Gettysburg: An Analysis of the Training Value of Commercial Models

THESIS

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Captain, USA

AFIT/GST/ENS/92M-02

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This study investigated the possibilities of using commercial combat models/war games dealing with the battle of Gettysburg as aids for the training of soldiers and leaders in the military.

With the downsizing of the military and the high cost of training, there exists a need to reduce training costs while not affecting the quality of training. The military employs various military models to assist in training but has yet to fully tap the wealth of commercial combat models. One reason may be the lack of an investigative analysis into the soundness and applicability of commercial combat models to military training.This study selected three commercial combat models, one computer and two manual board games, to examine as an initial investigation into their applicability to military training. The models were evaluated against the concepts of the principles of war, the tenets of Airland Battle, and the factors of METT-T and OCOKA.

The results of the study indicated that all three of the models provided opportunities for effective military training. The models could be used to train different military levels of organizations from platoons to battalions. Beyond these initial results, remains a vast area worthy of further investigation concerning the utility of commercial combat models to military training.

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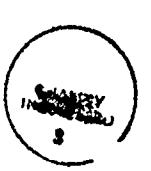

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Preface

The purpose of this study was to examine the possible use of commercial combat models as training aids for military training. Three commercial combat models were selected and evaluated against a series of military training concepts to determine the soundness of this concept.

Although only a small sample of the numerous commercial combat models were investigated and only those dealing with the battle of Gettysburg, promising results were obtained. Beyond these results there still remains a vast area worthy of further investigation concerning the utility of commercial combat models to military training.

I would be remiss if I did not express my gratitude for the guidance and countless hours of dedication from my thesis committee: Major Michael W. Garrambone and Professor Joseph P. Cain. These individuals helped awaken my interest in combat modeling and its role in military training. Finally, I would like to thank my wife Karen for her support and understanding during the long and time consuming process called a master's thesis.

Jude C. Fernan

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Abstract

This study investigated the possibilities of using commercial combat models/war games dealing with the battle of Gettysburg as aids for the training of soldiers and leaders in the military.

The battle of Gettysburg was selected because of its repeated use within the military as a leadership training tool. With the downsizing of the military and the high cost of training, a need exists to reduce training costs whithout affecting the quality of training. The military employs various military models to assist in training but has yet to fully tap the wealth of commercial combat models. One reason may be the lack of an investigative analysis into the soundness and applicability of commercial combat models to military training.

This study selected three commercial combat models, one computer and two manual board games, to examine as an initial investigation into the applicability of models to military training. The models were evaluated against the concepts of the principles of war, the tenets of Airland Battle, and the factors of METT-T and OCOKA.

The results of the study indicated that all three models provided opportunities for effective military training. The models could be used as training tools at levels from platoons to battalions. The model *Thunder at the Crossroads* was of particular interest because it allowed for the training of an entire battalion staff. Beyond these initial results, remains a vast area worthy of further investigation concerning the utility of commercial combat models to military training.

Gettysburg: An Analysis of the Training Value of Commercial Models

I. Introduction

1.1 Background

Traditionally, military officers of all services have studied history as a key element in their leadership development and training. This tradition continues in the U. S. Army which identifies battles such as the 1863 Civil War battle of Gettysburg as particularly important and worthy of in-depth analytical study. Books concerning all aspects of the battle appear on every professional military reading list officers receive during their careers. Students at the U. S. Army War College, all successful battalion commanders, conduct terrain walks and combat analysis of the Gettysburg battlefield. These students, who go on to be division operation officers and brigade commanders, represent the future senior leadership of the U.S. Army. Unfortunately, not everyone in the Army has the opportunity to participate in terrain walks or combat analysis and simply reading about a battle cannot provide the same degree of training as being there.

Training is the Army's number one priority and the focus of a unit's peacetime mission (8:1-1,1-5). High quality and cost effective training is more important today then ever before due to the downsizing of the military, the increased pressure to reduce defense spending, and the continuing competition for scarce resources. These scarce resources of maneuver space, dollars, and training time play a major role in determining the quality and type of training a unit is able to conduct. In an effort to deal with all these constraints and still maintain high quality training, the Army has emphasized the use of training aids such as models (8:4-3).

The term model or simulation has many connotations and can be defined as "a representation of a system" (6:1). One of the systems that the Army is concerned with representing is that of warfare. In modeling warfare, the Army uses both manual and computer war games. A war game is:

> A simulation, by whatever means, but with man-in-the-loop to a substantial degree, of a military operation involving two or more opposing forces, using rules, data, and procedures designed to depict an actual or assumed real life situation. (15:27)

The term man-in-the-loop represents the amount of human influence in the preparation and execution of the model. Manual war games require a high degree of human involvement while computer war games require varying degrees depending on the data and system requirements.

One of the advantages of using models for training is reduced costs. Training costs are a substantial part of a unit's budget, and they dramatically increase with the size and length of the training exercise. These costs include fuel, food, ammunition, and maintenance of equipment. Besides these costs are the time costs associated with preparing, planning, and recovering from training exercises. The time costs associated with a military exercise can actually outnumber the planned training time. With the use of models to supplement or replace some of this training, costs can be dramatically reduced while still maintaining high quality training. An examination of training models used in armor battalions in the U. S. Army illustrates their usefulness.

When tank battalions train for gunnery exercises, a model called the Unit of Conduct Fire Trainer (UCOFT) is extensively used. UCOFT is in many ways similar to a video game. UCOFT models the commander's and gunner's position in a tank while linked to a computer that records the users' performance. The commander and gunner engage targets and situations that they would encounter on a practice firing

range or in combat. UCOFT then provides visual and written feedback on crew and individual performance. Through analysis of the feedback, crew performance is improved prior to any fuel or ammunition being expended.

For the training of command and control, each division maintains an Army Training Battle Simulation System (ARTBASS) center. ARTBASS is an interactive computer training device that allows commanders and staff to plan and execute operational plans against a reactive enemy opponent (15:a-55). At the company level, leaders use a conventional war game called "Dunn Kempf". Dunn Kempf is a manual war game representing central Europe that assists company leadership in training, rehearsing, and executing small level tactics (15:d-23).

Despite the availability and use of over 300 models throughout the military (15:M-1–M-73), models are no substitute for actual hands-on training but do possess certain advantages. Models allow players to practice, rehearse, and investigate the factors influencing combat without paying the associated high costs or penalties. Players can recreate actual historical battles, create and fight their own designed battles, and examine the underlying principles of warfare with models. Officers can use models to form the basis of a professional development program or as a training tool for their soldiers. Finally, doctrinal and tactical issues such as synchronization of combat forces, command and control, and resupply can be examined to varying degrees with models.

There are dangers, however, associated with a blind devotion to models and their output. The scope and dimensions of the war game and the resources needed to execute and support the model are issues. Some models require a substantial investment of time to develop data bases and scenarios or require trained cadre to run the model. Other issues are related to the model's design and purpose. Game designers create models from historical data and events but with a specific objective in mind. The faithful representation of the historical event may conflict with the requirements of flexibility, marketability, or proponent desires (10:33,115–116). The

bottom line is that poor models teach poor lessons that can result in the loss of precious training resources or even soldiers' lives during combat.

As a community, the Department of Defense (DOD) has not done well in modeling warfare. This circumstance is due to many factors such as unverified data bases, neglected historical trends, invalidated or misapplied algorithms, and the lethargy of large institutions (16:88–89); (10:86); (25:xviii). The facts associated with producing models in DOD illustrate another problem. The average developmental cost and time of a model in 1973 was $276,900 and 18 months respectively (5:9,13). Since this report, the situation has not improved. Because of this long time and high cost, the ability of DOD models to be responsive to the training requirements of the military is severely limited.

Commercial modeling companies, on the other hand, do a somewhat better job of modeling warfare for several reasons. Their overwhelming attention and emphasis to the historical event upon which the game is based is foremost among these reasons (10:142). Another reason is the large number of commercial companies that produce models and provide high quality products necessary for their commercial survival. A scan through any issue of *Strategy and Tactics*, a commercial modeling magazine, will list numerous commercial modeling companies and their products. Within weeks of the invasion of Kuwait, *Strategy and Tactics* editors had developed a rough draft of a war game dealing with this subject (11:4). Their November 1990 issue contained a copy of the war game *Arabian Nightmare*, complete and ready for play. This type of responsiveness and the vast number of commercial games are some of the strengths of the civilian modeling community.

These strengths can be tapped by the military for its benefit. The military is always searching for methods to work and train more efficiently. In the past, the military has contracted with commercial designers for war games to support training. A notable example was the war game called *Firefight*, designed by James Dunnigan for the Infantry School at Fort Benning, Georgia. The purpose of *Firefight* was to

assist in the training of small infantry leaders and their soldiers. Unfortunately, the war game was ultimately dropped due to disagreements between the military and the designer. This was an instant were the desires of the military clashed with the perspectives of the commercial designer (10:87).

Despite this political failure of a commercial design to be adapted to military requirements, the high costs and stakes associated with quality training demand an investigation into commercial models. With approximately 10% of commercial wargamers in the military, and 71% of these people between the ages of 17 and 35, there seems to be fertile ground for the use of commercial war games as training tools in the military (10:87,166). Unfortunately, no one has officially determined the utility of commercial war games as possible training devices.

1.2 Specific Objective

It is the purpose of this research to analyze and compare the battle dynamics of the historic battle of Gettysburg to three of the many commercial models of that battle, and to correlate the value of the models as a leadership/battle staff training aid.

Achieving this objective requires the following actions:

- Analyze the battle of Gettysburg
- Review current techniques of modeling
- Select appropriate models of the battle
- Compare historical and modeled events
- Analyze and report the findings

1.3 Methodology

The starting point for this research was a general study of the American Civil War and the battle of Gettysburg in particular. The historical works of Edwin B.

Coddington's, *The Gettysburg Campaign*, James McPherson's *Battle Cry of Freedom* and Ker Burns's film, *The Civil War* were consulted. Discussions with Jay Luvaas, associate professor of military history at the U.S. Army War College, and local area experts provided additional insights. A battlefield visit provided an opportunity to walk the ground, to examine the terrain, and to develop a sense of the battle for later use in the comparison with the terrain of the commercial models. The historical research provided a solid groundwork for an understanding of the battle and the comparisons with the results of the chosen models.

Current literature on combat modeling by James Dunnigan, Peter Perla, James Hartman, and others was reviewed to develop an understanding of the methodology, applicability, and dangers associated with combat modeling. An understanding of the combat modeling environment was crucial for the evaluation and analysis of the commercial models. The increased awareness of combat modeling aided in the investigation and analysis of the chosen models.

The selection of models for use in the study began with a collection of potential candidates from commercial game companies. The potential game companies included Avalon Hill, Strategic Simulation Institute, and many other smaller companies. Each of these companies produced war games covering the historical period of the American Civil War. After identifying all of the applicable commercial models, the selection of potential candidates was accomplished through a general examination of the models' complexity and potential execution times. The thought process was to proceed from the general models toward the more specific and detailed ones as information and expertise on the battle and modeling increased.

The chosen models were then compared and evaluated against the events of the historical battle. The step was accomplished through an examination of the game and an execution of scenarios within the model to provide data for comparisons with the historical events. A historical setup with each model was played or created with the intent of exercising the model's best representation of the actual historical battle.

This comparison gave an indication of the plausibility of the models to duplicate real events.

In analyzing and reporting the findings of the research, two critical questions were asked: What could be learned from the model and what military concepts could be taught using the model? To answer these questions the models were evaluated against certain chosen training criteria. How well the models matched up against these criteria and other chosen model characteristics provided insight into the models' effectiveness as a military training aid.

1.4 Constraints

Due to the large number of commercial game companies and the popularity of the battle of Gettysburg, an investigation of this subject must be limited in scope and operate upon a number of assumptions. The major constraint upon the scope of this project was the limitation of time. This limitation of time affected the number of commercial models collected and chosen as well as the level of investigation into each chosen commercial model. The limitation of time additionally drove many of the assumptions used in the study.

In examining the models, it was assumed that there were no outside constraints to the use of these models for training such as limited training time or a lack of computer support. The models were evaluated solely for their strengths and weaknesses as training aids. Other assumptions dealt with the characteristics of the models. One of the major assumptions was that the models collected and chosen could be learned within the time constraint of the study and to a degree such that insights could be made concerning their training value. Secondly, that the chosen models were a representative sample of the models in the commercial modeling community, and finally, that a reasonable understanding of the battle of Gettysburg and combat modeling could be sufficiently developed to evaluate the chosen commercial models.

II. Literature Review

2.1 Introduction

Before beginning an investigation of the utility of commercial combat models as training aids, an examination of several areas was required. These areas were historical accounts of the battle of Gettysburg, combat modeling in the Department of Defense, and the use of models to support training. An understanding of the American Civil War and the battle of Gettysburg was crucial to forming the basis of a comparative analysis of commercial combat models based on the battle. The current use and misuse of models as training devices in the Department of Defense provided a sense of the strengths and weaknesses of combat modeling. Finally, an investigation into current attempts to reconcile historical facts and combat modeling to improve and support training was necessary. The following paragraphs will review the present state of the literature pertinent to each of these areas.

2.2 The American Civil War

The American Civil War and the battle of Gettysburg in particular, are two of the most studied and analyzed historical events in modern times. With over 50,000 books currently in print and the number growing each year (23:ix), these two events still provide strong stimulus for modern discussions and analysis concerning the war. The availability of a wide range of literature on the topic, presented in all forms and all perspectives, was crucial to the development of this research.

Concerning the Civil War in general, James M. McPherson's *Battle Cry of Freedom* presented a balanced, investigative approach to the conflict. In this large volume, McPherson delved into the causes, effects, and conduct of the war. This book was an excellent source of background reading material because it not only examined the war but the event leading up to the first shots. A companion to *Battle*

Cry of Freedom was the 18 hour Public Broadcasting Service series, *The Civil War* by Ken Burns. This nine part series presented a modern visual approach to the war, supplemented with comments from leading historians such as Shelby Foote and Edwin Bearss. Critically acclaimed, *The Civil War* described the effects of the war on the nation and the people and brought the totality of war into people's living rooms.

Hand outs from the Department of History at the United States Military Academy on warfare and the military profession provided an excellent overview of the war from a military point of view. These notes and the maps that accompanied them, demonstrated how battles were fought and the military lessons to be learned. These lessons concerned the proper or improper use of forces, the effects of generalship, and the application of the seven principles of war. The principles of war are a codified list of concepts believed by military professionals to be imperative to successful military operations. These principles were mass, objective, offensive, unity of command, maneuver, security, surprise, economy of force, and simplicity.

Gettysburg: The Final Fury by Bruce Catton, a well known Civil War historian, was an excellent report on the battle, the major forces, and the personnel. To breath life into the battle, *The Killer Angels* by Michael Sahara had no equal. This book, a historical characterization of the war personalities based upon written accounts, transported the reader back to the carnage and excitement of the battle.

For a current examination of the battlefield, *The U. S. Army War College Guide to the Battle of Gettysburg* by Jay Luvaas and Harold Nelson provided a mechanism to conduct a self guided tour. At each of the major points of conflict, the authors discussed the actions of the combatants and described the surrounding terrain. The book, written by a historian and military officer, was especially useful in describing the battlefield and the conflict. Supplemented with personal accounts from official records and letters from actual participants, this work provided information similar to that obtained from a personal reconnaissance.

As the requirement for knowledge and greater historical detail increased, the research moved to Edward Coddington's work, *The Gettysburg Campaign* which was cited as the definitive work on the battle (22). Coddington drew on the official records of the Civil War and other primary sources to provide a detailed account of the battle. With over 200 pages of endnotes, *The Gettysburg Campaign* was an insightful, in-depth journey into the events leading up to and including the battle. This book contained an excellent description of and commentary on the battle, the organizations, and the personnel down to the brigade level: the major fighting force of armies in the Civil War.

To develop additional details at levels below the brigade and to provide information on individual units, personalities, and technologies of the era the periodicals *The Gettysburg Magazine* and *Civil War* were used. These magazines helped to illustrate the tactics, leadership, and training skills of the era. Supplementing these magazines was the book *Arms and Equipment of the Civil War* which provided illustrations of the equipment of the era and their operation. The book also discussed unit tactics and the characteristics of the equipment used by the armies. Almost a guide to fighting Civil War era units, this book demonstrated and described such tasks as deploying a skirmish line ahead of infantry, the firing of an artillery piece, and the deployment of cavalry.

2.3 Department of Defense Models

Models are used throughout the Department of Defense for analytical, training, and educational purposes. These models are used with the intent of affecting the level of efficiency and preparedness of today's forces. The models are classified according to their main purpose, function or area of concentration (15:M-1-M-73).

In the Navy, the leading expert on wargaming is Peter P. Perla. In *The Art of Wargames*, Doctor Perla examines the history of war games, their essential principles, and their impact on the future. With Doctor Perla's long association with the Naval

War College and his lifetime experience as a wargamer, his readers are provided with current and insightful comments concerning the state of modeling in the 1990's.

According to Doctor Perla, the importance of war games are their ability to help investigate the art of warfare, to train junior officers, and to provide inspiration and incentive for players to examine the underlying themes of the model's subject matter (25:6,9). The examination and questioning of the principles and themes of warfare improves the understanding of the officers involved and increases the chances that in times of conflict, they will react in accordance to the lessons learned from the model.

The Navy uses war games exclusively as mechanisms to train and educate both new analysts and senior officers (25:295). The use of models are prevalent at the United States Naval Academy, the Surface Warfare Officer School, the Naval War College, and in the fleet where they are used to train commanders and staffs (25:296). War games while not accurately replicating the stress and horror of combat, do mirror many of the planning and staff actions necessary for success in battle (25:250-251).

Doctor Perla believes the three main uses for war games are as organizing, exploratory, and explanatory tools. To build an effective war game, a designer must organize and rank many concepts and factors and focus them on a common goal. As an exploratory tool, war games allow players to investigate actions, reactions, and doctrine in a variety of situations and finally, war games help explain historical, operational, and analytical insights to decisionmakers and other parties (25:181).

Referring to James Dunnigan's book *The Complete Wargames Handbook*, Doctor Perla cites realism and the ease of playing as two requirements for a good war game (25:189). The challenge facing wargamers today is to balance these two requirements. The game must have detail, but not to such a degree that it overburdens the player. The degree of detail however, is a function of the difficulty in obtaining accurate historical data and translating it into the model. How well this task is accomplished affects the play and realism of a model (25:239). The litmus test of a

game's results is not only who wins and loses, but whether the model's results reflect a reasonable degree of reality.

Current reviews of war games concentrate more on, "how to play better", then on an analysis of the game themselves. According to Doctor Perla, "the lack of serious compact review and criticism of professional wargames is a significant shortcoming" (25:266). Since a review of this nature does not exist, there will continue to be unanswered questions concerning the validity of war games (25:279).

Other agencies within DOD that are using models include the component colleges of the National Defense University: the National War College, the Industrial College of the Armed Forces, and the Armed Forces Staff College. These institutions use war games and simulations as training aides for their students. They believe that the use of these devices, "encourages creativity, innovative thinking" (21:23).

The Combined Arms Center at Fort Leavenworth maintains responsibility for building effective training teams and leaders for the Army. A method by which this is accomplished is through the Corps Battle Simulation model, Joint Exercise Support System (JESS) for divisional level commanders and staff. At the lieutenant and captain grade level, the Army uses the simulation model JANUS to educate and train its officers (1:36,40).

At the Marine Corps Wargaming and Assessment Center located at Quantico, Virginia, models are seen as efficient, economical, and viable means to maintain and improve combat readiness (19:38). The center is very much interested in the applicabilit, f manual war games having developed two games, TACWAR and STEELTHRUST, for use by their own troops. In addition, the Marine Corps specifically studies the battle of Gettysburg for the lessons the battle provides on the tactical and operational levels of war(31:73).

The Air Force Wargaming Center located at Montgomery, Alabama, is also a prominent player in the design, use, and investigation of combat models. Their

attention is primarily concentrated in the area of air models to support training and operational planning.

2.4 Historical Research

James Dunnigan, a renowned expert in the field of the design and play of war games, is the author of well over 100 simulations and 300 published articles and books. As an experienced and respected member in the gaming community, Dunnigan believes in the need for realism in war games based upon a study of history. In his book, *The Complete Wargames Handbook*, he provides a complete package to the art of wargaming. The book provides the reader with information concerning all facets of the wargaming arena. This includes a process for examining and playing war games, a brief history of games, a discussion on how to construct and analyze games, and a list of games on the commercial market, each with their own commentary.

Another expert on war games and history is Colonel Trevor Dupuy USA-Retired. As the head of the Historical Expert Research Organization (HERO), Colonel Dupuy has spent a lifetime devoted to historical research. Colonel Dupuy's belief is that the knowledge of history is invaluable to the design of effective simulations and war games (13). That is, the proper application of history can provide an effective base upon which to build a combat model.

In a study performed for the Army's Concept Analysis Agency (CAA), a Department of the Army level organization, Dupuy and his organization examined numerous historical battles throughout history to develop a list of critical measures of effectiveness with which to evaluate battles. Over 600 battles including Gettysburg were examined, from which a data base was constructed to support combat models. This data base concerned the issues of force ratios, terrain characteristics, weather, and other factors that affected the battles. Dupuy carried his research further by implying that high level Department of Defense models were providing

useless results if they were not grounded in the historical accuracy now provided by his work and organization (12:58).

Trevor Dupuy's efforts continued toward developing a theory of combat and combat relationships based on the historical information. In his book *Numbers, Predictions and War*, he discusses an approach for predicting battle results called the quantitative judgement model (QJM). With the assistance of a team of combat veterans, Dupuy developed a list of combat variables that could affect the outcome of a battle. This list included such factors as weather, morale, leadership, weapon lethality, and some sixty others. The affect of these variables on units would help explain the outcome of historical battles (13:40–56).

Along with Dupuy's study, CAA initiated an in-house study, *Historical Characteristics of Combat for Wargames*, to develop a check list to evaluate war games. This study examined 260 battles to develop a check list with which to gauge the historical accuracy of war games. The developed check list was much like a medical blood test form with upper and lower tolerance levels representing the boundaries for credible battle outcome characteristics (24:2). Model outcomes could be evaluated against the check list and if the individual measures of effectiveness fell within the feasible window, then the parameters could be considered reasonable or within range. On the other hand, outlying measures of effectiveness, suggested an area worthy of greater investigation to determine the reason for such outcomes.

2.5 Summary

Despite the long term use of models by both the military and civilian institutions, there exists today significant issues needing to be examined. While work by experts in the field have sought to focus and increase the power and usefulness of models within their limitations, there still exists a considerable question in the minds of today's experts about the credibility of results not based upon historical facts. The battle of Gettysburg, as one of the most studied and analyzed battles

in history, represents a unique case for study. Despite the interest in models, there is no record of any analytical investigation into the usefulness of the large market of commercial wargames for military training. Commercial game reviews of these combat games address only generalities and bear no relation .o military questions of training merit. It is in this area that the research will apply analytical techniques to commercial combat models to assess the models' usefulness toward training.

III. Approach to the Problem

3.1 Introduction

To understand and bring together the three underlying themes of this research: the battle of Gettysburg, combat modeling, and military training, required a basic and simple approach. This chapter will discuss an approach to the problem by which data will be collected and analyzed. The approach consisted of a series of building blocks designed to break the research problem into pieces and reconstruct them into a solid foundation for understanding this complex problem.

There were six building blocks necessary for this study. The building blocks were becoming a subject area expert from a historical and a combat modeling perspective, partitioning the battle into spatial and temporal segments, describing the components of the chosen models, executing the partitioned events of the battle with the specific model, and analyzing the model results against the selected measure of effectiveness.

3.2 Historical Expertise

The battle of Gettysburg represented a crucial point in the American Civil War for a Confederate victory would threaten the Union capital and possibly, invite foreign recognition of the South. A Union victory was needed, especially after the defeat at Chancellorsville, for a successful battle would restore confidence in the righteousness of the North's mission. With so much at stake for both sides, it is no wonder that the battle has become a focal point for study throughout history. The approach to becoming an expert on the battle first involved a collection of material related to the battle arranged in a logical organization. This organization separated the information into categories ranging from general to specific in nature.

A general perspective of the battle was developed through an investigation of material that dealt with the battle as one of a series of events comprising the Civil War. The most comprehensive source was *Battle Cry of Freedom* by James M. McPherson which covered the entire war and provided a keen overview to all events military and otherwise. This study was followed by the viewing of Ken Burn's 18 hour series on the Civil War. The television series added a new dimension to the study of the battle by providing a sense of 19th century issues and values to the viewer. This general view was supplemented by reviewing class handouts and battle maps from military history courses.

