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Monterey, California

THESIS

A BAYESIAN MODEL TO INCORPORATE HUMAN FACTORS IN COMMANDERS' DECISION MAKING

by

Sakura Sen Therrien

June 2002

Thesis Advisors:	Nita Lewis Miller
	Saverio Manago
Second Reader:	Matt Chesney

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13. ABSTRACT ***(maximum 200 words)***

In the near future, commanders and their respective staffs will interact with subordinate and opposing forces whose physical and cognitive behaviors are represented in software and simulation. This paper presents a model of the human factors and environmental variables that influence stress and risk assessment. These variables contribute to situational awareness, which is a force protection issue.

Leaders integrate information from various sources. These sources range from observations, training, orders, and reports. The leaders use this knowledge with doctrine and tactics to develop an understanding of the situation. This paper describes a Bayesian network model of the variables associated with risk assessment and stress in combat scenarios. The level of situational awareness is determined by what the commander knows about the unit and the surrounding conditions. This model lends structure to the environment and enables a probabilistic interpretation of risk and stress levels. This model is applicable to various combat scenarios ranging from brief engagements to sustained operations.

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A BAYESIAN MODEL TO INCORPORATE HUMAN FACTORS IN COMMANDERS' DECISION MAKING

Sakura S. Therrien
Captain, United States Army
B.S., University of Central Florida, 1994

Submitted in partial fulfillment of the
requirements for the degree of

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June 2002

Author: Sakura S. Therrien

Approved by: Nita Lewis Miller, Thesis Advisor

Manago Saverio, Thesis Advisor

Matt Chesney, Second Reader

Jim Eagle, Chairman
Department of Operations Research

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ABSTRACT

In the near future, commanders and their respective staffs will interact with subordinate and opposing forces whose physical and cognitive behaviors are represented in software and simulation. This paper presents a model of the human factors and environmental variables that influence stress and risk assessment. These variables contribute to situational awareness, which is a force protection issue.

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ACKNOWLEDGMENTS

This is dedicated to my dearest friend, Vedat Bayram. Through his patience and gentle heart, he gave me the light to walk through this tunnel and motivated me to complete this school. I have never had a friend like him who is truly a blessing from God. He will always have a special place in my world and heart.

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EXECUTIVE SUMMARY

This paper presents a model of the human factors and environmental variables that influence stress and risk assessment. These variables contribute to situational awareness, which is a force protection issue. Leaders integrate information from various sources. These sources range from observations, training, orders, and reports. The leaders use this knowledge with doctrine and tactics to develop an understanding of the situation. This paper describes a Bayesian network model of the variables associated with risk assessment and stress in combat scenarios. The level of situational awareness is determined by the commander's knowledge of the unit and surrounding conditions. This model lends structure to the environment and enables a probabilistic interpretation of risk and stress levels. This model is applicable to various combat scenarios ranging from brief engagements to sustained operations.

With the rapid development of sophisticated equipment and weapon systems, today's combat systems are lethal and complex. Therefore, the human ability to master these systems and incorporate them into the decision-making process must grow proportionally to the rate of the ongoing battle. Regardless of whether the unit is combat arms (such as infantry, armor, or artillery) or combat services support (ranging from ordnance, quartermaster, or transportation) the unit must be thoroughly trained in certain tasks in order to complete the mission and make sure that it is successful in battle. Safety and combat effectiveness are two elements of force protection that have not been adequately addressed in the past. By considering human factors, we can enhance force protection. Part of ensuring safety and combat effectiveness is good situational awareness. Modern leaders have difficulty keeping track of all the variables and complexities required for good situational awareness. The complexity and structure of this environment can be graphically modeled with Bayesian networks to enhance situational awareness.

This thesis takes into account pertinent factors such as logistics, physical fitness, threat, planning, risk assessment, mission, stress, performance and duration of the operation. The model can be modified depending on threat, location, and mission. Probabilities for events occurring for each node in the model have been assigned based

on experience and beliefs. This model is designed to help leaders gain a better understanding of their environment and how it affects risk and stress. The model should give leaders insight into expected levels of stress and risk. This model considers numerous factors; however, there are other variables that may affect risk and stress, which may be included.

I. INTRODUCTION

The military services recognize the importance of improving unit training, personnel, equipment, tactical doctrine, weapon systems and ergonomics. In general, the United States Army notes that accurate measurements of combat effectiveness are vital to the following objectives: (1) determining the combat readiness of units; (2) assessing and evaluating the training of units and identifying needs for follow on training; (3) identifying improvements in doctrine, training, organization, material, and leadership that will contribute to greater success on the battlefield.

Regardless of whether one is from the French Foreign Legion or Merrill's Marauders, as time progresses, the military relies on actual combat to evaluate their leadership, training, and organization. For example, in 1876, Lieutenant Colonel (LTC) George Custer marches into Little Big Horn Valley with the 7th Cavalry. Unfortunately, LTC Custer does not know that 4,000 angry Indians are waiting to meet the 7th Cavalry. Ultimately, Custer's command is destroyed. Ironically, history repeats itself almost 100 years later in 1965. Now it is Lieutenant Colonel Hal Moore. He moves 7th Cavalry into the Ia Grang Valley in North Vietnam. There he engages 4,000 angry North Vietnamese. The only difference is that LTC Moore is successful in his engagement. How does LTC Moore know what to do? Maybe he is familiar with LTC Custer and the engagement at Little Big Horn. The military does not like to repeat its mistakes. LTC Hal Moore studies the scenario and the history of the Ia Grang Valley in North Vietnam. He realizes the similarities of this mission with respect to those of LTC George Custer in the Battle of Little Big Horn Valley. LTC Moore knows that he must not repeat the steps of LTC Custer or the engagement would be an automatic loss. Studying the history aids in his success in the battle. (Knowledge from books is an asset in making sure that leaders do not make the same mistake).

History cannot always prepare us for future battles. Changes in equipment, soldiers, and doctrine often make many historical lessons of limited utility. Leaders must rely on realistic training in order to prepare for modern battle. The problem is that the

more realistic the training, the more costly it is to perform. Thus it is vital to develop another method of enlightening leaders on various aspects of engagements while minimizing the cost. The Bayesian network model in this thesis is designed to help junior leaders understand the situation and to give senior leaders timely information so as not to repeat mistakes. Obviously, LTC Hal Moore modeled in his mind what was required to take place and when it was to occur so that he would not go down in history with LTC Custer. With the improvement of technology, DOD has worked to develop models and simulators to cut down on the cost of actual training. Unfortunately, many analysts have developed models that "capture the combat capabilities of one service at a time" (Powers, 1998). Models that reflect the capabilities of all services are required in order to have a more complete representation of the battlefield.

The model in this thesis is an initial effort to incorporate the capabilities of all services using a Bayesian Network. With the rapid development of sophisticated equipment and weapon systems, today's combat systems are lethal and complex. Therefore, the human ability to master these systems and incorporate them into the decision-making process must grow proportionally to the rate of the ongoing battle. As time has progressed, military research seeks to find the relationship between training for combat and many other variables. Two such variables are unit performance (based on human influence) and direction by the commander. Regardless of whether the unit is combat arms (such as infantry, armor, or artillery) or combat service support (ranging from ordnance, quartermaster, or transportation) the unit must be thoroughly trained in certain tasks in order to complete the mission and make sure that it is successful for the overall battle. Safety and combat effectiveness are two elements of force protection that have not been adequately addressed by leaders in the past. By considering human factors, we can enhance force protection. Part of ensuring safety and combat effectiveness is good situational awareness. Modern leaders are stretched to keep track of all the variables and complexities associated with good situational awareness. The complexity of this environment can be modeled with Bayesian networks. In return, the model will give leaders valuable insights into issues such as human performance, stress and risk.

A. THE PROBLEM AND ITS SETTING

1. The Statement of the Problem

The development of combat models and combat simulations do not accurately represent human factors and the impact that they have on combat operations.

2. The Hypothesis

The development of this Bayesian Network model will improve situational awareness, enhance decision-making capabilities, and will improve the ability of leaders to consider issues of operational tempo and risk which are key force protection issues.

3. The Scope

This thesis will focus primarily on the development of a Bayesian network that incorporates the various aspects of human performance, risk and combat effectiveness that are considered vital to a unit's performance.

4. Assumptions

The Bayesian network model is fluid. This model changes in accordance with the stated mission and the factors involved with particular unit(s) and mission(s).

The conditional probabilities are based on expert opinion, documented data, and doctrine for the US Army. For instance, in the Node *Fitness Level*, Army doctrine states that the unit will maintain a unit readiness of 90%. Thus for the state of Fitness Level 1 (the worst case for physical fitness), in the absence of any information, the probability of 10% was given.

Doctrine governs what percentage of readiness is necessary for success of the mission. A readiness level of 90% governs certain nodes such as *Fitness Level, Logistics, Threat,* and *Risk Assessment*. For instance, if vehicles are not 90% mission capable, then the unit is not considered to be fully functional and may not be deployed.

5. Importance of the Study

Decision-makers may use this model in the development of an algorithm/program that will enhance decision-making capabilities that are necessary given a particular mission or scenario. The Bayesian network model represents the variables associated with stress and risk assessment and how they impact our combat operations. The network can be adapted to accommodate various scenarios from all services ranging from brief engagements to sustained operations.

II. LITERATURE REVIEW

A. OVERVIEW

Prior to its recognition as a formal field of study, psychological principles were applied in organizational settings. It was not until the beginning of the 20th century that psychologists began studying workplace behavior (Smither, 1998). One of the critical reasons for examining workplace behavior was, and still is, the desire to improve human performance. People work together in complex organizations that have a variety of goals. Organizational goals influence how people behave, but people bring their own objectives, ideas, and patterns of behavior to organizations. Therefore, the study of the psychology of work is important to organizational effectiveness.

The U. S. Army has attempted to determine how various aspects of the environment, including stress, influence human behavior. The U.S. Army Research Institute (ARI) initiated a major research program designed to better understand the effects of stress on Army units. This research focused on training conducted at the National Training Center and Joint Readiness Training Center.

Since the 1990's, one of the primary missions of the U. S. Army Research Institute for the Behavioral and Social Sciences has been to conduct research and develop methods to maximize the performance and effectiveness of combat units. Even though ARI has increased its emphasis on unit-collective training research, it recognizes that the army fights in a unit consisting of a group of soldiers of varied backgrounds and cultures. ARI's research on unit collective training has not been without challenges. Some of the challenges to be considered are:

1) The development of reliable measurement methods and technologies for assessing unit performance effectiveness,

2) Determining the effects of soldier courage in combat,

3) Ensuring that Army doctrine keeps up with technological advances and capitalizes on them, and

4) Maximizing the training opportunities with advanced technology while minimizing the cost of this training.

Despite these challenges, the US Army seeks to understand the relationship between preparation for combat and unit performance effectiveness. Most research and study efforts have been designed to explain individual performance by using individual factors, such as mental aptitude scores. The challenge for the military is to understand unit effectiveness. Human behavior will determine the outcome of a battle and must be considered.

B. THE HUMAN DIMENSION IN COMBAT

In preparation for combat, there is more than just technical and tactical training of soldiers. Other factors, which may be considered when preparing soldiers for combat, are morale, motivation, esprit de corps, fear, courage, and the anxiety levels of individual soldiers. These are critical to the conduct of warfare. The Army Research Institute has conducted a vast amount of research to measure the effects of soldier morale, motivation, and cohesion on performance outcomes in simulated combat.

Military leaders know that courage is the heart of a soldier's combat performance. Courage is a soldier's fortitude, inner strength, and will to persevere despite fear and the adverse conditions of combat. A person can learn to fire a rifle and use military equipment; however, this alone does not make a soldier. A soldier's courage is molded by Army values and training principles, which help develop his spirit and his relationship with his comrades (Ozkaptan, 1994).

The role of man in combat was the obsession of COL Ardant du Picq. The quotation characterizes his beliefs.

> "…never for a second did Ardant du Picq forget that combat is the object, the cause of being, the supreme manifestation of armies. Every measure therefrom, which relegates it to the middle ground is deceitful, chimerical, fatal. All the resources accumulated in time of peace, all the tactical evolutions, all the

strategical calculations are but conveniences, drills, and reference marks to lead up to it" (du Picq, 1921).

The primary focus of COL du Picq was the human dimension of the battlefield. He believed that man is an incomparable instrument whose elements, character, sentiments, fears, energies, instincts, and desires are stronger than the rules and theories, which we use when we engage in battle. Experts and simulators have made great strides since the time of Ardant du Picq who set the stage in modeling human characteristics on the battlefield. Today, we are able to obtain and model information and data at rapid rates. COL Ardant du Picq observed that while all other circumstances alter as time progresses, human limitations remain the same. Humans are capable of only so much endurance, sacrifice, and effort.

The Defense Modeling and Simulation Organization (DMSO) proposed a framework to model human behavior to meet short, intermediate, and long-term goals. Four elements were considered. These are: 1) collect and disseminate human performance data, 2) develop accreditation procedures for human behavior models, 3) support sustained model development in focused areas, and 4) support theory development and basic research in necessary areas.

For the first element, the DMSO wanted to extend results from laboratory studies of basic human capacities to the way military forces actually behave. The main goals are to:

- support the development of accreditation procedures,
- compare model outputs in validation studies with target performance,
- set the guidelines of the actual models of real-world taskings,
- test and evaluate the effectiveness of those models, and
- challenge the existing theory to lead researchers to new concepts that will provide the basis for future models.

An ancillary goal would be to have data that could be shared and applicable to all branches of the military.

For the second element, DMSO has established a formal procedure for accrediting human behavior models. After measuring human performance quantitatively, the modeler should determine the cost-effectiveness of incorporating the various aspects of human performance into alternative models. The objective is to create a method that would provide for human behavior representation in military combat models. The accreditations should include:

- demonstration and verification,
- validation,
- analysis,
- documentation, and
- summary.

For the third element, the modeler should use task analysis and structure. This will establish the model's purpose. For this task analysis, interdisciplinary teams should be used and benchmarks should be specified.

For the fourth element, there is a requirement for continued support of theory development and basic research in areas such as decision-making, situational awareness, learning and organizational modeling. The United States continually strives to move forward in technological development so that our country can defend itself and minimize threat. We need to support future generations of models in order to provide insight to the technological advances taking place.

Based on the four goals listed above, progress has been made in developing reliable measurement methods and technologies for assessing unit performance effectiveness (Holz, 1994). However, additional improvements can always be made. The Bayesian network model in this thesis is an effort to apply existing probabilistic theory to the modeling of human behavior.

C. BAYESIAN NETWORKS

Since the early 1990s, Bayesian networks have attracted a great deal of attention from research as well as industrial applications. To effectively exploit their use, Bayesian networks require theoretical insight and practical experience. The Bayesian

network concept began in the late 1960s where the first expert systems were developed. An expert system is a point of view based on a person and that person's area of expertise such as a pilot flying an aircraft. The concept was that experts could be replaced by computer systems that are modeling the experts in their field throughout the world.

The rules began with some basic building blocks for modeling. The condition was a logical expression or **rule** such as **if** *condition* **then** *fact* or **if** *condition* **then** *action* (Jensen, 1996). The combination of the knowledge base and inference system (deductions) developed the rule-based system. A set of these rules develops the knowledge base while the inference system utilizes rules and observations to think of conclusions for a state within a particular job or area of expertise.

In mathematical concepts, a Bayesian network is a graphical representation of the joint probability distributions for a set of discrete variables. The representation consists of a directed acyclic graph. The probability assigned to each node is the conditional probability given the parents of that node.

The graphical representation makes Bayesian networks a flexible tool for constructing models of uncertainty, which show relationships between variables. Specifications of probabilities are focused on small parts of the model. In this model, *Threat* is related to *Operational Tempo*, which is related to *Sleep Condition*. The state of some variables remains constant. For example, during Task Force Smith, the *Threat* during the operation remains constant. In the Battle of Midway, the node for *Weather* stays the same throughout the duration of the battle. Once a variable is instantiated, marginals are computed and the conditional probabilities for each variable are updated. Algorithms/programs are developed for probability updating. They perform very efficiently on a large variety of models (Shenoy and Shafer). This is what makes Bayesian networks well suited for probabilistic inference and diagnosing. This Bayesian network is a graphical representation of the variables associated with human factors.

