knowledge using symbols rather than numbers and with rules-of-thumb, or heuristics, methods for processing information." [Mishkoff 1985:p. 11] Finally, the Brattle Research Corporation emphasizes another important aspect of AI:

> In simplified terms, artificial intelligence works with pattern-matching methods which attempt to describe objects, events, or processes in terms of their qualitative features and logical and computational relationships. [Mishkoff 1985:p. 3]

The aforementioned definitions describe the essential elements of AI: human-like intelligence; use of symbolic, non-algorithmic methods; use of heuristics; and pattern-matching capabilities.

2. AI Characteristics

a. Symbolic, Non-Algorithmic Methods

The prominent Von Neumann[4] computer architecture is designed around processing numeric data and

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[4]Von Neumann is the genius behind the standard computer architecture dominating present-day computers.

representations, which it does extremely well. Humans, on the other hand, tend to process information symbolically, providing a better mechanism for intelligent cognitive processing. To adequately emulate the human mind, AI must be adept at symbolic processing.

As with numerical processing, computers typically process programs algorithmically in a fixed, step-by-step fashion. The human mind is more sophisticated, rarely depending on alogrithmic, cookbook approaches to reasoning and mental processes. Again,I must shed the algorithmic mold to better approximate intelligence.

b. Heuristics

In addition to the mental abilities of symbolic and non-algorithmic processing, humans also use rules-of-thumb, or heuristics, to reason and make decisions. Rather than rethink a decision situation entirely each time it is encountered, humans rely on heuristics for rapid decision-making. For example, when an individual is hungry, he deduces that he must feed himself (i.e., I am hungry, therefore I must feed myself). Without such a heuristic, the individual would have to analyze the environment through several iterations to come to the same conclusion. Humans utilize a wealth of conscious and subconscious heuristics for daily decisions.

c. Pattern-Matching Capability

The final characteristic of human intelligence is the pattern-matching facility. Our ability to reason and derive conclusions is dependent on being able to recognize patterns and recognize relationships in the environment. As Mischoff states "One of the ways that we make sense of the world is by recognizing the relationships and patterns that help give meaning to the objects and events that we encounter." [Mishkoff 1985:p. 13]

3. AI Applications

With the conceptual basis of AI developed above, one may wonder how AI will benefit man; the question of computers replacing humans is raised constantly. Today AI has led to more powerful on-line tools in decision support systems and expert systems. These systems are addressing problems in speech recognition; image analysis; surveillance; weather forecasting; crop estimation; medical and electronic diagnostics; circuit design; military planning; nuclear power plant regulation; tutorial and remedial instruction; air traffic control; and battle management. With the rapid improvements in micro-chip technology (e.g., INTEL 80386 operating at up to 25 MHZ)[5]

[5]The speed of a computer is heavily dependent on the speed of the internal clock which provides the pulses equating to the zeros (0) and ones (1) of basic computer code; the higher the clock speed in megahertz, the faster the processing generally.

the prospects for even more advanced AI-based systems is excellent.

J. SUMMARY

Decision support systems (DSS) are inter-active computer-based systems which facilitate solution of unstructured problems. They are being used in public and private industry to enhance the timeliness and quality of decision-making at all levels. The expert system, a DSS derivative, is helping provide solutions to problems in such areas as medical diagnosis, mineral exploration, and micro-processor design. Within the military, complex weapon systems are augmented by a DSS-like shell providing semi-automatic and automatic modes of operation; combat planning has been revolutionized with the addition of computer-based models; and military strategic planning has been augmented by sophisticated interactive wargaming simulations.

With increased growth and advancement in artificial intelligence, DSS will continue to provide extensive, valuable assistance to the decision-maker.

V. RSAS IN THE CONTEXT OF DECISION SUPPORT

A. INTRODUCTION

The previous chapters have dealt with background information on gaming, strategic analysis, the RSAS, and decision support systems. The questions that remain to be answered are:

- Is the RSAS a decision support system (DSS)?
- Is the RSAS an expert system (ES)? If not, should it be?
- Is the RSAS a crisis management support system (CMDSS)? If not, should it be?
- If the RSAS is a DSS, can it support decision-making at the highest levels of government (e.g., JCS, CINCs, etc.)? - Is the RSAS capable of going beyond net assessment analysis? and
- How can the RSAS be used beyond net assessment within the DOD?