When an understanding of the war had been developed, the focus changed to an examination of the battle. An exploration of possible sources of information led to discussions with Doctor Jay Luvaas, an associate professor at the U. S. Army War College and an authority on the battle of Gettysburg. Doctor Luvaas provided guidance and advice concerning sources of information on the battle. This information led to what proved to be the primary reference source for this study: *The Gettysburg Campaign* by Edward Coddington. This in-depth and well-balanced study formed the groundwork for the investigation of the battle of Gettysburg and the combatants.

As the research continued there developed a need for detailed information concerning specific battle actions and personnel. Further investigation focused on exploring these events to determine their role and effects in the battle. This information was found through the investigation and reading of magazines devoted entirely to the battle. These articles appeared in *The Gettysburg Magazine*, and they discussed the actions of entire units or the actions of a specific leader which affected the battle.

As a result of the reading of various accounts of the battle representing all levels of action, the next area of research was the battlefield. A tour was conducted and the events of the three days of the battle were traced across the battlefield. The tour of the battlefield and its major landmarks assisted in bringing to life the historical

accounts and characteristics of the area. The vastness of the fields across which the Confederates marched on the third of July against Union fire was now evident. The visit assisted in the comparison of the actual terrain with maps found in reference sources and a topographical map of the battlefield as it appeared in 1863. These comparisons and the visit in general, highlighted the difficulties and challenges each commander faced at Gettysburg.

With an understanding of the terrain and the actions of the combatants, it became important to understand the tactics and the equipment of the battle. All of the resource materials possessed a level of information concerning these topics, but the major sources were Edward Coddington's book due to its all encompassing look at the battle, and *Civil War Equipment and Arms* which provided sketches and drawings relating to every branch and piece of equipment in the war. Doctor Luvaas also provided a ready resource for specific questions concerning actions, personnel, and tactics of the era.

The process of becoming a subject matter expert was a continuing effort and never stopped throughout the research. Each new turn brought questions concerning some aspect of the battle or a need for an additional level of detail to analyze the war games. Most information was gained through repeated readings of the reference material while being attentive to a new angle or approach.

3.3 Modeling Expertise

The process of becoming a combat modeling expert was more of a challenge then developing a historical expertise. This process consisted of developing a background and some practical investigation of DOD combat models.

The background to combat modeling was developed through the instruction and study of course work and material on combat modeling. The courses addressed two areas of combat modeling. These areas were high resolution and aggregate modeling. High resolution modeling was concerned with the actions of individual

entities such as specific planes or soldiers while the aggregate course dealt with groups of entities such as flights of planes and Army combat divisions.

Coupled with the courses on combat modeling were extensive readings of selected works by combat modelers and current experts in the field. Handouts by James Hartman and the reading of Frederick W. Lanchester's *Aircraft in Warfare: The Dawn of the Fourth Arm* were examples of some of the material investigated. *The Complete Wargames Handbook* by James Dunnigan was especially useful in providing insight to a proven framework for the investigation of commercial combat models.

In the application of this growing knowledge of combat modeling, investigative studies and reports were conducted on two current models used in DOD. These reports provided practical work in the analysis of models which resulted in a firmer understanding of combat modeling.

The level of expertise in combat modeling continued to grow throughout the study as a result of the readings and practical analysis. The strength of the expertise became a situation of increasing the awareness to detect weak or illogical issues in the models. This critical eye improved the quality of the analysis of the chosen model's.

3.4 Partitioning of the Battle of Gettysburg

With a firm understanding of the battle of Gettysburg, the battle could now be partitioned into logical segments. These segments could be the geographical locations of the battlefield, the time elements of the different engagements, or the combat actions of units. By dividing the battle into specific, discrete engagements, the scope of the study and the examination of parallel events in the chosen commercial combat models was improved.

Geographically, the battle revolved around engagements for selected pieces of terrain such as McPherson's Ridge and Little Round Top. Time partitioning of the

battle of Gettysburg depended upon the required degree of detail and interest. The battle could be examined from the perspective of the entire three days or by the individual days. Each individual day could be further broken into specific engagements of some time duration. Combat unit partitioning consisted of examining the events from the perspective of the units involved. The actual partitioning of the battle that provided the greatest benefit was a combination of the three components. Events were partitioned and described based upon their geographical location, the time of the event, and the units involved.

The battle of Gettysburg was a fairly organized battle with the action and events following a basic flow of major and minor attacks. The examination of these major and minor attacks at their specific times and locations assisted in the research of the battle and the models. In comparing the battle with the commercial combat models, the partitioning of the battle coincided with the descriptions of the different scenarios provided with the commercial models. Therefore, the execution of the different scenarios in the models could be compared with the actual partitioned event with little difficulty.

3.5 Model Evaluation

The evaluation of the currently available commercial combat models required a logical framework that would be applicable to all the models despite their complexity or level of play. The framework was designed around the basic concept used when confronted with a new project or piece of equipment. The general characteristics of the project or piece of equipment are examined to develop a general idea of the system before concentrating on the details. With the commercial combat models, three stages were required to develop a general idea about the models. These stages were an overview of the model, an examination of the components, an investigation of the rules.

3.5.1 Model Overview. The model overview provided information to the user concerning the models' general characteristics. With a subject as popular as the battle of Gettysburg, there were numerous models with similar names by different companies. Therefore, the name and company that produced each of the models were listed. The resolution of the model and a description of scenarios provided were also discussed. The resolution of a model can be described as where the action takes place. If the players are concerned with the movement and control of counters representing divisions, then the game is a division level game. Similarly, models can concentrate their attentions at smaller levels such as brigades or regiments. At the lower level of action, models generally became more complicated, time consuming, and detailed. The number and type of scenarios provided with the models were also discussed as well as the general organization of the game turns.

3.5.2 Components. An examination of the components of the game focused on the battle board, and the markers or counters. These components were generally examined for clarity, attention to detail, completeness, and historical precision. Of special interest on the battle board was the depiction of the battle area, the terrain, and the marginal information provided. The battle scenarios would be refought on this board and how well it represented the actual terrain would impact on the play of the model. The different type of counters and the information depicted on them were examined for their relationship to the play of the game. The overall strength or weakness of the components directly reflected on the games' realism and ability to recreate historical events.

3.5.3 Rules. The rules were the heart and soul of a model's effectiveness as a training tool because they controlled the model's execution and relationship with the real event. The basic rules of the games were examined for their ability to portray historical accuracy and highlighted for deficiencies that might detract from model play. The criteria used to investigate the rules was the battle operating systems

as defined by the U. S. Army. The battle operating systems represent the major actions occurring on the battlefield and provide a method to ensure successful combat operations (8:2–4). The seven battle operating systems were maneuver, command and control, fire support, intelligence, mobility/survivability, combat service support, and air defense (8:2–4). Since the air defense operating system deals with defeating enemy airplanes and missiles, it was not examined for obvious historical reasons. A description of the battle operating systems is listed in table 1.

3.6 Model Play and Investigation

The selected models scenarios could be executed now that a framework to investigate the games, a knowledge of the historical event and a sense of combat modeling were developed. The approach to the execution of the models began with the lowest resolution game where activity revolved around the movement of divisions and progressed to the highest resolution model which addressed the movement of brigades.

Within each model, the scenarios chosen for examination were ones that represented the historical battle. The scenarios were executed within the historical framework of the battle including unit's historical arrival time on the battlefield and their relative positions. How much of the actual battle of Gettysburg that was played depended upon the amount of study time and the complexity of the models. Other constraints to the execution of the models were the availability of trained participants, the learning curves of the models, model acquisition times, and the quality of documentation.

At the completion of the investigation and execution of each of the models, they were subjectively evaluated against a set of measures of effectiveness designed to provide insight into the model's utility as a training device.

Table 1. Description of the Battle Operating Systems

Battle Operating System	Description
Maneuver	The movement of forces on the battlefield to provide maximum advantage in the accomplishment of the chosen objective.
Command and Control (C^2)	The actions necessary to organize, coordinate, and direct forces toward the execution of the mission.
Fire Support	The use and integration of indirect fire to support maneuver forces in the accomplishment of the mission.
Intelligence	Gaining information and knowledge concerning the enemy for use in the planning of operations.
Mobility/ Survivability	Actions taken to support the movement and maneuverability of forces and their protection against enemy weapon systems.
Combat Service Support (CSS)	Actions necessary to support forces including the areas of supplies and personnel.

(8:glossary 3-6)

3.7 Measures of Effectiveness

In selecting measures of effectiveness (moe) for the analysis of the models, the research concentrated on finding measures that would indicate a correlation or lack of it between the models and the historical battle so to predict their usefulness as training devices. The mere result of the winner or loser of the scenario or game was not enough to make valid insights. Instead, the research concentrated on finding measures of effectiveness that represented current military training themes.

The measures were selected from military training and operational literature and could be categorized into two separate categories. One category dealt with mission planning factors: mission, enemy, terrain, troops, and time (METT-T); ob-

servation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA). The other category dealt with the general issues of military planning: the principles of war and the tenets of Airland Battle doctrine. Finally, the characteristics of resolution level, learning time, playing time, and documentation of the model were examined to provide insights into the play of the model.

In evaluating the models, there existed a high degree of subjectivity concerning the degree of training value that each model possessed. In describing the training value of the models a subjective scale was developed that relied upon the military judgement and experience level of the researcher. This evaluation was applied to the military training and operational measures of effectiveness.

- Poor: The depiction of the measures of effectiveness was extremely limited and required extensive effort to provide training benefit.
- Fair: The depiction of the measures of effectiveness was adequate and required an awareness of and an attention to these measures to provide training benefit.
- Good: The degree of depiction of the measures of effectiveness was sufficient to require the player to understand and apply the measures for successful game operation.
- Very Good: A high degree of depiction of the measures of effectiveness demanded that the player exercise and apply the measures to successfully conduct model play.

3.7.1 The Factors of METT-T and OCOKA. The mission training factors of METT-T (mission, enemy, terrain, troops, and time) and OCOKA (observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach) are used at all levels within the military to develop operational plans. METT-T is used by leaders to examine and develop a method for accomplishing their mission. All of the factors of METT-T are examined as to how they relate to the overall

mission. The missions from higher headquarters and supporting units are examined to determine all of the required or implied tasks. The execution of the mission is balanced against a description of the enemy, his strength, capabilities and intentions. The leader also evaluates his own troops both qualitatively and quantitatively for any effect they may have on the accomplishment of the mission. The terrain is evaluated for its support or lack of support for the mission, and finally, the leader must be aware of the time available to prepare and execute his mission.

The leader examines terrain with the help of an acronym called OCOKA. This acronym provides a methodology for determining the military aspects of the terrain and its impact on the mission. The qualities and characteristics of the terrain play an important role in the success or failure of a mission. The ability to see or be seen is examined under the term observation. Cover or protection from battlefield effects and concealment or protection from battlefield observation are examined under cover and concealment. The planner determines the natural or man made obstacles to his plan and any key terrain which might effect the operation. Key terrain is terrain that is advantageous to either side to control. Avenues of approach describe potential paths that forces can take into the battle area.

3.7.2 The Principles of War. In the conduct of war, there are several concepts whose mastery and understanding are crucial to the success of the fighting forces. The concepts are called the principles of war and represent warfare in their most general form. The principles were adapted from the works of British Major General J. F. C. Fuller who developed them as a result of World War I (8:173). A description of the components and their meanings is shown in table 2.

3.7.3 The Tenets of Airland Battle Doctrine. The tenets of Airland Battle Doctrine represent the U.S. Army's current approach to fighting. The tenets are derived from and supportive of the principles of war and consist of the factors of; agility, initiative, synchronization, and depth. Initiative concerns the retaining of

Table 2. Description of the Principles of War

Principles of War	Description
Objective	The goal of every operation must be attainable and clearly defined.
Offensive	Commanders must work to ensure they, "seize, retain, and exploit the initiative" (7:173).
Mass	The sum total of the combat power must be brought to bear to the right place at the right time.
Economy of Force	Place the minimum necessary combat power to lower priority areas.
Maneuver	Use the mobility of ones forces to place the enemy at a disadvantage.
Unity of Command	Ensure that there is an overall commander to direct the efforts against a particular objective.
Security	Prevent the enemy from gaining an unexpected advantage.
Surprise	Attack where and when the enemy least expects it.
Simplicity	Develop clear and concise orders to prevent misunderstandings.

(7:173–177)

a freedom of action while denying the enemy the same, supported through long range thinking and contingency planning. Agility represents the ability to react to a variety of situations quicker and more efficiently then the enemy. Depth deals with the concept of looking beyond the immediate area of operations to all areas that could influence battle actions Synchronization means the process of combining all of ones combat power at the decisive place and time to provide the maximum effect (7:15–18).

3.7.4 General Characteristics. The general characteristics of the models concerned issues that affect the use of the model as a training device. These issues were the resolution level of the game, the learning time, the playing time, and the quality

of the documentation. All of these issues were interrelated and affected the training value of the models. An explanation of the terms is listed below.

- Resolution level: The military level at which action takes place in the model.
- Learning Time: The length of time required to read, understand, and become comfortable with the rules and the play of the model.
- Playing Time: The length of time required to play a standard scenario.
- Documentation: The quality of the documentation as it affects the play of the model.

3.8 Summary

The development of an approach to the research provided a guide for the investigation and analysis of the selected models. The starting point and groundwork for this study revolved around the battle of Gettysburg. Before the investigation of any models could begin, an understanding of the historical battle of Gettysburg and the combatants was necessary.

IV. The Battle of Gettysburg

4.1 Introduction

In the spring of 1863, the South was riding high from the success of General Lee's victory at Chancellorsville. General Lee saw an opportunity to strike a decisive blow to the Union and argued for an invasion of the north. Lee believed that the South had more to gain by concentrating her efforts in the northeast instead of the west. The advantages of taking the war north were compelling. A campaign in the north would relieve the hardships of military campaigning on the southern people, allow the military to take advantage of the rich, fertile countryside of the Cumberland Valley, and provide an opportunity for the southern army to win a great victory on northern territory. A great victory would increase the possibility of international recognition and assistance, and could provide the catalyst for a negotiated peace with the north (9:225-228).

For the north, there was an air of confusion and disappointment. Major General Hooker, the Commanding General of the Army of the Potomac who had reorganized and molded the army into a capable fighting force, had personally performed miserably at Chancellorsville. Despite an overwhelming number of forces, Hooker had allowed the Confederates to outmaneuver and outfight his forces. The Union army which had retreated across the Rappahannock River, northeast of Fredericksburg, sat in defensive positions awaiting General Lee's next move (3:31,33,34).

On the third of June, unbeknownst to the Union army, General Lee made his move, and started shifting his forces west and moving his army northward. It was these maneuvers which began a series of events that climaxed in a desperate bloody struggle near the small Pennsylvania town of Gettysburg.

4.2 Environment

The environment and the characteristics of the battle of Gettysburg were important factors in understanding the battle. These characteristics were the major terrain features, the dimensions of the battlefield, and the time sense of the engagements (16:32).

With a population of 2400 people, Gettysburg was a typical agricultural town in central Pennsylvania and except for the fact that several major roads intersected there, it was no different from hundreds of other Pennsylvania towns in 1863 (3:128,265). Three of the nine roads, the Chambersburg, Baltimore, and York, that converged on Gettysburg were all weather, durable pikes, capable of providing year round transportation (3:265). Parallel to the Chambersburg Pike ran an unfinished railroad cut (3:264–266). The surrounding area of Gettysburg consisted of rolling terrain with small hills, long ridges, and open fields: characteristics well suited for military operations. The network of roads and open fields could support large troop movements and the maneuvering and deployment of forces, while the hills and ridges provided ideal defensive terrain (3:265). A general overview of the Gettysburg area is illustrated in figure 1.

4.2.1 Description of the Gettysburg Terrain. The battlefield was dominated by several pieces of terrain that served as reference points for the battle as well as playing an important role in the battle. A series of five north-south running ridges dominated the terrain in the area of Gettysburg. West of town there were Herr, McPherson's, Seminary, and Oak Ridges, and south of town stretched Cemetery Ridge. An examination of these features was important for an complete understanding of the battle flow.

Herr Ridge lay furthest west, about two miles from the center of town and was the highest of the three ridges rising approximately 600 feet. A mile west of town at an elevation of 560 feet was McPherson's Ridge consisting of two crests 1000 feet

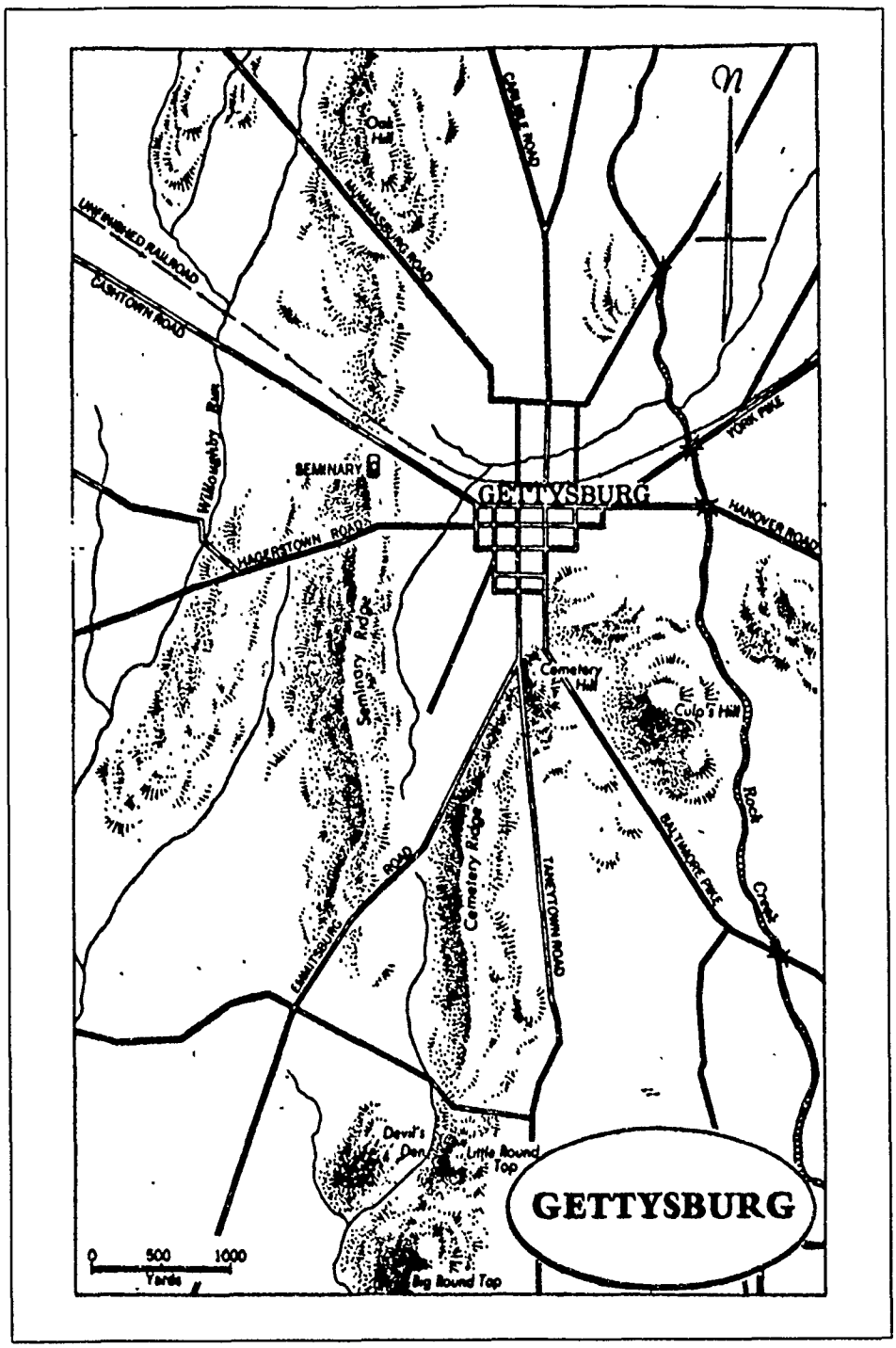

Figure 1. The Gettysburg Area circa 1863
Reprinted from (27:39)

apart. The crests joined in the center of the ridge in a wooded area called Herbst Woods. Along the ridge's western edge ran a small creek called Willoughby Run. Approximately three-fourths of a mile west of the town was Seminary Ridge with an elevation of 560 feet at its crest. Connecting with Seminary Ridge north of town and running due north was Oak Ridge at an elevation of 640 feet (3:266,300).

Cemetery Hill, a half mile south of town, stood around 630 feet and was flat topped and relatively clear of woods. Cemetery Ridge ran south from Cemetery Hill for about two miles before slowly tapering off in elevation. Cemetery Ridge rose slightly above the pastures and fields that lay to the west. At the southern edge of Cemetery Ridge sat two hills and a low lying area called Big and Little Round Tops and Devil's Den respectively. Big Round Top at 790 feet was taller, steeper, and the more heavily wooded of the two hills. Little Round Top, at 670 feet, was about one-half mile northeast of Big Round Top. Between the hills lay a rugged, wooded area strewn with boulders called Devil's Den (3:330-331).

Other terrain features of interest were Oak Hill, Blocher's (now Barlow) Knoll, and Rock Creek north of town. Oak Hill lay north of Mummasburg Road about a mile north of town. Blocher's Knoll sat west of the Heidlersburg Road at an elevation of 520 feet (23:658). In the south, east of Culp's Hill ran Rock Creek. Culp's Hill stood a half mile to the east of Cemetery Hill at 630 feet and contained steep and heavily wooded slopes (3:330).

4.2.2 Battlefield Dimensions. During the battle of Gettysburg, there were five separate but related engagements over the three days. In the north, fighting raged from Herr Ridge in the west to approximately 2.4 miles east to Rock Creek. In the south, the battlefield stretched for about a mile between Emmitsburg Pike and the Round Tops. From north to south, fighting raged from the intersection of the Baltimore and Emmitsburg Pike to Big Round Top in the south: approximately 2.4 miles in length.

4.2.3 Battle Times. The battle of Gettysburg is commonly accepted to have begun around 0800 hours on 1 July and ended 2 days later on 3 July around 1600 hours. On the first of July, fighting occurred from 0800–1130 hours when Union and Confederate forces first clashed in the vicinity of Herr Ridge. The forces later engaged in fighting from 1430–1600 hours west and north of town. On the second of July, combat raged from 1600–2100 hours in the south, and later from 1930–2100 in the north in the vicinity of Culp's Hill. There was early yet inconsequential fighting from 0500–1100 hours in the Culp's Hill area on the third of July, but the major fighting occurred later in the day. The major fighting began with a preliminary bombardment of the Union lines, lasting from 1300–1500 hours, and was followed by General Longstreet's Confederate assault from 1530 hours till 1600 hrs (3).

4.3 Order of Battle

The two armies moving toward each other in late June had survived the pounding of two years of intense and bloody combat. As the leaders had changed and evolved, so had the organizations they commanded. During the Civil War era, the three major fighting components of an army were infantry, artillery, and cavalry units. Despite differences in pure numbers and quality of equipment, the two armies were nearly evenly matched (3:259).

4.3.1 The Army of the Potomac. Before Chancellorsville, Major General Hooker instituted a series of reforms and reorganizations designed to improve the efficiency and fighting spirit of the Union Army (3:26–31). Despite its defeat at Chancellorsville, the army was still a formidable opponent consisting of seven infantry corps, a cavalry corps, and an artillery reserve with a total battle strength of around 85,500 men (3:249–250). A diagram of the major units and their commanders is illustrated in figure 2.

The infantry corps consisted of 51 infantry brigades with each brigade made up of between 4–5 regiments and totaling between 1000–2000 men (3:244–245). However, by 1863 the effects of fighting and poor personnel policies had reduced the numbers and strengths of the regiments such that very few were near full strength (3:41). Two-thirds of the infantry regiments carried Enfield or Springfield muzzle-loading rifled muskets that were deadly at ranges up to 500 yards (3:252,257). The remaining regiments were equipped with smoothbore muskets or a mixture of rifled and smoothbore weapons (3:257). Smoothbore muskets had a considerably lower range then the rifled muskets and were viewed as third-rate weapons (3:256).

The Cavalry Corps had much improved since the beginning of the war and possessed top quality equipment. The Corps had proven its fighting qualities before the Gettysburg campaign when it had seriously threatened the Confederate cavalry at the battle of Brandy Station on the 8th of June (3:65). The Cavalry Corps was equipped with the breech-loading Sharps carbine or Spencer repeating rifles. The advantages of these weapons were the higher rates of fire and the ability of the marksman to stay concealed while reloading (3:258).