When we engage in battle, our human limitations can influence the outcome of battle, regardless of our level of training or knowledge of doctrine. Present-day battlefields tend to be nonlinear and dynamic. It is the dynamic nature of the current

battlefield that leads to more uncertainty in the decision-making process. Leaders must be able to leverage technology in order to keep pace with system developments and the rapidly changing face of the modern battlefield. Bayesian Networks can enhance a leader's ability to conduct probabilistic reasoning to deal with the uncertainty associated with the rapid changes taking place.

D. MODELS OF HUMAN FACTORS

Human factors are the interaction of people with equipment, environment, and other specified conditions (MSRR, 2002). Human participation and influence permeates combat. The effects of human performance are frequently considered only implicitly, if at all in combat models. As a result, there has been a need for better representation of the human element in combat models. The majority of the current analytic combat models have provided a better representation of equipment capabilities than the human component of the weapon system. Biomechanics helps design systems that utilize human physical strengths and disregard the weaknesses. "Biomechanics uses laws of physics and engineering concepts to describe motion undergone by the various body segments and the forces acting on these body parts during normal daily activities (Eliason, 1999)." This field incorporates the effects of fatigue, stress, and environmental factors on human performance.

The Center of Army Analysis (CAA) has collected data on human performance in the field. They have developed a data source that is called the Model Effectiveness as a Function of Personnel (ME = f(PER)). The project encompasses areas that model the battlefield processes to include the effects of human factors and human performance. The purpose of this project is to identify those areas in which the modeling of battlefield processes in the Center of Army Analysis could and should be adapted to include the effects of human factors and human performance. The collected data demonstrated that human factors affects combat. Therefore, the Force Evaluation Model (FORCEM) could be modified to reflect the detrimental effects of environment and stress on humans. Also, this project shows that preprocessing and sensitivity testing should be used to evaluate the effects of soldier characteristics such as mental status, which does not change greatly

during the combat period. The results were a list of variables that should be included in combat models, an implementation plan for the list, and another list of important variables that requires additional testing before it can be incorporated.

ME=f(PER) is not a simulation. It is a model that collects data on the effects of human factors and human performance. By collecting actual data, the military can learn to incorporate these factors into their work environment and training. This will give researchers a better understanding of how to train soldiers to prepare them for battle.

In June of 1998, the Human Research and Engineering Directorate of the US Army Research Laboratory developed the Improved Performance Research Integration Tool (IMPRINT). IMPRINT is a model that incorporates human factors. The model is a stochastic network tool. Performance time, operational missions, and maintenance support are connected in a network. Profiles for the soldiers are created so that their work distributions are recorded and examined. The system will collect data on the high and low points of their work distributions during the exercise. IMPRINT monitors the personnel characteristics, environmental stressors, and training frequency during the exercise (IMPRINT, 2000). The system requirements refer to "soldier-driven constraints" of equipment design. It uses the collected data from soldier performance within the new system. Then it estimates what is necessary in making the system better. During the simulation, IMPRINT utilizes task analysis, decision-making, and personnel characteristics (IMPRINT, 2000).

Manpower and Personnel Integration (MANPRINT) incorporates soldier and unit needs throughout the entire system acquisition process and life cycle. This program was designed to improve the effectiveness of system performance at minimum cost to personnel, maintenance and repairs. MANPRINT integrates 7 key features: manpower, personnel, training, human factors, system safety, health hazards and soldier survivability (MANPRINT, 2000).

Dr. John Weisz, Director of the US Army Human Engineering Laboratory at Aberdeen Proving Ground in the 1960's stated that "we can no longer afford to develop equipment and merely hope that the necessary manpower can be found to operate and

maintain it in a relatively short time. The cost of training and time available to conduct it on a mass basis may not permit this process under wartime conditions." MANPRINT was developed because two problems continuously surfaced. First, when soldiers used a new system, the actual field performance did not meet the desired standards during the development. Next, replacing an older weapon system with a more complex one often required more personnel to operate, maintain, and support the system (MANPRINT, 2000).

With the advancement of weapon systems in the early 1980s, there were concerns about sustainability, mobilization, and readiness. General Walter Kerwin and General George Blanchard decided that human performance assessments were not integrated in the systems. During the design stage of the acquisition process for the system, human performance was ignored. General Accounting Office (GAO) stated that 50% of the equipment failures were due to human error. This illustrated the need to integrate manpower, personnel and training with the development of the system (MANPRINT, 2000).

E. MODELS IN RISK ASSESSMENT

In July 1995, the Chief of Staff of the Army stated, "Risk Management is the Army's principle risk-reduction process to protect the force. Our goal is to make risk management a routine part of planning and executing operational mission." At this point, the US Army redefines its standard for risk management. The leadership, regardless of the level of authority, would make informed decisions to minimize the risks and control the hazards. Leaders now became responsible for properly assessing their mission or operation as a total system. They would also make sure that the planning, risk management decisions, and execution would include verifying the hazards, considering the associated risks, and implementing control measures necessary to reduce the risk level.

Risk management became a priority in the late 1980s (Safety Center, 2002). The US Army has compiled pamphlets, reference cards and guides books for the senior leaders to minimize risk in various situations, whether at the workplace or in the field.

Of course, most operations and missions have a degree of risk. The level of authority for making decisions on operations that include high levels of risk are established prior to an operation. Thresholds are set that direct commanders to different levels of authority, depending on the level of risk. To clarify, if there are no resources available to control a high risk, then the issue must be brought to the attention of the higher command. The leader is to continue up the chain of command until there is level of command that has the ability to eliminate or control the hazard. Then the decision can be made as to whether or not to commit to the mission (Safety Center, 2002).

Risk management is a 5-step problem-solving process based on the standard Army decision-making process. These steps are to be integrated in the decision-making process. The main points of risk management are 1) to identify hazards and 2) to develop and implement controls. The following are the 5 steps to risk management (see Figure 1):

Figure 1. Risk Management Model

1. Identify the hazards. Hazards are conditions that lead to accidents. Identifying possible hazards is the first step to prevent the loss of combat power, injured soldiers, or damaged equipment (Leader's Force Protection Card, 1995). An example would be driving M1 Abrams tanks on icy roads.

2. Assess the hazards. Determine how badly the identified hazards can affect the mission. There is a risk assessment card at most units that measures the level of risk. An example of a risk assessment card is located in Appendix N (Leader's Force Protection Card, 1995). Continuing with the example above we would use the risk assessment card and score the risk value of driving on the ice with the tank.

3. Select Controls and Make a Decision. Leaders must eliminate unnecessary risks. The leader must find the balance between benefits to be gained from the mission and the potential costs to the mission (Leader's Force Protection Card, 1995). For our example, the leader needs to determine how to prevent sliding when driving the tanks.

4. Implement Controls. Control measures are part of the operations order. Leaders need to make sure that all soldiers are aware of the potential hazards and the control measures that reduce the risk (Leader's Force Protection Card, 1995). In this case, the leader needs to have some of the rubber track pads removed. This will increase traction similar to snow chains on a car.

5. Supervise. A strong command climate, good discipline, and thorough training will reduce the risks associated with operations. Reinforcement of control measures will protect the force from accidental losses (Leader's Force Protection Card, 1995). To see if the unit followed instructions, the leader should check the vehicles for compliance.

Since the end of the Cold War in 1989, the Army has had more deployments than in previous 40 years. Our deployment rate has increased by 13-fold (Safety Center, 2002). The Army's overall air and ground accident rates have decreased dramatically. The Army’s risk management program has made a significant contribution towards minimizing accidental losses (Safety Center, 2002).

F. MODELS IN STRESS

Stress is any demand (such as a force, pressure, or strain that is placed on the body) as well as the body's reaction to these demands. Everyone experiences stress at some point in his or her life. People cope with stress differently. When people refer to stress, it usually has a negative connotation. As people are threatened or challenged in situations, the reactions or feelings that are encountered are described as stress. Stress reactions are not necessarily all negative. Some stress is required for survival, but after a long period of time, it could have an adverse effect on the body.

Research in this area has dealt with the body's reaction to stress and cognitive processes that are influenced by stress. People who experience similar situations in life do not react the same. Therefore, stress levels are different from person to person (Pearlin, 1982). Because of these factors, stress is being re-evaluated.

People show the effects of stress in numerous ways. Some examples of things that can be affected are personal and work relationships. Examples of things that cause stress are taking an exam or driving in rush hour traffic. The Biopsychosocial Model of Stress (Bernard & Krupat, 1994) was designed to incorporate these various factors. This model is based on three components. They are: 1) external 2) internal and 3) the interaction between the external and internal components (Cordon, 1997).

The external component involves environmental events that trigger and release a stress response. Examples include times when a person feels aggravated, pressured, or are in conflict. Usually, these feelings belong in one of four categories (Cordon, 1997). They are personal, social/family, work, or the environment. For instance, a person does not work well with a fellow peer. They constantly have disagreements during the day. At least one of the two people will have increased health problems such as ulcers or nausea until the issues are resolved (Bernard & Krupat, 1994). If the situation is not resolved soon, chronic stressors can pose a serious health risk because of the prolonged manifestations of stress in the body.

Secondly, the internal component deals with a set of neurological and physiological reactions to stress (Cordon, 1997). According to Hans Selye, stress is

"nonspecific." While a person experiences prolonged stress, he/she will go through three internal phases. They are Alarm, Resistance, and Exhaustion phases (Selye, 1985). This is also known as General Adaptation Syndrome (GAS). In this situation, the person will engage all resources to deal with the impending problem or threat. In the first stage of Alarm, the body begins a "fight-or-flight" response (Cordon, 1997). This is a neurological and physiological response that confronts the stressor. Basically, the body goes through a series of system checks to increase the metabolism and energy of the person. In the second stage, Resistance, you experienced a heightened state of arousal (Cordon, 1997). If this state lasts for too long, then the high level of hormones becomes detrimental to the internal organs leaving the person vulnerable to illness. The third stage, Exhaustion, occurs after prolonged stress. At this point, the body has relinquished all energy reserves and begins to break down (Cordon, 1997). Examples of stress-induced illness include headaches, insomnia, high blood pressure, and coronary disease.

The third component is the interaction between the external and internal factors. This involves the individual's cognitive processes. This component focuses on the interaction between the individual and the environment (Cordon, 1997). The emphasis is primarily on the meaning of the event for the individual and not the physiological response. In other words, it is how the person views whether the situation is stressful or not. For example, when encountering a potential bomb, an explosive ordnance disposal unit will not experience as much stress as a person with no experience diffusing bombs. Overall, the way an individual views the situation determines the magnitude of the stress response.

The Holmes-Rahe Scale (Appendix B) measures stressful life events. If any of the events listed have occurred in the person's life within the last 12 months, then the person checks the block next to the event. A score is associated with each event. The total scores for the indicated events are then tallied and a total score is given. The grand total indicates how stressful the past year has been. Thresholds are set for different levels of stress. They are 1) a score less than 150 is low, 2) a score between 150 and 299 is in the middle, and 3) a score greater than 300 is high. By taking this simple test, leaders

may become aware of personal problems and stress that may be hindering a soldier's performance. Leaders can take action accordingly to assist the soldier (APFRI, 2002).

The primary models mentioned earlier, that are presently used in measuring human performance, also incorporate risk assessment as well as stress. Those models are Model Effectiveness as a Function of Personnel, Brigade/Battalion Battle Simulation, and MANPRINT. These models also link human factors with stress and risk assessment.

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III. METHODS

A. THE MODEL

The primary task in model building is to identify variables that affect the mission and to understand how these variables interact with each other. Bayesian networks are one modeling technique that provides a graphical representation for handling domains of inherent uncertainty. The purpose of a Bayesian network is that its purpose is to give probabilities for events of variables that are either not observable (or only observable at an unacceptable cost). The task becomes to identify the types of information available to the modeler, which may reveal something about the state of the variables. Afterwards, the primary focus is to determine which events have a direct causal impact on other variables.

A Bayesian network is a directed acyclical graphical model. The graphical model has nodes that represent random variables and provide decision makers with a notion of dependence. Bayesian networks are subsumed by influence diagrams, which are commonly used to make decisions based on probabilistic reasoning and values of expected outcomes. The Bayesian network is one tool that allows decision makers to model the concepts and ideas of today's battlefield.

With combat systems being faster, more lethal and sophisticated than ever before, the present-day battlefield tends to be nonlinear and more dynamic. This dynamic nature leads to increased uncertainty in the decision-making process. Leaders must be able to leverage technology in order to keep pace with system developments and the rapidly changing face of the modern battlefield. Bayesian networks can enhance a leader's reasoning ability to accommodate probabilistic and rapid decision-making. This allows the leader to deal with the uncertain reasoning associated with the brisk pace of the changes that are taking place.

Decision-makers may use this project in the development of an algorithm that will enhance the decision-making capabilities that are necessary for a particular mission or scenario. The Bayesian network model represents a range of important human factors

and describes how these human factors may impact combat operations. The network can accommodate various scenarios ranging from short battles to long-term sustained operations.

This graphical model combines probability and graph theory. Uncertainty and complexity are the two problems that occur throughout missions, which continue to play an important role in combat systems and analysis. The model takes into account variables such as physical fitness, risk assessment, environmental factors, logistics, threat, and duration of the mission. The model can be modified to add or subtract variables based on the upcoming mission. The variables are connected in a directed acyclic graph and take into account prior knowledge. This representation allows decision makers to make explicit what they would normally do tacitly. To a novice, a Bayesian network can provide valuable insight and may serve as a training tool. This graphical representation can also offer valuable insight to experienced decision makers allowing them to take many variables into account simultaneously. As stated by Michael Jordan in 1998, "The graphical model framework provides a way to view all of these systems as instances of common underlying formalism."

The model is tested using three well-known scenarios from historical battles that are often used in training. The scenarios are Task Force Smith, The Battle of Midway, and The Battle of Kursk. The scenarios are located in Appendices E-G.

B. THE NODES

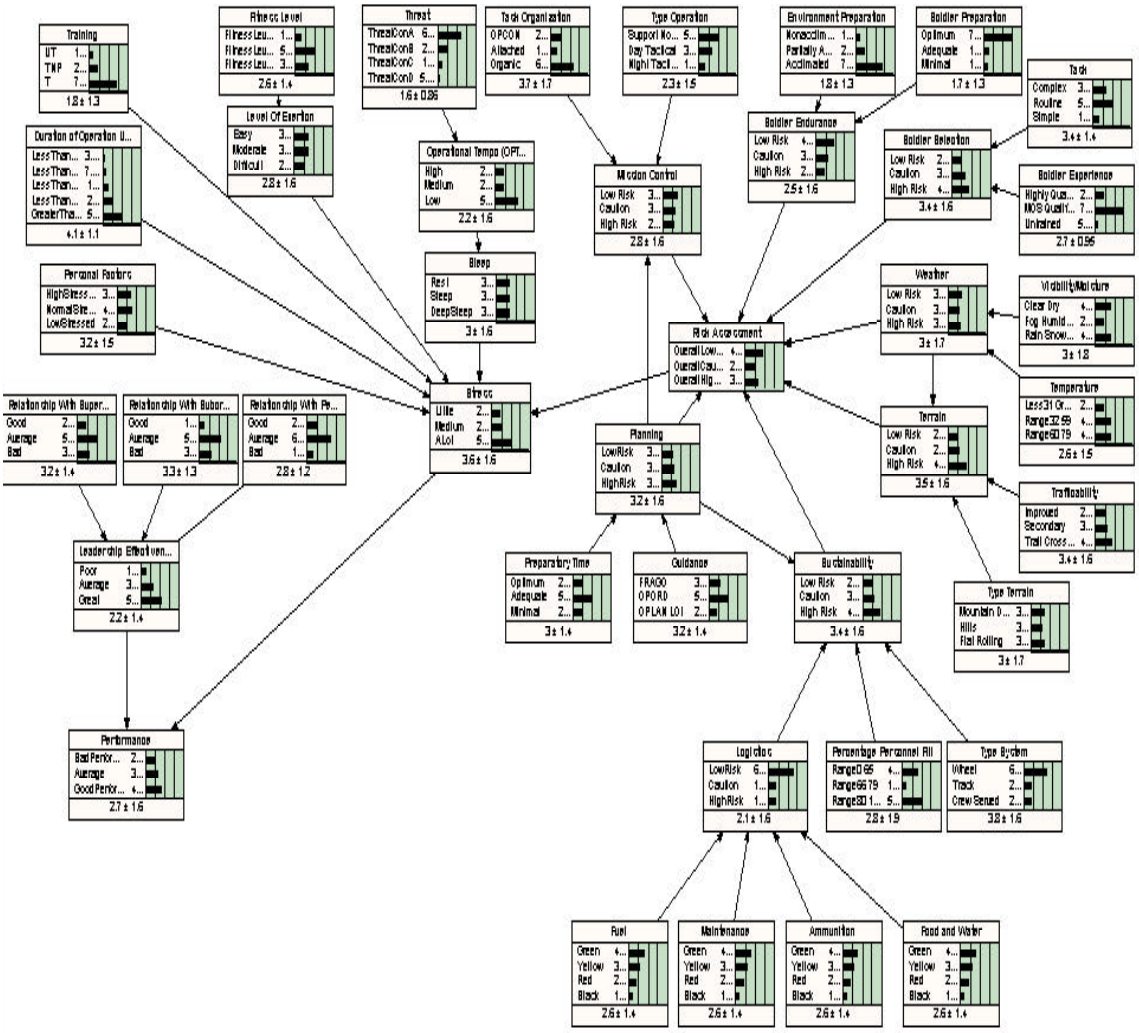

Figure 2. Generic Model of Bayesian Network for Stress and Risk Assessment

This model involves 41 nodes. There are four critical nodes, *Risk Assessment*, *Leadership Effectiveness*, *Stress*, and *Performance*. These four primary nodes are the focus of this model. The parent nodes, *Leadership Effectiveness* and *Stress*, flow into their child node, *Performance*. *Risk Assessment* flows into *Stress*. *Risk Assessment* is central to this model. The nodes represent factors that may be considered prior to a battle or during a battle. There are numerous possibilities to be considered in developing this

model. In all, these 41 nodes are just a handful of the variables that may be considered during a battle.