This chapter will address these questions in the context of framing the RSAS against the DSS characteristics and paradigms discussed in Chapter IV.

B. DECISION SUPPORT SYSTEMS AND THE RSAS

1. DSS Frameworks and the RSAS

As mentioned in Chapter IV, DSS theory has been developed around two paradigms--the data, dialog, and model (DDM) and the representations, operations, modeling, and control (ROMC) approaches. Within these areas the RSAS generally applies.

For the DDM paradigm, the RSAS definitely provides data (via databases and user-provided input) and models (Red, Blue, Green, etc.). Yet there appears to be a weakness in the dialog area. The RSAS is not a directed system which would provide on-line guidance to the user, prompting him for specific action. This can make the RSAS cumbersome, requiring extensive system knowledge to operate.[1] Additionally, there is no real mechanism for helping the analyst initially frame the problem (save system default values) for better insight or understanding. The analyst must develop the scenario and set up the problem prior to system execution.

Within the ROMC context, the RSAS applies with the exception of representations; it adequately provides operations, memory, and control components. As with the dialog component mentioned above, the system is weak in helping the analyst initially frame the problem on-line through graphics, tables, graphs, etc. Essentially, the RSAS graphics capability provides representations that help the user: follow simulation execution; check the scenario

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[1] According to the National Security Affairs Department at the Naval Postgraduate School, the estimated minimum training period required for proficiency on the RSAS is six months.

status at selected intervals; and facilitate post-run audit and analysis only. Such features, however, are sufficient for defense analysis and decision-making and do not disqualify the RSAS as a DSS, especially as an "indirect DSS" discussed in a subsequent section.

2. DSS Characteristics in the RSAS

According to Sprague and Carlson, decision support systems are "computer-based systems that help decision-makers confront ill-structured problems through direct interaction with data and analysis models." [Sprague and Carlson 1982:p. 97] Other important DSS characteristics include: supporting rather than replacing managerial judgment; improving the quality of decisions; and providing an ad hoc (What if...?) capability. In subsequent sections the RSAS will be appraised against these criteria.

a. Ill-structured Decisions

Looking at ill-structured decision-making, the world of strategy and policy analysis, defense programming, and net assessment definitely connotates lack of structure. These processes are characterized by myriad variables (dependent and independent) interwoven in a complex, global political environment which typically has no "cookbook" approach for resolution. One need only look at the defense planning (weapon systems acquisition, strategic planning, etc.) process and its relation to the planning, programming, and budgeting system (PPBS)[2] to gain an appreciation for the lack of real structure in such matters. There is no black and white; decisions are made on judgment and intuition after considering numerous factors and supporting information. As cited in the Secretary of Defense's Annual Report to Congress for fiscal year 1988:

> Assessment of the military balance is not an exact science. It requires considering a very large number of factors that are difficult to measure. Comparing numbers of units, weapons, or soldiers is a start; but qualitative differences must also be taken into account, as well as their peacetime deployments, mobility, operational planning, and command, control, communications, and intelligence capabilities. The quality of leadership and training, the state of morale, and the ability to achieve surprise are also important factors. Indeed, in a number of historical cases they have proven decisive. [Weinberger 1987:p. 25]

As designed, the RSAS could help the decision-maker (analyst) confront ill-structured problems by allowing the user to access a large search space (database, multiple models, etc.) quickly and consider the probable outcomes of various plans and alternatives. Without the RSAS, the analyst is incapable of running a global simulation in a timely manner and handle the myriad variables involved. More typically, the analysis process would then take months if not years.