During the Civil War, the king of the battlefield was the artillery. The artillery was organized into an Army artillery reserve of 5 brigades, 1 brigade per Infantry Corps, and 2 brigades for the Cavalry Corps (3:41). The preferred gun was the Napoleon, a smoothbore muzzle-loading weapon with an effective range of 1200 yards but deadly at closer ranges against infantry. The other field guns had rifled tubes that gave them longer ranges, and were primarily used for counterbattery fire (3:250-251). Counterbattery fire was a tactic of identifying and targeting the enemy's artillery instead of its troops. The Union artillery was composed of 65 batteries of six guns each, and brought with them between 364-374 guns to the battle of Gettysburg (3:244).

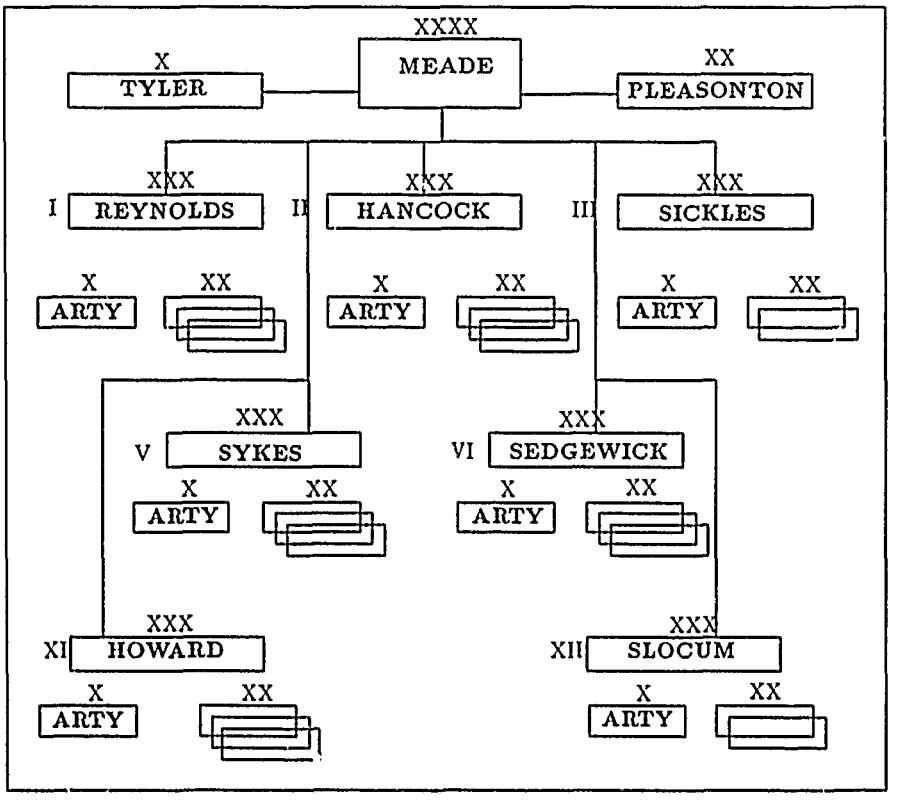

Figure 2. Union Order of Battle

Developed from (3:575-587)

4.3.2 The Army of Northern Virginia. The Army of Northern Virginia was a veteran, seasoned, and confidant fighting force that marched northward toward certain victory (3:23-25). After the battle of Chancellorsville and the death of General Stonewall Jackson, Lee reorganized his army into three infantry corps and a cavalry division (3:11-13). The artillery units were reorganized and placed under the command and control of the corps and division commanders. The strength of the Confederate army was now around 75,000 men (3:249-250). A diagram of the major units and their commanders is illustrated in figure 3.

The infantry corps were broken into three divisions with four to five brigades to each division. The Confederates brought 37 brigades with strengths of between 1000-2000 soldiers each northward to Gettysburg (3:245). The majority of the soldier were equipped with the Springfield or Enfield rifles while the remainder were equipped with smoothbore muskets (3:252).

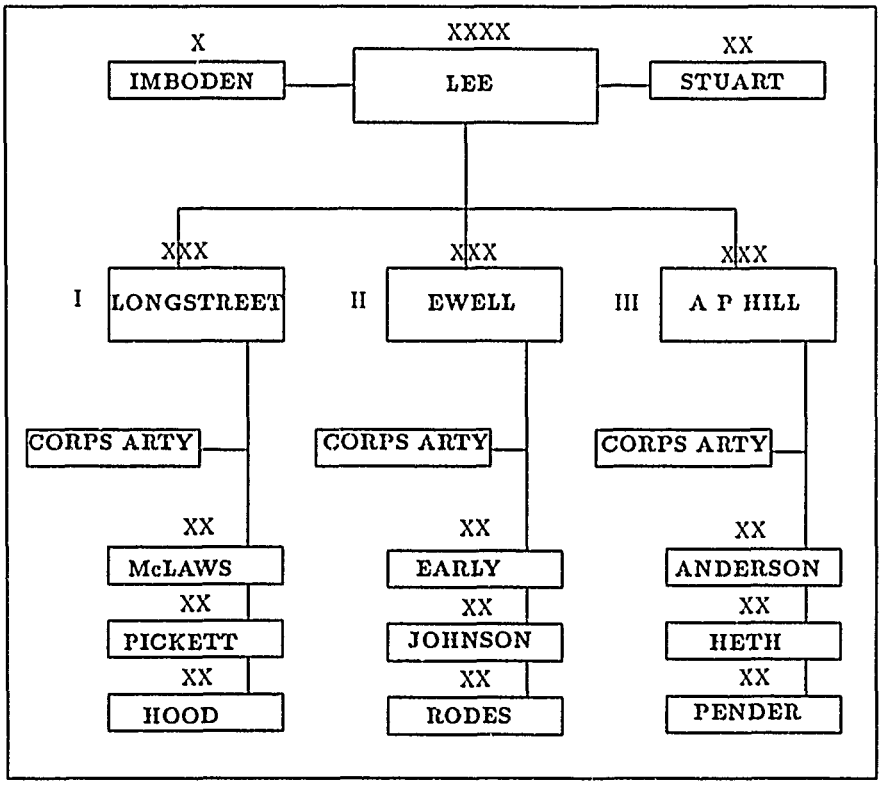

Figure 3. Confederate Order of Battle
Developed from (3:587-595)

The Confederate cavalry was still a formidable force despite its disadvantage in equipment and weapons in comparison to the Union cavalry. Their most serious deficiencies were a lack of carbines and quality horses (3:16-17,258-259). Both of these deficiencies affected the firepower and efficiency of the cavalry.

The artillery equipment was comparable to the Union artillery except in organization. The Confederate army did not maintain an artillery reserve. Instead, the

artillery was organized into brigades of 5 battalions under the control of the Corps Commanders. Each division was assigned a battalion with two in reserve (3:13). The Confederate mixed types of cannons in their batteries which ranged from 4-6 guns. At Gettysburg the overall army count of guns was between 272 and 281 (3:244). The deficiencies of the Confederate artillery were its mixed caliber gun batteries and the high percentage of defective ammunition (3:14). The mixture of caliber weapons became a logistical nightmare, and the defective ammunition impacted directly on the artillery's combat effectiveness.

4.4 The Battle

By 30 June, both General Lee and Major General Meade, who replaced Hooker as the Union commander two days earlier, felt that a clash of their forces near Gettysburg was imminent. Both commanders began concentrating their forces in that general area (3:260-261). Figure 4 illustrates the general situation as of 30 June.

4.4.1 1 July 1863. On the afternoon of 30 June, Brigadier General Buford, the commander of the 1st Division, Union Cavalry Corps, occupied the town of Gettysburg with two brigades. Buford deployed his cavalry to cover the northern and western approaches to town establishing a Union skirmish line to guard against a Confederate approach. He now awaited the arrival of the vanguard of the Army of the Potomac on the first of July. The vanguard under the command of Major General Reynolds consisted of three units: Reynolds' I Corps, Sickles' III Corps and Howard's XI Corps (3:261).

For the Confederate troops of Brigadier General Heth's Division of Lieutenant General A. P. Hill Corps, 1 July started early as they marched off at 0500 hours toward Gettysburg. The first shot of the battle of Gettysburg began when Heth's troops encountered Buford's skirmish line around 0800 hours (3:266-267). The Union

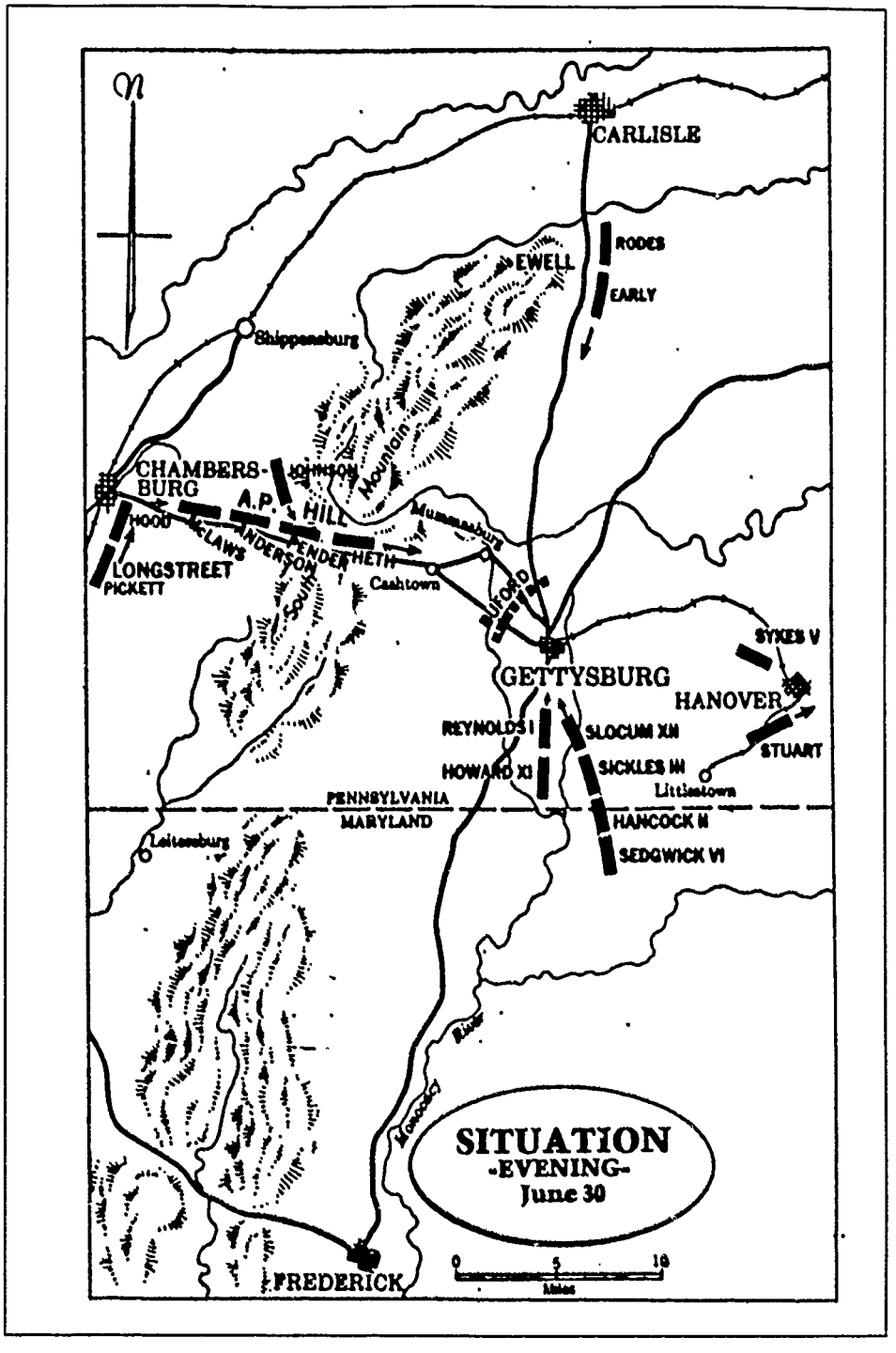

Figure 4. Relative Positions of the Major Forces on 30 June
Reprinted from (27:69)

troops slowly fell back under the pressure of the advancing Confederates. By 0900 hours, the Union cavalrymen had been pushed back to McPherson's Ridge where the fighting continued (3:266). Major General Reynolds arrived on McPherson's Ridge around 1000 hours to confer with Buford about the situation. Reynolds made the decision to hold the ridge against the enemy and sent staff officers back to hurry up the lead elements of his forces. The lead element of the vanguard, first Division/I Corps, was still approximately 30 minutes away from arriving on the battlefield (3:266,267).

Around 1030 hours, the Confederates of Heth's Division moved against the forces on McPherson's Ridge attacking north and south of Chambersburg Pike. Elements of the Union's First Division, having just deployed, met the attackers. The ensuring fight raged back and forth along the ridge for over an hour with both sides inflicting substantial casualties. Surprised by the nasty welcome and the stiff resistance, the Confederates withdrew to Herr Ridge around noon to regroup (3:267-272, 274). Figure 5 depicts the deployment of forces around 1100 hours.

During the next few hours, both Armies realigned and reorganized their forces. By 1200 hours, the remaining Divisions of Reynold's I Corps arrived and were emplaced along Seminary and McPherson's Ridges, northeast to Mummasburg Road (3:279). Howard's XI Corps continued moving north toward town. Around 1230 hours, Union cavalrymen reported a Confederate force moving south toward Gettysburg along the Carlisle Road. This force was the Divisions of Major General Rodes and Major General Early of Lieutenant General Ewell's Corps (3:282).

The Union XI Corps reached Gettysburg around 1300 hours. Their commander, Major General Howard, became the ranking officer on the field due to the death of Major General Reynolds earlier in the day on McPherson's Ridge. Howard placed the Second Division, XI Corps upon Cemetery Hill as a reserve force and moved the remaining divisions north of town to meet the threat of Ewell's Corps. The XI Corps under the temporary command of Major General Schurz established positions north

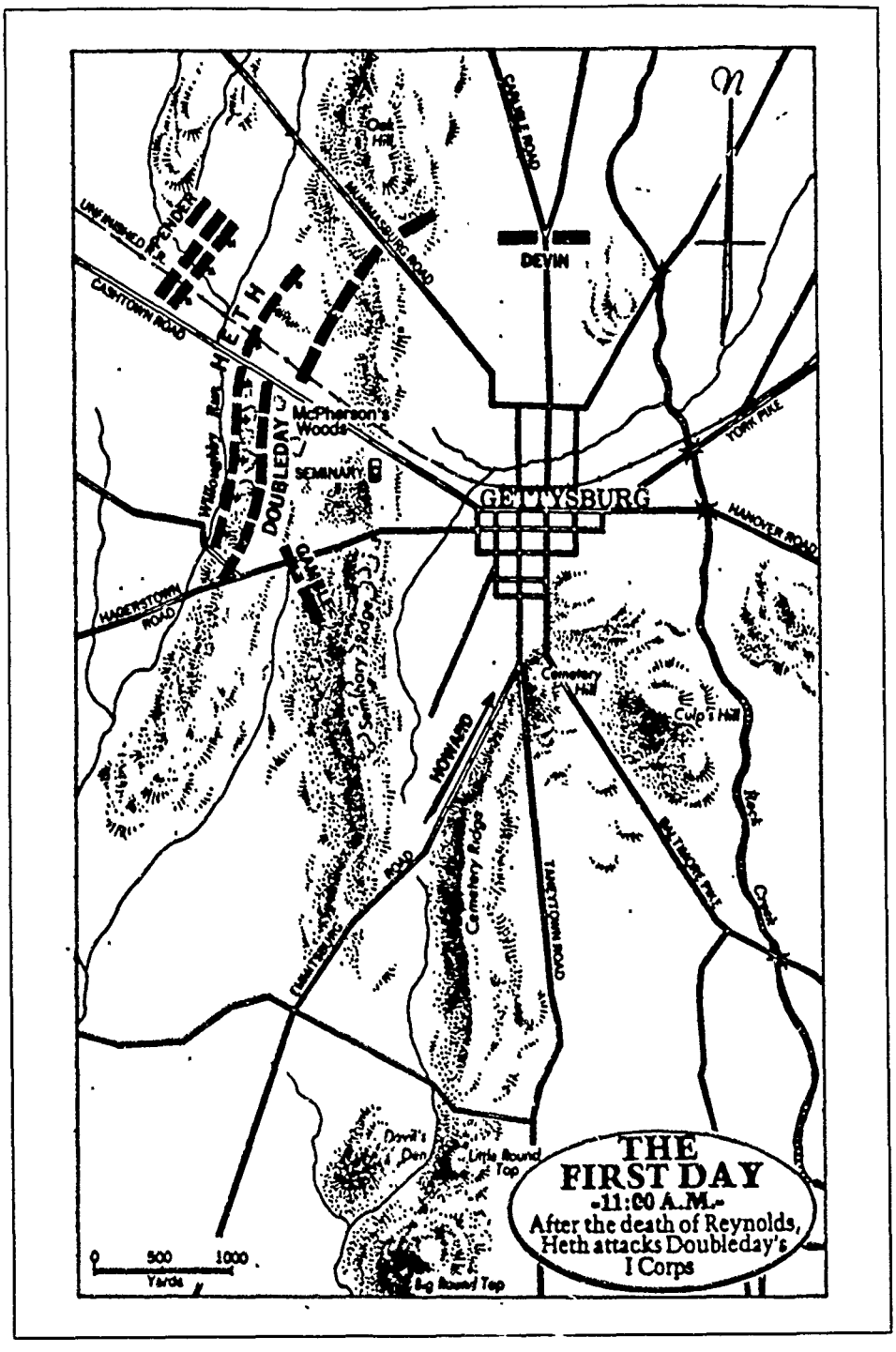

Figure 5. Placement of Forces at 1100 hours 1 July
Reprinted from (27:98)

of town by 1400 hours (3:279–280). The Union lines now ran from west to north of town in a three mile semi-circle. Figure 6 illustrates the deployment of forces as of 1500 hours.

Fighting broke out again around 1430 hours as elements of Rodes' Division attacked I Corps positions along the Mummasburg Road. As Rodes' Division became engaged, Heth renewed his attack upon McPherson's Ridge. Around 1500 hours, Early's Divisions attacked XI Corps and succceded in turning their right flank. As the Confederate pressure mounted on the Union positions, the Union units began to waver and give way. The first to fall back was the XI Corps. Due to the retreat of XI Corps, the right flank of I Corps was left unprotected and they too withdrew through the town of Gettysburg while being pursued by the Confederates. By 1600 hours, Union forces were scrambling into the reserve positions on Cemetery Hill. The Confederates meanwhile were reorganizing, taking prisoners, and deciding on their next move (3:286–294). As darkness set in, day one of the battle of Gettysburg had come to a close. The final disposition of forces at the end of the day are shown in figure 7.

The fighting on the first day was fierce and determined but the battle had just begun. Both forces spent the last hours of the first of July and the early hours of the second moving troops and re-formulating plans. Meade spent the evening receiving and sending reports to his various Corps to insure the concentration of Union forces at Gettysburg (3:325–327). Lee conferred with his leaders in examining the situation and discussing his battle plans but his intent was simply stated: "If the enemy is there tomorrow, we must attack him" (3:361).

4.4.2 2 July 1863. Upon his arrival at Gettysburg, Meade reconnoitered the battle area and indicated general battle positions for each of his Corps (3:330). The Union defensive positions were arranged in a fishhook fashion stretching from Culp's Hill around and down along Cemetery Ridge. The Union positions favored

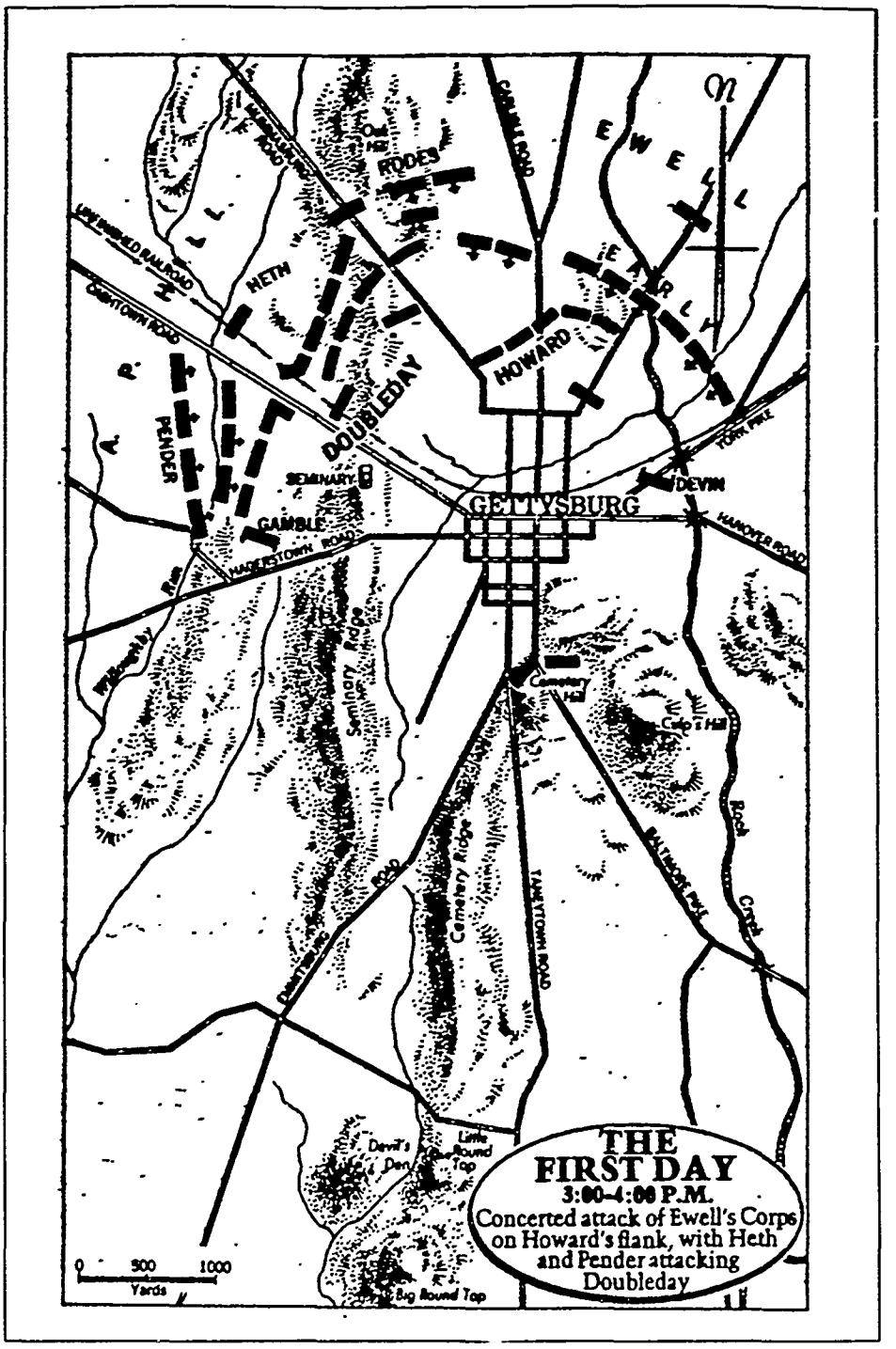

Figure 6. Force Deployment as of 1500 hours 1 July
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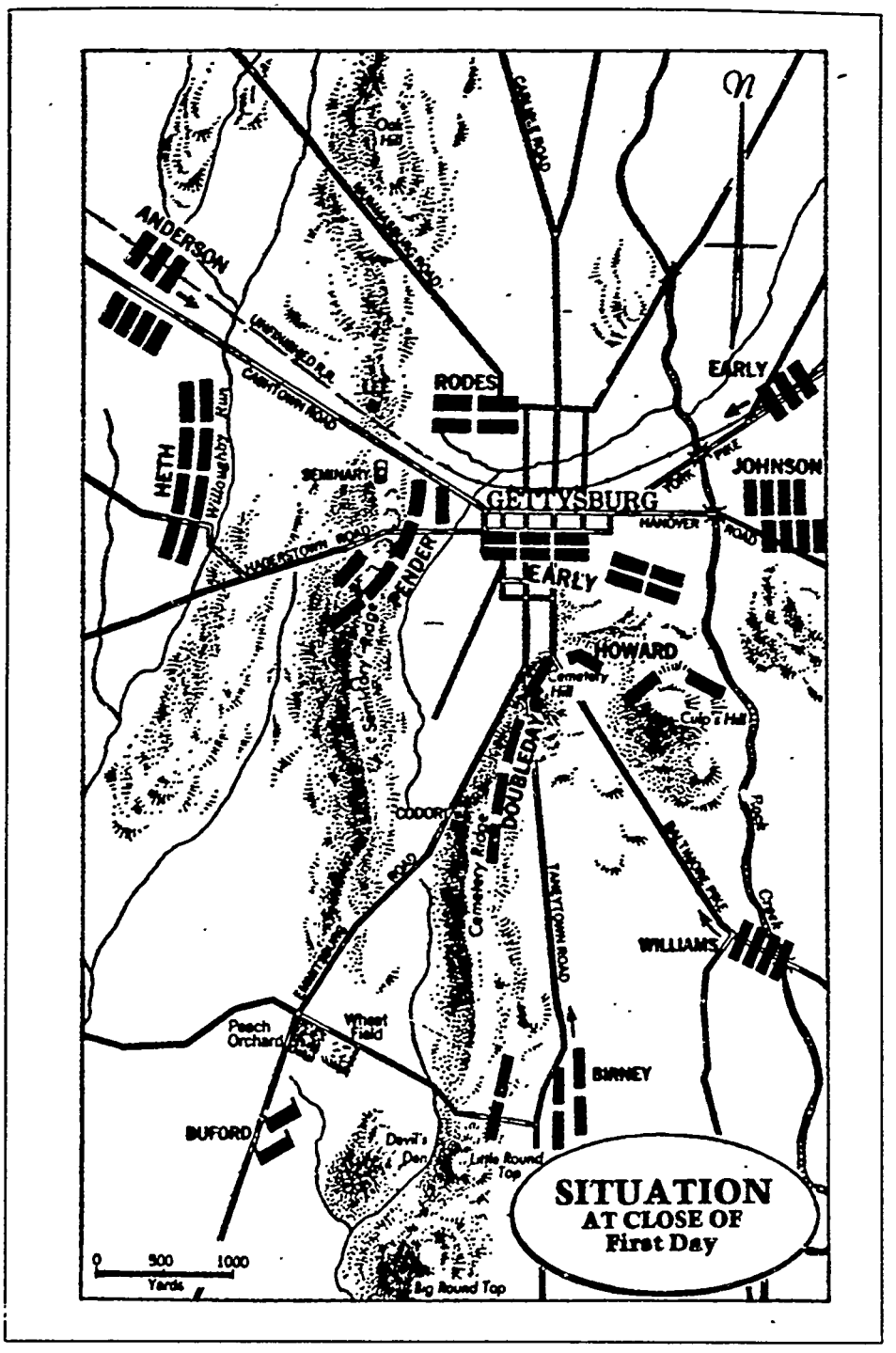

Figure 7. General Situation as of 1800 hours 1 July
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a determined defender and provided excellent fields of fire for artillery against any attacking infantry. Another advantage of the positions was their proximity with each other. Troops could easily be shifted from one flank to another depending on the situation. Meade spent the rest of the morning and early afternoon attending to the many tasks required to get his army prepared for the coming battle (3:332–333).