First we will begin with a brief introduction to leadership effectiveness. Field studies give the researcher data on the relationship between a leader and superior. The leader's intellectual abilities are utilized best in situations where the relationship between leader and superior are relatively free of stress. When the relations are stressed, the more intelligent leaders make poorer decisions than those with lower intelligence. Stress strongly affects how effectively you think on your feet versus making a calculated decision. Interpersonal stress diverts the individual's focus from the task to the troubled relationship. The leader may then spend time contemplating the consequences of failure, the need to avoid the superior, or how to find another job. These thought processes divert the leader's intellectual effort from the task and thus lower the relationship between leader intelligence and task performance (Heller, 46).

In 1980, D. H. Bordon conducted a study of an army infantry division that was designed to assess the effects of stress caused both by job and supervisor. The combat infantry division‘s officers and noncommissioned officers (45 company commanders, 37 company executive officers, 106 platoon leaders, 42 first sergeants, and 163 platoon sergeants) underwent various intellectual tests and questionnaires. The primary test used was the Wonderlic Personnel Test. This test measures general mental ability for aid in personnel selection for particular jobs or positions. One questionnaire asked personnel to rate stress with their seniors and stress created by the job (Heller, 47).

From this study, it was concluded that stress is a moderating factor in the correlation between the leader’s intellectual ability and the performance of their unit. There are three explanations for the influence of stress on leadership performance. First, stress may divert a leader’s intellectual effort from the task at hand. Second, stress may affect clarity of communications. Third, stress may interfere with supervision and control of the task. Thus stress may impair the leader’s ability to plan and implement decision-making (Heller, 47).

This is just an example of how stress impacts superiors, peers, or subordinates and the steps in which a leader will process information to make an accurate decision. The decisions and his/her personal actions could determine the performance of the unit and the outcome of the battle, just as this model shows some factors to be considered for a wartime situation. This Bayesian Network will show, through historical scenarios, that stress plays an important role in the performance of the decision-maker.

The stress faced by the decision-maker or a professional may be substantial. For many professionals, it is intrinsic to the job itself, where competing demands and pressures cannot be escaped. The sheer volume of work can also be overwhelming at times. Either from his or her own direct experience or from observing colleagues, stress can have serious consequences. Stress can become a living nightmare of running faster and faster to stay in the same place, feeling undervalued, feeling unable to say 'no' to any demand but not working productively or efficiently on anything. Signs of stress include sleeplessness, aches and pains, and some physical symptoms such as anxiety or nausea associated with work. Unfortunately, some personnel are chronically stressed, becoming irritable, and self-absorbed, lacking energy and commitment. Concentration on even one task becomes difficult for these individuals and they become unreliable in completing their job, mission, or task (Fontana, 1989).

And yet, there are some people that possess the ability to control stress and workload levels, handling job frustrations without becoming worn out, irritable, or depressed. These people are able to handle stress, balancing the rough with the smooth, keeping a sense of humor and renewing their energy and resources so that the working life continues to bring pleasure and reward (Fontana, 1989).

Performance is another factor that must be looked at carefully. The documentation that addresses the performance of humans on specified systems tasks and task sequence constitutes a performance standard. Human factors performance standards usually are concerned with how well an individual or team performs as evaluated against system-specific performance specifications. Human performance standards may include time to select an action; time and accuracy in making decisions; accuracy interpreting information, problem solving, diagnosis, action selection, team performance,

communication and control activities, time to respond, and workloads associated with a control sequence (Charlton, 57).

The primary node related to this is *Performance*. *Performance* is a descendant of every other node in this model. *Performance* is broken into three states - Poor Performance, Average Performance and Good Performance. The decision-maker determines what he/she expects to be a Poor Performance, Average, or Good Performance.

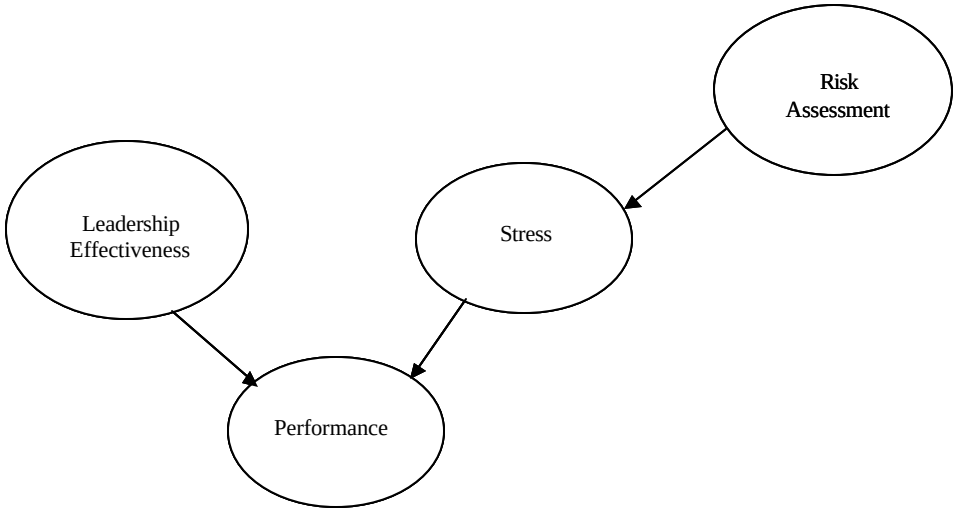

Figure 3. The Basis for the Model

One node leading to *Performance* is *Stress*. The soldier/sailor is the backbone of the military. With the demands imposed by a new situation, the stress on a soldier/sailor can be significant. The node *Stress*, representing the soldier's well-being, has the following parent nodes: *personal factors*, *level of exertion, sleep condition, duration of operation*, and *risk assessment.* The *Stress* node possesses three states defined as low, moderate, and high. "Low" stress is defined as the lower 25% of the various combinations for stress, "moderate" ranges between 26%-74%, and finally, "high" is defined with a range greater than 75%. Of course, this status of well-being is based on an individual level. Some people function much better in a stressful environment than in relaxed settings.

A parent node of the stress node is *personal factors*, which deals with the soldier's individual problems and his/her dealings with those problems. Leaders recognize that most soldiers have a desire to contribute to the team and to be part of the team effort. Leaders build on a soldier's personal motivation by realizing that each soldier has different abilities (FM 22-102, 1987). A good leader develops individual soldier strengths into team strengths. Thus if the soldier has personal problems, caring means that the leader strives to assist him/her in dealing with those problems. When a soldier is unable to focus, personal problems add to the stress, which can hinder mission accomplishment. When problems are discussed with peers or leaders, stress can be reduced. Life events that generate stress can be measured using a scale such as the Holmes-Rahe Stress Scale. On the Holmes-Rahe scale, "Low Stress" is a score of 150 points or less. This score indicates that the person has a slight risk of illness. "Normal Stress" is with a score of 150-299. The risk of illness to this person is moderate. "High Stress" is defined as 300+ points. The person with this level of stress has a greatly increased risk of serious illness and efforts to reduce stress level should be undertaken immediately (Holmes & Rahe, 1967).

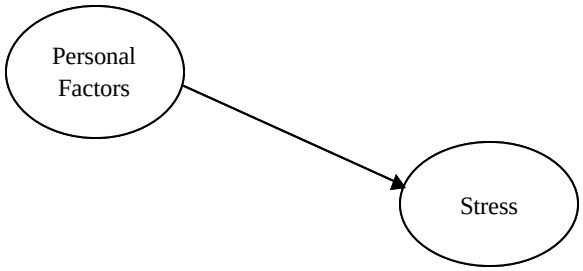

Figure 4. Personal Factors Node.

Level of Exertion possesses the following state spaces: Easy, Moderate, and Difficult. A soldier's level of exertion can impede the success of the mission. If soldiers are not prepared for tasks, whether physical or mental, then the level of exertion is increased. Usually with the increase in the level of exertion there will be an increase in stress. This varies from person to person (FM 22-102,1987). Thus, stress will increase under the influence of level of exertion. *Fitness level* is independent of *Stress* given *Level of Exertion*. *Fitness Level* influences *Level of Exertion*. If the soldier/sailor is

physically fit, then the level of exertion required to accomplish a task is decreased when compared to a soldier or sailor who is not fit (FM 21-20, 1992). These ratings are based on the Borg Scale of Perceived Exertion. Borg's scale (Borg, 1982) ranges from 0 to 10, with 0 as no exertion and 10 as extremely strong exertion (almost maximum).

Easy ranges from 0-3.

Moderate ranges from 4-6.

Difficult ranges from 7-10.

The next parent of the *Stress* node is *Level of Exertion. Fitness level* is the parent of *Level of Exertion*. A soldier's level of physical fitness has a direct impact on his combat readiness. There are many components to physical fitness such as weight control, diet, nutrition, stress management, and spiritual and ethical fitness. *Fitness level* is just one factor that influences how one's stamina will be affected. *Fitness level* focuses on three different areas of the body: cardiovascular training, strength training, and flexibility training. Cardiovascular training requires some type of aerobic activity. With aerobic exercise, the goal is to get your heart rate into the target zone (50-85% of the person's maximum) and sustain that pace for a specified period of time. Second, strength training refers to muscular strength and is defined as the maximum force that can be exerted by a muscle or muscle group. Third, flexibility is defined as the range of motion (ROM) around a joint. Within each joint, there is an optimum ROM necessary for peak performance. Factors that affect flexibility include age, inactivity, gender, body type and strength training. The states of fitness level are as follows:

-Fitness Level 1 refers to a soldier who never (or rarely) participates in aerobic activity, performs resistance-training exercises, or rarely stretches (Balbach, 2001).

-Fitness Level 2 refers to a soldier who participates in aerobic activity for at least 20 minutes, 3 times per week, performs at least 1 set of 15-20 repetitions on 8-10 of the major muscle groups, 2-3 times per week, and occasionally stretches most of the major muscle groups (Balbach, 2001).

-Fitness Level 3 refers to a soldier who comfortably participates in aerobic activity for at least 30 minutes, 3-4 times per week, performs at least 2 sets of 8-12 repetitions on 8-10 major muscle groups 3-4 times per week, and always stretches the major muscle groups (Balbach, 2001).

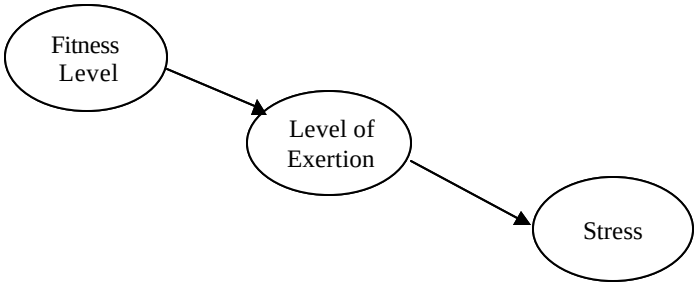

Figure 5. Fitness Level Node.

Stress is a descendant of the node, *Sleep Condition.* Humans have a sleep reservoir that fluctuates depending on how much sleep a person receives on a daily basis. In this model, the node, *Sleep Condition,* will use the following states: Inadequate, Adequate, and Well-Rested. Inadequate sleep refers to a condition when a person fails to get enough sleep over any period of time. This could include acute or chronic sleep deprivation. Failure to get enough sleep results in a "sleep debt" (Blue, 2000). If the sleep reservoir continues to be depleted, the body will refuse to stay awake, regardless of how hard the person tries to fight it (www.salvoblue.homestead.com/sleep). Adequate sleep refers to a condition when a person receives an adequate amount of sleep. Most sleep experts agree that an average of 8 hours of sleep per day is required. Well-Rested refers to a condition when a person has received 8 or more hours of sleep. Proper sleep and rest are necessary to keep soldiers functioning at their best. The leader needs to develop a sleep discipline routine both for the soldiers and for him/herself. Soldiers cannot operate efficiently without proper sleep and the leader needs to rest to make appropriate decisions. Without proper sleep, the leader or soldier/sailor becomes irritable and friction develops within the unit. A sleep-deprived person becomes a detriment to the unit. This can have a negative effect on the cohesiveness and performance of the unit (FM 22-102, 1987).

The parent to *Sleep Condition* and grandparent to *Stress* is *Operational Tempo*. *Operational Tempo* refers to the pace of the operations and influences the quantity of sleep allocated to the soldiers and sailors. A high operational tempo will detract from the quality of sleep each person will receive (FM 22-102, 1987). The three states of *Operational Tempo* are High, Medium, and Low.

-Low refers to preparing for war in accordance to the timeline discussed with the threat at a minimum.

-Medium refers to continuous preparation where the threat of war can occur at any time and units prepare in accordance to the timeline.

-High refers to a prepared state of readiness for war. The timeline for tasks/mission accomplishment decreases by at least 50% of the time allocation set by higher headquarters and the chain of command.

The parent to *Operational Tempo* is *Threat*. Threat condition or THREATCON is defined as a formal level of anti-terrorist readiness, directed by commanders to upgrade physical security readiness to deter terrorist attack (COMNAVFORJAPANINST 5530.7, 1999). Depending on the immediacy of the threat, operational tempo affects quality and quantity of sleep (see Figure 6). With these factors considered, a soldier's stress level can fluctuate greatly. *Threat* has the following phases:

-Threatcon A is a condition that applies when there is a general threat of possible terrorist activity against installations and personnel, the nature and extent of which are unpredictable, but when circumstances do not justify full implementation of the measure of Threatcon B.

-Threatcon B is when an increased and more predictable threat of terrorist activity exists. The measures in this THREATCON must be capable of being maintained for weeks without causing undue hardship, without affecting operational capability, and without aggravating relations with local authorities.

-Threatcon C is the condition that applies when an incident occurs or when intelligence is received indicating that some form of terrorist action against installations

and personnel is imminent. Implementation of this measure for more than a short period will probably create a hardship and will affect the peacetime activities of the unit and its personnel.

-Threatcon D is the fourth condition that applies when a terrorist attack has occurred or intelligence has been received that terrorist action against a specific location is likely. Normally, this THREATCON is declared as a localized warning (COMNAVFORJAPANINST 5530.7, 1999).

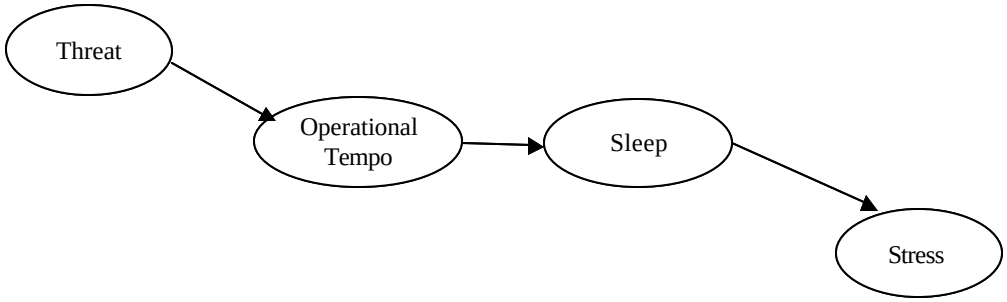

Figure 6. Threat Node.