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[2]The PPBS is the process of procedures whereby changes to the Five Year Defense Plan (FYDP) are reviewed, approved, and funded.

b. Support for the Decision-Maker

In contrast to expert systems, decision support systems do not provide recommendations or implement a solution to the problem at hand; the emphasis is on supporting the decision-maker and leveraging his mental skills. The RSAS provides suggested outcomes to pre-designed scenarios of armed conflict; it is up to the analyst to interpret the results and apply them to the various analytical processes (e.g., policy analysis, defense program planning, war planning, and net assessment). The RSAS lacks decision models to provide recommendations; only the probable outcomes of a simulation are provided. As a result, the analyst is <u>supported</u> by the RSAS simulation and thus able to gain insight and understanding in a timely manner. This analysis, in turn, is supplied to decision-makers at higher levels.

c. Decision Quality

According to Tritten and Masterson the benefits to wargames and simulations include: allowing the user to examine and focus on issues rather than the outcome of an individual campaign; illuminating concepts that are difficult to grasp in the abstract (ill-structure); stimulating innovative thought and educating sponsors and players; and forcing participants to consider what types of decisions have to be made, in what order, and by whom [Tritten and Masterson 1987:pp. 117-118]. As such, analysis and gaming with the RSAS could result in higher quality analysis which could lead to higher quality decisions within the political-military world. One must be cautioned, though, that poorly designed simulations or improper use of them can result in poorer quality decisions. The assumption here is that RSAS is an adequate model that is utilized effectively.

d. Ad Hoc Capability

Any problem requiring a solution is better addressed by having the capability to see the implications of various alternatives--performing "What if...?" or sensitivity analysis. This ad hoc capability is an important characteristic of a DSS according to Reimann and Waren [Reimann and Waren 1985:p. 173]. The RSAS, with its deterministic modeling, meets this requirement nicely. Through the use of sensitivity analysis, the analyst utilizing the RSAS can test multiple scenarios to better understand concepts and issues. This feature is critical in defense analysis (e.g., policy analysis, defense program planning, war planning, and net assessment). Additionally, the RSAS does this extremely fast, especially when compared with manual analytical methods still in use (e.g., the Joint Strategic Planning System (JSPS) within the JCS).

e. Level of Support

From the previous discussions it is apparent that the RAND Strategy Assessment System fits the recognized definition and paradigms of a decision support system. Yet, one area not addressed is scope and level of support. Most academicians and theorists have studied decision support in the context of middle to upper management within the private sector. Those studies involving military and national defense issues have concentrated on the lower spectrum of the scale--middle to lower management.

The RSAS was initially designed to further the nation's net assessment capability and posture. As such, it supports detailed analysis conducted at levels below the upper strata of military and government management (e.g., the JCS, CINCs, NSC, etc.). These analytic results are used to research and support defense proposals and spending, ultimately influencing high-level decisions.

This is a departure from the traditional view of a DSS being utilized directly by the principle decision-maker(s); but this obviously does not disqualify the RSAS as a DSS. On the contrary, the RSAS <u>is</u> a DSS in the broader view, feeding detailed analysis information from the staff level up to the higher levels of decision-making.

For example, if the RSAS were to be used by the Force Structure, Resource, and Assessment Directorate (J-8) under the Joint Chiefs of Staff, detailed force-on-force analysis would be conducted and the results submitted for consideration to the Joint Chiefs by an Action Officer (AO).

The AO would conduct a briefing outlining the salient points and plausible alternatives for review.

The type of decision-making at such a high level is characterized by a group meeting replete with extensive background research information and viable alternatives. Rarely, if ever, is detailed analysis performed on the spot. Rather, broad issues and supporting information are supplied by staff members. Major players discuss issues and insight face-to-face and rely on instinct and intuition tempered by detailed supporting analysis. Such a scenario describes a JCS dss[3], or unautomated DSS.

Thus the RSAS functions as a DSS that feeds an upper level dss. Figure 5.1 illustrates this concept.

C. SPECIFIC DSS APPLICATIONS AND THE RSAS

1. Expert Systems

The distinguishing feature between a decision support system (DSS) and an expert system (considered by many a derivative of DSS) is the expert system's ability to provide a recommended solution or to implement a decision (e.g., flight control and nuclear reactor control systems). The RSAS is not designed to provide solutions; its intent is

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[3] A dss, as described in Chapter IV, provides decision support without automation for more structured decision making. In this example, the ultimate problem may be ill-structured, but through the support provided by the RSAS, it becomes more structured and hopefully easier to assess.