After further discussions with his leaders, Lee decided to attack the Union left flank with Longstreet's Corps and to tie up Union forces elsewhere by conducting demonstrations along the Union lines with his two other Corps. Hill's Corps was positioned against the center of the Union lines while Ewell's Corps was situated in the north against the Union's right flank. Ewell's Corps was also given a mission to be ready to conduct a full attack if an opportunity presented itself (3:383–384). Lee spent the remainder of the day awaiting the sound of Longstreet's attack on the Union left flank. Lee's plan was ambitious, requiring coordination among an army whose units were stretched out over three miles from left to right flank (3:354).

As Longstreet maneuvered his forces toward the Union left flank, Major General Sickles Union III Corps was destroying the integrity of Meade's defensive plans by moving forward to occupy positions along the Emmitsburg pike south to Devil's Den. The immediate deficiency of Sickles' position was his exposed flanks to Confederate fire and the thinly held line of defending soldiers (3:355). With the gaps left in the Union's defensive line and the weight of the oncoming Confederate attack, the battle in the south would prove to be difficult, bloody, and critical throughout the day. Figure 8 depicts the arrangement of forces at the start of the Confederate attack.

At 1600 hours an artillery barrage crashed against the troops of III Corps as the Divisions of Major Generals McLaws and Hood attacked across the open areas toward Devil's Den (3:385–386). As the Confederates attacked, it became clear that Sickles left flank was threatened. The key to Sickles' left flank and of the entire Union Army's position was Little Round Top (3:388). With luck and skill, Union

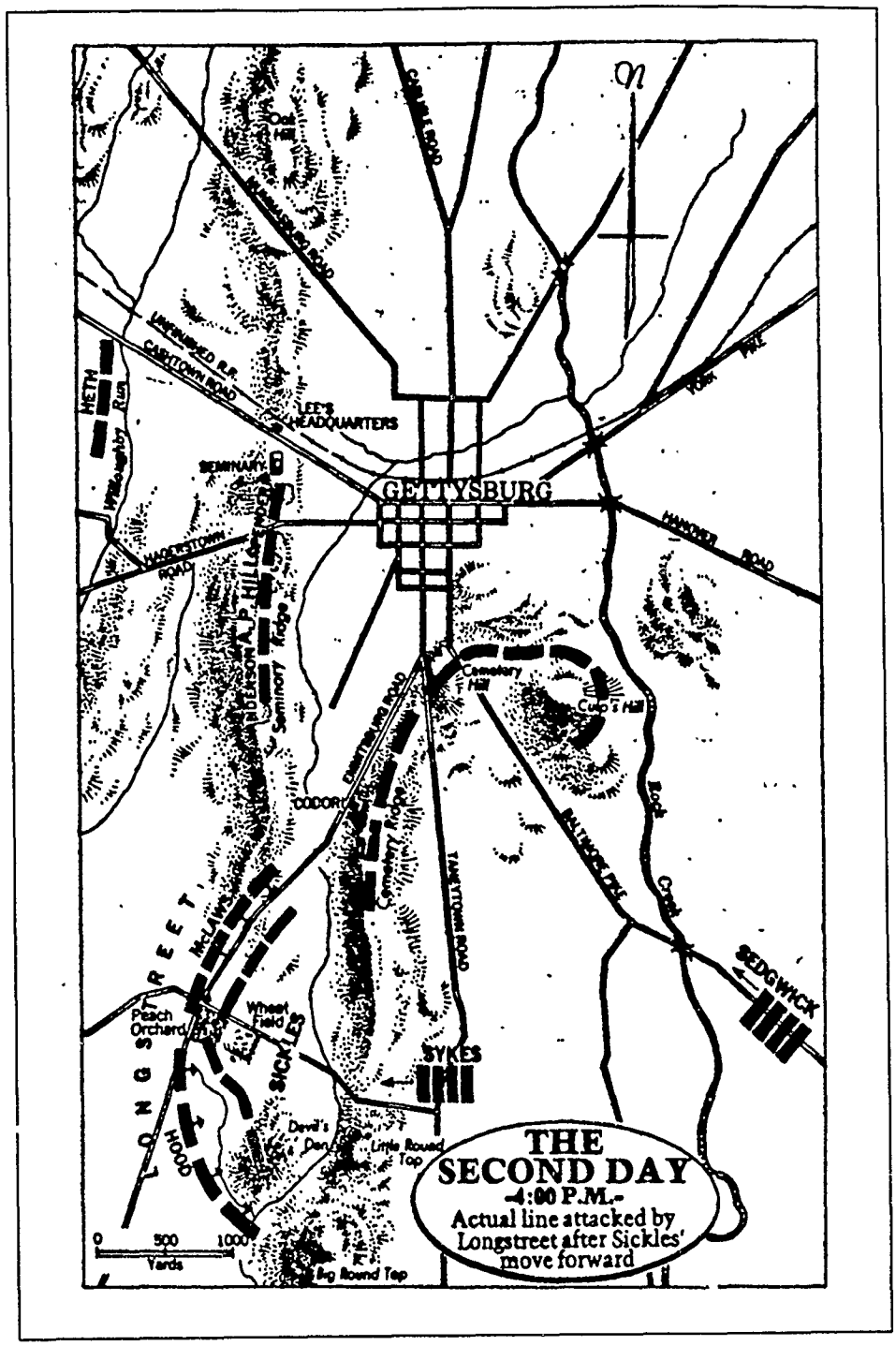

Figure 8. General Situation at 1600 hours 2 July
Reprinted from (27:202)

elements arrived on Little Round Top and were able to hold the ground before the Confederate forces could gain a foothold. During the ensuring combat actions, Union forces were able to repel the Confederate attack in that area and eventually solidified the Union left flank (3:389-394).

While the left flank stood firm, the center of the Union line began to waver under the pressure of the Confederate attacks (3:396). The weaknesses of the position required Meade to send reinforcements immediately. Major General Sykes' V Corps were sent into the battle at critical points in an attempt to hold the line (3:400). The intense fighting in this area consisted of attacks and counterattacks as both sides fought to gain an advantage. The final blow occurred around 1815 hours as the Brigades of McLaws' Division attacked the center of the Union line on the northern edge of Cemetery Ridge near the Peach Orchard, splitting the Union lines and driving them back onto Cemetery Ridge (3:420). Despite courageous and ferocious attacks for over three hours, the Confederates forces were still faced with the task of piercing the line of troops and reinforcements that had arrived to bolster the main Union defensive lines. The reinforcements and the effort of the lead elements of the Union VI Corps convinced the Confederates to fall back and prepare to fight on the next day (3:409-410).

Meanwhile, Hill's Confederate III Corps action in the center against Hancock's Union II Corps was proving to be an uncoordinated and unsuccessful attack. As McClaws' Division moved against the Union position, Anderson's Division of Hill's Corps was ordered to move forward against the Union lines, thereby taking advantage of McClaws' initial success (3:420). Three of the five brigades attacked in line and fought fiercely but could not hold onto any ground previously gained. The ability of Hancock to move forces to critical areas prevented a breakthrough and forced the Confederates back across the Emmitsburg Road (3:425-426).

The final crisis of the second day of July was Ewell's attack in the north on Cemetery and Culp's Hill. In a remarkable case of coordination, Ewell's artillery

opened up at 1600 hours just as Longstreet began his attack on the Union left flank (3:427). Unfortunately, the actual assaults did not begin until 1930 hours, well after the crisis in the other areas had subsided, depriving Lee of any advantages of tying up Union troops in the north. Early's Division of Ewell's Corps attacked the elements of XIth Corps on Cemetery Hill and gained a foothold before being driven off by Union counterattacks. A hesitancy to renew the attack in darkness saved the Union position from anymore combat (3:435). Johnson's Division of the Confederate II Corps moved against the steep slopes and the protected defenders of Culp's Hill and by 2300 hours was able to gain a foothold on the slopes of the hill (3:431,435).

After seven hours of fighting, the Confederates had inflicted serious casualties upon the Union forces but had not thrown them from the field. The situation at the end of the day is shown in figure 9. The ability of the Union commanders to shift forces had overcome the deficiencies of the III Corps position and the Confederates' ferocious attacks. By the end of the day, both sides were exhausted. The Confederates were pondering their next move while the Union stood ready for whatever the morning brought.

4.4.3 3 July 1863. The third of July started amid much preparation for the forces on the battlefield. Lee, a fighting man, was not ready to give up the fight and prepared to assemble an overwhelming infantry force for one more chance to punch through his enemy's lines. Meade correctly guessed that his center, consisting of Hancock's II Corps and parts of I Corps, would bear the brunt this attack (2:61).

Lee's plan was to strike the Union center with supporting attacks against Culp's Hill and the Union rear (2:67). The attack on the Union center was spearheaded by Pickett's fresh Division with other Confederate Divisions assisting. The point of attack was "the clump of trees" that marked the center of the Union lines. An intense artillery barrage designed to weaken the Union lines of infantry and artillery would precede and later support the attack (2:67,73). Also supporting the attack

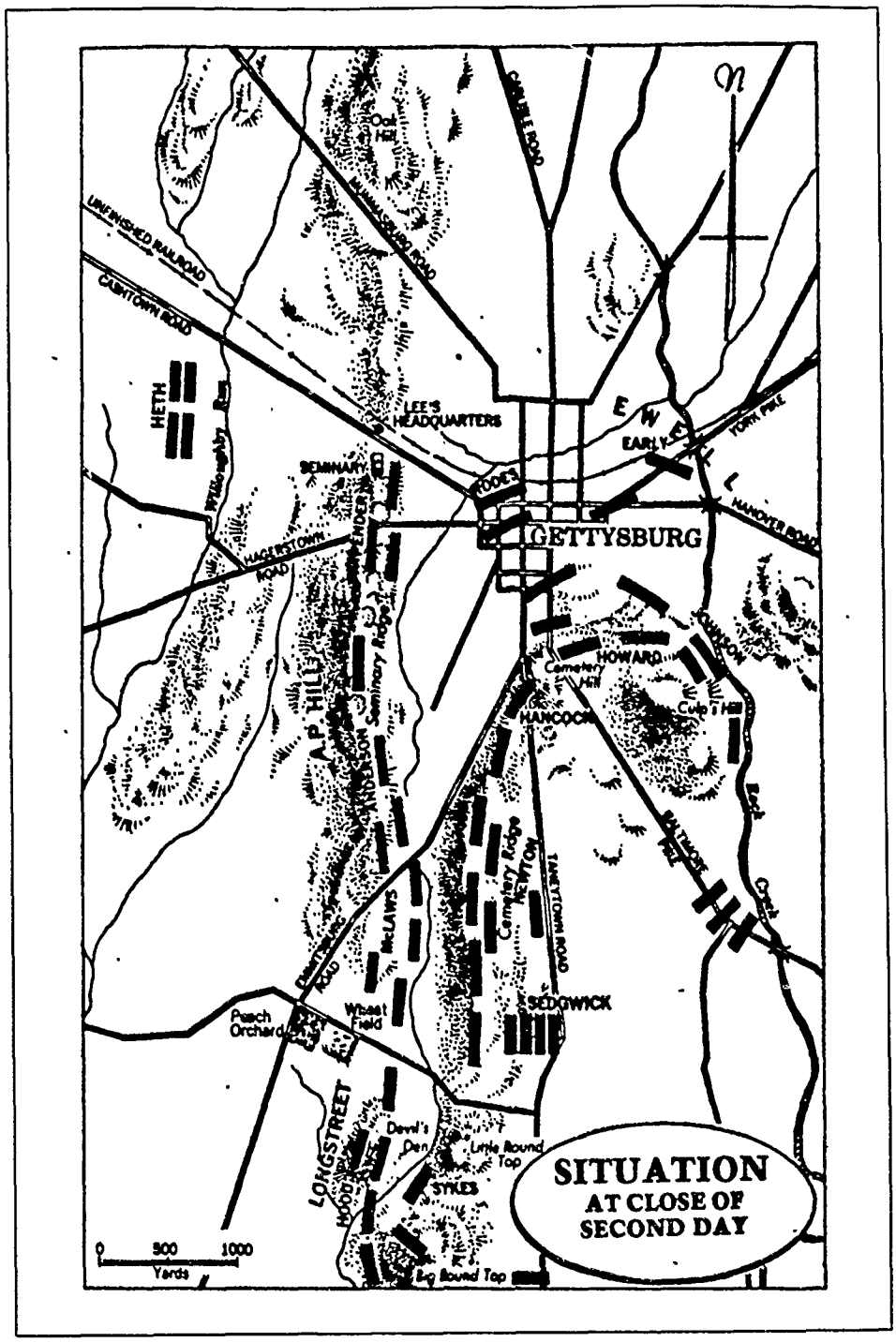

Figure 9. General Situation as of 2300 hours 2 July
Reprinted from (27:271)

in the center would be Ewell's renewed assault on the Unions northern positions on Culp's Hill and Stuart's cavalry assault on the Union rear (2:73).

Ewell's forces renewed their attack on Culp's Hill at daylight against the strong and fortified Union positions. Despite their difficulties, the Confederates continued to push their attack until finally they were forced to withdraw around 1100 hours (2:74). Stuart's attempt to get to the Union rear and disrupt activities was thwarted by Union cavalry. The fighting consisted of the two cavalry units engaged in charges and counter charges until around 1500 hours with little results (3:522-523). During all this activity, the start of the attack in the center was awaiting the formation of the 11 assault brigades of 13,500 infantry whose target was the 5500 men of the two Union Divisions of Gibbon's and Hay's Corps (3:462-463,476). Lee's coordinated plan would result in not three attacks against the Union lines but one final heroic charge.

The climatic attack of the battle of Gettysburg began at 1300 hours with a tremendous Confederate artillery barrage. On this hot, hazy summer day, many of the Union soldiers were resting and trying to relax when the barrage began. Though the barrage from 159 guns was impressive, it failed to achieve its objective of weakening the Union infantry and artillery units before the start of the Confederates' assault. The general plan for Confederate attack is depicted in figure 10.

In response to the Confederate barrage, Major General Hunt, the Union army chief of artillery, ordered his batteries to conserve their ammunition for the upcoming infantry assault. The weak response of the Union artillery gave the Confederates the mistaken impression that their barrage had succeeded. This belief coupled with the circumstance of dwindling supplies of artillery ammunition, forced the Confederates to attack (3:498-501).

At 1500 hours, Pettigrew's Division in the north and Pickett's Division in the south marched out toward the Union lines. As the Confederate forces moved across the open field in parade ground precision, the Union artillery opened up and began

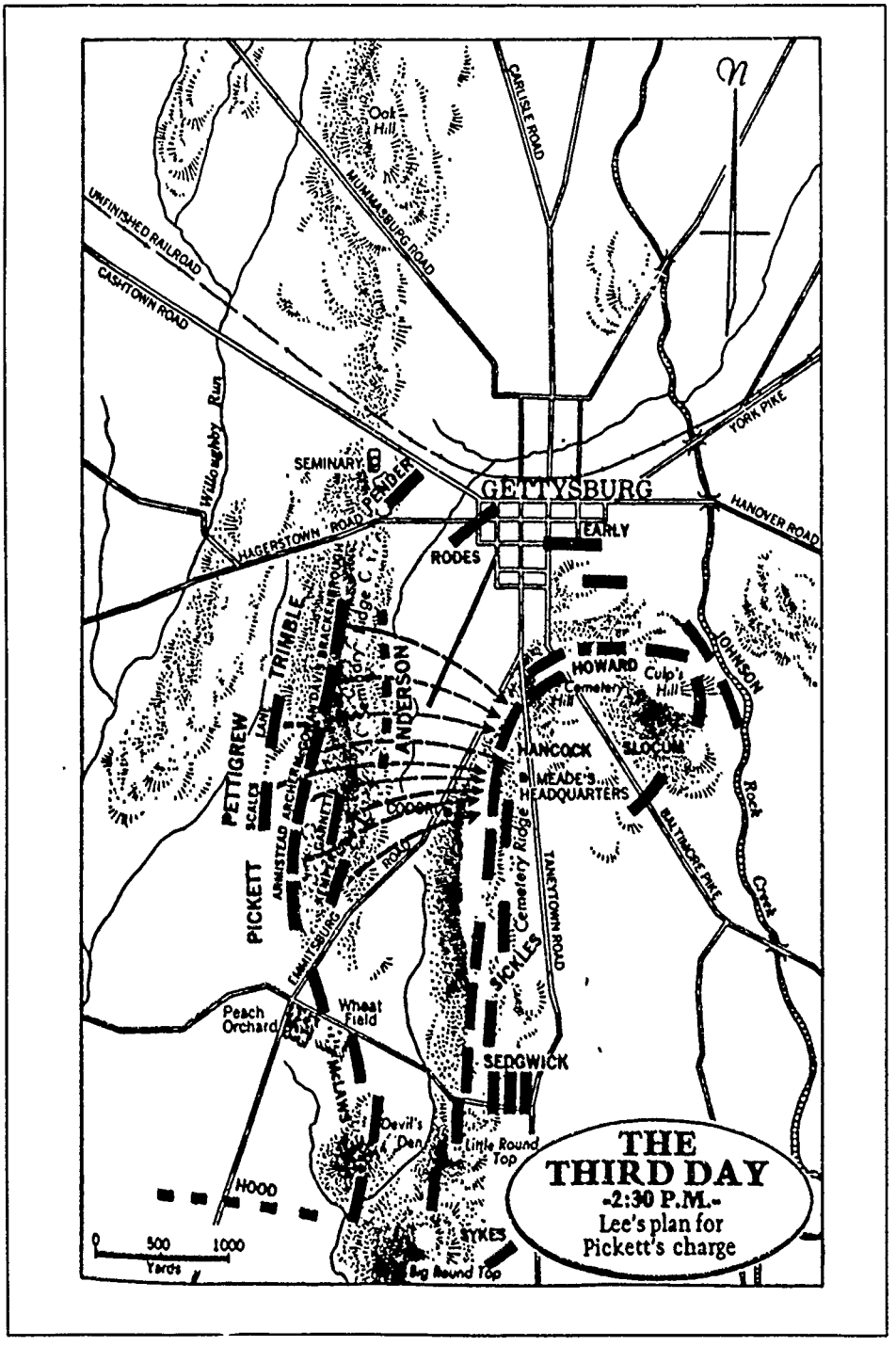

Figure 10. Confederate Attack 1600 hours 3 July
Reprinted from (27:287)

to exact a fearful toll. With the Confederate infantry approaching in formation, the Union troops were able to rake the flanks of the attackers. Despite the damage to their flanks and the carnage of artillery exploding into their ranks, the Confederates continued to focus on the "clump of trees". The Confederates, through a valiant effort, reached the Union lines and were able to breach them momentarily but had no strength to exploit their initial success. Union reinforcements continued to arrive and by 1600 hours, the survivors of what became known as "Picketts Charge" were either retreating or surrendering. The "clump of trees" marking the furthest Confederate penetration and became known as the high water mark of the Confederacy.

Realizing the magnitude of the defeat and the need to be prepared for a potential Union counterattack, Lee, Longstreet, and other officers began the tasks of preparing defensive positions. Lee personally rode down to meet the remnants of the Confederate attack while Longstreet and others, regrouped and repositioned units. Despite the magnitude of their losses, the Confederate army was still strong in spirit and by 1700 hours was ready for anything the Union chose to throw at them (3:526-527).

The Union army was occupied with its own problems recovering from the attack and collecting wounded and prisoners of war. Meade rode to the front to determine a sense of the battle and issued orders for pickets and skirmishers to move forward to probe the enemy for a possible counterattack. Despite these preliminary moves, no attack developed prior to the approach of darkness (3:532,534).

4.4.4 The Aftermath. Not only did an attack not occur in the late afternoon of the third but neither did it occur on the fourth. As Lee waited in defensive positions, Meade tended to his own army and its needs and made no offensive moves toward the enemy. Having decided to retreat back to Virginia, Lee started his retreat toward crossing points on the Potomac on the night of the 4th of July. After numerous entreaties and inquiries from Washington Meade moved out in pursuit

of Lee's army. Lee however, conducted a skillful campaign as he moved his forces toward the Potomac and was able to escape unmolested across the river on the 14th of July. The Gettysburg campaign had ended (3:535-561).

The Gettysburg campaign may have ended but the war would continue for another year. Lee's army had been defeated with a high cost of casualties. The loss of 20,451 men could not be easily replaced in the manpower short South (3:536). For the Union, the 23,049 casualties were greater but the North was better able to absorb such losses (3:541). As a result of the battle of Gettysburg, the South never again had the strength to conduct an offensive war and any hope of foreign recognition or a negotiated peace was lost. For the Union, Gettysburg represented a great victory but the North still awaited the genius of another commander to finish what had begun at Gettysburg.

V. *An Investigation of Gettysburg*

With a firm understanding of the historical account of the battle, the research began with an investigation of the model *Gettysburg.* This model was chosen because of its general approach to the historical event, and presented an opportunity for an initial investigation of the battle and the basic concepts of combat modeling.

5.1 Overview of Gettysburg

Gettysburg was produced by The Avalon Hill Game Company in 1988 and was designed for players ages 12 and up. Two players functioned simultaneously as the Army, Corps, and Division commanders of the Union and Confederate forces while moving and controlling counters. Game turns represented 120 minutes of real time and consisted of a movement and combat phase with the Confederate player always moving first.

Five different scenarios were provided with the model representing different events in the battle. The scenarios depicted each of the individual days of the battle, the fighting on the second and third of July, and a grand scenario of the entire historical battle. Information for setting up and controlling the scenario was provided through a historical background on the battle, a description of the combat status of each of unit, and a listing of the required victory conditions. Victory conditions were based upon objective and casualty points. Objective points were awarded through the controlling of key terrain such as Little Round Top or Cemetery Hill. Casualty victory points were awarded through the attrition of enemy forces (20:3).