The fourth node out of six that feeds into the *Stress* Node is the *Duration of the Operation.* The length of the operation can affect the morale of the soldiers and unit. The leader should assist soldiers in dealing with the duration of the engagement and teach them about the physical and mental effects of sustained operations. This in turn will reduce S*tress* (FM 22-102, 1987). The states should be self-explanatory and vary according to the battle. The states are as follows:

-Less than 30 hours
-Less than 60 hours
-Less than 90 hours
-Less than 120 hours and
-Greater than 120 hours.

These states represent the time limit in which a mission should be completed. The time limit that is planned for may not occur. Increased time for individuals may cause individual or unit moral to decrease.

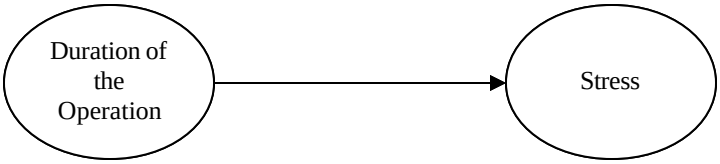

Figure 7. Duration of the Operation Node.

The fifth node that affects the *Stress* node is *Risk Assessment*. This is the most complicated node for the entire model. In itself, *Risk Assessment* has 7 parent nodes; some of which feed into other parent nodes as seen in Figure 8. For example, *Planning* is the parent to *Risk Assessment* but simultaneously is feeding into *Sustainability* and *Mission Control*. *Risk Assessment* contains the states of:

-Overall Low Risk

-Overall Caution

-Overall High Risk.

The Army Risk Assessment Guide defines the states listed above and the parent nodes listed below. The overall states are based on the parent nodes and their states of Low Risk, Caution, and High Risk. The parent nodes are as follows:

-*Mission Control*

-*Soldier Endurance*

-*Soldier Selection*

-*Weather*

-*Terrain*

-*Sustainability*, and

-*Planning.*

Their states are Low Risk, Caution, and High Risk. Low Risk is estimated as less than 25% chance of danger from the mission. Caution is estimated between the ranges of 26-75% chance of danger. High Risk is estimated at 76% chance of danger being immanent (Risk Assessment Worksheet, 1993).

Risk Assessment directly affects *Stress.* The Chief of Staff of the Army in 1995 stated that with the proper assessment, "Risk Management allows us to operate successfully in high risk environments. Leaders at every level have the responsibility to identify hazards, to take measures to reduce or eliminate hazards, and then to accept risk only to the point that the benefits outweigh the potential costs." Prior planning to reduce risk can reduce stress.

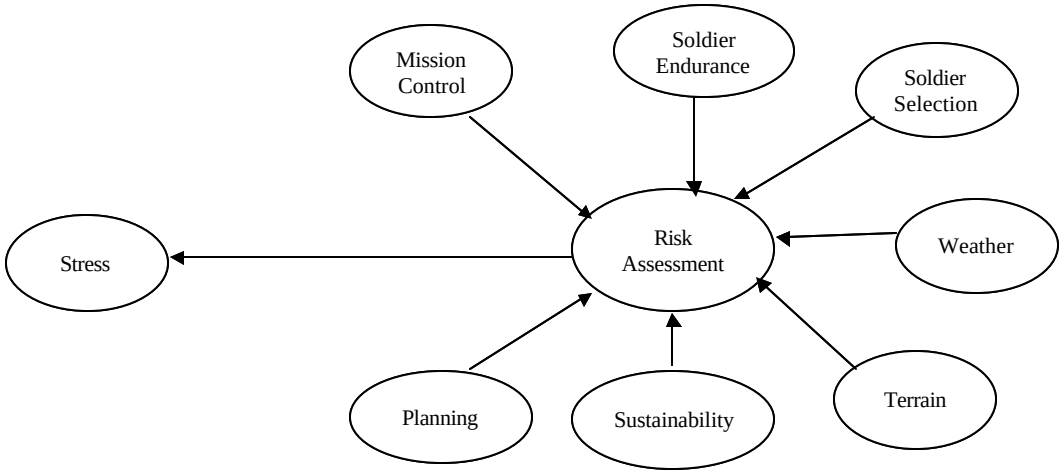

Figure 8. Risk Assessment Node.

Task Organization, Training Event, and *Planning* are parents to the *Mission Control* node as shown in Figure 9. These factors affect the difficulty of the mission and determine what the soldiers/sailors may endure. The *task organization* for a leader will determine if he/she has mission control of the situation. A leader is used to working with a particular group of soldiers. When the group dynamics change by adding a new member to the unit or by removing a subunit to complete another tasking, mission control becomes less certain. In turn, when a leader is determining the requirements needed to achieve a successful mission, he/she must consider the availability of his/her own unit. They must also consider what is required to support any attached units as well (FM 7-20,1992). Each node's state is briefly discussed below.

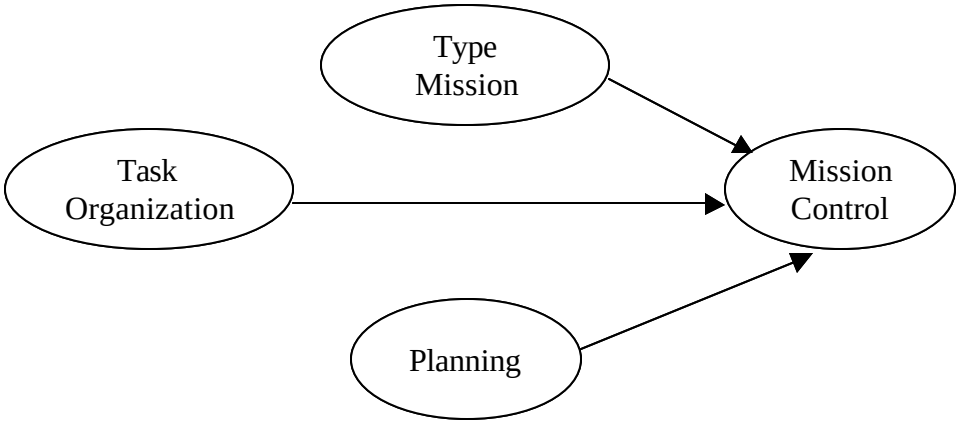

Figure 9. Mission Control Node.

Task Organization has the following states: OPCON, Attached, and Organic. The command relationship refers to the relationship between the various units of the battalion. They are defined below (FM 7-20,1992).

-OPCON refers to a unit provided to another commander for specific missions or tasks (FM 7-20, 1992).

-Attached refers to the unit operating temporarily with an organization. Logistics for this unit are the responsibility of the supported unit (FM 7-20,1992).

-Organic are the personnel and equipment that make up the unit (FM 7-20, 1992).

Type Mission has the following states spaces: Support Nontactical, Day Tactical, and Night Tactical. These three state spaces are the ways in which the military will engage in actual operations. The military trains the way it intends to fight because historical references show the direct correlation between realistic training and the success on the battlefield (FM 25-100, 1988). When units train as they fight, the soldiers/sailors are familiar with the procedures of that unit, given a particular mission. This permits the leader to think and deal with other situations. Control required for daytime non-tactical operations is less than that required for daytime tactical operations. Night tactical operations require the most control due to the increased hazards associated with night operations (FM7-20, 1992). The state spaces are defined below.

-Support Nontactical is when a unit supports the warfighter through logistics required to accomplish the mission (FM7-20, 1992).

-Day Tactical is movement during the day by the warfighter to obtain battle position (FM 7-20, 1992).

-Night Tactical is movement during the night by the warfighter to obtain battle position (FM 7-20, 1992).

The *Planning* node, with state spaces of low risk, caution, and high risk, considers many aspects of the Deliberate Decision Making Process (DDMP). If improper mission analysis is done and time is not properly allocated then there is a high probability that the commander will have to do more supervision during the execution of the plan. In combat, the situation changes rapidly, communication is broken, units are disrupted, and the commander's personal presence is limited both in time and space. When planning for an operation, leaders must consider these factors.

Guidance takes into account the fact that subordinates must be able to do what their commanders want them to do. Mission-type orders and the commander's intent provide soldiers and leaders with guidance so that they can exercise individual initiative. The guidance from superiors will determine what the leader/commander is allowed to do to complete the mission (FM7-20, 1992). From there, the mission analysis is conducted and the leader determines what personnel, equipment and supplies will be required to sustain and accomplish that mission.

Preparatory Time considers how much time a commander allocates to his subordinates to accomplish the mission. If the commander does not allocate time according to the "1/3 – 2/3 Rule" (which means that for planning purposes, HQ can take only 1/3 of the allocated time with the remaining two-thirds left for each subordinate HQ) then many problems can occur. One of the problems is that soldiers must skip steps or move more rapidly in order to accomplish the mission under the compressed timeline. This increases the amount of supervision required to mitigate risk and ensure that tasks get accomplished. Also, if there is very little preparatory time to begin with, the level of detail in the planning stage of the operation will be diminished. Thus *Preparatory Time*

and *Guidance* influence *Planning*. With proper planning, sustaining the fighting force will be less risky as is seen with Figure 10.

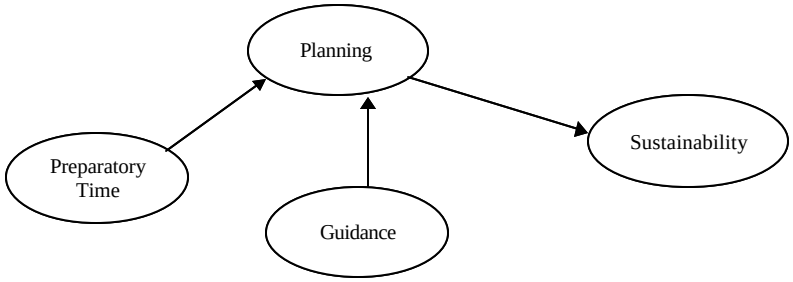

Figure 10. Planning Node

The state spaces for the node, *Preparatory Time*, are listed below.

-Minimal gives the soldiers less than 33% of the time to get ready for the mission.

-Adequate gives 50% of the time allocated for soldiers to prepare for deployment.

-Optimum is maximizing the time for planning and allowing the individual soldiers to accomplish the mission and task by allowing two-thirds for preparation.

Guidance is the other parent node to Planning (FM 7-20, 1992). *Guidance* is the guidelines that are given by higher headquarters and followed for the unit to accomplish their mission. The leader uses this guidance to plan for the mission.

The three states for these nodes are:

-FRAGO is a fragment of the operation order (OPORDER). Details of the mission are not available just as time is probably not either.

-OPORD is a full plan given by higher headquarters and what the unit's procedure is to accomplish the higher headquarter's mission.

-OPLAN/LOI is the operations plan for the theater of operations.

Another link to the *Risk Assessment* node is the *Soldier Endurance*. *Soldier Endurance*, with states spaces of low risk, caution, and high risk, is a measure of how much a soldier/sailor can tolerate before his/her body physically becomes exhausted. This node has two parents that are *Environment Preparation* and *Soldier Preparation* as shown in Figure 11.

Environment Preparation will take into account whether or not the soldier's physical aspect can meet the challenges of the mission in a particular environment. The body requires time to adapt to various temperature changes and conditions. For instance, a person who is moving from Alaska to Panama will require a period in which to adapt to the drastic temperature changes. In another example, when air pressure changes from sea level to high altitude such as moving from Ft. Polk, Louisiana to Colorado Springs, Colorado, breathing is a difficulty. *Environment Preparation* influences *Soldier Endurance*. If a soldier is not acclimated to his/her environment then he is likely to feel the effects of fatigue more rapidly than someone who is adjusted to their environment. The states are as follows:

-Nonacclimated. This is the state in which the soldier has not adapted to the environmental conditions.

-Partially acclimated. This is the state in which the soldier has been with the gaining unit for a brief time (50% of the unit's requirement to adapt to the environment) but is not yet fully acclimated to the environment.

-Acclimated. This is the state in which the soldier's body has adapted to the environment.

Soldier Preparation is the amount of time that a soldier requires to get ready for a mission. The military personnel may need time to prepare his/her personal effects as well as gather equipment for deployment or mission. The state of mind of a soldier knowing that he/she is situated with their personal affairs and is confident with their abilities as a soldier will determine how much a soldier can endure (FM 22-102, 1987). The states are the same as for *Preparatory Time* node.

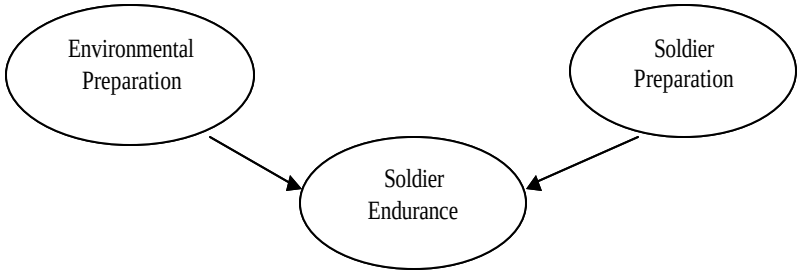

Figure 11. Soldier Endurance Node

The next node is *Soldier Selection*. There are two parent nodes. They are *Task* and *Soldier Experience*.

A *Task* is a clearly defined and measurable activity accomplished by individuals and units (FM 7-20, 1992). It is a specific activity that contributes to the accomplishment of a mission. The commander must conduct a task analysis, which identifies and understands all tasks required for success. This includes those required to ensure unity of effort with adjacent units. This includes specified and implied tasks. After the leader does his/her analysis, the leader will assign the specific tasks to those selected soldiers that are capable of completing the task or mission. Leaders must attempt to match a soldier's experience with the task in order to capitalize on it. The *Task* node utilizes the following three states.

-Simple tasks are tasks that anyone can complete with general knowledge.

-Routine tasks are the basic tasks that are within their branch that are commonly known to everyone within the unit or field.

-Complex tasks requires more time than is allocated to accomplish the task or mission.

Soldier Experience offers the senior leadership qualities that can be exploited in accomplishing the mission. The soldiers are trained by taking tasks explained in their field manuals and actually accomplishing the task to the given standard and set time. Within the guidance of the regulations, the soldiers will be qualified within their military specialty. Actual engagements such as war may qualify soldiers because the book does

not encompass everything that a soldier may experience in a battle situation. These are the state spaces for sol*dier experience*.

-Untrained. The soldier is not able to do a 90% of the tasks assigned to that military field per SOP.

-MOS qualified. The soldiers are fully qualified in all of the tasks that are required for their own specialty.

-Highly qualified. Soldier is able to adapt to the changing situation without higher guidance or without the aid of manuals. Individuals are able to apply what the field manuals have taught and use them for the situation at hand.

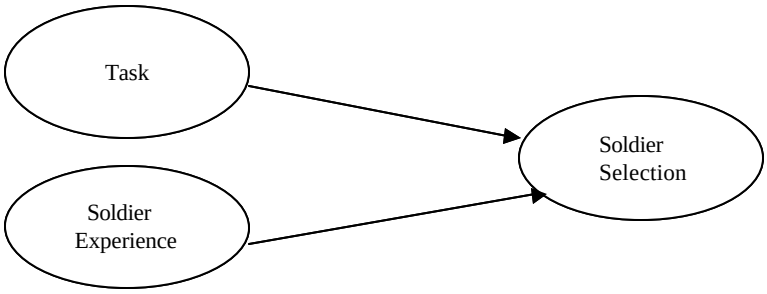

Figure 12. Soldier Selection Node

The next node is *Weather*, which has the states spaces of low risk, caution, and high risk. *Weather* is an important factor such that it governs how the unit will accomplish the mission. *Weather* influences the *Terrain* node by assisting or impeding the friendly or enemy forces. For example, hard compacted dirt roads are great for soldiers to travel on but when rain pounds the dirt into mud, vehicles have a tendency to move slowly and/or get stuck. When vehicles are traveling in a convoy or solo, they are more vulnerable to attacks with unsuitable driving conditions. *Visibility/Moisture* and *Temperature* influence *Weather*. These two factors will influence how the leader will analyze and approach the area of operations with respect to friendly and enemy capabilities. The two primary parent nodes are *Temperature* and *Visibility/Moisture*.

The *Temperature* states are self-explanatory. They are as follows:

-Less than 31 degrees and greater than 80 degrees Fahrenheit

-Range between 32-59 degrees Fahrenheit and

-Range between 60-79 degrees Fahrenheit.

The *Visibility/Moisture* states are self-explanatory. This node has the following states:

-Clear/Dry.

-Foggy with humidity.

-Rain/Snow/ Ice.

