SURFACE-TO-AIR MISSILE OPERATIONS CENTER

(SAMOC) THREAT ASSESSMENT STUDY

SARA LYNNE ROYER

Department of Mechanical and Industrial Engineering

APPROVED:

Dr. Thomas J. McLean, Chair

Dr Carroll Johnson

Dr. David Williams

Associate Vice President for
Research and Graduate Studies

To my grandmother, Sara Diaz,
and my uncle, Jose Feliciano Diaz.
They made me believe that I
could do anything.

SURFACE-TO-AIR MISSILE OPERATIONS CENTER (SAMOC) THREAT ASSESSMENT STUDY

by

SARA LYNNE ROYER, B.S.C.S.

THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

Department of Mechanical and Industrial Engineering

THE UNIVERSITY OF TEXAS AT EL PASO

December, 1992

ACKNOWLEDGEMENTS

My sincerest thanks go to Dr. Thomas McLean, whose support and patience have been invaluable to me in this endeavor, and to the other members of my committee, Dr. Carroll Johnson and Dr. David Williams.

I will never be able to express enough gratitude to my family and friends who, not only have inspired me to continue my education, but have provided love and support throughout my life. Special thanks go to my mother, Isela Royer, my sister, Sandra, and my other "moms", Sara Gutierrez and Mary Rayon, who have always been there when I needed them. My gratitude also goes to Henry Amparan, who motivated me to pursue my graduate degree, and who has been there from start to finish.

Appreciation is also extended to Wes White and John Armendariz, whose encouragement and flexibility have made the continuation of my education possible. I can never repay the debt I owe to Charlotte Cloninger for her help--she has been an invaluable ally.

November, 1992

ABSTRACT

As technology has advanced, there has been need for defense systems to keep up with these advances. The Surface-to-Air Operations Center (SAMOC) is a proposed air defense system that is being developed to provide upper echelon support for today's High-to-Medium Altitude Air Defense (HIMAD) systems. The SAMOC threat assessment requirements are currently being developed, and an analysis of these requirements is necessary.

The objective of this thesis is to analyze the effectiveness of the proposed SAMOC system's threat assessment logic by determining if the combined threat order list is a reasonable and correct assessment of the target threat. This objective will be met through the use of computer simulation and analysis of the data collected during the simulation execution.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

1.0 INTRODUCTION

As technology has advanced, air defense systems have increased in speed, accuracy, and levels of automation. Developments in systems, such as Patriot and HAWK, have made it necessary to provide a new method of controlling air battles. Current command and control methodology at the upper echelon level cannot effectively insure success of the air defense mission.

In order to meet anticipated air defense demands, the German Air Force and the United States Army are defining the preliminary requirements for a brigade level system known as the Surface-to-Air Missile Operations Center (SAMOC). As a brigade level system, SAMOC will be the higher echelon node for High-to-Medium Altitude Air Defense (HIMAD) battalions, such as the Patriot Information Control Central (ICC) and the German HAWK Operations Center (GEHOC). What makes SAMOC unique systems is that it will be developed to provide Management by Exception rather than simple Command and Control. It will only command actions at the battalions if it appears that the air defense mission cannot be accomplished by anticipated ICC and GEHOC behavior. In such cases, the SAMOC will intervene and command specific actions to the battalions.