5.1.1 Components. The components of the model were a 14 by 11 inch battle board depicting the battle area, 82 counters for playing and controlling the game, and two 10 sided die (30). A breakdown of the basic counters is shown in table 3.

Table 3. Counter Breakdown for *Gettysburg*

Type	CSA	USA
Infantry Divisions	9	19
Artillery Brigade/Battalions	7	14
Cavalry Brigade	7	8
General	5	13
Total	28	54

The battle board presented a one dimensional picture of the area which was adequate for the moving and controlling of the game pieces. The battle board consisted of hexes representing approximately 700 yards of terrain from center hex to center hex. Each of the hexes were lettered and numbered to allow for the movement and tracking of units. Terrain was represented in a general sense with only the most prominent features shown on the map. Wooded areas, rough hills, roads, and streams were shown on the map as well as historically relevant areas like the Peach Orchard or the Wheatfield. The lack of terrain detail and the amount of ground covered in a hex increased the difficulty of using the battle map in a precise representation of the historical events.

The model provided 82 counters for the play and control of the game. The combat units of infantry, artillery, and cavalry were represented as divisions, battalions/brigades, and brigades respectively. These counters were aggregated to represent the level of fighting which the combat units engaged in at Gettysburg (30). Army and Corps commanders were represented with general counters. Additional markers were provided for optional rules and the control of the game. Counter information consisted of unit identification, movement and combat factors, parent organization, and entry turn onto the board. General counters portrayed the same information as the combat markers except for the combat factor.

Unit identification was represented by a symbol, the name of the historical commander, and the number of the higher headquarters. The symbols used to represent the infantry, cavalry, and artillery were an Army flag, a cavalry pennant, and a cannon silhouette respectively. Unit commanders were listed by their name and the number of their higher Corps. Combat factors were a number representing an aggregation of the unit's historical strength, quality, morale, leadership, and armament of the unit (30). A change in a unit's combat factor was represented by the flipping of the counter. The backside of a counter listed the identical information as the front except for the different combat factor. The backside represented a loss of unit strength due to combat. The movement factors indicated the number of hexes a unit could move per turn. A unit's entry turn onto the board was also listed on the counter.

5.1.2 Rules. The rules associated with *Gettysburg* were of a basic design to compliment the level of aggregation of the terrain and counters while still attempting to maintain a reasonable historical accuracy of the game. The two major rules of *Gettysburg* dealt with movement and combat of forces. The rules concerning combat were slanted in favor of the defender as an examination of the combat resolution process indicates. A description of the rules with respect to the battle operating systems is listed in table 4.

During combat resolution, the combat modifiers and the adjudication of combat results favored the defender. The defender gained modifiers to his combat factor based upon his location during combat. The modifiers applied only to the defender, provided that the attacker was not co-located in identical terrain,. If the two units were in the same features, no modifiers applied. Resolution of combat was decided by the difference between the sum of the two unit's combat factors, modifiers, and die roll. Ties were decided in favor of the defender which increased his chances of winning the combat to 55% with a ten sided die. As a comparison, a six sided die would cause the percentage to jump to 58%. Based upon the weight of the com-

Table 4. Battle Operating Systems in *Gettysburg*

Battle Operating System	Description
Maneuver	Basic system allowing for the adequate movement of forces in the model.
Command and Control	Exercised through movement of forces and general counters. General counters affect the stacking and moving of forces.
Fire Support	Limited to direct fire. Optional rule increases range but only for counterbattery fire.
Intelligence	No specific mechanisms: open intelligence for both sides.
Mobility/ Survivability	Mobility of forces dependent on movement and terrain factors. Survivability based upon combat modifiers.
CSS	No specific mechanisms: optional rule allows for reorganization of units after eight turns.

bat modifier given to the defender, the use of a 10 sided die lessened the defender's advantage and gave the attacker an incentive to attack.

Maneuver

Units maneuvered at the cost of movement factors which were effected by terrain and enemy zones of control. Zones of control represented the hexes surrounding an enemy counter for 360 degrees. A unit's movement stopped when it entered a

enemy's zone of control. The standard cost of moving into a hex was one movement point with additional costs dependent upon the terrain and the enemy. The terrain characteristics of roads, woods, streams, and rough hills added additional movement costs as did enemy controlled hexes.

A general investigation of the infantry movement rates in the model provided insight into the accuracy of the game's movement factors. An ideal planning factor for an infantry unit moving on a road was 2.5 miles per hour (22) which equated to 8800 yards per two hour turn in the model. Each infantry division had 5 movement

factors per turn and could therefore, move a total of 10 hexes along a road in one turn. This value of 7000 yards was less than the historical numbers but an acceptable number given the aggregated level of the game and the many factors that could affect movement rates.

Command and Control

Gettysburg provided only very basic mechanisms to replicate the command and control of units. Units were controlled through their movement factors. General markers could be used to provide additional benefits to combat units. General markers allowed two units to stack within a hex and provided an additional movement factor to the stack (20). The influence of a general marker represented the effects of a general officer on movement and organization of units.

There were two optional rules dealing with command and control. One rule restricted general units from stacking with any units but their own. This restricted the command authority of their leadership. Initiative was portrayed in the model but only with respect to combat results. Players could use an initiative marker to re-roll for combat results if they did not like the original roll. The initiative marker alternated between players (20:23,26).

Fire Support

Fire support was portrayed in the model with artillery acting as a direct fire weapon. To engage enemy infantry, artillery had to move into their zone of control which brought the full weight of an infantry unit against the artillery unit. This provided an unfair advantage to the infantry. Typically, the stronger infantry units possessed a three or four combat factor advantage over the artillery unit which resulted in the destruction of the artillery unit with no damage to the infantry. An optional rule permitted artillery to increase their range to two hexes but only for the purpose of firing against other artillery targets. This counterbattery fire was subject to the constraints of line of sight to the target.

Intelligence

There were no mechanisms or rules governing the control of information in the model. Intelligence is this model was complete and two sided. Both players had the same opportunity to observe the disposition and strengths of his opponent's forces and the potential arrival of reinforcements. There was no mechanism to allow for deception of one's intentions or to create any level of uncertainty in the model concerning the opponent's actions.

Mobility and Survivability

The model did not provide any rules or address the issues of the construction of obstacles or any other characteristics which would affect the mobility or survivability of forces. The mobility of units was dependent upon their movement factors and the terrain. Survivability was depicted with combat modifiers for advantages to the use of hills or woods as defensive measures. Any other level of protection against enemy fire was not depicted at this level of aggregation.

Combat Service Support

Combat logistics was not a factor nor was it portrayed in the game. Personnel was aggregated into the combat factors of each unit which were affected by combat. An optional rule allowed for the reorganization of units whereby a unit regained full strength. However, the unit was required to be immobile for eight complete turns before reorganization could be accomplished (20:25).

5.2 Model Play

With an understanding of the components and rules of the war game, an examination and investigation of one of the scenarios could begin. The scenario representing the entire battle was chosen because it provided the greatest opportunity to experience the full power of the model. The basic nature of the model allowed for the

entire scenario to be played within a reasonable amount of time while investigating various issues and determining strengths and weaknesses of the model.

Two issues that affected model play were the stacking of units and zones of control. Zones of control in this model represented the entire number of hexes that surrounded a unit. When a unit entered an enemy zone of control, all movement stopped and combat occurred. The model did not make any accommodation for the front, rear, or flanks of units. A unit defended or attacked in a 360 degree circle. Due to this design decision, there was no possibility to flank or surprise a unit from the rear. To bring combat power to bear on a unit required the enemy to move forces within the enemy's zone of control and stack elements. The stacking of units allowed for the concentration of combat power around the target, especially when lower rated artillery units were involved but could only be accomplished with the a general counter.

5.2.1 Strengths of Gettysburg. The strengths of *Gettysburg* were a function of its basic nature. The war game was able to portray information concerning battle actions in a straightforward manner, while the quick, uncomplicated nature of the model play provided a good introduction to the battle and modeling concepts.

The basic play of the model was supported by the aggregation of the units and the terrain and model turns that consisted of only a movement and a combat phase. The rules supported this level of play by addressing only basic concepts which allowed for quick and uncomplicated play. *Gettysburg* provided an excellent introduction into basic modeling concepts of movement of counters, the use of combat modifiers, and the fighting combat units. Players experienced the model at a level that allowed them to fight the battle and learn about combat modeling concepts without becoming overwhelmed with too much detail. The experimentation with this model formed a good foundation for future work in combat modeling. The

amount of information concerning the historical battle and the modeling concepts needed to play the game were easily provided by the game documentation.

An example of the useful information provided by the model is shown in figure 11. The growth of the two armies' combat power onto the battlefield can easily be obtained through an examination of the order of arrival information of the two forces plotted against time. Figure 11 illustrates the growing strength of the Union army after the end of the first day (turn eight). This figure provided a visual picture of the battle in terms of the strengths of the armies and provided input into potential game strategies for each side.

5.2.2 Weaknesses of Gettysburg. The weaknesses of this model concerned the artillery play and the process of attrition. Within the model, the full weight of artillery was not represented because of the aggregation of the artillery units and the process of attrition. An artillery brigade or battalion represented enormous firepower on the battlefield, but this killing power could not be brought to bear against enemy units unless the artillery units stacked and surrounded the enemy. The stacking was necessary to offset the differences in combat factors between infantry and artillery units. Typically, the artillery units could not affect the strength of the enemy alone.

Attrition was conducted after a player's movement phase with the Confederate having the advantage of always attacking first. Attrition was a one-sided or "bloodless" type of combat. In this model, the winning side suffered no casualties while inflicting casualties on the enemy. As a result of combat a unit's strength could be one of three states: full, reduced, or zero (elimination). This was clearly unrealistic as actions during the battle of Gettysburg were bloody for both sides. As long as the die rolls were favorable, one side could decimate the other. Another problem with attrition concerned the resolution of combat. When a player attacked with more than one unit and lost, he was allowed to chose which unit suffered the attrition.

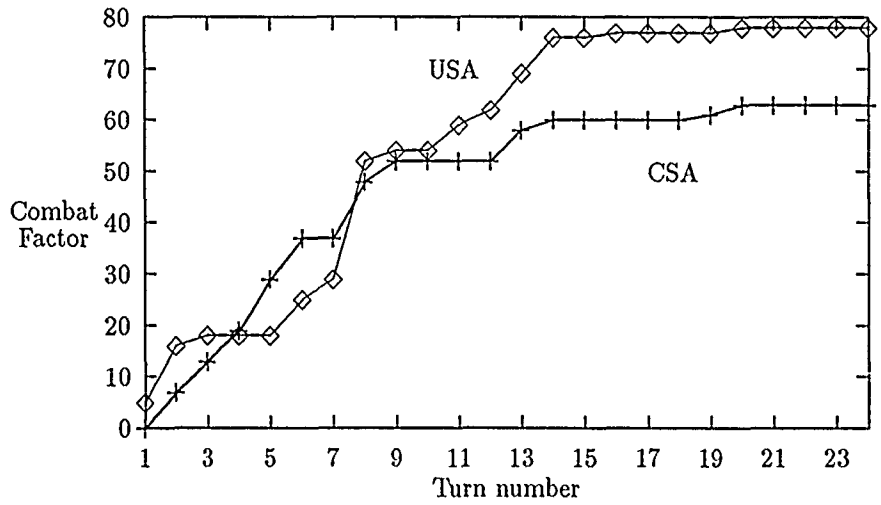

Figure 11. Comparison of Cumulative Combat Factor Growth over Time

All of the other units remained unaffected which allowed the attacker to conserve valuable infantry strength while sacrificing artillery units.

The results of the model play indicated the difficulty of producing accurate results with a model where all functions were treated in a basic manner. The aim of the model revolved more around determining a winner and loser than in providing detail to enable a recreation of the battle. The results of the play of the selected scenario are shown in figure 12. The figure illustrates the combat factor losses suffered by each side. The Union forces lost more strength points than the Confederates which generally agrees with history but the Confederates won the sample battle by seizing Big Round Top. The control of this key terrain gave the Confederates enough objective points to win the battle.

5.3 Results of the Investigation of Gettysburg

Gettysburg presented challenges to the leader in formulating and evaluating training. The model provided all the components to conduct battle planning or "what if" training but did not provide sufficient detail required for the training of

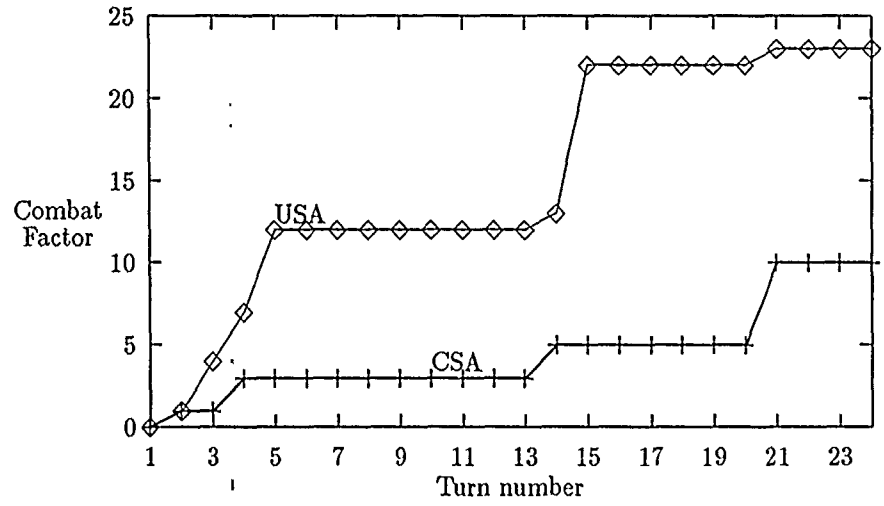

Figure 12. Comparison of Cumulative Combat Factor Loss over Time

specific concepts. Consequently, the value and quality of training with this model required an energetic, innovative leader.

5.3.1 The Factors of METT-T. Despite the general level of play of the model and the terrain, *Gettysburg* provided some benefits with respect to the explanation and training of the factors of METT-T. The depiction of the factors are listed in table 5. With all of the historical units represented in the model, a leader could organize different types of test armies for use in a battle scenario. Subordinates could be assigned command of the test armies and issued orders requiring them to develop and brief a battle plan using the factors of METT-T. The leader could also provide historical information concerning relevant factors of the battlefield and the combatants to enhance the value of the training evert.

By issuing an operational order, the leader would require his subordinates to evaluate the mission within a specific time using the board and the factors of METT-T. The components of the test armies would allow the subordinates to address the

Table 5. The Factors of METT-T in *Gettysburg*

METT-T	Evaluation
Mission	Battle map can be used as an area of operations for depicting a tactical situation requiring action.
Enemy	Counters could be used to depict an enemy force and used on the board.
Terrain	Instructive in a general sense for evaluating the impact on mission accomplishment.
Troops	Counters can be used to represent friendly troops available and characteristics.
Time	External criteria applied to the situation.
Overall Training Evaluation: FAIR	

issues of enemy and friendly troops and their impact upon mission accomplishment. The battle board could be used to discuss the terrain in general terms.

5.3.2 The Factors of OCOKA. The use of this model to evaluate and train the factors of OCOKA highlighted the difficulty with the aggregated terrain in the model. The terrain was not depicted in great detail primarily due to the level of the forces employed in the model. This lack of terrain detail made it extremely difficult to provide anything but an overview of the factors of OCOKA. The factors of key terrain and potential avenues of approach could be addressed, but the model was overall a poor aid to the training of OCOKA. The depiction of OCOKA in the model is shown in table 6.

5.3.3 The Principles of War. The training of the principles of war with this board game was challenging and required effort and imagination by the leader. Many of the concepts were represented in the model but the ability to exercise and train them was adversely affected by the general nature of the model. An evaluation of the concepts are illustrated in figure 7.

Table 6. The Factors of OCOKA in *Gettysburg*

OCOKA	Evaluation
Observation and Fields of Fire	Difficult to describe at aggregated level.
Cover and Concealment	Not portrayed or evaluated.
Obstacles	Not portrayed or evaluated.
Key Terrain	Depicted or marked on the battle map.
Avenues of Approach	Depicted only in a general sense.
Overall Training Evaluation: POOR	

Players in this model acted as Army, Corps, and Division commanders in executing their plans. This inherent unity of command focused forces toward an objective. The seizing of that objective required a simple plan as players could not afford to dissipate their forces throughout the board. To concentration forces in an area for an attack required the maneuvering of units and the use of small forces to defend lower priority areas. The lack of any intelligence function in the game made it difficult to portray the elements of security or surprise which demanded the use of simple and clear plans. The offensive nature of a player's plan depended upon which side they were playing and the number of forces available. The attrition process in the model also influenced the offensive nature of the plan. Winning units could continue to attack and push onward to the objective because they suffered no losses in this model. Overall, the model did a fair job in its ability to train the principles of war but was hindered by the model's lack of detail and basic approach to the battle.

5.3.4 The Tenets of Airland Battle. The training of the tenets of Airland Battle was also possible but only rated as fair due to the level of play in the model. This board game with its grouping of forces and action at the division level, and the limited scope of the terrain did not allow for a proper training of the tenets. An evaluation of the model and the tenets is listed in table 8.

Table 7. The Principles of War in *Gettysburg*

Principles of War	Evaluation
Objective	Players can designate an objective with their forces. Objective points indicate key areas.
Offensive	A function of the player's tenacity and mission plan
Mass	Player must work within stacking limitations and zones of control to mass combat power against enemy forces.
Economy of Force	A requirement because of the model's board size, movement factors, and the need to mass combat power.
Maneuver	Portrayed though movement factors.
Unity of Command	Player acts as Army, Corps, and Division commanders.
Security	No mechanism portrayed in the model.
Surprise	No mechanism portrayed in the model.
Simplicity	Model demands simple and straightforward plans.
Overall Training Evaluation: FAIR	

The only tenet that was addressed in detail was synchronization. Due to the stacking rule and the requirement to amass combat factors for a reasonable chance of combat success, a player was required to maneuver and arrange forces so that they would arrive at the designated point at the designated time. To accomplish this task required work and attention to the battle. However, the size of the battle board and the play of the model did not task or stress the other factors of agility, initiative, or depth. The action of the model and scope of the battlefield did not emphasize any of these factors and made it difficult to highlight or train on them.

5.3.5 Model Characteristics The war game *Gettysburg* was a basic model that emphasized the play of the model versus an intense level of detail. The resolution was at the division level which allowed players to easily learn and execute the model. With the emphasis on the play of the model, any reliance on this model to replicate historical events to determine results in anything but a general sense would be doomed. A general overview of the model's characteristics are listed in table 9.

Table 8. The Tenets of Airland Battle *Gettysburg*

Tenets	Evaluation
Agility	The relatively small number of counters did not place a large demand upon a player's reactions.
Initiative	Not depicted except in a gamesmanship role.
Depth	The small size of the battle board was not conducive to the exploitation of all actions.
Synchronization	Minor role due to aggregation level of the units.
Overall Training Evaluation: FAIR	

The learning time of the model was short due to its level of play and the basic nature of the rules. The time necessary to read the rule books and practice some of the typical situations could be easily accomplished within two hours. However, to become comfortable with the flow of the game required several readings and practices which could increase the learning time to four hours.

The playing time depended upon the scenario chosen but would generally last about 15-20 minutes per turn. With each of the day scenarios consisting of eight turns, an average playing time for a one day scenario would probable last around 120-160 minutes. This relatively quick playing time was a function of the model's aggregation level and the rule system.

The documentation of this model consisted of a rule sheet and a battle manual and was basic enough to explain the rules the rules and model play. The rule sheet was a two page sheet providing all the information necessary to play the war game. The information was presented in a clear, concise manner describing the components, the rules concerning movement and attrition, and other required information. The battle manual supplemented the rule sheet by providing background information on the combatants, their equipment, and their organizations. Each of the scenarios were presented describing the setup for each side. Designer hints and practical examples of rules were also provided to assist in the playing of the model.

Table 9. General Characteristics of *Gettysburg*

Characteristics	Evaluation
Resolution Level	Combat and maneuver conducted at the division level.
Learning time	A reading of the rules and an ability to conduct model play required 2-4 hours.
Playing time	Playing time average around 10-15 minutes per game turn.
Documentation	Basic but well written with designer hints and explanations of critical rules.

5.4 Summary

Gettysburg provide a basic tool for the investigation and introduction into the Civil War and modeling in general. However, the value of the model as a training tool was affected by this same basic approach to the subject area. To improve the training value of commercial combat models would require greater detail concerning the battle and the combat model. As the detail and complexity of the models increased, a similar increase in the user's knowledge of the historical event would be required. As the model's complexity increased, the learning and playing time of the model would also be affected. To offset any increase in these parameters and to increase the detail of the model, the research moved toward the investigation of computer simulations.

VI. An Investigation of the Universal Military Simulator I

Manual board games have existed for a long time, and the common thread to all of these games has been the requirement for the players to do all the work to make the actions occur on the board. As manual board games attempted to account for all the actions of warfare, the complexity and playing time of these games increased. The processes of moving the battle pieces, resolving combat, and other repetitious tasks became a detriment to the actual playing and fighting of the game. With the growth of computers and their relative low cost, the next logical step in wargaming was a move toward the use of computers to assist in the playing war games. The *Universal Military Simulator I* (*UMS I*) represents one of these computer war games.

6.1 Overview of Universal Military Simulator I

UMS I was developed by the Intergalactic Development Company in 1987 as a war game construction model and provides the components to simulate conflict on any terrain against any enemy (28:7). The model, designed for one or two players, allows players to construct scenarios dealing with forces of any size. The size of the force determined at which command level the players acted: platoon, battalion, or higher levels. Five simulations of historical battles were included in the model which served jointly as demonstration tools and programs that the user could play and modifier to their own needs. These simulations represented the battles of Arabela, Hastings, Marston Moor, Waterloo, and Gettysburg.

6.1.1 Components. Unlike a manual board game that consisted of counters, battle boards, dice, and other tools necessary to play the model, *UMS I* was organized around the creation and execution of scenarios. The four basic areas or components of *UMS I* were designing armies, designing maps, creating scenarios for the maps and armies, and finally, running scenarios.

6.1.1.1 Army Creation. To create armies, the model provided a template of 18 standard units and 6 wild card or spare units. The 18 standard units represented common units for each historical simulation plus templates for the creation of modern forces. Examples of the possible units were infantry, cavalry, armor, elephant, and pikemen. Wild card units allowed players to create their own units with their own characteristics.

The standard unit characteristics were name, strength, flag name, moves allowed, unit's speed, and efficiency rating. The name of the unit was an internal control measure that allowed the player to keep track of units. The flag name depicted the name of the unit as it appeared on the map. The strength of a unit merely represented the number of combatants. Unit movement was controlled by the maximum value set for moves per turn. Based upon the scale of the map, the player gave each unit a realistic value for the number of map boxes the unit could move in a turn. The speed of a unit was not related to the number of moves per turn and had no affect upon the play of the game or the unit (29). The efficiency of a unit related to the units' leadership qualities, experience, and other intangibles factors (29). Unit efficiency ratings were poor, average, crack, and elite. The creation of an army required a level of knowledge about the historical era and the participants to provide the inputs to the unit creations.

6.1.1.2 Map Creation. Maps in *UMS I* were represented as a large square consisting of many small boxes arranged and shaded to represent different terrain and elevations. The maps were displayed in three dimensions which added realism to the display. The maps provided with the simulation could be edited or new ones created to represent a specific area. The scale of the map was controlled by increasing or decreasing the amount of actual terrain depicted. The viewing of the map was controlled through a orientation and a zoom command. The orientation option allowed the user to observe the battlefield from the eight standard points of the compass. To observe a specific portion of the map in closer detail, the zoom

function could focus the viewing into a 10 by 10 box area. Both of these functions were important in the evaluation of terrain and the positioning of troops.

Specific maps could be designed using the model's map function. With the map function, the player could design maps with the specific features of woods, hills, ridges, depressions, and towns. Landmarks could be placed on a battle map to indicate an important area and impart a sense of orientation to the map. *UMS I* lacked the capability to depict roads, rivers, or other terrain feature which affected the detail of the created maps. In creating maps, the player could also use the random design feature where the computer randomly generated and dispersed standard terrain features on the map to create a battle area.

6.1.1.3 Scenario Creation. Once an army and a map had been designated, a scenario could be created. During the scenario creation, all of the factors that controlled the play of the game were selected. These factors included the start and end times, the length of game turns, the range variables, the accuracy variables, and the firepower scores. The final step in the scenario creation was to position the units of the two armies onto the battlefield.

The start and end times for the scenario represented the battle duration the player was interested in modeling. Game turns were divided into eight segments and the length of a game turn depended upon the time chosen for the segments. The time steps ranged from a minimum of a 1 minute increments to 99 minutes. Therefore, the minimum turn length was 8 minutes in duration.