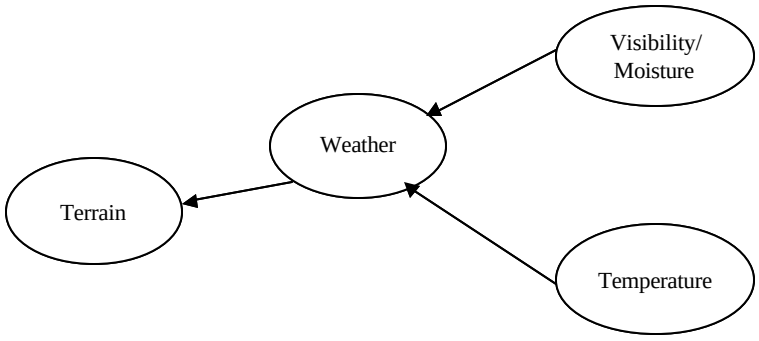

Figure 13. Weather Node.

Another piece of the puzzle that is required for determining *Risk Assessment* is *Terrain*. There are three parents for *Terrain*. They are *Weather, Trafficability,* and *Type Terrain*. *Weather* will either impede or assist the unit depending whether they are in an offensive or defensive position.

Trafficability allows the decision-makers to become aware of movement conditions for soldiers and equipment and how it will assist or hinder in the navigation of the terrain. Traveling on cross-country trails can be a higher risk than traveling along improved roads because of possible enemy attack. Yet, with improved roads, greater quantities of vehicles and people are able to move faster and with a smaller chance of being attacked. Then there is the combination of the two, quantity and quality. For example, there are improved roads that meander along the side of a mountain. No matter how fast a leader wants to arrive at a particular place and time, *Trafficability* is governed by *Terrain*. The levels are:

-Improved. The roads are paved and accessible through smaller roads.

-Secondary roads. The roads are able to carry vehicles and soldiers but are usually smaller in width (one way at a time) and are made of compressed dirt or clay.

-Trail Cross-Country. Roads allow passage through a highly dense vegetation area but the trail is not suitable to movement of people or equipment because of possible attack.

Type Terrain has three states that are defined below (FM 7-20, 1992). Terrain type will determine if the land or sea is navigatable. They are regarded as natural or man-made obstructions that canalize, delay, restrict, or divert movements of a force.

-Go. Terrain that is judged Go is fairly open and presents no hindrance to maneuver. Nothing need be done to enhance mobility. Terrain that would hinder one type of unit may not hinder another type of unit (FM 7-20, 1992).

-Slow-Go. Terrain is judged SLOW-GO if the slopes or vegetation it contains can slow or disrupt maneuver of the force being considered to move through it. SLOW-GO terrain hinders maneuver less than NO-GO terrain. Other assets are also needed to enhance mobility. Terrain that is SLOW-GO to a mechanized force might be GO to a dismounted force (FM 7-20, 1992).

-No-Go. Terrain is judged NO-GO if movement through it by a particular type of force seems impractical unless much effort is made to enhance mobility. The road network in an area might still support mounted movement, even if the terrain itself does not support maneuver (FM 7-20, 1992).

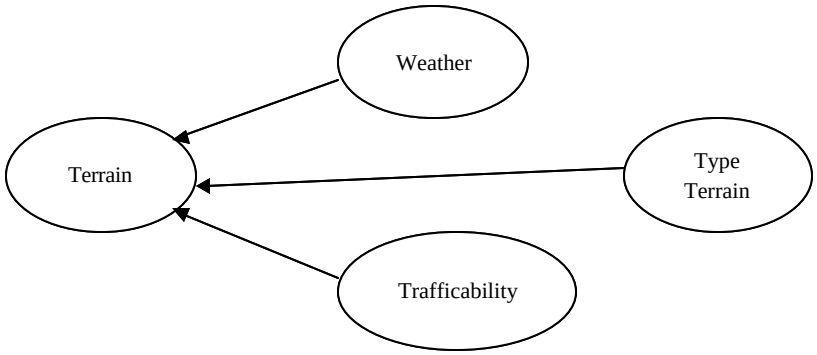

Figure 14. Terrain Node.

The last parent node to *Risk Assessment* is *Sustainability,* with state spaces of low risk, caution, and high risk. *Sustainability* is the ability to sustain a unit for a period of time to accomplish their mission. This node is influenced by *Logistics* because combat cannot be sustained for long periods of time without proper resupply of personnel and equipment. If personnel and equipment are not sustained, the assets for engaging the opposing side will be depleted. The parents are *Type System* and *Percentage Personnel Fill.*

In the node, *Type System,* the system offers protection to the soldiers in those vehicles and mobility to the destination point. The types of system are wheeled, track or crew served. *Type System* will determine what degree of support is required. If numerous vehicles are taken, the leader needs to calculate what quantities of fuel, maintenance, and drivers are needed in order to sustain the mission. Type System influences sustainability because supply requirements for track vehicles are greater than other supply vehicles - such as wheeled vehicles. The increase in supply requirements creates a heavier load on the system, thus putting it at risk. These states refer to vehicle types.

Percentage Personnel Fill. The states are Range 0-65%, Range 66-79%, and Range 80-100%. This is self-explanatory and indicates the personnel status. This affects what size force the decision-maker will have in sustaining for the engagement.

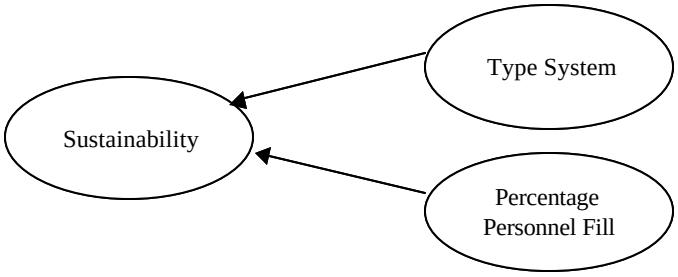

Figure 15. Sustainability Node.

Logistics is vital in sustainability. Without preparing for the battlefield, soldiers and equipment will take a great loss. The states of the *Logistics* node are Low Risk, Caution, and High Risk. Low Risk is defined in this and other nodes as having less than 25% loss to equipment and personnel. Caution is defined with the possible loss of 26%

to 75% of the unit equipment and personnel. Lastly, High Risk is probable loss of 76% or more of unit equipment and personnel. Resource constraints will always affect how support operations are conducted. The development of programs and sustainment systems ensure continuous support and are critical functions of sustainment planning and execution. As shown in the diagram below, *Fuel, Maintenance, Ammunition, and Food and Water* influence *Logistics*. There are a selected few classes of supply that are vital to the sustainment of battlefield.

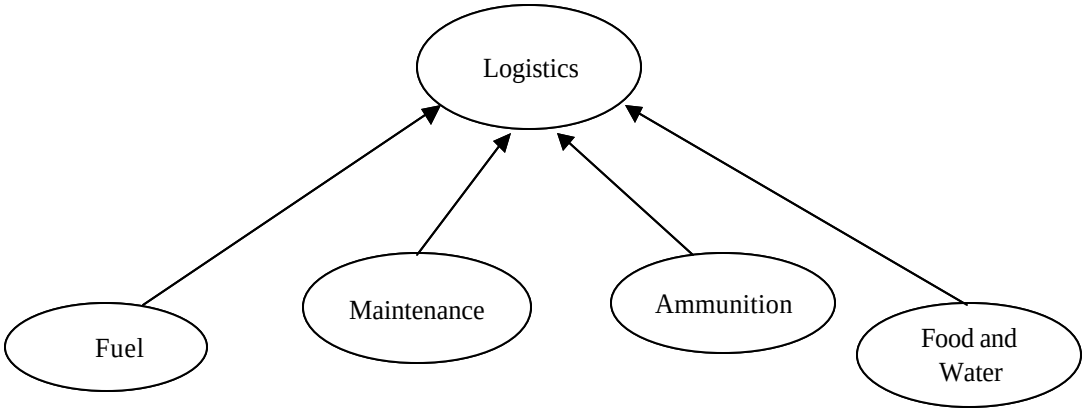

Figure 16. Logistics Node.

The parents of the *Logistics* node, with states spaces of low risk, caution, and high risk, are *fuel, maintenance, ammunition,* and *food and water*. Each of these nodes is separated into four states. The states are green, yellow, red and black. Green is defined with having less than 25% loss, yellow is defined with a probable loss between 26% and 74%, red is having the loss rate of 90% or less while black ranges between 91%-100%.

Logistics is an asset for survival on the battlefield. Sustainment is vital to the success of the operational and tactical levels of war. The ability to provide and sustain support for combat operations is predicated on thorough, integrated planning. This causes an inseparable relationship between operations, tactics, and sustainment whether you are on the land, at sea or in the air (FM 100-10, 1998).

-*Fuel* is an asset necessary to move vehicles, ships, and aircraft. It also helps support units in running generators, medical equipment, and heaters. These are pertinent

in making sure that forward units are able to continue sustained movement towards the objective. A fighting force can move and fight only as long as it is supplied with fuel. The modern high-performance aircraft, ships, and ground vehicles provide great potential mobility, but consume vast amounts of fuel. This remains one of the many important factors a leader must consider (FM 100-10, 1998).

-*Maintenance* assists the units in fixing and maintaining their vehicles for battle. Maintenance also pertains to support equipment such as forklifts and generators. Maintenance operations must be planned to support the momentum of the battle and massing at critical points. Repairing at the point of malfunction or damage is a priority. The momentum is enhanced when the maximum number of weapon systems can be kept operable and mobile. Mechanics must be able to perform their mission in the forward areas (FM 100-10, 1998).

-*Ammunition* is a vital asset in destroying the enemy. Regardless of the position, soldiers require ammunition to fight the opposition. Today's fighting force uses a large variety of sophisticated weapon systems, which consume large quantities of ammunition. The arming system must deliver the right mix and quantities of ammunition to the right place and at the right time. Weapon systems must be armed to the point of employment as the tactical situation permits (FM 100-10,1998).

-Lastly, *food and water* support the individual. Without food and water, the body will grow weak and collapse. This can also affect the mind, resulting in poor decision-making (FM 100-10, 1998). The human body can survive 3 days without water and respectively, 3 weeks without food. Food and water are among the most important factors in soldier health, morale, and welfare (FM 100-10, 1998).

The last node is *Leadership Effectiveness*. This node is parent to *Performance*. There are three parents that feed into Leadership Effectiveness. Each node possesses three states of Good, Average, and Bad. These levels are not defined because it is an individual opinion and judgment. That opinion will determine the Leader's confidence to lead the unit into the engagement. The parents are as follows:

-Relationship with Superiors

-Relationship with Peers and

-Relationship with Subordinates.

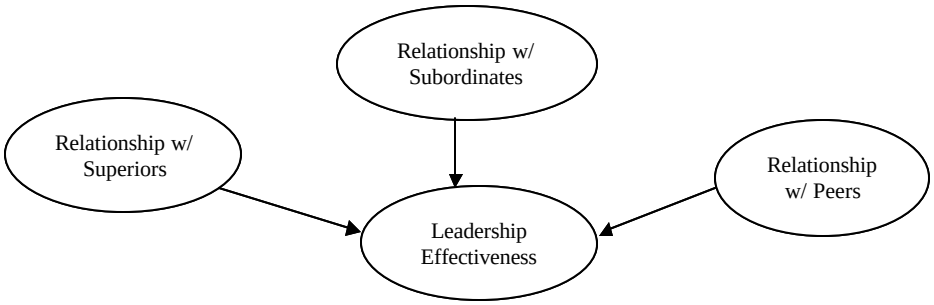

Figure 17. Leadership Effectiveness Node.

In the Scenario of Task Force Smith and the Battle of Kursk, the nodes remain the same for both. In the Battle of Midway, three nodes are changed. They are as follows:

- Threat in Vicinity of Operation,

- Sea State,

- Platform.

The node name for *Trafficability* changes to *Threat in Vicinity of Operations*. The state spaces change accordingly to the respective names designated by the United States Navy. Since the US Navy does not use roads and travels via sea-lanes, the states are defined in accordance to the presence of the enemy's threat. The states are as follows:

-Immediate. Travel on the sea-lanes is near impossible. The threat of the enemy is imminent and they are preparing to engage in battle. The sighting of another ship is far and few.

-Near. The enemy is nearby but is not yet ready to engage in battle.

-Distant. The sea-lanes are open and mobility and agility to travel is easy. The sighting of another ship is rare. Enemy threat is at a minimum. The leader has time to prepare for engagement.

The second node to change is that Type Terrain becomes Sea State. Weather influences the sea states. If weather is becoming violent, then the sea states are increased drastically, which impedes operations and movement on the sea-lanes. There are 12 states to this node and they are defined according to the United States Coast Guard. Sea state is defined by the value of the sea surface displaced at any random time. The equation to calculate the displacement is as follows:

$$f(z) = \frac{1}{\sqrt{2p}\, s_z} e^{-\frac{1}{2}\left(\frac{z}{s_z}\right)^2}$$

A commonly used description of sea states is listed below. See Appendix D for pictorial representation.

-*Sea State 0* - Wind speed is less than 1 knot and sea is like a mirror.

-*Sea State 1* - Wind speed is 1-3 knots, wave height is .1 m, ripples with appearance of scales, and no foam crests.

-*Sea State 2* - Wind speed is 4-6 knots, wave height is .2-.3 m, and small wavelets with crest of glassy appearance not breaking.

-*Sea State 3* - Wind speed is 7-10 knots, wave height is .6-1 m, and large wavelets with crests beginning to break and scattered whitecaps.

-*Sea State 4* - Wind speed is 11-16 knots, wave height is 1-1.5m, and small waves become longer with numerous whitecaps.

-*Sea State 5* - Wind speed is 17-21 knots, wave height is 2-2.5m, and moderate waves taking longer form, many whitecaps and some spraying.

-*Sea State 6* - Wind speed is 22-27 knots, wave height is 3-4m, and larger waves forming with whitecaps everywhere and more spraying.

-*Sea State 7* - Wind speed is 28-33 knots, wave height is 4-5.5m, the sea heaps up, and white foam from the breaking waves begins to be blown in streaks along the direction of the wind.

-*Sea State 8* - Wind speed is 34-40 knots, wave height is 5.5-7.5m, the moderately high waves of greater length with the edges of crest begin to break into spindrift and foam is blown in well-marked streaks.

-*Sea State 9* - Wind speed is 41-47 knots, wave height is 7-10m, the high waves, sea begins to roll, dense streaks of foam along wind direction, and spray may reduce visibility.

-*Sea State 10* - Wind speed is 48-55 knots, wave height is 9-12.5m, very high waves with overhanging crests, sea takes white appearance as foam is blown in very dense streaks, rolling is heavy and shocklike, and visibility is reduced.

-*Sea State 11* - Wind speed is 56-63 knots, wave height is 11.5-16m, exceptionally high waves, sea covered in white foam patches, and visibility still more reduced. The sea states are defined by the US Coast Guard and are from the website: http://www.irbs.com/bowditch/pdf/chapt37.pdf.

The third node to change is *Type System* to *Platform*. *Platform* is the type system that the Navy uses and the states are self-explanatory.

-*Carrier*

-*Battleships*

-*Cruisers*

-*Destroyers*

-*Submarines*

-*Transporters* and

-*Mine Sweepers.*

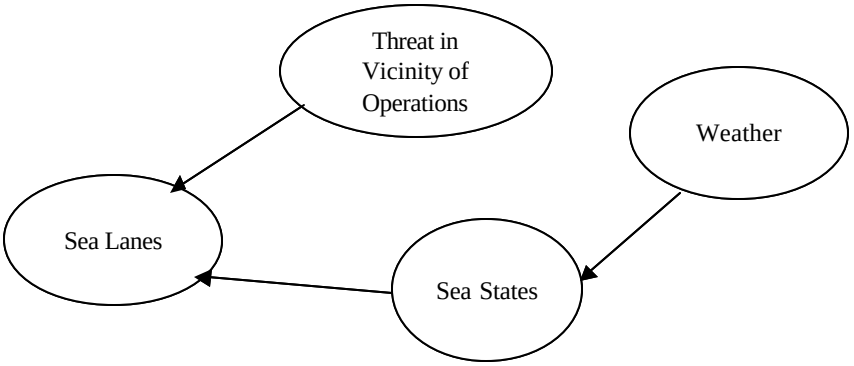

Figure 18. Sea-Lanes Node.

These nodes represent several factors that would affect the decision-maker and the possible performance of the unit under a particular situation. These components would assist the leader during any particular event regardless in training or war. There are numerous factors to be included. This model just represents a portion of them.