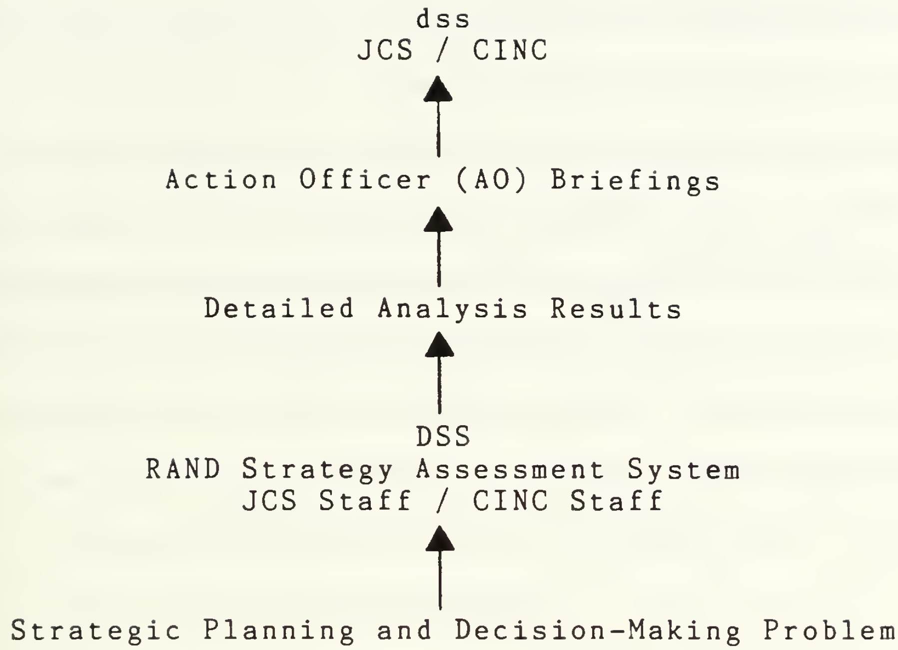

Figure 5.1 The RSAS DSS Fit

to provide an in-depth analysis capability for supporting defense analysis (e.g., policy analysis, defense program planning, war planning, and net assessment). It should be noted that the RSAS has expert-like components which utilize artificial intelligence (AI) within the software for making programmed decisions concerning appropriate force requirements and reactions within the simulation.

The natural questions to follow are "Would one ever want an RSAS-like expert system?" and "If so, what would it do?" Obviously there is a danger in allowing an aggregate simulation like the RSAS provide recommendations based on a modeled world involving variables too numerous to consider and too difficult to address. Most expert systems today have knowledge and rule bases that utilize well-known, proven heuristics and methodologies (e.g., medical diagnostics, flight control systems, inventory control, etc.). The art of waging war globally, on the other hand, is so ill-structured that a simulation such as the RSAS can only be used for gaining insight into required inputs and probable outcomes to the problem at hand. The RSAS cannot replicate the human mind and therefore should not be substituted for it in the guise of an expert system.

Alternatively, a viable solution would be to redesign the RSAS to take a goal, such as superiority over the Soviets in Central Europe, as input and provide recommendations or a plan to meet that goal. This equates to a "backward chaining" AI development where the system tells you how to reach a desired end. Such an enhancement could improve our defense planning immensely and should be evaluated further.

2. Crisis Management Decision Support

Crisis management decision support systems (CMDSS) are designed to provide the decision-maker with timely information to help in a crisis situation usually characterized by time constraints and the need for real or near real-time information. Because of its aggregate nature, the RSAS is ill-suited for this application despite its ability to provide sensitivity analysis in confined scenarios. Crisis decision support requires modeling that benefits the immediate, low-scale environment--not a global one.

As stated before, the need for real or near real-time assistance is another requirement of most CMDSS. The RSAS, though quick in it own right, is not capable of supporting real or near real-time requirements in the context of crisis management, nor should it be because of the systems aggregate modeling. Even as a training tool, the user could become dependent on a system that is only available for simulated conditions.