There were three factors that affected combat in the model. These factors were the range value, accuracy variable, and the firepower value. Units that could fire long range weapons such as artillery or armor required a range value to be designated. The range value indicated the number of boxes the units could fire. The accuracy variable determined the upper and lower boundary for infantry and artillery combat. Accuracy represented the hit percentage of the firing unit on the enemy unit. A value

of 15-25 indicated that between 15% and 25% of the unit's firepower would hit its target (28:42). The killing power of weapons on the battlefield was represented by a firepower score with heavy infantry having a base value of 1.0 (28:25). In comparison, artillery's firepower value was 12.0. The range, accuracy, and firepower values were all adjustable to represent changing circumstances or scenarios.

6.1.1.4 Scenario Execution. This section consisted of a command and a combat phase. In the command phase, all units were issued commands indicating their future movement and status. The unit's future movement route was marked out on the map at a cost of some or all of the unit's movement points. The standard cost was one movement point for each segment of a map box traversed. Movement points were also affected by terrain and elevation with steep terrain requiring double the movement points of level terrain.

A unit's status represented its combat posture and the choices were maneuver, attack, defend, or reserve. The player placed a unit in a specific posture based upon his plans for that unit. The computer could also be used to issue commands to the units. A battle logic option within the model allowed the player to use the computer to command and control the forces on the board. Some of the command options were attack, defend, double envelopments, and flank attacks (28:16). The player could also allow the computer to decide the best strategy for each side.

Once commands were issued to the units, the combat phase began. During this phase of a game turn, the player had no influence on the actions or outcomes of the direct fire units. If the movement commands brought opposing units within 1 hex of each other then combat occurred and was resolved. For units that conducted ranged combat, the player was required to indicate the target for each unit. The player had the option to conduct ranged combat during each of the eight segments of a game turn.

At the end of each game turn, a preliminary casualty count was presented. Players could also investigate the strengths of their units by observing the order of battle information during the command phase of the next turn. A scenario continued until the end of the duration of the battle . At the end of a scenario, a final tally was presented. The start and end strengths of the opponents were presented with a subjective evaluation of the level of victory if any. These evaluations were marginal, minor, decisive, and a draw.

6.1.2 Rules. The next step to understanding the role of *UMS I* was an investigation of the rules that controlled the behavior and execution of the model. The framework for examining the rules was through the battle operating systems. An overall description of the rules as they apply to the battle operating system is listed in table 10.

Maneuver

Units maneuvered along the sides or the diagonal of a map box and the distance covered was controlled through the movement value assigned and the associated movement costs of the terrain. Maps in *UMS I* had two distinct factors that affected movement: elevation and woods. These two areas doubled the movement cost through them. Movement was also affected by the status of the units. Units in defense or reserve lost any remaining maneuver points while attacking units suffered a reduction of 25% in movement points. In response to combat, the losing unit retreated randomly along the box sides or diagonal at no cost of movement points until the unit was out of the range of the attacker.

Command and Control

The command and control of *UMS I* presented a basic system to allowed the movement of units and the execution of operational plans. Commands could be executed manually or through the model's battle logic system. All commands were received and executed without fail and with no associated time delay. The commands

Table 10. Battle Operation Systems in *UMS I*

Battle Operating System	Description
Maneuver	Basic with limited degradation for terrain.
Command and Control	Basic but allows for computer assistance. Does not model potential difficulties of C^2.
Fire Support	Functional and adequate in basic concept.
Intelligence	No mechanism except through gamesmanship.
Mobility/Survivability	Exists only due to terrain features.
CSS	Not depicted or evaluated.

were limited to movement and combat actions. Each command had a hidden effect on the unit's combat ability that was applied as multipliers during combat actions. A listing of the factors as a function of the unit's command are shown in table 11.

The status factors were applied during the resolution of combat between units to provide an adjustment to the weight of a unit's firepower. Units on the defensive, a stronger position then other possibilities, were given a weight of 1.75. Similarly, retreating or reserve units' firepower numbers were decreased by a factor of 1.33.

Fire Support

A basic fire support system existed in the model that allowed targets to be selected and fired upon with indirect or ranged weapons. The model possessed a line of sight option that could be toggled on and off to determine the effect of hills and ridges on artillery. Wooded areas in the model did not affect the line of sight of artillery. Artillery casualties were determined by the range of the target, the accuracy variable, and a random number draw. Fire support required human control in its targeting and firing as compared to the automatic nature of infantry combat.

Intelligence

There were no intelligence mechanisms built into the model to delay, confuse, or prevent the transfer of information between users. The user has total information

Table 11. Status Factors for Combat Resolution

Status	Factors
Maneuvering	$\div$ 1.33
Attacking	$*$ 1.33
On Defensive	$*$ 1.75
Retreating	$\div$ 1.33
Reserve	$\div$ 1.33

concerning the status of every combatant through an examination of the order of battle of the opponent.

Mobility/Survivability

The mobility of units was effected by the terrain and elevation but *UMS I* had no mechanisms to replicate survivability. A difference in terrain between units affected the factors involved in combat resolution, but units were not afforded any protection or additional factors from the woods or any man made features in the model.

Combat Service Support

Combat service support was not portrayed in this model. Units conducted their movements and combat actions without regard to logistics or personnel. Personnel were lost due to combat but there was no mechanism for allowing units to recover lost personnel.

6.2 Model Play

An examination of the Gettysburg scenario provided by the computer simulation showed that the scenario had numerous historical discrepancies and dealt only with the third day's battle. The discrepancies concerned the forces depicted in the scenario. The designer of the game had built the entire order of battle for both armies and placed them on the battlefield in the areas historically held by both

sides as of 3 July. The designer's description of the units were correct but not all the units in the game's scenario participated in the battle of 3 July. Elements that were decimated on 1 July were listed at full strength in the scenario. Due to the nature of the Gettysburg scenario, there were two choices: adjust the given scenario to conform to known fact or develop a new scenario depicting a different phase of the battle. The latter option possessed greater learning potential for the study and was adopted.

Selecting a portion of the battle to depict was difficult. There needed to be a balance between the complexity of the scenario and the time required to build and execute the scenario. Too basic of a scenario would not yield enough information while a complicated one would be time consuming and potentially cloud the evaluation of the game as a training device.

Each of the days of the battle were examined to determine which one would best fit the needs of the study. The battles of 2 and 3 July were dismissed because of the large number of units involved on both sides and the difficulty in determining an exact historical sequence of events. The battles during these days were fought at the brigade and regimental levels in fierce actions involving infantry skirmishing and artillery barrages. These facts would have increased the complexity of a scenario at any level of resolution. This left the battle of 1 July as an option. The fighting on the first day occurred both in the morning and in the afternoon. The morning fight was somewhat small and basic in the number of participants and tactics involved. The afternoon fight however, showed promise in its potential. There were a reasonable number of units involved and the issues of synchronization, command and control, maneuver, and others could all be examined.

Having chosen a particular event in the battle to depict in a scenario, there still existed a need to learn more about the workings and relationships of the model. Prior to the building of a 1 July scenario, effort was invested in the creating of a test scenario for the purpose of learning more about the model.

6.2.1 Test Scenario for UMS I. Before creating the test scenario, outside assistance for information concerning the simulation was obtained through the designer of the game. The designer was able to answer general questions but left many unanswered. The answers to these questions were to be found in a test scenario.

The test scenario consisted of various units placed on the Gettysburg map and fought against each other. The test units were infantry, cavalry, and artillery with various characteristics. Table 12 lists the units involved in the test scenario and their characteristics. The characteristics of the units, except for moves and speed, were taken from the simulation's army data bases representing the two opponents. The accuracy variable was left on the default values of 2–15 for infantry and 1–25 for artillery. The line of sight was toggled on and a scenario time frame and turn length of 30 minutes and 1 minute respectively were used to allow for sufficient experimentation with the units.

The moves and speed of the units were based upon historical investigation. A comparison of the Gettysburg scenario battlefield with operational maps provided an estimate of the scale of the Gettysburg map. Each box represented approximately 395 yards on the ground. With a historical rate of 2.5 miles per hour for infantry (22), an infantry unit should be capable of moving 11-12 boxes of straight line distance during one hour of game time. Artillery had a road speed of 5.0 miles per hour (4:73) but did not always maintain this speed cross country or when accompanying infantry. Therefore, the artillery movement rate was only slightly higher than the infantry units. Since the speed factor had no affect on the model play, reasonable values based upon historical research were used for demonstration purposes only.

Several trials were conducted to examine and determine the relationships and validity of the model's play. These trials consisted of typical actions that occurred during the battle of Gettysburg. These actions examined for all types of terrain were infantry versus infantry engagements, artillery versus artillery and infantry, and cavalry versus artillery and infantry. The test scenario provided a clearer understanding

Table 12. Description of Units for the Test Scenario

Name	Type	Strength	Efficiency	Moves	Speed	Firepower
CSA1	Heavy Infantry	1000	Average	4	2.5	1.0
USA1	Heavy Infantry	1000	Average	4	2.5	1.0
CSA2	Heavy Infantry	1000	Crack	4	2.5	1.0
USA2	Heavy Infantry	1000	Crack	4	2.5	1.0
CSA3	Heavy Artillery	1000	Average	5	5.0	12.0
USA3	Heavy Artillery	1000	Average	5	5.0	12.0
CSA4	Heavy Artillery	1000	Crack	5	5.0	12.0
USA4	Heavy Artillery	1000	Crack	5	5.0	12.0
Gamble	Heavy Cavalry	1000	Crack	6	5.0	1.5

of the model and how it approached certain processes. The first process of interest was the process of attrition.

6.2.1.1 Attrition. Attrition in this model was a linear relationship and a function of several factors. These factors were strength, elevation, weaponry, morale, status, efficiency, and accuracy. The process of attrition began with a unit's strength and factors were progressively applied to represent the killing power of that unit in a particular set of circumstances. Combat actions involving two or more units against a common target were resolved in a sequential process which negated the effects of massing combat power against an opponent. Additionally, there was no concept of flanks in the model and combat resolution was resolved as one unit against another. Table 13 depicts the attrition relationships and the example of a 1000 strength, crack efficiency heavy infantry unit of untried morale defending from a hill against some unknown target. With an accuracy figure of 2%, this unit would inflict 52 casualties on the enemy. Similarly, the other unit involved in this action would produce its own casualty figure. The winner of the engagement is the unit that inflicted the highest number of casualties. The procedure in table 13 was used in all combat engagements involving infantry and cavalry units. Artillery attrition was a function of the target's range, the artillery's firepower score, and a random number. The results of the test

Table 13. *UMS I* Attrition Relationships

Characteristic	Formula	Example
Strength	The numerical strength of the unit.	1000
Elevation	Strength ÷ .667 or 1 if there was no difference between the elevations of the units.	1500
Weaponry	Elevation * Firepower value	1500
Morale Morale Factor	Weaponry * Firepower Value * Morale factor Untried = 1, Poor = .55, Good = 1.45	1500
Status	Morale * Status of Unit (see table 11)	2625
Efficiency	Status or 1.55 * Status for crack unit	2625
Accuracy	Random number representing % of hits by the firing unit, drawn from accuracy parameters	2
Total	Accuracy * Efficiency	52.5

scenario provided indications about the importance of the attrition relationship in the play of the model.

In initial engagements between combatants, the strength of the unit and its status were the most important factors in determining the outcome of the engagement. In initial engagements, morale for both units was always untried and therefore, canceled out. Defending units possessed a 1.75 versus 1.33 force multiplier that normally was sufficient to defeat an attacking force despite their accuracy level. If the attacking unit was a crack efficiency unit against an average defender, the defender usually lost due to the attacker's additional 1.55 multiplier. Overall, the attrition process associated with attacking and defending forces made tactical sense. Generally, stronger and more efficient units should be able to defeat weaker and less efficient ones. However, combat is never that straightforward, and the simulation did not allow the player to change unit's morale state either before or after combat. With this ability, units could enter a battle in different morale states dependent upon past experiences, leadership, or a number of other factors.

In subsequent engagements between combatants, the crucial factor in determining winners and losers became the morale of the unit. After a unit's first en-

gagement, their morale changed to reflect the outcome of the fight (29). A winning unit's morale factor increased and the unit received the benefit of a 1.45 multiplier while a losing unit's morale factor decreased and suffered the effects of a 0.55 multiplier. Units could not change their morale status after initial engagements and a losing unit would continue to lose and retreat until annihilated. The momentum of the initial attack continued for the winning unit. This was not always the case in combat where units could break through enemy defenses but later be thrown back by reserves. On 2 July the Confederate gained footholds in the Union lines both in the south and the center of the lines but were repulsed by reserve troops.

An examination of the artillery in *UMS I* showed that it had enormous power and advantages due to the default firepower value of 12. Because of this advantage, artillery easily destroyed infantry units within one hex or 400 yards which was unrealistic. Historically, when artillery operated without infantry support, they suffered tremendous casualties (3:270). If the artillery did not break the charge of the assaulting infantry, they did not survive. In the test scenario, artillery could fire counterbattery against other artillery with reasonable results based upon range, firepower, and random numbers. The artillery in the model also had the ability to fire in and through woods with no adverse affect to the attrition values. The line of sight option in the model only applied against hills and ridges.

The test scenario illustrated that the model could replicate basic battlefield actions of command and control, movement, and attrition. The attrition process was clearly the most influential in the model and the many parameters involved required attention in order to maintain reasonable results. As a result of the information gained from the test scenario, a reasonable battle scenario of the events of the afternoon of 1 July could be built.

6.2.2 Battle Scenario. The first step in building the battle scenario was developing a battle chronology to highlight and clarify the historical actions. The

battle chronology provided a description of the events and interactions and assisted in the creation of the required units. The battle chronology is listed below.

Battle Chronology: 1 July

Time (hours)	Event
0500	Heth's Division of Hill's Corps with Pegram's Artillery Battalion departs for Gettysburg.
0800	Gamble reports a string of enemy force pushing in his pickets. He moves to defend Herr Ridge with 1600 men and one battery of horse artillery.
0800-0900	Fighting breaks out between Confederate skirmishers and Union cavalry.The Union forces retreat to McPherson's Ridge.
0800-0930	Reynold's I Corps and Howard's XI Corps, both under the operational command of Reynolds, depart Emmitsburg for Gettysburg. The order of march is 1st Division/I Corps, 2nd U S Maine artillery battery, 3rd Division/ I Corps followed by XI Corps.
1000	Reynolds and Buford, the Cavalry Division commander talk on McPherson's Ridge concerning the battle situation.
1030	1st Div/I Corps arrives and deploys along McPherson's Ridge.
1045	2nd U. S. Maine's battery opens up on Confederate artillery at a range of 1300 yards, forcing the Confederate guns to displace.
1030-1200	Union and Confederate forces clash on McPherson's Ridge. The Union defend with Culter's brigade along the RR cut and south of the pike and Meredith's brigade on the left wing of the ridge. The Confederates attack with Davis's brigade north of the road and Archer's south of the road. The Confederate units are repulsed with high casualties.
1100	Reynolds is killed and Doubleday takes command of I Corps.
1130	Howard arrives at Cemetery Hill and assumes overall command of the Union forces on the field.
1130	Heth's Division retreats to Herr Ridge (17:15).
1200	2nd and 3rd Divisions/I Corps arrive and deploy to McPherson's and Seminary Ridges. The approximate strength on McPherson's Ridge is 4586 men and on on Oak and Seminary Ridges approximately 3800.
1230-1430	Union and Confederate units engage in artillery duels and skirmishing along the lines west and northwest of Gettysburg (17:16,17).

1200	Howard turns over command of XI Corps to Schurz. 2nd Division/XI Corps with 3 batteries of artillery is placed on Cemetery Hill as a reserve force.
1230	Union cavalry reports an enemy force 3-4 miles north of town between the Heidlersburg Road and York Pike.
1300	1st and 3rd Division/XI Corps arrive and move north of town.
1330	Howard sends a message to V Corps to move forward and provide support.
1330	Hancock leaves Tanneytown to take command of forces on field.
1400	Howard sends situation report to Meade at Tanneytown, 13 miles away.
1400	1st and 3rd Divisions of XI Corps are set north of town with an approximate strength of 6000 men. Each division has a battery of artillery in support (Battery I, 1st Ohio Light and 13th NY light).
1400	Early's forces move south to attack XI Corps.
1400	Howard and Doubleday meet on McPherson's Ridge to discuss positions.
1430	Rodes attacks the right flank of I Corps with the brigades of Iverson and Daniel. Iverson's brigade is shattered while Daniel's is repulsed and regroups to renew the attack. O'Neal's brigade is in support while Doles' brigade skirmishes with left flank of XI Corps.
1430	Early's artillery battalion (12 guns) pours fire along the flanks of XI Corps lines from east of Heidlersburg Road.
1430-1500	Gordon's brigade of Early's division attacks Von Gilsa's Union brigade driving them from Blocher's (now Barlow's) Knoll.
1430-1500	Dole's brigade continues pressure upon Union lines.
1530-1545	Avery and Hays's brigades crash into the right flank of XI Corps (18:47). Doles's brigade begins counterattack and XI Corps breaks and begins falling back toward Gettysburg.
1430-1500	Pressure mounts all along Union lines. Heth's Division renews the attack against McPherson's Ridge with Pettigrew and Brockenbrough's brigades pushing back the defenders. Pender's division passes through Heth's to continue the attack and pursuit.
1530	McPherson's Ridge falls to the Confederate forces and the Union troops fall back to Seminary Ridge (17:24).
1530-1600	I and XI Corps lines are broken and the units retreat through town.
1530-1630	Union forces emplaced upon Cemetery Hill in defensive positions.
1600-1630	Hancock arrives on Cemetery Hill.

1730	Slocum's XII Corps arrives in the vicinity of Gettysburg.
1730-2400	Union and Confederate forces reinforce and consolidate.
	Information compiled from (3:261-300)

The order of battle for both sides for the afternoon of 1 July was created from information gained through the battle chronology. All of the basic unit characteristics such as the types of units and their efficiency ratings, were taken from the model's data base. The strength of the units was adjusted to represent the effects of the morning fighting in which several of the units were engaged. The goal of the battle scenario was to arrive at numbers comparable to those engaged in the actual fighting on the afternoon of 1 July. Historically, these numbers were around 23,000 Confederates and some 18,000 Union troops (3:308). The two created armies consisted of all the units on the battlefield involved in the afternoon fight with the exception of the artillery units. These units were omitted from this first scenario for several reasons. The reasons dealt with the historical examination of the battle and the battle scenario development. A breakdown of the units in the scenario and their characteristics are listed in table 14.

After careful historical examination of the events of 1 July from all perspectives, the fighting on the afternoon of 1 July could be narrowed down to a series of infantry engagements despite the considerable number of artillery guns present on both sides (17:20). During the afternoon fighting, the battle became a classic infantry fight with close-in fighting, charges, and blazing muskets. Artillery participated with barrages of massed infantry formations and counterbattery fire, but the infantry's minié ball ruled the battle.

In developing the battle scenario, the number of infantry and cavalry units involved provided an adequate level of forces to gain insight into the model. To determine the extent and impact of the numerous artillery units on the battlefield and on the many targets would have required an investigation of the battle beyond the scope this study. Adding artillery units to the scenario with the requirement

Table 14. Descriptions of Units for 1 July Scenario

Name	Type	Strength	Efficiency	Moves	Speed	Firepower
The Army of Northern Virginia						
Daniel	Hvy Infantry	2158	Average	4	2.5	1.0
Doles	Hvy Infantry	1400	Average	4	2.5	1.0
Iverson	Hvy Infantry	1450	Average	4	2.5	1.0
Ramseur	Hvy Infantry	1100	Average	4	2.5	1.0
O'Neal	Hvy Infantry	1685	Average	4	2.5	1.0
Hays	Hvy Infantry	1292	Average	4	2.5	1.0
Avery	Hvy Infantry	1242	Average	4	2.5	1.0
Gordon	Hvy Infantry	1200	Average	4	2.5	1.0
Pettigrew	Hvy Infantry	2400	Average	4	2.5	1.0
Brockenbrough	Hvy Infantry	880	Average	4	2.5	1.0
Archer	Hvy Infantry	1130	Average	4	2.5	1.0
Davis	Hvy Infantry	2400	Average	4	2.5	1.0
Perrin	Hvy Infantry	1100	Average	4	2.5	1.0
Lane	Hvy Infantry	1734	Average	4	2.5	1.0
Scales	Hvy Infantry	1401	Average	4	2.5	1.0
The Army of the Potomac						
Wadsworth	Hvy Infantry	2340	Crack	4	2.5	1.0
Robinson	Hvy Infantry	2500	Average	4	2.5	1.0
Rowley	Hvy Infantry	2633	Average	4	2.5	1.0
Barlow	Hvy Infantry	2059	Average	4	2.5	1.0
Von Steinwehr	Hvy Infantry	2861	Average	4	2.5	1.0
Schutz	Hvy Infantry	3327	Average	4	2.5	1.0
Gamble	Hvy Cavalry	1600	Crack	6	2.5	1.5
Devin	Hvy Cavalry	1311	Crack	6	2.5	1.5

to select and fire each unit during the eight segments of a game turn would have increased the complexity and running time of the scenario to an unacceptable limit.

With the creation of the two armies and the battlefield already built in the model, the battle scenario was almost ready to begin. The parameters of the model were set with a game turn lasting 16 minutes and the scenario running from 1430-1600 hours. The firepower scores, and accuracy values were not changed from the default values of the model. The next step was to conduct a series of runs to explore and evaluate the battle scenario and the model.

6.2.3 Experimentation with the Battle Scenario. The experimentation with the battle scenario helped demonstrate the features of the model and its potential training value. Several runs were executed while varying the parameters of the accuracy level and the amount of computer control. The basic concept was to recreate the historical fighting with the Confederates attacking while the Union forces attempted to defend. Various runs were made with the battle scenario and the first one involved complete human control of both sides.

Executing the battle scenario while fighting both sides required concentration and attention to detail. Both sides required orders to execute a semblance of the historical event. These orders required the Confederate units to attack all along the front while positioning follow on forces. The Union forces were required to defend while not becoming overrun or decimated. The movement and positioning of forces in the scenario was made to roughly confirmed with the historical flow of the battle. Actual historical conflicts between known combatants did occur but with drastically different results. The attrition process in the model caused casualties to be exceedingly high which impacted on the ability to recreate the battle. A graphical result of a typical run shown in figure 13 illustrates the dramatic loss of combatants in the battle scenario. As the turns continued, the changing flow of the battle was represented through the movement and repositioning of forces. The

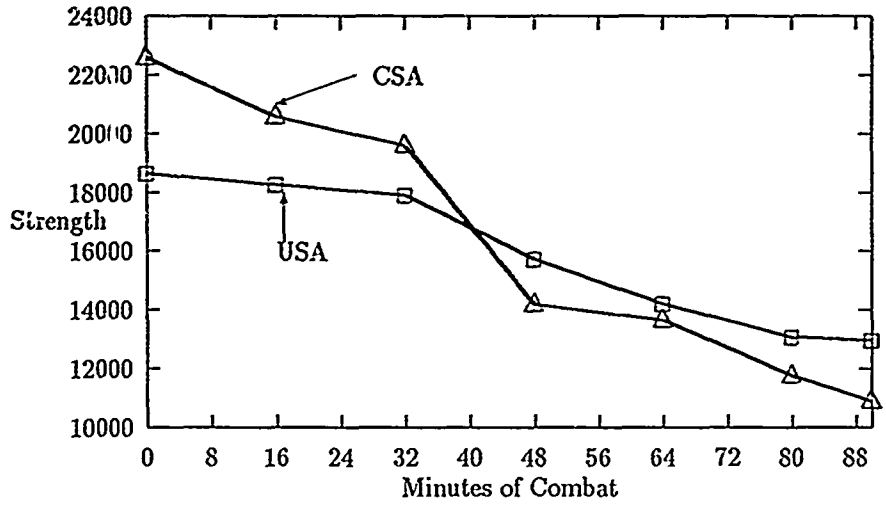

Figure 13. Strength Loss versus Combat Time

fighting withdrawal of the Union forces from the field and the Confederate attacks along the flanks were reasonable recreated within the scenario.

One challenge in the model involved phasing the movement and orders of different units so they would attack the same unit. Due to the model's logic, these "simultaneous" attacks were still conduct sequentially. In playing the scenario, units could quickly become annihilated if forced to continually attack after an initial engagement loss. The player was required to adjust forces and evaluate the risks to avoid these situations. These constraints also led to a further investigation into the accuracy variable and its effect in the model.