C. THE SCENARIOS

The scenarios are taken from historical accounts. The information prior to the battle is instantiated within the model and then the probabilistic outcome is updated as the battle is completed. When completed, the model is compared to the final outcome of the battle to see if the same conclusion is drawn.

There are three scenarios being used:

1. US Army - Task Force Smith during the Korean War,
2. US Navy - Battle of Midway during World War II,
3. German Army - The Battle of Kursk.

Task Force Smith was a crucial 7-hour battle that would change that pattern of the whole Korean conflict and maybe the course of history. Within the history books, it is stated that only one out of seven men serving in Task Force Smith were combat veterans. Those that had enlisted prior to the Korean War were there to escape the boredom in small town America. The 43% of the lower ranking enlisted soldiers scored in the two lowest categories of the Army's qualification tests, which denies enlistment to most candidates today. The soldiers were devoted to LTC Brad Smith and their peers. They

were willing to stand and fight so that the majority of the soldiers could return to base camp when the order of retreat was given. LTC Smith earned the respect of his seniors when Gen Collins stated, "Now matured and with combat experience back of him, he was well qualified to lead the first American army troops to fight in the Korean War." This gives you a basic idea of the relationship between superiors, subordinates and peers, the stress that would be placed on this unit, and the performance that would result. See Appendix E for a detailed account of the battle.

In the Battle of Midway, it must have been fate when Admiral Spruance replaces Admiral Halsey due to an illness. Spruance's intelligence, adaptability, and flexibility were just the right mixture to counter the methodology of the Japanese. The sailors were devoted to their ship and to each other. They were working around the clock to fix the damaged Yorktown. With their steadfast work, the Yorktown was ready to sail with Rear Admiral Fletcher's Task Force. The main stress was time pressure to complete the repairs. After the attack on Pearl Harbor, the US Navy was preparing for a counter-attack against the Japanese. The limited time available to make repairs and counter attack the enemy was stressful for everyone. But, the Americans had surprise and luck on their side. On June 4th, they discovered the Japanese fleet northeast of Midway. An air battle quickly developed. The turning point came at mid-morning. The Japanese fighters were drawn down to sea level by attacking America torpedo bombers, all of which were lost. Their sacrifice cleared the skies above for American dive-bombers. Within minutes three Japanese carriers were ablaze. By the afternoon, the Japanese fleet retreated. The one-day battle reversed the tide of war in the Pacific by placing the Japanese on the defensive. See Appendix F for a detailed account of the battle.

Lastly, in the Battle of Kursk, Adolf Hitler instilled his leadership style and attitude through the soldiers and people of his nation. He has stated in a letter to Herr Gemlich on 16 September 1919, "The Republic in Germany owes its birth not to the uniform national will of our people but the sly exploitation of a series of circumstances which found general expression in a deep, universal dissatisfaction. These circumstances however were independent of the form of the state and are still operative today. Indeed, more so now than before. Thus, a great portion of our people recognizes that a changed

state-form cannot in itself change our situation. For that it will take a rebirth of the moral and spiritual powers of the nation. And this rebirth cannot be initiated by a state leadership of irresponsible majorities, influenced by certain party dogmas, an irresponsible press, or internationalist phrases and slogans. [It requires] instead the ruthless installation of nationally minded leadership personalities with an inner sense of responsibility." Initially, the German soldiers believed in Adolf Hitler. As time progressed, Hitler's leadership style controlled people out of fear because of the repercussions that he would inflict to his supporters and own soldiers/officers for any opposition to the Fuhrer. Once he was in power, nothing could stop him. The people of Germany realized that it was too late. If given the chance, the officers would flee Germany and join forces with the French Foreign Legion. Hitler's leadership style was harsh. This stressed and victimized the leaders' ability to think for themselves and obstructed their performance to successfully complete the mission. See Appendix G for a detailed account of the battle.

D. THE DATA

The research was based mainly on secondary data. Secondary data were used to test the hypothesis.

1. Primary Data

Primary data are collected data during the experiment or model. In the development of this Bayesian network, no data were collected. Data should be collected to expand upon this work presented in this thesis.

2. Secondary Data

Secondary data are data obtained from previous experiments, historical documents, questionnaires, and government publications. The research data consists of technical reports from US Army doctrine and Joint Publications. Knowledge of the mission capabilities allowed for probabilities to be objective throughout the model. A basic model was created. After the basic model was built, each model was configured to

factors common to each branch of service and for each scenario. Afterward, each generic model for each scenario split into two more models with a situation for before and after the battle. Then a comparison of the data was made between the before and after to verify the accuracy of the model with the actual outcome of the battle.

The data consisted of literature that were based on public forums, various electronic surveys, previously conducted experiments, and historical scenarios. Accountability of the occurrences with each scenario was gathered from historical records. The states spaces for the nodes of the models were determined by this data.

3. The Criteria Governing the Admissibility of the Data

Personnel, both military and civilian, possessed competent knowledge of Bayesian Networks and Human Factors. All the primary data were obtained through Joint Publications. These publications set the standards that determine if a unit is deployable which assist leaders in deciding what unit will move forward into battle.

Secondary data were obtained form the previously conducted experiments, historical facts, electronic websites, and NETICA itself.

Here is an example of the states spaces used in the generic model prior to instantiating. Through doctrine and models, the numbers with each state space represent the probability of occurrence of that particular state space. With respect to the node, Relationship With Superiors, the chance of having a good relationship is 20%, an average relationship is 50%, and a bad relationship is 30%. Each of these three nodes feed into *Leadership Effectiveness.* The result is that overall majority of the units have great leadership with a result of 54.4%.

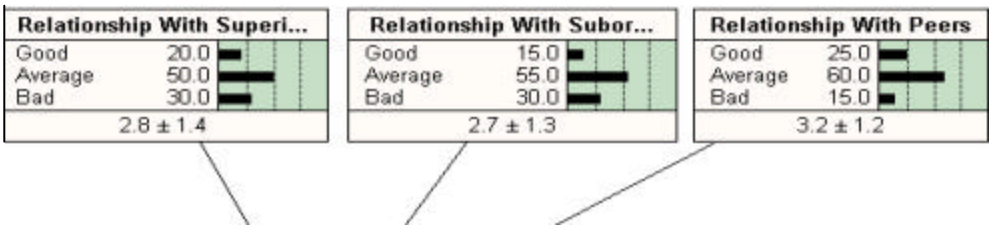

Figure 19. State Space Example.

The primary research method is quantitative and is supported by US Army regulations and Joint Publications.

The commercial software used for this thesis is Netica, which can interact with SIMKIT or other software programs using the API programmer's version. The model allows the decision-maker to consider various possibilities to evaluate the best probable outcome of different approaches to military situations incorporating personal behavior and other individual patterns. It is desired that this research will give insight into the complex behaviors of humans and their resulting performance under battle conditions, their self, and the commander's orders. In the initial phase of designing the Bayesian network, the process is similar to brainstorming in which the designer writes down the factors such as environment, risk, or physical fitness (as in this model) that would affect the main node. Afterwards, the decision-maker will decide what factors/nodes feed into what particular node via the directional arcs. Probabilities are propagated through the network. Thus, the probability of an event occurring on a node of interest is updated. This model makes it possible to decide which is the best tactical approach with the varying human factors. LT Amy Barsnick is completing congruent work dealing with personality traits. This model feeds into LT Barsnick model through the Stress and Risk Assessment node. Leaders can perform probabilistic inference based on data that they enter into the model.

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IV. RESULTS

In the three scenarios, Task Force Smith, The Battle of Midway, and The Battle of Kursk, the model presented in this thesis supported the outcome of each battle as described historically. The outcome for each scenario is based on the four primary nodes, *Performance, Stress, Leadership Effectiveness,* and *Risk Assessment.* Throughout these three scenarios, *Performance* remained consistent with an outcome of "Good Performance". The following sections address each scenario independently.

A. TASK FORCE SMITH

Leadership Effectiveness remains strong prior to and during the battle, with a status of "Great Leadership" (see Figure 20). General Dean admitted that the thought of failure never crossed his mind. The command had overconfidence bordering on arrogance, the prevailing mood for the Far East Command. The mood was prevalent amongst all ranks from General MacArthur down to the most junior soldiers from LTC Smith's unit. Superiors believed in LTC Smith. General Collins stated, "Now matured and with combat experience back of him, he was well qualified to lead the first American army troops to fight in the Korean War." The soldiers were supportive of each other as well as of their leaders. This demonstrated that leadership was strong throughout the unit and chain of command.

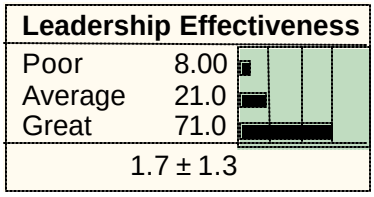

Figure 20. Leadership Effectiveness - Before and After the Battle

Risk Assessment initially was believed to be a low risk, yet, by the end of the battle, with the depletion of supplies, destroyed vehicles, high casualty rate, and poor

weather, risk went to a high state. Now the confidence of the Far East Command would become a weakness as concerns emerge about the success of the mission as shown below in Figure 21.

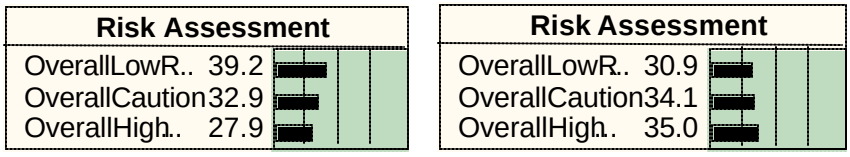

Figure 21. Risk Assessment - Before and After the Battle

Stress was at a heightened state, rated as "high" from the beginning to the end of the scenario. In anticipation of engagement, the stress level escalated. Morale and courage were very high for the soldiers going into the battle. However, the sheer number of North Korean attackers overwhelmed the overly confident soldiers. Since soldiers expected the battle to last less than 24 hours, soldiers initially had high morale. When the North Koreans decided to stand and fight, the comradery kept the men together but morale steadily eroded as time went on, thus adding to the *Stress*.

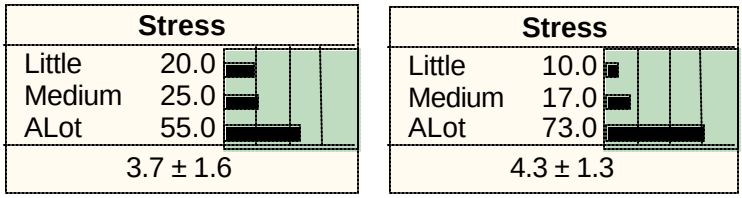

Figure 22. Stress - Before and After the Battle

B. BATTLE OF MIDWAY

The leadership effectiveness remains consistent throughout the battle. As Spruance replaces Halsey after an illness, sailors continued their mission with high motivation. Besides having the respect of his seniors and peers, it was the intelligence, adaptability, and flexibility of Spruance that lead to the successful victory of Midway. Leadership kept the sailors focused in completing the mission. Sailors were working diligently for hours on end to fix the Yorktown to prepare it to sail with Rear Admiral

Fletcher's Task Force. This was just a sample of the discipline the soldiers demonstrated in support of the mission.

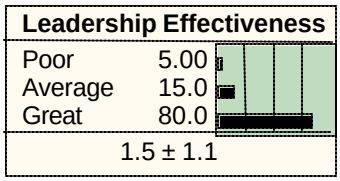

Figure 23. Leadership Effectiveness - Before and After the Battle

Risk Assessment was difficult to begin with but by the end of the battle it had more than doubled as shown below in Figure 24. *Weather* was the node that remained consistent throughout the duration of the battle, which helped to maintain steady sea states. Unfortunately, the sailors were tired from repairing ships and preparing for movement out to sea. The combination of all these factors increased their stress level.

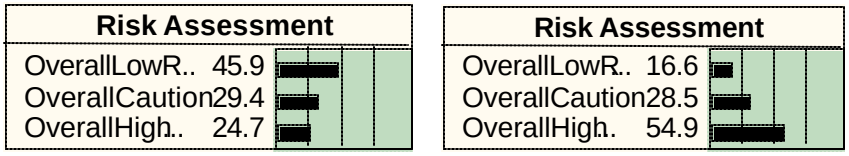

Figure 24. Risk Assessment - Before and After the Battle

Besides the stress due to severe time constraints, sailors were physically drained. The *Stress* nearly doubled from the beginning to the end of the battle. With very little sleep and reaching physical exhaustion, sailors could not properly perform their tasks. This had a direct impact on the combat readiness and mental stamina of the sailors.

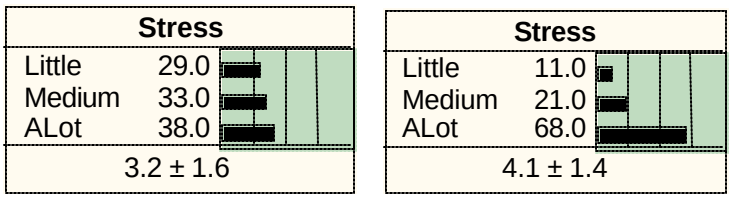

Figure 25. Stress - Before and After the Battle

C. THE BATTLE OF KURSK

Initially, the German leadership followed orders as a duty to their country. But as time progressed, there was a decrease in support for the Third Reich. Leaders were afraid to do anything without the permission of higher headquarters. As a result, *leadership effectiveness* dropped as shown below.

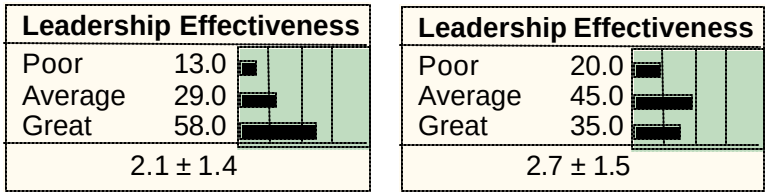

Figure 26. Leadership Effectiveness - Before and After Battle

The leadership style placed the greatest amount of stress on the soldiers. Even though stress was "High" before and after the engagement, there was no security that support and supplies would assist them in waging war against Russia. From the beginning, shortages of *Fuel* and lack of *Maintenance* added to the stress level. The soldiers knew that they were not the primary concern.

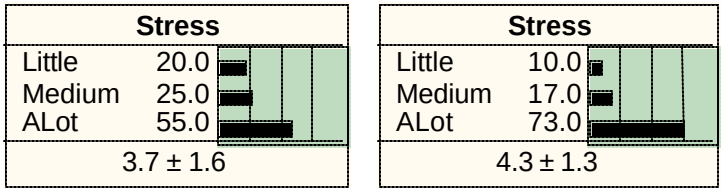

Figure 27. Stress - Before and After the Battle

In the end, *Risk Assessment* played a big part. The German forces started at a disadvantage with lack of initial supplies, no possible resupply, terrible weather, and difficult avenues of approach. The factors for risk outweighed the probability of success.

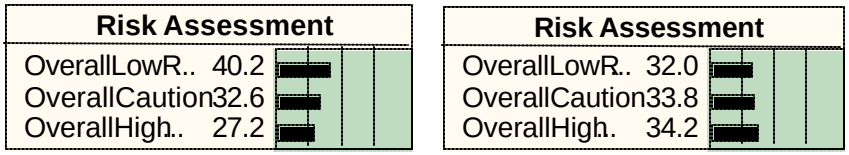

Figure 28. Risk Assessment - Before and After the Battle

The model output is consistent with the outcome of each battle, justifying the applicable use of the model. Therefore, the model may be a practical and useful tool in the military.

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V. CONCLUSIONS

Based on this work, the following conclusions may be drawn.

1. Bayesian networks can provide a graphical representation of the domain that can be implemented in current combat models. The graphical representation offers leaders of various levels of experience a visual display of the factors affecting stress and risk assessment. In visualizing the model, leaders can gain a different perspective on the situation.

2. Bayesian networks can represent some of the variables that affect *Risk Assessment* and *Stress.*

3. Based on these variables, a probabilistic measure of the degrees of *Stress* and *Risk Assessment* can be given. The present model allows the experimenter to assess the probabilistic outcome accurately based on the previous research from specialists in the fields of stress and risk assessment. The gathered information from specialists and researchers is collected and implemented in the model. As the state space for each variable is instantiated, the probabilistic outcome on the nodes of interest are updated.

4. These probabilities can be used to provide input into other models (see concurrent thesis by LT Amy Barsnick). The level of detail in the model associated with the nodes is sufficient for use in the probabilistic representation of those variables in any other combat model.