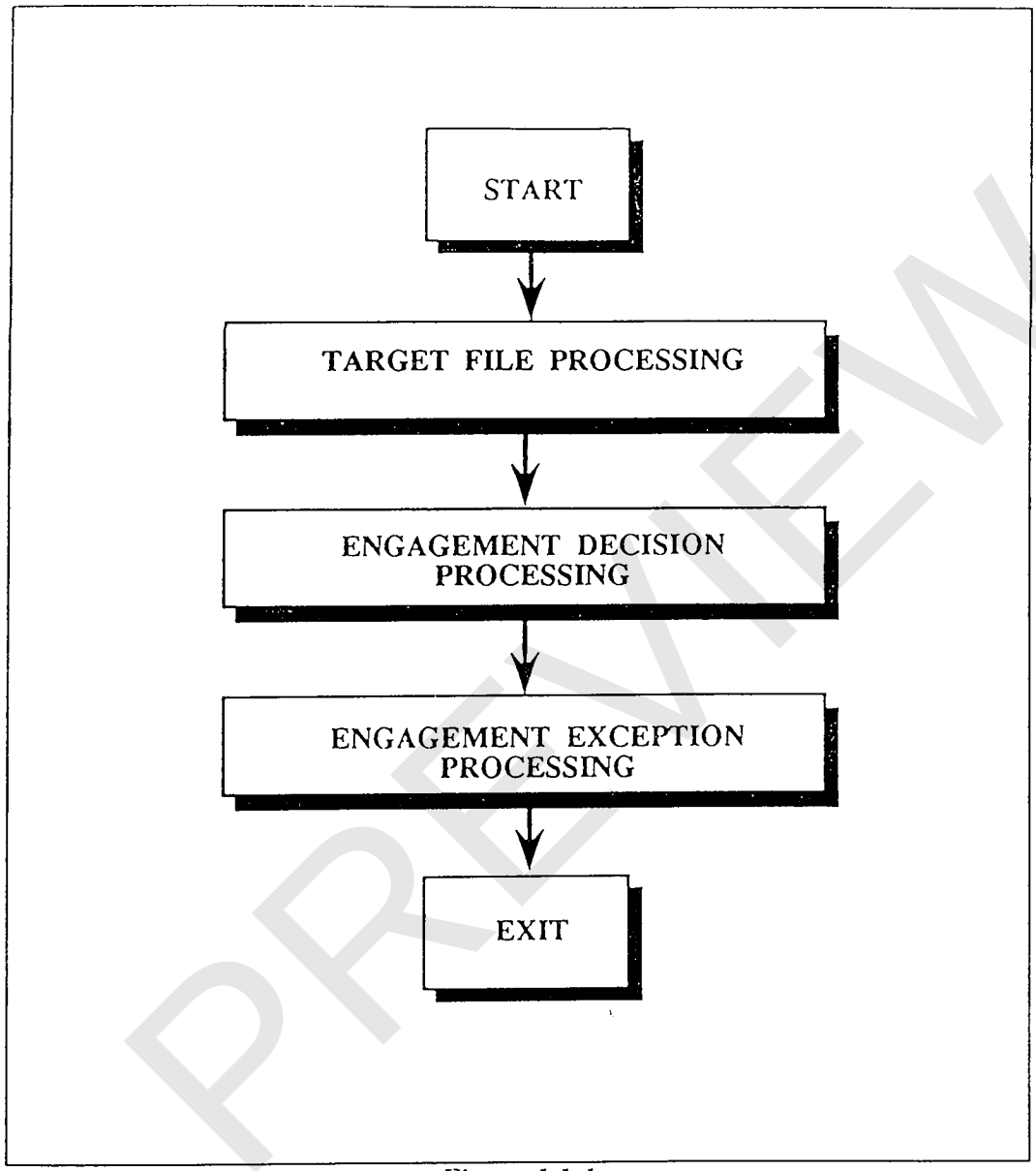

Figure 1.1-1
Overview of SAMOC

1.1 SAMOC

An overview of the proposed SAMOC processing is shown in Figure 1.1-1. Preliminary requirements have been defined for each of the main processes of target file processing, engagement processing and engagement exception processing [1].

1.1.1 Track File Processing

Track file processing will include two (2) steps--building the target file and determining target attributes. Building the track file will consist of SAMOC processing the target updates received by the SAMOC from its subsidiary battalions and determining the air picture from these updates. If the SAMOC receives target updates from two different sources, but the target data appears to be for the same aircraft, the SAMOC will correlate the track data to develop a single entry in the track file. Whenever the SAMOC receives a target update which cannot be correlated with any existing track entry, the SAMOC will assign the track as a new track file entry. In this manner, the SAMOC will have knowledge of the air picture present at all of its battalions.

The second portion of track processing is the determination of target attributes. The types of attributes that may be assigned are:

- identification parameters,
- flight path prediction, and
- fire platoon coverage.

The attributes may be used during threat and engagement processing to determine actions to be taken against the target. As proposed in the SAMOC Conceptual Paper [1], a new method of assigning these attributes may be used. It is anticipated that before an air battle begins, a layout of the SAMOC area of responsibility will be made. This layout will be built of "cubes". These cubes are multiple small volumes of space which will completely encompass the area of responsibility. Each cube will

have associated with it attributes which describe the space they envelope. These attributes will include terrain features, identification of specific areas, fire platoon coverage areas, and attack route features. Once a target is determined to be within a specific cube, the target will inherit all of the attributes for that cube. By keeping a history of the attributes that the target has been given, the SAMOC will attempt to predict future behavior from past behavior.

As part of the track attribute processing, the SAMOC will attempt to predict a target's position at x seconds in the future. This prediction of future positions, which will be used in engagement decision processing, is unique to the SAMOC system. More than one (1) predicted position may be generated for a target. A probability, called a certainty factor, will be assigned to each predicted position and will define the level of certainty for the prediction.

1.1.2 Engagement Decision Processing

The SAMOC engagement decision processing has two (2) portions--threat assessment and engagement sequencing. In threat assessment, the SAMOC will evaluate each non-friendly track file entry and assign it an overall threat value. The threat value will be based on the target's predicted positions in relation to defense sites that the SAMOC has been assigned to defend. Defense sites will include defended assets, fire platoon positions, and area defense volumes. Area defense volumes are a new type of defense site specifically developed for the SAMOC. These volumes allow the SAMOC to defend large and oddly shaped areas that do not conform to the size or shape of defended assets.