The investigation was conducted by recreating the scenario as best as possible but with different accuracy levels. Due to the small number of units and the basic battle plan, the recreations could be accomplished fairly easily. Two runs were attempted using the different accuracy values of 15 and 50. Both the upper and lower ranges of the accuracy variables were set to 15 and 50 respectively so that within a run both sides had the same accuracy percentage. The different impacts are shown in figure 14. The results of this investigation illustrated that a figure

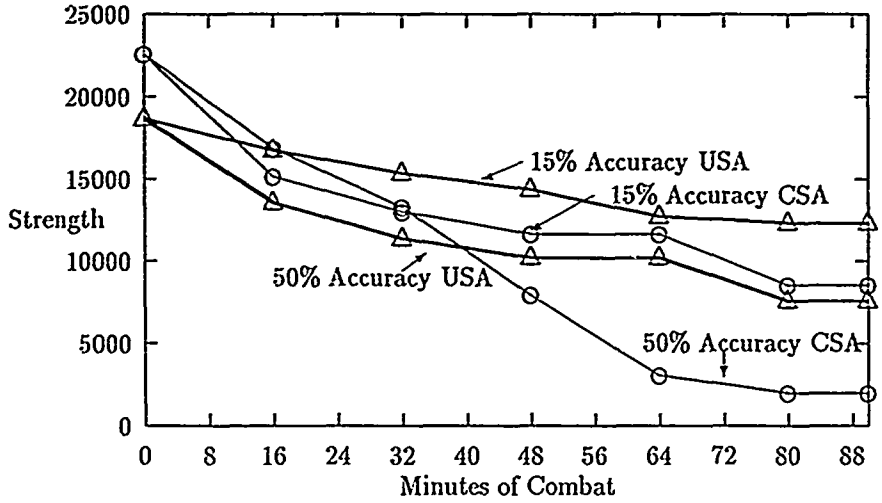

Figure 14. Strength Loss versus Combat Time for Different Accuracy Levels

of 50% accuracy for troops was probable too high and 15% too low for acceptable attrition loss.

Other runs of the battle scenario were executed using limited or no human control. Under limited control, the computer was chosen to play the Confederates and forced to attack the Union. Once these runs began, it became impossible to follow any degree of historical sequence and the task became to react to the computer's moves. Invariably, the computer would attack in the center near Rodes's historical attack of the right flank of I Corps and push through the defenses toward Gettysburg. The computer continued to execute its battle plans without regard to the strategy of the opponent and would not pursue or engage units once they were out of range. During these runs, the challenge became to shift and move forces fast enough to try and halt the Confederate forces. The results normally ended in a draw or minor victory for the Confederates.

When placing both forces under computer control and forcing the Union to defend and the Confederates to attack, the usual result was a draw. The Confederates would attack in the center and break through the Union defenders and continue on

to Gettysburg. The forces along the flanks would have little or no conflict based upon their initial setup positions. The indications from observing these runs were that the enemy's weight was positioned against the center of the Union lines and more forces were required to defend this area.

The creation of the battle scenario and subsequent experimentation yielded insights and created a level of interest and excitement for the model. The placement of units and their related movements were challenging and instructive. The basic nature of the scenario allowed the player to experiment or replay the scenario to improve the actions and the results. Finally, the computer battle logic allowed for interesting solo play or observations of the relative weight of one's forces in a particular battle scenario.

6.3 Results of the Investigation of UMS I

Despite the model's simplistic approach to warfare representation, there were significant learning points and possibilities for the use of *UMS I* as a training and teaching tool. The model was particularly well suited in training the factors of METT-T and OCOKA although all of the training factors were able to be exercised and examined.

As an additional training benefit of the model was the process of building a scenario for the model stressed the importance of the study of the historical battle. This battle analysis required an investigation and analysis of the battle. The understanding of the underlying principles and trends of the battle provided valuable leader and professional training.

6.3.1 The Factors of METT-T and OCOKA. The map features and the scenario building process of the model offered good possibilities for evaluating and training on both of these factors. To train subordinates on the factors of METT-T required an enterprising leader who could develop a scenario and use the map creat-

ing functions of *UMS I* to stress and highlight the importance of understanding and applying the principles of METT-T.

The construction of a practice scenario consisting of friendly and enemy forces created on a battle area representing actual or fictional terrain would provide the basis for any terrain exercise. Soldiers would receive an operational order as the commander of the notional force created in the model. The soldiers would be required to evaluate the mission, area, and military assets available according to the factors of METT-T. A time constraint added to the exercise would increase the realism and pressure of the situation. In developing the mission plan, the soldier could observe the battle area using the graphic map in the model and view the terrain from all angles. The different characteristics of the forces could be investigated through the order of battle information in the model. At the end of his allotted time, the soldier would be required to brief the situation to his commander and how the subordinate would execute the mission. Table 15 depicts the possibilities of *UMS I* and the training of METT-T.

In evaluating the terrain according to OCOKA, the map features of the model could be used. The ability to read terrain and effectively use it to support your mission is a skill that requires constant practice. A failure to appreciate terrain can cause disasters at all levels of command. Historically, both Doubleday and Howard were questioned concerning the wisdom of defending from McPherson's Ridge instead of Seminary Ridge on the afternoon of 1 July 1863 (3:300-301). Various battle areas could be created representing specific locations or just randomly created to require subordinates to evaluate the terrain. The terrain could be examined from the perspective of either an attacking or a defending force. With the model's zoom functions and the ability to observe terrain from different points of view, the soldiers could conduct leader reconnaissances of those positions and report their findings to their leaders. The portrayal of the factors of OCOKA in *UMS I* are listed in table 16.

Table 15. The Factors of METT-T in *UMS I*

METT-T	Evaluation
Mission	Terrain can be used as an area of operations for depicting a mission.
Enemy	Positions can be illustrated on the terrain and order of battle function allows examination of forces available and their characteristics.
Terrain	Instructive in evaluation of its impact upon the mission and its execution.
Troops	Positions can be illustrated on the terrain and order of battle function allows examination of forces available and their characteristics.
Time Available	Not evaluated
Overall Training Evaluation: GOOD	

6.3.2 The Principles of War. The training of principles of war with *UMS I* required a simple approach due to the basic nature of the model. However, the simple nature of the model worked to an advantage by observing the principles in a very basic and uncomplicated manner. Table 17 illustrates the model's approach to the principles of war. The challenge of training the principles of war in *UMS I* was to highlight the applicability of the principle at all levels of operations and illustrate their importance. *UMS I* portrayed several of the principles stronger then others but was rated fair overall due to the attrition process in the model which affected all aspects of the model play.

The standard principles involved in the planning and execution of missions namely: objective, mass, maneuver, unity of command, and simplicity were all tasked in conducting battle operations in the model. An objective for the forces must be indicated and decisions made concerning the massing, maneuvering, and commanding of forces to achieve that objective. However, the degree with which these principles were necessary for the play of the model and the influence of the

Table 16. The Factors of OCOKA in *UMS I*

OCOKA	Evaluation
Observation and Fields of Fire	Instructive through the use of the map and different viewing functions.
Cover and Concealment	Not portrayed or evaluated in the model.
Obstacles	Not portrayed or evaluated in the model.
Key Terrain	Terrain can be built and evaluated as to its impact upon an area of operations.
Avenues of Approach	Map feature allows for a discussion and examination of possible avenues of approach.
Overall Training Evaluation: GOOD	

attrition process on model play affected the training value of the model with regards to the principles of war.

6.3.3 The Tenets of Airland Battle. The training of the tenets of Airland Battle concentrated on the issues of synchronization and agility. The orders process and the execution of game turns forced an attention to these concepts to insure mission accomplishment. Table 18 shows the applicability of the model to the tenets of Airland Battle.

Issuing orders to units and controlling their subsequent movements required an ability to think and plan not only for the current turn but for the future turns. This synchronization of units and combat actions became more complicated as the number of units in the scenario increased. During the combat phase of each turn, input was received from all the units that engaged in combat, similar to battle reports received in a unit's tactical operations center. These reports described the unit's situation and provided information needed to formulate new orders. As the situations changed, the player was required to maintain a level of agility of forces and mind in order to react to the new challenges. The challenge for the leader was to consider the entire situation and the impact of all the units when issuing new orders.

Table 17. The Principles of War in *Universal Simulator I*

Principles of War	Evaluation
Objective	Defined by the player as the focus of his efforts.
Offensive	Model benefits winners of initial combat actions.
Mass	A function of unit size and not quantity of units.
Economy of Force	Massing of units requires risks taken elsewhere.
Maneuver	Executed through movement values.
Unity of Command	Player acts as the overall commander of forces on the battlefield.
Security	No mechanisms in the game.
Surprise	No mechanisms in the game.
Simplicity	Model play demands simple plans and actions
Overall Training Evaluation: FAIR	

Each set of orders had to make sense and fit into the plan. Miscalculations could result in units being destroyed during a game turn before the player could issue new orders. The synchronization of forces against the enemy forced the enemy to react and provided the player with the initiative.

6.3.4 Model Characteristics. An examination of the models general characteristics provided valuable information concerning its use as an aid for training soldiers. A summary of the results are shown in table 19.

The resolution level of the game was defined by the user. If he wanted to fight a platoon of soldiers or an entire Army Corps, the units could be built. The difficulty associated with larger units was in determining their characteristics so that the actual battle units could be built.

The learning time of this model was fairly short due to its simplistic nature and the ability to experiment quickly with the model. After a reading of the rules and a period of practice, the model could be played with a reasonable level of understanding

Table 18. The Tenets of Airland Battle in *UMS I*

Tenets	Evaluation
Agility	Required to react to battle reports and computer actions.
Initiative	Players required to issue commands maintain the offensive against the enemy and control the actions.
Depth	Difficult concept but possible with the map and counters.
Synchronization	Players must control and coordinate the actions of many units and processes to accomplish objectives.
Overall Training Evaluation: GOOD	

within 1–3 hours. The majority of that time would be involved in experimenting with the model.

The scenario running times were dependent upon the complexities of the scenarios and the length of the game turns selected. Scenarios involving numerous artillery or ranged combat would increase in playing time. The average playing time of a scenario could run from 1-2 hours dependent upon the size of the scenario. As a general rule, as the familiarity with the model increased, the playing times of the scenarios decreased.

The documentation for *UMS I* consisted of two manuals. The scenario handbook described the historical events and the scenarios while the user's manual explained the use of the model. The documentation was written clearly but was lacking in depth for an analytical study. The documentation failed to explain the attrition process or any of the underlying control features adequately enough to allow for a complete understanding of the model or its abilities. The designer instituted a system of passwords taken from the scenario handbook to allow individuals to execute the model as a counter to the lack of a copyright. This system was time consuming and annoying to any full time user of the model.

Table 19. General Characteristics of *UMS I*

Characteristics	Evaluation
Resolution Level	User-defined by the level of detail necessary to portray the battle.
Learning time	The reading of the rules and comfort level of use of the model's functions: 1–3 hours.
Playing time	Dependent upon scenario and number of entities approximately 5–10 minutes per turn.
Documentation	Related only to the actual model play leaving numerous questions unanswered.

6.4 Summary

UMS I provided a basic showcase for the advantages and limitations associated with computer war games. The resolution of movement and combat occurred much quicker than in a board game but dealt with these issues in a more basic manner. This model easily supported single player games with its battle logic center though single player games do not emphasize the skill and work necessary in competing with and against humans. This skill is something that cannot be taught but must be experienced. The interaction or team building that occurs in multi-player games is important at all levels in the military.

The training ability of *UMS I* was centered around the use of the simulation as a part of a integrated training plan and not as a stand alone event. While *UMS I* has several advantages and potential, the use of *UMS I* alone to train soldiers and leaders was not enough. Trainers could exercise simple techniques and themes of warfare but the more complicated ideas were tougher to address. A model that addressed the battle in greater detail and paid more attention to the actual historical battle was required. For these reasons, the investigation moved to the examination of a different model.

VII. An Investigation of Thunder at the Crossroads

In the board game *Gettysburg*, combat action was focused at the division level. However, a majority of the combat action at Gettysburg was fought at the lower levels of brigades and regiments. In order to capture this level of action, a board game was required which focused on thcse lower levels. The war game *Thunder at the Crossroads* provided an opportunity to examine the events and actions at the brigade level.

7.1 Overview of Thunder at the Crossroads

Thunder at the Crossroads was produced by The Gamers Inc. in 1988 and is one in a series of three games produced by the company concerning the American Civil War. This model, a high resolution multi-player war game, was designed to fight brigade level units while providing a realistic portrayal of Civil War battle processes (26:1). To reproduce the atmosphere and interactions of the era, the designers developed a rule system that paid particular attention to the concept of command and control. The command and control process was one factor that separated this model from the Avalon Hill model. *Thunder at the Crossroads* also addressed the issues of combat, movement, morale of forces, stragglers, and the uncertainty of your opponent's actions.

To experience this model, and therefore, relive the battle of Gettysburg, seven different scenarios were provided. These scenarios represented historical and "what if" situations as well as minor variants of the battle. Four of the scenarios modeled the days of 1–4 July while a separate historical scenario representing the entire battle was also provided. Special scenarios depicted Longstreet's attack on Little Round Top, and the hypothetical situation of Stonewall Jackson's presence on the battlefield (26:3–7).

The play of the model was divided into 30 minute game turns consisting of four phases. These phases were command, movement and close combat, fire combat, and a rally phase (14:1). In the command phase, players executed all the steps necessary for issuing orders and the control of forces. In the movement and close combat phase, the active player executed his plans and conducted close combat. Close combat represented short intense action by cavalry or infantry at ranges of 100–150 yards (14:6). During the fire combat phase, the non-active player was given the opportunity to fire upon any active player's units followed by the active player's return fire. Fire combat represented combat at ranges greater than 150 yards by artillery, cavalry, and infantry (14:6). The rally phase represented an opportunity for the players to conduct the actions necessary to prepare for the next game turn such as recovering stragglers and upgrading the morale states of their units. There was a general end turn phase where players executed game administration activities. With a general understanding of the game setup, the next step was an investigation of the components of the model.

7.1.1 Components. The components consisted of two 22 by 28 inch map sheets, 560 counters depicting all aspects necessary for playing the game, two six-sided die, and a game and series rule books (26:1).

The two map sheets represented the battlefield and surrounding area of Gettysburg and were constructed in a series of six sided hexes representing 200 yards of terrain from center hex to center hex (26:2). The hexes were identified by the map sheet and a four digit number which allowed for the placement of forces on the board. The major points of entry used by the forces into the battle area were marked alphabetically for ease of location. The actual size of the battle board was larger and more detailed than the *Gettysburg* war game and focused on a more detailed representation of the battlefield.

The increased level of detail was accomplished through a closer representation of the terrain, elevation, natural, and man-made features of the battle area. Terrain elevations ranged from 430 to 640 feet and were depicted through a color coded system. Sixteen different features such as primary and secondary roads, streams, creeks, and areas of extreme slopes were also marked on the battle board. The result of this detail provided an accurate and useful map board that allowed for the emplacement of units according to historical information and a more accurate representation of the effects of terrain on military operations. However, the use of color to distinguish changes in elevation required additional time and effort to become familiar with the nature of the terrain. This additional time was a tradeoff with the benefits of a more colorful map. Marginal information was also provided describing the different colors and symbols used in the map.

The play of the model was controlled with a variety of counters. These counters represented the fighting and controlling elements of the game. The primary counters used to represent the battle were infantry, cavalry, artillery, leader, and headquarters counters. The leader markers represented the commanders of the various organizations and were used in the command and control process. The headquarters units were used to mark the center of an organization and had no combat or movement value associated with them (14:4). Additional counters were provided to depict greater detailed information concerning a unit's posture or combat capability. Some of this explanatory information was morale status, reduced fire levels, and extended flanks. These additional counters were placed under the parent unit. A breakdown of the primary counters is listed in table 20.

Counter information depicted essential items to describe the organization of the unit, its formation, and its combat capability. Organizational levels and ownership were represented for all the maneuver units, headquarters, leaders, and supply trains. Combat and movement formations of the infantry, artillery, and cavalry were depicted on the front and backsides of the counters. The frontsides for in-

Table 20. Counter Breakdown for *Thunder at the Crossroads*

Type	CSA	USA
Infantry Brigades	37	52
Artillery Battalions	17	23
Cavalry Brigades	7	7
Leaders	14	30
Headquarters Markers	4	9
Total	79	121

fantry, artillery, and cavalry represented column, limbered, and mounted formations respectively, while the flip sides represented line, unlimbered, and dismounted. A unit's formation affected its ability to maneuver and conduct combat. Artillery, for example, could move but not fire in a limbered formation.

Combat capability was depicted with strength points and fire levels for the infantry and cavalry and gun points for the artillery. A strength point represented 100 men and was used to depict losses due to combat and stragglers. The loss of strength points affected a unit's fire level which indicated the volume of fire the unit could deliver (14:10). Fire levels ranged from A to C and were linearly related: an A was equal to two B's and a B was equal to two C's (14:6). As units suffered losses, their strength points decreased which affected their fire levels. Gun points represented artillery organizations and were used to indicate casualties to artillery. Gun points ranged from 1-5 and represented approximately 3 cannons each (14:2). Artillery could be detached into 1-3 gun points to represent smaller organizations or attachment to infantry and cavalry units.

Unit morale ranged from A to E with A being outstanding and B/C average (14:8). Morale levels sought to represent the effects of leadership, experience, bonding, and small group dynamics of a unit and did not change during the game. The effect of combat on a units' morale was depicted with morale states. The differ-

ent possible states were blood lust, normal, shaken, disorganized, and rout. A unit started a scenario in a normal state and its morale states fluctuated as the result of combat. The different morale states applied both positive and negative effects on a unit's movement and combat capability (14:8).

7.1.2 Rules. The rules were designed to closely represent the actual battle of Gettysburg and the atmosphere of 19th century combat. The model provided rules that accounted for the issuing of orders, combat actions, morale changes, and every other possible battlefield event. There were tables provided that resolved all the issues based upon unit characteristics and die rolls. An illustration of the results is portrayed in table 21. Additionally, because the rules were applicable to a number of other games by the same designer, special rules for this battle were also included.

Both the Union and Confederate forces had special rules to increase the historical accuracy of the model. The Union's special rules included an unlimited supply of artillery ammunition, an increased weapon potential of their cavalry, and an order of rank of the Union corps commanders (26:2). The basis of these rules was the relative proximity of the Union supply bases to the battlefield, the spencer carbines carried by the Union cavalry, and the need for a successor to Reynolds as the acting Army commander in the event of his death in the model.

The Confederate special rules concerned Lee's rating as a commander and the control of Confederate divisions (26:2). Lee's ability to issue orders was restricted due to his relatively high percentage of inexperienced officers filling major command positions with two of the three corps commanders having not seen action in their present command positions (3:11-12). The Confederate forces were also given the ability to operate individual divisions independent of normal command and control restrictions due to the fact that Confederate divisions frequently operated independently of their parent corps (26:2).

Table 21. Battle Operating Systems in *Thunder at the Crossroads*

Battle Operating System	Evaluation
Maneuver	Highly accurate to movement rates and effects of terrain and formations on movement capability.
Command and Control	Logical representation requiring skill and forethought Portrays difficulties associated with C^2.
Fire Support	Artillery subject to standard terrain movement and firing restrictions.
Intelligence	Portrayed through restriction of information concerning opponent's forces.
Mobility/ Survivability	Depicted through movement and combat modifiers that provided units protection from enemy fire.
CSS	Supply markers required to be moved on the board to maintain supply actions. Ammunition and personnel were tracked and accounted for.

Maneuver

Maneuver and the movement of forces in this model was based upon terrain and a unit's formation. The combat units (infantry, artillery, cavalry) all possessed a standard movement allowance based upon their different formations. The act of changing between combat and movement formations cost movement points and represented the time and effort required to accomplish the change. Unlimbered artillery for example could not move and was required to limber their guns before moving.

Movement of units on the board was affected by the type of terrain. Cross country movement by an infantry unit for example, cost more then movement along a road. The model also applied a cost for movement up and down slopes and through urban hexes. Wagons and limbered artillery were prohibited from moving up or down extreme slopes while all units were prohibited from crossing creeks and rivers. Such terrain features required the use of a bridge to cross.

To understand the movement values associated with the various units a demonstration was made with units moving down a road. Road movement for infantry, cavalry, and artillery cost 0.5 points per hex entered. During a 30 minute game turn, an infantry unit could move 22 hexes or 4400 yards. These numbers turned yielded a speed of 2.7 miles per hour. The values for artillery and cavalry were 3.2 and 5.0 miles per hour. These values while perhaps a bit high were reasonable from a historical point of view.

Command and Control

The command and control of forces was an important aspect of this game centered around the orders process. The orders process could be deleted from the game with the result of quicker play but with a decrease in the historical accuracy of the model. The orders process accounted for the formulation of orders to subordinate units, the delivery and acceptance of those orders, and the unforseen factors associated with command and control. The delivery of orders replicated the actual methods employed during the Civil War era which increased the realism of the model play. The tables associated with command and control of forces in the model appear in table 22.

The orders process began with a leader's rating which determined the number of order points per turn. Higher rated leaders possessed more command points and therefore, could issue more orders per turn. The cost of issuing orders was based upon the type, force, and method of the order.

Order types were either complex or simple. A complex order "is one that includes movement to, into, or around areas of enemy control or tacit control . . . "(14:3). Simple orders were by definition everything else. A measure of common sense was required in determining the type of order (26:3). All orders were recorded with the basic information on the name of the sender and receiver, the order type, and the time sent. Complex orders also required a start time or signal, an axis, and an

Table 22. Command and Control Tables for *Thunder at the Crossroads*

Table	Purpose
Command Points	Determined the number of command points per turn for each rated commander.
Order Costs	Lists the costs of orders based upon method, force, and type.
Order Delivery	Determined the number of turns till delivery and whether the order is lost.
Acceptance	Used for determining acceptance/delay or distortion of orders.
Formation Effects	Lists the effects of formations on movement and combat.
Morale Effects	Lists the effects of morale on model play.
Movement	Lists movement costs for all elements.

objective. In developing an order, the sender was required to be specific about his intent and could not issue open ended commands such as "attack west."

Orders possessed three force levels representing the sender's urgency to have the order carried out. Orders were delivered in person or by an aide which required a certain amount of time to accomplish. In person orders were always oral while aides could deliver oral or written orders (26:3). The delivery time of the order depended upon the distance and the number of movement points required to reach the location. The result of this calculation was the number of turns required for the order to reach its destination.

On the turn when the order was due to arrive, a check was made to determine whether or not the order actual arrived to the desired location. If the order arrived, then the acceptance of the order was checked. Acceptance represented the quickness of reaction of the receiver to the order (26:3). The possible options were that orders could be accepted, distorted and thus thrown away, or delayed by some amount of

time. The acceptance of orders was a function of the rating of the two leaders, the method, force, and type of order and was determined from the acceptance table.

The acceptance table depicted the general relationship between command quality and its effect on orders. When the leaders were competent, there was a higher chance of receiving and quickly executing the orders. This resulted in higher numbers on the acceptance chart. As the acceptance numbers increased, the chances of acceptance grew from 0% to 45%, distortion dropped from 45% to 9%, delay of one turn dropped from 36% to 9% and delay of more than one day dropped from 45% to 9% (26:3).

The control of units was based upon the concepts of command radii, divisional goals, and direct orders from Army headquarters. The use of command radii and divisional goals insured that commanders at all levels concerned themselves with the positioning and actions of their subordinate units (26:10). If the subordinate units were out of control, the higher unit could not accomplish its orders. Command radii restricted subordinate units from operating outside the control of their higher headquarters. The definition of control was based upon subordinate units operating within a specific number of hexes of its headquarters marker. These units could operate without specific orders but were required to support the higher unit's goals and stay within the command radii limit.

The concept of divisional goals accounted for the instances when a unit's missions sometimes required a greater than normal degree of latitude. Divisional goals were a type of order that allowed units to operate at greater distances from the headquarters but still required them to support the corps orders. Orders from Army headquarters represented the chance occurrence of units receiving orders directly from the commanding general (26:4).

The command and control process in the model required players to think and behave much like the historical commander they were imitating. The player needed to develop an overall plan and oversee its successful execution including reacting to

the possibilities of lost orders or enemy actions that upset the plan. The process encompassed many of the natural difficulties and challenges associated with the command and control of forces.

Fire Support

The artillery had a maximum range of 10 hexes subject to the constraints of visibility and line of sight. Visibility was restricted during game turns representing night time and early and late in the day. Line of sight required a determination of the intervening terrain between the gun and the target. Artillery elements took losses due to combat which resulted in the loss of gun points. The game also provided for the lose of gun points when an artillery unit tried to move out of close range of an enemy infantry unit. The ability to limber and escape from attacking infantry was a hazardous and risky operation for artillery units which normally resulted in casualties.