5. Based on the historical accounts of the three battles, the results are consistent. The expected outcome for *Performance, Stress,* and *Risk Assessment* in the model matched the historical data for the scenarios of Task Force Smith, the Battle of Midway, and the Battle of Kursk.

6. These models can represent joint, combined, and enemy forces. Through the three scenarios mentioned above, the model can be used for all the branches of service and together in joint models. Also, this model can follow the enemy's possible decision-making strategy. An application would be to have two identical models, one for friendly

forces and one for enemy forces. The leaders can use the model to plan accordingly to accomplish their mission. Then the two leaders can begin wargamming to see who would win based on tacit knowledge and doctrinal knowledge of their opposition.

7. These models can be used as training aids for situational awareness, risk assessment, and force protection. Novice leaders can be taught to be aware of these factors in their decision-making.

8. The model is based on expert opinion. Hence, the model is only as good as the expert's knowledge of the domain and their ability to express that tacit knowledge. The expert reads field manuals and doctrine and incorporates that with one's experience to design the model. An expert may not have practical experience in dealing with some factors. This causes a little problem in that the expert has no way of knowing what to expect. Thus, it is an advantage to the experimenter to seek guidance and knowledge from those people who have practical experience in those fields.

Lastly, this model displays what a leader should consider when training and, more importantly, in battle. Even though this model considers numerous factors, there are more variables that influence the performance of a unit. It is the leader's responsibility to incorporate those ideas or factors into training or for a deployment. Using a Bayesian network provides a “check and balance” for the leader. The model is a graphical display of the variables considered with a probabilistic outcome that helps the leader consider viable options.

VI. RECOMMENDATIONS

This Bayesian model covers several factors that revolve around the performance of a leader. There are three recommendations that I have regarding this model. The first is to focus on the expansion of the nodes, *Leadership Effectiveness* and *Performance*. The second recommendation is to consider adding additional nodes. An example would be *Type Mission*. The third is to actual collect data and determine how they influence the present model.

The nodes of *Leadership Effectiveness* and *Performance* are influenced by numerous factors. For instance, *Leadership Effectiveness* could be impacted by culture, age, experience, and education to name a few. Then *Performance* can be predicted by variables such as gender, position, location of solider, location of unit, and relationship between leaders. Of course, there are more variables to consider. Prediction of *Leadership Effectiveness* and *Performance* would require their own model. These two nodes were not expanded on because each could be a thesis in itself.

For *Type Mission*, the state spaces could involve "attack, defend, breaching movements, movement to contact, ambush, and MOUT". The state space for this variable would change depending on the size and type of force. There are other nodes that would influence the *Type Mission* such as assault force, breach force, attacker or defender (FM 7-20, 1992). The node *Type Mission* could be an element of a larger Bayesian network. However, this expansion is beyond the scope of this thesis.

Lastly, real data would be the most beneficial aspect to this model. Data should be collected in a location where soldiers train under similar conditions as that of the environment you are trying to model. For instance, the observer should prepare a survey prior to the exercise that asks how the soldier is feeling, what his/her stress level is, and the relationship to his/her peers, subordinates, and superiors. The observer should go to the field to observe a squad go through particular drills such as MOUT, reacting to a sniper, or reacting to an ambush. Then the observer needs to monitor the time, write various operations, and interactions between unit members throughout the duration of the

exercise. Finally, the observer should repeat the same survey to see if there is a difference at the end of the exercise. If possible, the observer could have the soldiers wear actigraphs so that the sleep could be monitored. This will allow an actual measurement of sleep and rest for the soldier in comparison to what he/she states how they think they slept. The reason for one location is to control the possible climate changes of the region. The use of a field exercise would provide many of the similarities that soldiers might face in an actual battle. This would be a more accurate assessment of the model and data will not be tainted with unnecessary variables.

The US Army Research Institute for the Behavioral and Social Sciences has developed sample questionnaires for the company commander and the platoon leader. These questionnaires gather information from successful leaders about how they lead and use this information to recommend ways to develop effective leaders (ARI, 1999). A good questionnaire or survey could provide detailed information vital to a model if the questions are posed correctly.

Elicitation of expert knowledge can be accomplished using a few different methods such as questionnaires, surveys, or models. Elicitation of expert knowledge is obtained in the following ways: 1) if modeler acquired expertise through personal experience, 2) if modeler is intimately related to the situation, 3) if modeler receives formal training or education in doctrine, 4) modeler observes leaders in action, and 5) modeler surveys experts on domain of interest (Ft Leavenworth Research Unit, 1999). These are just a few factors that need to be considered in making this model a practical tool used by senior and junior leaders alike.

APPENDIX A

ABBREVIATIONS

ARI - Army Research Institute

BBS - Brigade/Battalion Battle Simulation

CAA - Center of Army Analysis

DAG - Directed Acyclic Graph

DOD - Department of Defense

DMSO - Defense Modeling and Simulation Office

FORCEM - Force Evaluation Model

GAS - General Adaptation Syndrome

IMPRINT - Improved Performance Research Integration Tool

JRTC - Joint Readiness Training Centers

LFX - Live Fire Exercise

MANPRINT - Manpower and Personnel Integration

ME=f(PER) - Model Effectiveness as a Function of Personnel

OPFOR - Opposition Forces

NSC - National Simulation Center

NTC - National Training Centers

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APPENDIX B

HOLMES-RAHE SOCIAL READJUSTMENT RATINGS SCALE

SCALE FOR ADULTS (18 AND OVER)

Life Event	Life Change Units
Death of a Spouse	100
Divorce	73
Marital Separation	65
Imprisonment	63
Death of a Close Family Member	63
Personal Injury or Illness	53
Marriage	50
Dismissal from Work	47
Marital Reconciliation	45
Retirement	45
Change in Health of Family Member	44
Pregnancy	40
Sexual Difficulties	39
Gain a New Family Member	39
Business Readjustment	39
Change in Financial State	38
Change in Frequency of Arguments	35
Major Mortgage	32
Foreclosure of Mortgage or Loan	30
Change in Responsibilities at Work	29
Child Leaving Home	29
Trouble with In-Laws	29
Outstanding Personal Achievement	28
Spouse Starts or Stop Work	26
Begin or End School	26
Change in Living Conditions	25
Revision of Personal Habits	24
Trouble with Boss	23
Change in Working Hours or Conditions	20
Change in Residence	20
Change in Schools	20
Change in Recreation	19
Change in Church Activities	19
Change in Social Activities	18
Minor Mortgage or Loan	17
Change in Sleeping Habits	16
Change in Number of Family Reunions	15
Change in Eating Habits	15
Vacation	13
Christmas	12
Minor Violation of Law	11

Score 300+: Be extremely careful

------ you are at a greatly increased risk of serious illness (reduce stress now!).

Score 150-299+: Be cautious

------ your risk of illness is moderate (reduced by 30% from the above risk).

Score 150-: Be glad

------- you only have a slight risk of illness (but still need to take care of yourself!).

NOTE: Since individual responses vary so greatly, your score is only a crude measure of your level of stress... but you will see better WHY you are stressed.

SCALE FOR CHILDREN (18 AND UNDER)