3. Group Decision Support

Group decision support involves three distinct applications of DSS technology: the decision room; the local decision network; and the teleconference. Since the type of decisions that the RSAS supports (i.e., defense analysis) are analyzed at a low level for consideration at a higher level, the decision room and the teleconference do not appear as a viable implementation choices.

This is not to say a distributed network could not be installed among users (e.g., JCS and CINCs) for exchange of database information. This sharing could prove beneficial by eliminating duplication of effort, allowing replication of simulation runs by interested parties, and sharing lessons learned. Also, if gaming, versus analysis, were distributed this could reduce costly travel expenses and encourage more cooperative gaming sessions. All this would maximize system use.

Finally, the local decision network is viable for the RSAS. A local area RSAS network would provide for two sided gaming with human interaction as well as stand-alone analysis. This is commonly known as a local area network (LAN) which is described in Chapter III.

D. RSAS APPLICATIONS BEYOND NET ASSESSMENT

From the previous discussion, it is apparent that the RSAS is capable of providing utility to the DOD beyond net assessment. Such areas include education, research, indirect decision support,[4] and gaming. Such present and future applications are discussed below.

1. Present Applications

The RSAS is being already being used by academic institutions such as the Naval Postgraduate School and the National Defense University in Washington, D.C. Future plans include installation at the Air Force Institute of Technology, the Army War College, and the Naval War College. These research seats can benefit greatly from the power and capability the RSAS brings as students, whether military officers or their civilian counterparts, gain tremendous

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[4]**Indirect decision support** is a derivative of DSS whereby the RSAS supports the decision-maker indirectly by feeding him analysis results from a staff level.

insight into national political-military affairs through hands-on interaction with the RSAS utilizing case studies. Also, the RSAS is ideally suited to support faculty research projects concerned with defense analysis by providing educators with an on-line capability for global political-military gaming.

Additionally, the RSAS models are presently undergoing validation by the Force Structure, Resource, and Assessment Directorate (J-8) under the Joint Chiefs of Staff.[5] Once verified, the RSAS could be run in parallel with present methodologies to enhance analysis within the Joint Strategic Planning System (JSPS)[6] and more specifically the Joint Strategic Planning Document (JSPD)--the principle document that communicates advice of the Joint Chiefs of Staff to the President, the Secretary of Defense, and the National Security Council on the military strategy and force structure required to support national security objectives. [AFSC Pub 1 1986:p. 5-6] Also within the JCS, the Plans and Policy Directorate (J-5) is coming on-line

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[5]This staff performs force-on-force analysis near to mid-term.

[6]The JSPS is the means by which the JCS: give military advice to the President and Secretary of Defense; establish the strategic foundation for the the Secretary of Defense's Defense Guidance; set guidance and apportion forces for contingency planning and operation planning in the near term; and gain a measure of planning continuity, as the final phases of the planning cycle form the basis for the start of the next cycle.

with the RSAS. In contrast to J-8, this JCS staff is responsible for analyzing the Joint Strategic Capabilities Plan (JSCP) and validating it through various means such as gaming, simulation, and modeling.

According to the AFSC Pub 1:

> Normally, the JSCP assigns planning tasks to the commander of a unified or specified command and, in that tasking, specifies whether the CINC is responsible for preparing an operations plan in complete format (OPLAN) or in concept format (CONPLAN). Regardless of the amount of detail that will be contained in a plan, the CINC must prepare a well-thought-out concept of operations. The CINC and his staff must consider the major combat forces apportioned for planning and then phase the deployment of those units to accomplish the mission. [AFSC Pub 1 1986:p. 6-4]

The RSAS could be used to ensure that individual theater war plans (e.g., Europe, Pacific, etc.) developed by the CINCs mesh well into a synergistic global plan. It could also be used to test various global scenarios and alternatives. Such analysis would validate the robustness of the JSCP.

2. <u>High-Level Applications</u>

Implementation of the RSAS at those levels of government where detailed strategic analysis in support of research and net assessment is conducted is viable. The question still remains as to its use at higher levels such as the JCS "tank" where the Joint Chiefs discuss and resolve strategic issues, both short and long-term.