Intelligence

Intelligence was portrayed by restricting information to the opponent regarding the status of one's forces. Each player was only able to observe the events on the board without information concerning the arrival of future enemy forces. Internal information concerning casualties, stragglers from combat units, the number of wrecked brigades, future orders, and the player's subjective assessment of his army were withheld from the opponent. This restricted information combined to create a "fog of war" for the players to operate under and increased the correlation of the model with typical combat.

Mobility and Survivability

Mobility and survivability were depicted through the detailed map and the movement and combat modifiers used in the model. The modifiers accounted for the effects of terrain on units involved in combat. Due to the detail of the terrain, units could gain protection from the characteristics of the terrain such as elevation.

There were no modifiers for barricades or breastworks due to a designer's decision to withhold them from the game (26:9).

Combat Service Support

Logistics were played by requiring players to account for ammunition and personnel. Army and Corps commanders were required to move and position supply wagons to insure an unrestricted path of supplies to their subordinate units. As long as the path was free of enemy units then the flow of supplies was continuous. If an infantry unit became low on ammunition because of combat, resupply occurred when the supply wagons were within two hexes of negotiable terrain (14:9). Otherwise, the supply wagons or the unit were required to move to within the prescribed limit to accomplish resupply. The resupply between corps and army supply wagons operated under the same restrictions. The effect on infantry and cavalry units of low ammunition was applied through column and row shifts in the appropriate combat tables. Artillery units did not become low on ammunition but were required to maintain a path unrestricted by enemy units to their supply wagons. Their fire power was reduced to 50% if the path was not clear.

Personnel losses were recorded on loss charts to indicate losses due to combat and stragglers. Both losses affected the combat power and status of a unit, but straggler losses could be recovered during the rally phase. The process of accounting for and being aware of ammunition and personnel provided a method of replicating an important element of command and imparting a higher degree of realism to the model's play.

7.2 Model Play

Due to the robustness of the war game, an attempt to play the entire model or even one of the day scenarios was beyond the scope of the study. Instead, an examination of the model combined with the practical work of moving units and resolving combat was attempted. The results of this approach allowed for an investigation of

the numerous tables involved in playing the game. The tables were organized into command and control, combat, and rally tables. The command and control tables were discussed previously and the elements of the combat table and rally tables will now be examined.

7.2.1 Combat. Combat is divided into two separate types in this model: close combat and fire combat. Close combat represented an attempt to fight and occupy the defender's territory or hex while fire combat occurred against forces at some distant range. A list of the tables dealing with combat are shown in table 23. Two issues that were associated with combat were the stacking of units and zones of control.

The stacking of units had constraints to the number of units in a hex and the max number of units that could fire from a hex. The stacking limits were based upon the concept that only so many units could occupy a position and similarly, that there was a limit to the amount of fire that could be controlled from a position. The stacking limits for units were 10 gun points and 3 A fire level units while the fire limits were 5 gun points and 1 A level unit (14:5). The reduced level of fire from a hex of stacked units accounted for the requirement of units to change into battle formations (unlimbered and line formations) when conducting combat and the additional terrain needed for these formations. An unlimbered artillery battery of 3 guns would cover a front of approximately 82 yards while an A fire level unit representing between 7 and 10 strength points (700–1000 men) in battle formation would cover between 250–333 yards (4:21,71).

Another issue was the concept of a unit's zone of control. Zone of control was used to represent the control of enemy forces around a unit (14:5). A unit's zone of control depended upon its facing. Facing was indicated by the position of the horizontal stripe on the counter and its relationship to the battle board. A unit's zone of control could consist of either two or three hexes to its front. These hexes

Table 23. Combat Resolution Tables for *Thunder at the Crossroads*

Table	Purpose
Combat Tables	Used to determine loss of strength points based upon range, number of fire points, and combat modifiers.
Morale	Determined the change in a units' morale status and any effect on position, or strength.
Stragglers	Determined the number of stragglers lost based upon the loss of strength points from fire combat and morale.
Leader loss	Determined the loss or wounding of leaders as a result of combat.
Gun Loss	Determined the loss of gun points for artillery limbering and moving out of a zone of control.
Corps Attack Stoppage	Determines if Corps attacks continue or stop.
Close Combat Odds	Adjudicates the results of close combat.

represented the frontal hexsides of the unit. Combat between forces could only occur through these frontal hexsides. Units moving into an enemy's zone of control were required to stop all movement.

7.2.1.1 Fire Combat. In resolving fire combat between two units, the attacker first designated his target and summed up the amount of fire levels and gun points planned for the attack. The fire levels and gun points were converted into fire points based upon the range to the target from the range tables.

The fire points were adjusted with combat modifiers representing possible situations such as changes in elevations between combatants, low ammunition, and the morale level of the target. The modifiers were applied through column shifts on the combat table. The combat table yielded indications of the amount of loss by the target unit. Losses were indicated in strength points and when a unit suffered a loss of strength points, a morale check was required. Morale checks could also result from the combat table even though no losses were assessed.

Any changes in morale were checked on the morale table based upon a unit's morale level and any applied modifiers for unit or situational effects. The results from the morale table indicated a change to the target unit's morale status. Units could change to all levels of morale status in addition to being forced to retreat and lose additional strength points.

The final portion of fire combat required a check for the loss of stragglers and leaders. Stragglers were a function of a unit's morale and the number of strength points lost due to the combat or morale table. Leader loss was determined simply with a die role.

To replicate a level of uncertainty into Corps attacks, the model used a corps attack stoppage table. This table required a check of an attacking Corps to determine if the attack continued or failed. The factors that affected the momentum of the attack were the number of wrecked divisions, the loss of leaders, and leaders' ratings. The concept of the corps attack stoppage table was to allow for the influence of several factors on the momentum and success or failure of attacks. If the check succeeded then the Corps continued to attack, however, a failure stopped the attack until further orders were received.

7.2.1.2 Close Combat. Close combat was initiated by the active player and occurred in the defender's hex. While many of the same tables were used to resolve the combat, additional restrictions were applied. Artillery and units whose morale status were below normal were prohibited from attacking in close combat. Mounted cavalry could attack in close combat representing a cavalry charge but only in clear terrain (14:7).

Attrition for close combat was simultaneously computed with units following the procedure for fire combat and applying any losses. In this manner, both sides suffered casualties. To determine the winner, who maintained control of the hex where the combat took place, the morale table was used. Each side had standard

modifiers based on whether they were attacking or retreating plus any additional modifiers that applied. The defender was given an initial advantage because he checked his morale at a higher level. The side that was forced to retreat as a result of the morale table was the loser. In the event neither side retreated, an odds table based upon the attacker defender force ratios was consulted. Again, the defender had the advantage with better than a 50% chance of winning.

7.2.2 Rally Phase. During the rally phase commanders recovered stragglers and upgraded the morale status of their units using the appropriate tables. The status change table was used once a turn by the Army commander to indicate the change in his army. This represented a subjective evaluation of the effects of the past turn's events on his army. Status ranges from 1–5 and affected the results of a panic check by the opponent. A compilation of the tables used during the rally phase are listed in table 24.

Each Army commander could demand a panic check of the opponent's army. If the Army's status was 1 or 2, then the commander was required to check his panic table to see if the panic demand succeeded. The panic table was based upon the number of wrecked divisions in an Army and the roll of the dice. If the panic demand succeeded, then the Army executed a set of predetermined orders which resulted in the retreat of the entire army. If the panic demand failed, play continued with the next turn.

The result of the investigation of the components and the various tables used to control and play the game illustrated the amount of detail and thought that was put into the development of the model. The essential components required to replicate 19th century combat were provided with an appropriate amount of chance to allow for the influence of the fortunes of war.

Table 24. Rally Phase Tables for *Thunder at the Crossroads*

Table	Purpose
Straggler Recovery	Determines the number of stragglers recovered based upon the morale level and a die roll. A higher level morale unit has greater odds of recovering stragglers.
Blood Lust Morale Check	Used with the rally table to remove a blood lust morale status from a unit and reduce its morale level back to normal.
Rally	Used to indicate and change the morale status of units from all states back to normal.
Status Change	Used by the Army commander to assess overall changes of Army's status.
Panic	Indicates the actions of the Army based upon an opponent's panic demand.

7.3 Results of the Investigation of Thunder at the Crossroads

Despite the cursory examination of the model, *Thunder at the Crossroads* possessed many potential uses as a training device. From the initial investigation and the accuracy of the model's portrayal of the Civil War era, the model was able to sufficiently address the training concepts of METT-T, OCOKA, the tenets of Airland Battle, and the principles of war.

7.3.1 The Factors of METT-T and OCOKA. In this model's approach to the battle, greater detail was required for both the terrain and the processes controlling model play. The greater detail allowed for a more accurate representation of the battle of Gettysburg and provided excellent opportunities to train on the factors of METT-T and OCOKA. Overall, the model was rated as good for its training value. The ability of the model to train and execute a mission using all the factors of METT-T and OCOKA contributed to this level of training.

Training could be conducted with the model with the issuing an order to subordinates requiring them to plan and execute a particular mission using the factors of METT-T. The different forces could be developed from the game counters to rep-

resent the friendly and enemy troops and positioned onto the map. The detail of the map would allow an intensive investigation of the terrain and its affect on the mission. The combat service support and command and control rules in the model would add an increased sense of realism to the exercise. Subordinates would be required to execute their missions within the constraints of their supply lines while supporting and reporting to their higher headquarters. Operating within a time constraint, the subordinates could brief the order back to the leader using the map as the training aid. A description of the factors of METT-T in this war game are listed in table 25.

The detail of the terrain in the model was useful in examining a mission with respect to the factors of OCOKA. The depiction of terrain features, elevations, and man-made objects assisted in the description and analysis of the terrain. Subordinates could develop overlays representing the areas on the map which hindered movement or represented potential avenues of approach into the battle area. Key

Table 25. The Factors of METT-T in *Thunder at the Crossroads*

METT-T	Evaluation
Mission	Battle map can be used as an area of operations for depicting a tactical situation requiring action.
Enemy	Counters could be used to depict an enemy force and used on the board.
Terrain	Very instructive for evaluating the impact on mission accomplishment.
Troops	Counters can be used to represent friendly troops available and characteristics.
Time	External criteria applied to the situation.
Overall Training Evaluation: GOOD	

terrain and the concepts of cover and concealment in this model could also be addressed and their effects factored into the mission planning. Table 26 illustrates the importance of the terrain depiction on the factors of OCOKA.

Table 26. The Factors of OCOKA in *Thunder at the Crossroads*

OCOKA	Evaluation
Observation and Fields of Fire	Possible due to the detail of the map.
Cover and Concealment	Possible to a degree due to elevation and terrain depiction.
Obstacles	Accurate terrain allowed for the identification of natural obstacles.
Key Terrain	Depicted and marked on the battle map. Terrain allows for greater emphasis of key features.
Avenues of Approach	Evident due to terrain and shaping of the map.
Overall Training Evaluation: GOOD	

7.3.2 The Principles of War. The investigation of this model provided very good opportunities to examine and train on some of the basic principles of war. By examining the steps involved in developing a mission plan, examples of the model's applicability to the principles of war are provided. An evaluation of the model's portrayal of the principles of war is listed in table 27.

When developing an operational plan, the commander must first determine an objective for his forces. With an objective in mind, a plan for the accomplishment of that objective must be developed. Based upon the realistic portrayal of the command and control system and the number of counters involved in the game, a simple plan has a greater likelihood of success.

As the game begins and the plan unfolds, the commander must continue to observe the situation and issue orders to maintain a unity of effort and focus on the objective and prevent a dissipation of resources by subordinate commanders or through the actions of the enemy. While each commander is attempting to execute his master plan, his opponent is attempting to gain control of the battle for his own purposes. Commanders must deploy and maneuver forces to maintain their offensive

Table 27. The Principles of War in *Thunder at the Crossroads*

Principles of War	Evaluation
Objective	Defined by the Army commander as a focus of his forces' efforts.
Offensive	Complexity and size of the model required players to control the flow of events.
Mass	Commanders required to maneuver forces to concentrate combat power in decisive areas.
Economy of Force	Large battle area and number of forces to control require Army commander to concentrate in crucial arcas and hold other with less forces.
Maneuver	Commanders must maneuver forces to execute plans and react to enemy actions.
Unity of Command	Controlled through Army commander and orders process to insure the accomplishment of the objective
Securi'y	Battle information restricted by players.
Surprise	Orders process and initiative allow for the use of surprise.
Simplicity	The complexity of the game demand simple straight-forward actions.
Overall Training Evaluation: VERY GOOD	

while maintaining forces in other areas to thwart enemy intentions. Security and surprise can be maintained through issuing orders and restricting information to the opponent such as the orders log,

casualty figures, and the general status of the forces. Units could be ordered to conduct diversionary attacks to confuse the enemy while the use of initiative by subordinate allowed for the opportunity to exploit an opponent's mistakes.

7.3.3 The Tenets of Airland Battle. In the play of this model, there was a very good degree of evidence of Airland Battle doctrine that allowed for instructive training. The crucial tenets displayed were initiative and synchronization. A description of the model's portrayal of the tenets of Airland Battle is listed in table 28.

The tenets of agility and depth were addressed indirectly through the play of the war game. As play continued and the amount of interactions increased, the player was required to maintain an agility of mind as well as actions to react to the changing situations. Not only did the player have to deal with his own combat actions but also he must be able to react to the actions of the opponent. The scope of the actions throughout the battle area from supply functions in the rear to enemy forces arriving into the battle area, forced players to consider actions occurring over the entire battle area. The detail of the map and the degree of widespread operations stressed the factor of depth in Airland Battle.

Initiative was portrayed by allowing Corps and Division commanders to change orders or act without orders. The model represented this process through the rating of the leaders involved. The ability for a leader to act with initiative was dependent upon his commander's desires that he did not. To determine whether initiative was granted, the leader subtracted his commander's ratings from his own rating. A roll of a die below the resultant number allowed the subordinate to act with initiative. When dealing with a high rated chain of command, it was tougher to act with initiative then wh the commanders' were rated lower. Intuitively, this made sense because with competent leaders there was not the need to change orders or act without them as frequently as compared with leaders of lower skill.

Initiative was also modeled in the resolution of fire combat. The model allowed for the non-active player to conduct fire combat during the active player's turn. In this manner, the non-active player could disrupt the plans of his opponent by inflicting casualties and seizing the initiative from the opponent.

Synchronization was a function of command and control, combat, and the level of resolution of the model. These factors required all levels of command to work to achieve a "focusing" of their combat power at the decisive place and time. To accomplish this synchronization, required forward thinking by all levels of command. A commander was required to control his organic forces reacting to the enemy's

Table 28. The Tenets of Airland Battle in *Thunder at the Crossroads*

Tenets	Evaluation
Agility	The size and number of board units required players react to many situations.
Initiative	Depicted in the orders process and the combat phase.
Depth	Depicted through the actions of the opponents to achieve the victory conditions of seizing terrain and entry points.
Synchronization	Players must control and coordinate the actions of many units and processes to accomplish objectives.
Overall Training Evaluation: VERY GOOD	

actions while continuing to support his commander's plan. As units continued to flow onto the battlefield and the scope of the battle expanded, the ability to fight while working to bring a plan together increased in difficulty. Even by playing the game without the orders process, the ability of bringing everything together was still a difficult process.

7.3.4 Model Characteristics. After the examination of the model, a better understanding of its potential as a training device was obtained. The results of the investigation yielded information concerning important modeling characteristics. A description is listed in table 29.

The learning time of the model with its realistic command and control system and action occurring at the brigade level, could be initially overwhelming. However, after exploring certain processes and numerous readings of the documentation, the model play became clearer and easier. The model was still large and complicated but not impossible. To develop a level of expertise or to play the game without constantly referring to the documentation was a function of the amount of time with the model. A conservative estimate of the amount of time required to learn this game would be 15-20 hours spent in investigation and exploration.

Table 29. General Characteristics of *Thunder at the Crossroads*

Characteristics	Evaluation
Resolution Level	Combat and maneuver conducted at the brigade level.
Documentation	Well written with designer hints and explanations of critical areas.
Learning time	A reading of the rules and an ability to conduct model play required 15–20 hours.
Playing time	Highly dependent upon the scenario and number of players, but roughly 30–45 minutes per game turn.

In determining the playing time of the various scenarios, there was a degree of uncertainty related to the level of expertise of the players. Based upon the research and the assumption of an average level player, a standard of 30–45 minutes per game turn could be expected. This time could increase by as much as three times based upon the amount of orders, movement, and combat involved in each turn. Overall, the play of a standard scenario could take anywhere from 10–15 hours.

One of the strengths of this model was its documentation. The rules and scenario handbook provided an excellent description of the model play and rules. The documentation provided examples to assist in the explanation and use of the tables in the model.

The documentation was divided into a set of game rules and series rules. The game rules described the particular rules for this game, background information concerning the historical situation and the two commanders, a listing of the units, and each of the seven scenarios. Each scenario description listed the combatants, the initial setup of the units at the start of the scenario, the scenario victory conditions, and some background information on the scenario. The designer also included notes on certain functions of the game and hints for each of the two sides. The series rules pamphlet described the components of the game, the different phases of the game turns, and the use of the numerous tables. The designer again provided explana-

tions of certain rules and replies to frequently asked questions. The documentation was well prepared and eased the learning of the model and increased the level of enjoyment.

7.4 Summary

As a result of the investigation of this model, it became clear that *Thunder at the Crossroads* provided a high degree of training opportunities in all of the training areas investigated. This high degree was a result of the level of detail and depiction with which the model approached the historical battle. The amount of detail and complexity also affected the amount of time and effort needed to use the model for training compared with the war game *Gettysburg* which was basic and quicker to play but also was not as robust of a training tool.

VIII. Conclusions

As a result of the analysis and investigation into the three commercial war games, *Gettysburg*, *Universal Military Simulator I*, and *Thunder at the Crossroads*, conclusions were drawn concerning the utility of using commercial combat models as training devices for the military.

8.1 Conclusions

Despite the small number of commercial models investigated and the limited time of the study, sufficient information was gained in the research to provide insights concerning the training value of the models. The conclusions of the research centered on three themes: the model's characteristics, the applicability of the training criteria, and the value of the general research process.

8.1.1 The Characteristics of the Models. Each of the three models possessed certain advantages and disadvantages with respect to the resolution level, the learning times, the playing times, and the quality of the documentation of the models. These characteristics affected the ultimate training value of each of the models. A description of these characteristics is listed in table 30.

The resolution level affected the learning and playing times of the models because of the greater detail required in the lower resolution models. *Thunder at the Crossroads* for example, was a more detailed and complex war game than *Gettysburg*. Because of this complexity, *Thunder at the Crossroads* required a longer time to learn and play than *Gettysburg* which dealt with the battle on a more aggregated level. *UMS I* provided an alternative to either model because *UMS I* allowed players to define the resolution level of the model. The strength of the models' documentation either assisted or detracted from the learning and playing times by making it easier or harder to understand and execute the model. With the various learning and

playing times of the models, the leader had an option when faced with which model best suited the time available and training level required.

In addition to the listed characteristics in table 30, the board games and the computer simulation possessed factors inherent to their model types which provided the player with added challenges when playing the model. The board games provided an increased level of excitement due to the intangible factors of working with a map and "counters", similar to operational planning in military organizations. Players, acting as high level commanders, could practice the tasks of battlefield command and control and battle management while evaluating the terrain and enemy forces to achieve a specific objective. *Thunder at the Crossroads* which could support up to six players per side required the players to form teams and operate as staffs. The success of the mission depended upon the cohesiveness of the teams which replicated the necessity for a good relationship among successful staff members in any military organization.

The computer game, while not forcing the same concept of team building, allowed players to conduct solitaire battles against the computer and challenge themselves in the investigation and execution of battle plans and principles. *Universal Military Simulator I* also provided quick access to battlefield information and the ability to view the battlefield in three-dimensions. A constraint to the quick collection and assimilation of battlefield information was the physical dimensions of the screen. Only so much of the battle area was shown, especially during combat actions, which acted as a filter to information relating to the overall battle situation. A player could not simply glance over the entire battle board for an update on the situation but was required to reorient and zoom into each specific area.

8.1.2 The Training Value of the Models. Each of the models possessed a different level of training value based upon their depiction of the training principles. How well the models portrayed the training principles was primarily a function of the

Table 30. Summary of Model Characteristics of the Commercial Combat Models

MOE's	MODELS		
	GBURG	UMS I	TAC
Resolution	Division	User defined	Brigade
Learn-Time	2–4 hours	1–3 hours	15 hours
Play-Time	2–3 hours	1–2 hours	10–15 hours
Documentation	Basic	Weak	Strong

models' resolution levels. A subjective evaluation of their portrayal of the training principles is shown in table 31. The evaluations ranges were poor, fair, good, and very good. All three of the examined models provided a different level and quality of training. While any individual model could be used as a training aid, it became clear that the most beneficial application would be the use of all three models in combination. An example of a training scenario demonstrates the potential training benefits when using all three models together.

Within an army battalion, the three models could be used to train the different levels of command from platoon to battalion. At the platoon level, the platoon leader could use *UMS I* to train and emphasize the importance of the mission planning factors of METT-T and OCOKA to his subordinates. The strength of the map creation features in the model would allow subordinates an opportunity to investigate and analyze different battle areas while stressing the training of the factors of METT-T and OCOKA.

At the company level, the commander and his officers could use *Gettysburg* to provide an introduction into combat modeling and the battle of Gettysburg while emphasizing the concepts of the principles of war and the tenets of Airland Battle. The level of resolution of *Gettysburg* would force company level officers to practice and concentrate on the actions of higher organizations, thus gaining effective training for higher level responsibility and command.

Table 31. Training Evaluation of the Commercial Combat Models

MOE's	MODELS		
	GBURG	UMS I	TAC
METT-T	Fair	Good	Good
OCOKA	Poor	Good	Good
POW	Fair	Fair	Very Good
TENETS	Fair	Good	Very Good

Concurrent with this lower echelon training, *Thunder at the Crossroads* could be assigned to a battalion project officer to investigate with the objective of becoming the subject matter expert on the model. This process would be made easier if the officer had a good background of the historical battle. Once the officer became the expert on the model, he would be able to facilitate the use of the model in a battalion level training exercise. After the platoon and company levels had trained on their respective models, a battalion level exercise involving the entire battalion chain of command could be initiated. The battalion commander and the staff would all participate in the roles designed within the model. The executive officer or operations officer could battle against the battalion commander as the oppossing army commander while other staff officers would operate in their standard battle roles. The company commanders would act as corps and division commanders receiving and executing orders from the army commanders. The use of the battalion staff in the model would exercise the mission planning process while the play of the game would generate questions and discussions concerning the underlying principles of warfare. The concepts and principles practiced and discussed through the play of the model would improve the overall operations of the battalion.

8.1.3 The General Research Process. Throughout the study of the commercial models and the battle of Gettysburg, the level of knowledge concerning the historical event and combat modeling continued to grow in the participants of the

study. The examination of the battle permitted an investigation into the principles and themes of warfare that impact on military leadership and tactics. The investigation of the commercial models highlighted the strengths and weaknesses of commercial combat models. The result of these two events was an increased level of tactical awareness and skill, a higher degree of expertise with combat models, and a greater preparation for higher levels of command.

8.2 Recommendations

The recommendations from this research effort were based upon an initial realization of the limited scope of the study and the current lack of analytical research into the benefits of commercial combat models. Additional recommendations were developed based upon the research conducted and the findings developed.

The first recommendation concerns the investigation and development of additional measures of effectiveness with which to judge the training value of the models. The measures used in this research were based upon one individual's expertise and military experiences. Other measures need to be investigated which may shed additional light onto the training value of commercial combat models.

With regards to the battle of Gettysburg, research into the training value of *Thunder at the Crossroads* and other models that deal with the battle in greater detail need to continue. Models that deal with the movement and combat of forces at the regimental level worthy of investigation are *Gettysburg: The Turning Point* and *Terrible Swift Sword.* The answer to questions concerning the relationship between model detail and training benefit must also be addressed. Additional work should concentrate on developing a list of training objectives for *Thunder at the Crossroads* to assist in the use of this model as a training device in the military.

The final recommendation concerns the continued investigation of the numerous commercial combat models on the market. A focus on commercial war games which treat modern warfare consisting of naval, air, and ground combat would

be beneficial. This investigation could be accomplished in conjunction with an investigation of the commercial war games used in support of Operation Desert SHIELD/STORM. Different military analysis agencies could be approached concerning which commercial combat models they may have used in the planning or wargaming of military operations.

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Vita

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