The SAMOC will calculate the distance from each predicted position to the defense sites and, depending on the priority of each defense site, assign a threat value to the target. Once a threat value has been assigned to each eligible target, the SAMOC will build a combined threat order list which will tabulate targets in priority order. The target with the highest threat value will have the highest priority.

After the combined threat order list has been built, the SAMOC processing will proceed to engagement sequencing. In engagement sequencing, the SAMOC will build several lists of target-to-firing platoon pairings. Each pairing will be based upon the ability of the fire platoon to engage the specific target within a specified time frame. The sequences will then be rated on the ability of that sequence to achieve the overall air defense mission. The SAMOC will also rate the anticipated engagement sequences of the battalions in comparison to the SAMOC-generated sequences. If the current battalion behavior is deemed acceptable, then no further engagement processing is done during that cycle.

1.1.3 Engagement Exception Processing

If the anticipated battalion behavior is not acceptable, the SAMOC will intervene to insure that the air defense mission is accomplished. The intervention will be either an **engage** type command or a **stop engage** type command, which will be sent to the battalion. Multiple commands may be generated within a single engagement processing cycle.

1.2 The Threat Assessment Study

When defining a new system, it is important to analyze the definition of the system and insure that the requirements are met. One way to do this is through computer simulation.

This approach was taken to analyze the SAMOC threat assessment function. The output of the SAMOC threat assessment function is the combined threat order list. This list is a ranking of the targets which pose the greatest overall threat to the area of responsibility. The priority threat list is used as input into the engagement sequencing process and into the engagement exception processing. Therefore, it is necessary that the combined threat order list approximate the threat ordered lists at the battalions. If this were not true, a large number of exception cases would be generated, and the SAMOC would need to intervene more often. The study has been divided into four parts:

- the development of the new software to simulate the SAMOC threat assessment;
- the development of a study plan which defines the approach to be used;
- the execution of the simulation and output of data to be used for analysis;
- the actual analysis and generation of a study report.

The simulation used for this study was the Patriot Tactical Operations Simulator (PTOS). This simulation was chosen because it provides high fidelity HIMAD battalion models which were to be used as SAMOC's subsidiary battalions. A brief description of the PTOS is given in Appendix A. SAMOC threat assessment software

was added as a separate module to the PTOS, but the SAMOC and PTOS can share required data. Chapter 2 presents the detailed software design which was used to code the software necessary to simulate the SAMOC functions. Once the software was developed, it was tested to determine if it was a correct implementation of the software design and of the SAMOC requirements. Intermediate data was analyzed against expected results. Small (5 to 10 targets) to large scale (50 to 100 targets) scenarios were executed to fully exercise the software. The source code for those sub-programs which perform the threat assessment function are given in Appendix B.

The study plan, which includes the objective of the study, the methodology, and the measures of effectiveness, is included as Chapter 3. The study plan was generated prior to the simulation "runs for record". The simulation runs were made using the scenarios described in Appendix F.

The study report is given as Chapter 4. It includes the details of the "runs for record", the data produced, and the analysis of the data. Also included in the study report are the conclusion and the recommendations.

CHAPTER 2

2.0 DETAILED DESIGN

In order to define future requirements for the Surface-to-Air Missile Operations Center (SAMOC), studies on the proposed SAMOC engagement processing [1] were done through the use of simulation. The simulation software used was the PTOS software which was modified to include the required SAMOC functions. A separate SAMOC module was developed for this effort, which interfaced with the two PTOS battalions--a Patriot ICC and a GEHOC.

This detailed design describes the SAMOC threat assessment module software, which was added to the PTOS to simulate the higher echelon threat assessment function. A brief description of the PTOS environment is given in Appendix A. The software modifications that were made fall into three categories:

- modification of the PTOS initialization software,
- the development of a separate SAMOC module, and
- the addition of data collection required to insure that the SAMOC module simulated the function of threat assessment as defined in the SAMOC Engagement Concept paper [1].

The source listings for the sub-programs, which were developed to process the SAMOC threat assessment function, are given in Appendix B.

The detailed design of the software required to model this function and to produce the data needed for the analysis of this function is provided in this chapter.

2.1 Assumptions

1. SAMOC modules were developed as a separate model within the PTOS environment. The current PTOS Patriot and GEHOC models were used without modification.
2. Communication links between the battalions and the SAMOC were not modeled in order to minimize the effects of link delays.
3. The SAMOC referred directly to data within the ICC and GEHOC models to determine the status of the battalions.
4. The current PTOS terrain processing was used for SAMOC [2].
5. The SAMOC had perfect knowledge of target positions, and future target positions and used this knowledge to provide flight prediction functions.
6. Although the air defense volumes are not included in this study, the software to support the use of air defense volumes has been developed.
7. A maximum of 100 volumes were be defined for the SAMOC.
8. The fire platoons used by the SAMOC were the same fire platoons developed for each of the battalions.
9. Rather than use SAMOC Track management functions, such as correlation, perfect knowledge of targets was be used.
10. The SAMOC simulation had one second granularity.