As discussed earlier, the type of decision-making at such levels would not justify the use of the RSAS, even with a dedicated, trained operator. Alternatively, the RSAS could prove beneficial to the various Commander-in-Chiefs (CINC) who have responsibility for drafting and implementing war plans and alternatives for trade-off analysis. Over time, CINC staffs contingency plans for their area of responsibility (e.g., CINCLANT, CINCPAC, and CINCSAC). Using guidance from the Joint Chiefs, the CINC staffs could utilize the RSAS game to become more adept at strategic planning. If used widely enough, sharing of information across command boundaries could result in a synergetic strategic planning effort. Such standardization would provide commonalty of systems and sharing of information.

Another unique concept for utilizing the RSAS is for strategic balance (SB) analysis in support of arms negotiations with the Soviet Union. Such an implementation could be used by the U.S. for analyzing alternative proposals before and during negotiations to assess the strategic balance under varying scenarios. Additionally, if a similar global simulation were developed and utilized by the U.S. and the Soviets concurrently (via some joint effort), a more synergetic negotiation process could result. An added bonus might be a better understanding of the Soviet perspective represented within this hybrid simulation and supporting sub-models.

As Dr. Vitaliy Tsygichko of the USSR Academy of Sciences Research Institute of Systems Studies states

> ... models are used for assessing and choosing military and political targets and priorities, working out military strategy, formulating the tasks of their solution, adopting concepts for the development of the armed forces. [Tsygichko 1988:p. 3]

He believes models can be effectively utilized by both sides for more meaningful arms negotiations. He goes on to say:

> Each side constructs the worst scenario of the beginning of war for itself and decides with the help of the model the correlation of the sides' potentials guaranteeing the impossibility of offensive operations by the other side. Thus we will get a margin in the correlation of the sides' potential where SB is guaranteed.
>
> Next, each side figures out the actual potential for the the other side under the same scenarios and the actual correlation of the potentials. If that correlations does not overreach the pre-modelled SB margin, then talks can centre on measures involving mutual troop reductions by the sides which naturally should not upset SB. If either side has an advantage, the task of the first stage of negotiations will be agreement on the attainment of SB: i.e., reduction of troops by the side which has the advantage or creation of conditions under which the said advantage disappears--for example, through the exclusion of conditions for a surprise attack. [Tsygichko 1988:p. 4]

Such a concept should be given serious consideration as it could provide an atmosphere for more effective and efficient arms negotiations.

3. <u>Operational Applications</u>

The RSAS is a vehicle to simulate the pre-war and combat environment on a global basis for exploration and analysis in support of defense planning; it is <u>not</u> a surrogate to the decision-maker. If a decision-maker is allowed to utilize the RSAS operationally to perform sensitivity analysis and rely on that analysis for making decisions in a time-constrained environment, he has stepped into the realm of direct decision support. Such a situation could lead to an over dependence on an aggregate simulation for making decisions. Unfortunately, that is not realistic in time critical scenarios, real or simulated. The present information systems technology (IT) of the RSAS does not support real or near real-time assessment nor does it provide solutions or recommendations. It only provides probable outcomes to pre-designed scenarios for testing what <u>might</u> happen.

However, it is conceivable that some operational situations could benefit from the use of the RSAS. Take for example the 1986 air raid on Libya. This event was not a knee-jerk or shoot-from-the-hip reaction; it was a planned and calculated undertaking. It is fair to say the RSAS could have been employed prior to and during the execution of this operation. Given adequate time to configure the system, the RSAS could have been used at the appropriate CINC staff level to game alternative scenarios such as:

- a detection of U.S. intent and a military reaction from Libya prior to the actual strike;
- a major movement of Soviet naval forces into the area as the situation unfolded; and
- retaliatory military action by Libya and supporting factions subsequent to the strike.

Although not real or near real-time, the RSAS could have provided insight (staff analysis input to the CINC) into probable situations as both inputs and outputs to such questions as "What political or military reaction can I expect from this strike?", "What is our ability to manage aggressive reaction to the strike?" and "How robust are our strategies to deal with the reaction?"

Another example is the invasion of Grenada. Here the CINC staff of that operation could have used the RSAS to again, play out multiple scenarios, not based so much on Grenada's ability to strike back, obviously, but on other nation's potential intervention during or after the fact.

These examples demonstrate how the probable outcomes to various scenarios can ultimately help the decision-maker(s) better assess the situation. Such use of the RSAS by CINCs operationally should be tested to validate the viability of such an implementation.

E. SUMMARY

The RAND Strategy Assessment System will provide decision support for the nation's defense analysis process at this level. This includes support for the Force Structure, Resource, and Assessment Directorate (J-8) and the Plans and Policy Directorate (J-5) under the auspices of the Joint Chiefs of Staff. Additionally, it will be an invaluable research tool for the study of national security affairs and related topics. The design of the RSAS is well suited for this lower level of what might be termed "indirect decision support" in that it supplies background analysis vital to decision-making at higher levels. In its present configuration the RSAS is not capable of supporting classical crisis management decision support or high-level decision making (e.g., in the JCS "tank") because of the nature of these decisions and its (the RSAS) aggregate nature, lack of real-time response, and complexity of operation. It could be used by the CINCs as a pseudo CMDSS with loose time constraints; an adjunct to other analysis and games; and as a tool for war plan development.

VI. CONCLUSIONS AND RECOMMENDATIONS

The RAND Strategy Assessment System is a comprehensive political-military simulation which fits the general paradigm for decision support systems (DSS), albeit at the strategic analyst level; it is an "indirect DSS" providing input to a high-level "dss" (e.g., at the JCS or CINC level). Its output has the capability to ultimately affect high-level decision making by providing background information crucial to augmenting the judgment and intuition of our nation's defense leaders.

The RSAS allows analysts, and ultimately decision makers, to:

- perform long-range planning for the allocation of resources in support of the national defense;
- evaluate and form policy recommendations;
- determine the limits of a decision by discovering the up side and down side of a situation;
- learn to ask the right questions;
- gain insight to how a subject or problem works; and
- practice warfare without extensive allocation of resources;

The RSAS is <u>not</u> a panacea for predicting the future; it is only one of many tools used for strategic analysis in support of the nation's defense assessment process. It is <u>not</u> a real-time system capable of supporting crisis management at high levels of military or governmental organizations; it is capable of training crisis managers (warriors) in properly designed scenarios under the guise of wargaming and as an adjunct to analysis of operational situations that are not time constrained. It does <u>not</u> provide pat answers to questions posed; it does provide a tool for research and dissecting a situation for greater insight and understanding.

To continue the advances the RSAS brings to strategic analysis and wargaming, further development of the RSAS software is warranted. Recommended uses include:

- supplying all the CINCs with the RSAS and ultimately tying them together in a distributed network including the JCS support staffs;
- augmenting established games such as the Global Game at the Naval War College and the TFCA within the J-8; and
- investigating the feasibility of modifying the RSAS to accept a goal and perform reverse analysis to provide recommendations on the required force structure to meet that goal;
- investigating the feasibility of using the RSAS as a tool for analysis during arms negotiations by the U.S.

Recommended enhancements and maintenance include:

- updating existing models to adequately reflect the current world state;
- updating and simplification of on-line documentation;
- adding models to expand the RSAS to a truly <u>global</u> simulation; this would include such things as the Pacific theater, third-world hot spots (e.g., Cuba), space-based weapons, and the like;

- modification of the user interface to simplify system operation for the layman; this would include more on-line help functions and tutorials;

- validation of models by third-party experts;

- increasing sophistication of on-line error-checking to allow the system to resume at the error detection point rather than having to default to the originating point; and

- increasing availability to analytical think tanks and research hubs throughout the DOD for standardization and exchange of information.

The RSAS is an invaluable tool to the strategic analysis community, net assessment, and ultimately to the national defense. Its inability to provide real-time decision support does not detract from its vital indirect role in decision making. With continued development the RSAS will play a prominent role in strategic thought and related defense issues beyond the realm of net assessment.

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