Life Event..... Life Change Units

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Getting married..................... 101
Unwed pregnancy..................... 92
Death of parent..................... 87
Acquiring a visible deformity....... 81
Divorce of parents.................. 77
Fathering an unwed pregnancy....... 77
Becoming involved with drugs or alcohol.. 76
Jail sentence of parent for over one year 75
Marital separation of parents....... 69
Death of a brother or sister....... 68
Change in acceptance by peers....... 67
Pregnancy of unwed sister........... 64
Discovery of being an adopted child..... 63
Marriage of parent to step-parent..... 63
Death of a close friend.............. 63
Having a visible congenital deformity.... 62
Serious illness requiring hospitalization 58
Failure of a grade in school....... 56
Not making an extracurricular activity .. 55
Hospitalization of a parent..... 55
Jail sentence of parent for over 30 days. 53
Breaking up with boyfriend or girlfriend. 53
Beginning to date.................. 51
Suspension from school.............. 50
Birth of a brother or sister....... 50
Increase in arguments between parents.... 47
Loss of job by parent.............. 46
Outstanding personal achievement..... 46
Change in parent's financial status..... 45
Accepted at a college of your choice..... 43
Being a senior in high school....... 42
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Hospitalization of a sibling.............. 41
Increased absence of parent from home.... 38
Brother or sister leaving home........... 37
Addition of third adult to family........ 34
Become a full fledged member of a church  31
Decrease in arguments between parents.... 27
Decrease in arguments with parents....... 26
Mother or father beginning work.......... 26
```

Score 300+: Be extremely careful

------ you are at a greatly increased risk of serious illness (reduce stress now!).

Score 150-299+: Be cautious

------ your risk of illness is moderate (reduced by 30% from the above risk).

Score 150-: Be glad

------- you only have a slight risk of illness (but still need to take care of yourself!).

NOTE: Since individual responses vary so greatly, your score is only a crude measure of your level of stress... but you will see better WHY you are stressed.

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APPENDIX C

BORG SCALE OF PERCEIVED EXERTION

SCALE	SEVERITY
0	No Breathlessness* At All
0.5	Very Very Slight (Just Noticeable)
1	Very Slight
2	Slight Breathlessness
3	Moderate
4	Some What Severe
5	Severe Breathlessness
6	
7	Very Severe Breathlessness
8	
9	Very Very Severe (Almost Maximum)
10	Maximum

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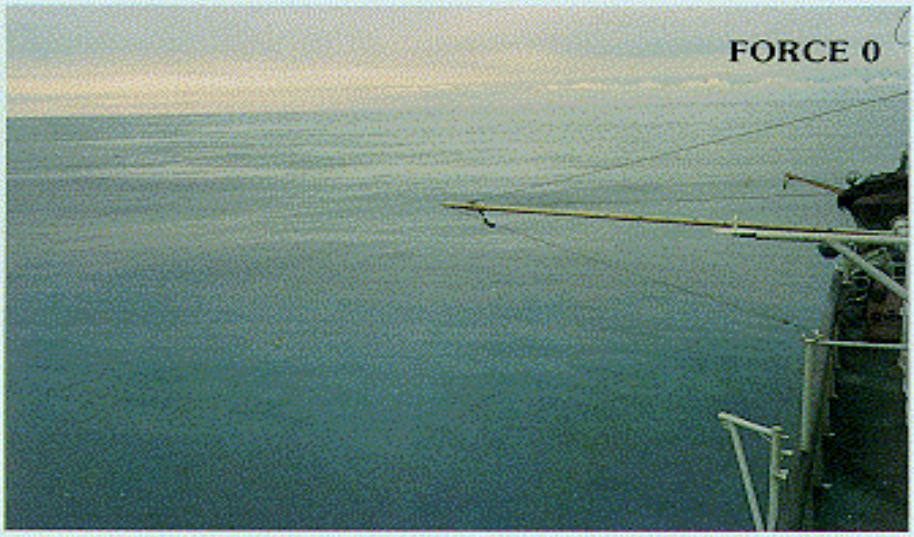
APPENDIX D

SEA STATE PICTURES



Force 0 Wind Speed less than 1 knot (calm)
Sea Criterion: Sea like a mirror.

Force 0 : Vitesse du vent inférieure à 1 noeud (calme).
Aspect de la mer : Mer comme un miroir.

Sea State 0

Force 1 Wind Speed 1 to 3 knots, (light air)
Sea Criterion: Ripples with the appearance of scales are formed, but without foam crests.
Probable Wave Height: 0.1 m (1/4 ft)

Force 1 : Vent de 1 à 3 noeuds (très légère brise).
Aspect de la mer : Rides ressemblant à des écailles de poisson, mais sans crête d'écume.
Hauteur probable des vagues : 0,1 m (1/4 pi).

Sea State 1

Force 2 Wind Speed 4 to 6 knots, (light breeze)
Sea Criterion: Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.
Probable Wave Height: 0.2 to 0.3 m (0.5 to 1 ft)

Force 2 : Vent de 4 à 6 noeuds (légère brise).
Aspect de la mer : Vaguelettes courtes, mais plus accusées; leur crête a une apparence vitreuse, mais elle ne déferle pas.
Hauteur probable des vagues : 0,2 à 0,3 m (0,5 à 1 pi).

Sea State 2

Force 3 Wind Speed 7 to 10 knots, (gentle breeze)
Sea Criterion: Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses.
Probable Wave Height: 0.6 to 1 m (2 to 3 ft)

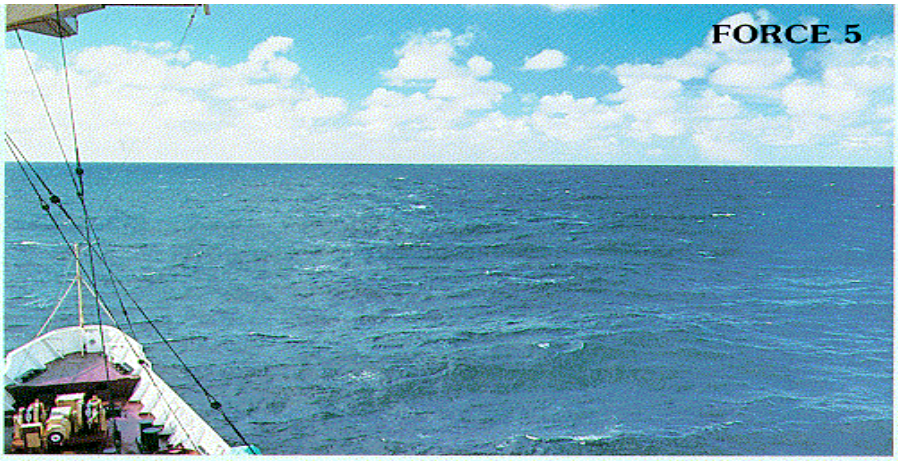
Force 3 : Vent de 7 à 10 noeuds (petite brise).
Aspect de la mer : Très petites vagues; les crêtes commencent à déferler; écume d'aspect vitreux; parfois quelques moutons épars.
Hauteur probable des vagues : 0,6 à 1 m (2 à 3 pi).

Sea State 3

Force 4 Wind Speed 11 to 16 knots (moderate breeze)
Sea Criterion: Small waves, becoming longer: fairly frequent white horses.
Probable Wave Height: 1 to 1.5 m (3.5 to 5 ft)

Force 4 : Vent de 11 à 16 noeuds (jolie brise).
Aspect de la mer : Petites vagues devenant plus longues, moutons franchement nombreux.
Hauteur probable des vagues : 1 à 1,5 m (3,5 à 5 pi).

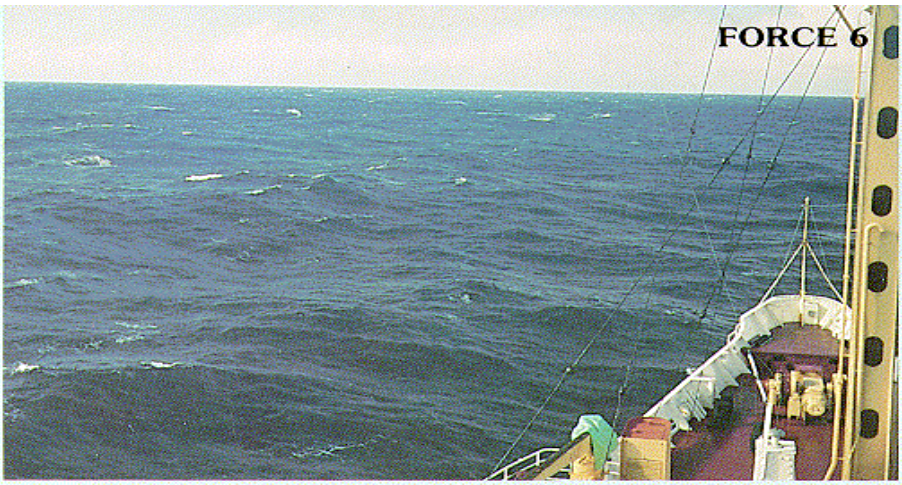
Sea State 4



Force 5 Wind Speed 17 to 21 knots, (fresh breeze)
Sea Criterion: Moderate waves, taking a more pronounced long form; many white horses are formed (chance of some spray).
Probable Wave Height: 2 to 2.5 m (6 to 8.5 ft)

Force 5 : Vent de 17 à 21 noeuds (bonne brise).
Aspect de la mer : Vagues modérées prenant une forme plus nettement allongée; formation de nombreux moutons; parfois quelques embruns.
Hauteur probable des vagues : 2 à 2,5 m (6 à 8,5 pi).

Sea State 5



Force 6 Wind Speed 22 to 27 knots, (strong breeze)
Sea Criterion: Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray).
Probable Wave Height: 3 to 4 m (9.5 to 13 ft)

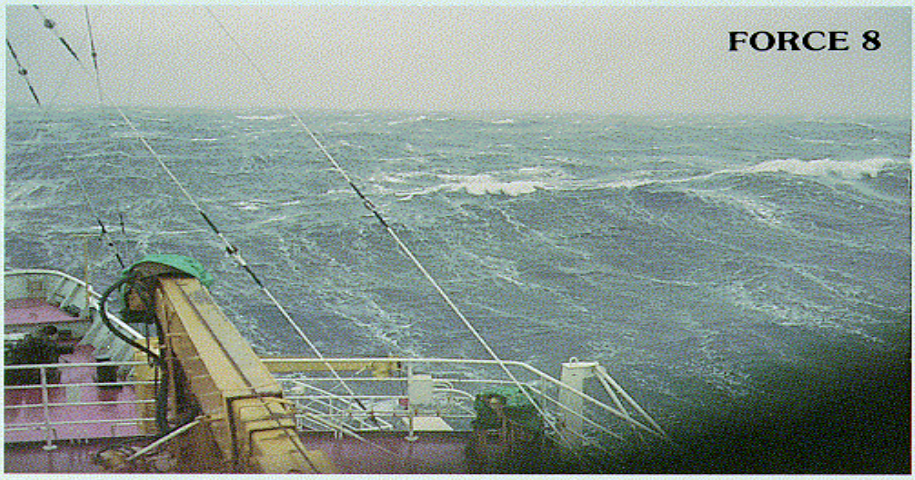
Force 6 : Vent de 22 à 27 noeuds (vent frais).
Aspect de la mer : De grosses vagues (lames) commencent à se former; les crêtes d'écume blanche sont plus étendues; habituellement quelques embruns.
Hauteur probable des vagues : 3 à 4 m (9,5 à 13 pi).

Sea State 6

Force 7 Wind Speed 28 to 33 knots, (near gale)
Sea Criterion: Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
Probable Wave Height: 4 to 5.5 m (13.5 to 19 ft)

Force 7 : Vent de 28 à 33 noeuds (grand frais).
Aspect de la mer : La mer grossit; l'écume blanche qui provient des lames déferlantes commence à être soufflée en traînées qui s'orientent dans le lit du vent.
Hauteur probable des vagues : 4 à 5,5 m (13,5 à 19 pi).

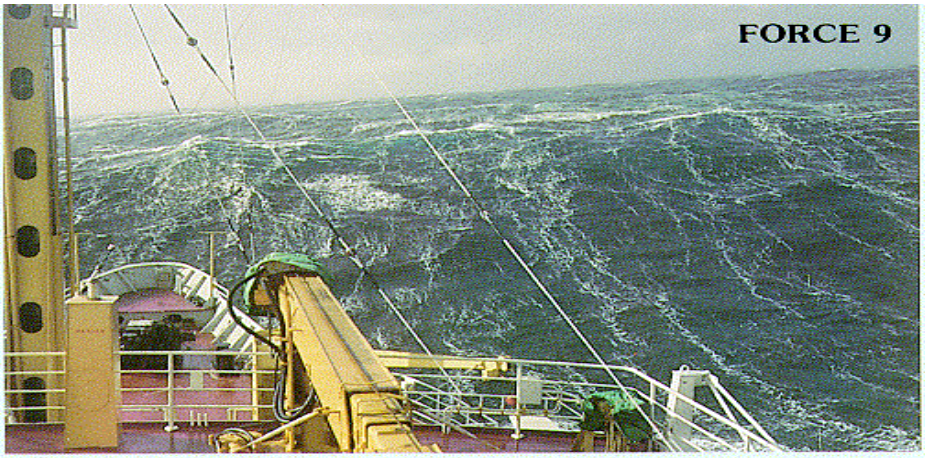
Sea State 7



Force 8 Wind Speed 34 to 40 knots, (gale)
Sea Criterion: Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind.
Probable Wave Height: 5.5 to 7.5 m (18 to 25 ft)

Force 8 : Vent de 34 à 40 noeuds (coup de vent).
Aspect de la mer : Lames de hauteur moyenne et plus allongées; au bord supérieur leurs crêtes commencent à se détacher des tourbillons d'embruns; l'écume est soufflée en traînées très nettes orientées dans le lit du vent.
Hauteur probable des vagues : 5,5 à 7,5 m (18 à 25 pi).

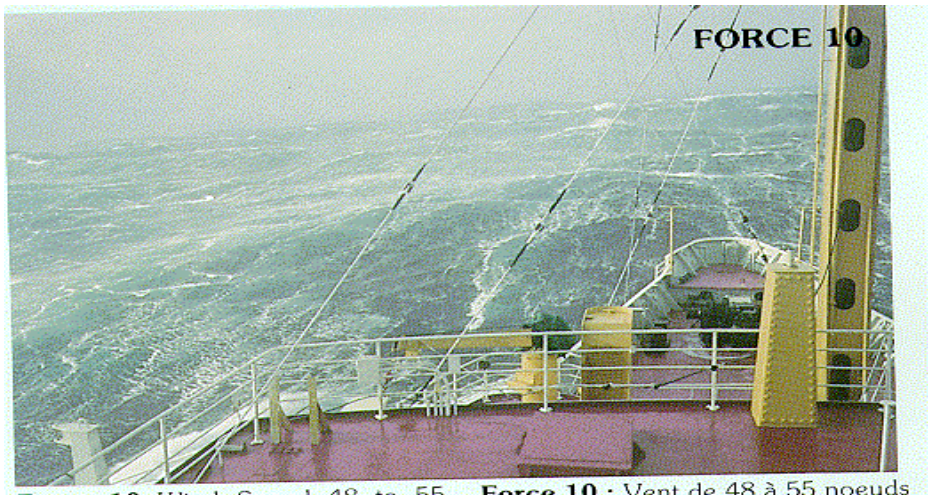
Sea State 8



Force 9 Wind Speed 41 to 47 knots, (strong gale)
Sea Criterion: High waves; dense streaks of foam along the direction of the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility.
Probable Wave Height: 7 to 10 m (23 to 32 ft)

Force 9 : Vent de 41 à 47 noeuds (fort coup de vent).
Aspect de la mer : Grosses lames, épaisses traînées d'écume dans le lit du vent; la crête des lames commence à vaciller, s'écrouler et déferler en rouleaux; les embruns peuvent réduire la visibilité.
Hauteur probable des vagues : 7 à 10 m (23 à 32 pi).

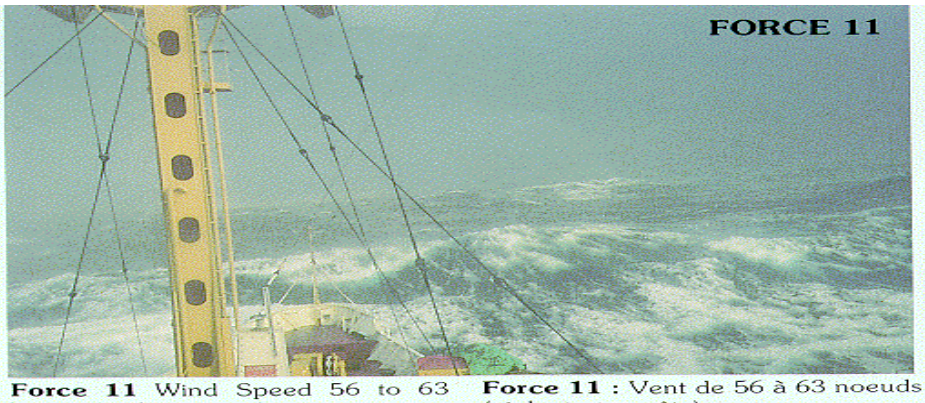
Sea State 9



Force 10 Wind Speed 48 to 55 knots, (storm)
Sea Criterion: Very high waves with long overhanging crests; the resulting foam, in great patches is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance, the tumbling of the sea becomes heavy and shock-like; visibility affected.
Probable Wave Height: 9 to 12.5 m (29 to 41 ft)

Force 10 : Vent de 48 à 55 noeuds (tempête).
Aspect de la mer : Très grosses lames à longues crêtes en panache; l'écume produite s'agglomère en larges bancs et est soufflée dans le lit du vent en épaisses traînées blanches; dans son ensemble, la surface des eaux semble blanche; le déferlement en rouleaux devient intense et brutal; la visibilité est réduite.
Hauteur probable des vagues : 9 à 12,5 m (29 à 41 pi).

Sea State 10



Force 11 Wind Speed 56 to 63 knots, (violent storm)
Sea Criterion: Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected.
Probable Wave Height: 11.5 to 16 m (37 to 52 ft)

Force 11 : Vent de 56 à 63 noeuds (violente tempête).
Aspect de la mer : Lames exceptionnellement hautes (les navires de petit et de moyen tonnage peuvent disparaître quelques secondes derrière les lames); la mer est complètement recouverte de longs bancs d'écume dans le lit du vent; le bord des crêtes est soufflé et donne de la mousse; visibilité réduite.
Hauteur probable des vagues : 11,5 à 16 m (37 à 52 pi).

Sea State 11

APPENDIX E

SCENARIO I

Excerpt of Task Force Smith from the *Army Magazine, February 2002*

OUTNUMBERED 50 TO 1, TASK FORCE SMITH WAS THE FIRST TO STOP THE REDS IN THE WAR'S MOST CRUCIAL BATTLE.

This is the epic story, told here for the first time, of the first handful of American ground troops ordered into combat in Korea.

They were only 406 men, dug in on a hill near Osan, but they blasted hell out of 20,000 on rushing communist troops spearheaded by 33 Russian-made T-34 tanks.

With their seven-hour gory stand on Heartbreak Highway, Task Force Smith, - consisting of only two under strength American rifle companies- forced the Reds to slow down their headlong assault, deploy their forces and thus lose the impetus that would have carried them to the docks of Pusan just a few days after the outbreak of war.

In what may have been the seven most crucial hours of that war, Task Force Smith changed the pattern of the whole conflict and perhaps the course of history.

Of the 406 grim and ill-equipped American who manned that hill near Osan, only 250 came out alive.

"The Lid Has Blown Off"

LTC Charles Bradford Smith, scrappy 34-year-old commander of the 1st Battalion, 21st Regiment, 24th Infantry Division, was asleep when the phone call came through: "Brad, the lid has blown off. Get on your fighting clothes and report to the C>.P." The routine seemed familiar. Smith, a West Pointer, had been routed out of bed at Pearl Harbor to rush his 120 infantrymen to defend an eight-mile stretch of Hawaiian beach. Now it was Korea.

This was on June 30th, four days after the Reds started their invasion of South Korea. The 24th Division was stationed at Kyushu, southernmost island of Japan. Less than 12 hours after orders left Washington authorizing the use of U.S. troops, C-54's began landing Smith's battalion on a rain-soaked runway 13 miles out of Pusan, Korea. On the wall of a barracks, one of Smith's men found time to scribble this classic little jingle:

"Clap your hands and jump for joy.
You were here before Kilroy!"

There was little joy among this meager, jittery vanguard of the great army that was to halt the Reds. The men were wet, tired, bewildered. Swept from a quiet spot in peaceful Japan, they are being tossed to an enemy they knew nothing about in a sickening country, in a confusing mysterious war. And yet this understrength battalion and its 19 jeeps represented the hope of 53 United Nations countries to held the Red forces plunging toward Pusan.

The Battalion was "Red Hot"

Only about one in seven of the men were combat veterans; the rest were green. The bulk of the riflemen, machine gunners and mortar men were 20 years old or less. But the battalion had reached its peak of training; in Army par lance, 1st Battalion, 21st Regiment, was "red hot."

Supporting the riflemen were four heavy machine guns, two 75mm recoilless rifles, six bazookas, two mortars, and a promise and a prayer that a battery of artillery would join them soon.

Major General William F. Dean, commander of the 24th (later captured by the Reds), had said to Smith: "When you get to Pusan, commandeer trucks, trains, anything else you can get your hands on. Head for Taejon. We've got to block the main Seoul-Pusan road as far north as possible."

There was no other information; no estimate of the enemy situation; no indication of what would be on the battalion's flanks; and no idea of when it could expect any reinforcements.

At Taejon, Smith met Brig. Gen. John Church, MacArthur's advance commander in Korea. "Well, Smith, we have a little action up here," said Church, pointing on a map to a strip of main highway south of Seoul. "All we need is an outfit up there that won't run when they see tanks."

Smith decided to look over the land he was to defend. Taking a handful of his battalion officers, he drove to a spot north of Osan and surveyed the high ground commanding the two avenues of approach into the town. Jutting out of the rich Uijongbu valley was a large hill, flanked on the east side by a railroad and on the west by the main highway.

"If we had to fight in this vicinity, here is the spot we could best defend," Smith told his officers. Then he mapped out supporting fires and final protective lines, dovetailed plans for company and platoon defensive positions and covering fires.

This was to be the first planned American battle line since the end of World War II.

Shortly after midnight, July 4, 1950, all of Task Force Smith moved out to Osan.

By this time, the Communists had made a clean break-through, and there was nothing between Smith and the Red spearhead even to begin to low the enemy down. Task Force Smith was the only organized resistance remaining on the bloody highway between Seoul and Pusan.

Task Force Smith Digs In

Smith's men moved into their positions rapidly. Foxholes were dug, communication wire was laid, and ammo and rations were unloaded and distributed. At the first light, the men scanned their fields of fire. In spite of the rain they had about 10,000 yards' visibility right down the main highway and railroad bed. Meanwhile, word had come through that the promised artillery had showed up - Battery "A" of the 52nd Field Artillery was digging in 1500 yards to the rear of Smith's position and was ready to start shooting. By 7:30 A.M., Task Force Smith was trimming up its positions. It had

test-fired its guns and rifles, and the artillery had fired several registrations on likely target areas in front of the riflemen's positions.

"B" Company with supporting elements was assigned to cover it. "C" Company was to cover the railroad. The second 75mm recoilless rifle was trained down the railroad tracks.

M/Sgt. Harvey Vann, a Texan, had bought a new car in Japan just before the battalion was flown to Korea. Now standing on the hill north of Osan, he offered it for sale. "It's a good buy, men," he assured his dug-in comrades, 'and I'm willing to sell it at a loss." He had no takers.

Daylight brought more rain-and the enemy. The weather doused any hope of air support for the defense.

At 7:30 A.M., July 5th, the communists struck. A column of thirty-three Russian-made T-34 tanks came rumbling out of Suwon down the highway toward the Americans on the hill.

Task Force Smith trained all its guns on the enemy. The artillery opened up at Colonel' Smith's call, but the infantry held its fire, waiting for the order to shoot. The initial enemy fire attack came when the tanks were about 1500 yards. They approached without caution, apparently not expecting to run into a force that would stand and fight.

"They couldn't have been surprised that we were on the hill," Smith recounted. "After all, we made plenty of noise when we test-fired and registered our guns at daybreak. They must have heard us."

The Communists Blast Our Hill

The American artillery continued to fire as the T-34's paused on the winding highway to pour shells into the U.S. Positions. Smith ordered the fire of the 75 recoilless rifles held until 700 yards range because of the shortage of ammunition. For the rest of the infantry-men, the order was; "Don't shoot till you see the slant of their eyes!'

The tanks came on.

Sergeant Pugh was in command of the 75mm rifle responsible for the highway. When the back blast of his gun immediately disclosed his position to the oncoming tanks, the Communists blasted his position, killing one soldier and wounding another. The sergeant and his remaining men moved the gun about 100 feet and resumed firing, continuing until their ammunition was exhausted. Because the bulk of their ammunition was the wrong type (probably high explosive and not armor piercing) no visible damage was done by their fire. The tanks were slowed down, but they weren't stopped. For an hour, they inched forward toward the American positions.

The tragedy of the defense was the failure of the anti-tank rockets to knock off the lead tank. Moving under the direction of LT. Janson Cox. A Missourian who has since been reported mission in action, the bazooka teams edged down to the road to engage the tanks. "It was heart breaking," reported Capt. Doody of "B" Company, "to watch those men firing pointblank and doing little damage. Rockets hit the tanks in the tracks, turrets and bogies, and still couldn't stop them!"

Lieutenant Ollie Conner, standing behind a knocked-out vehicle, fired 22 rockets from about 15 feet into the tanks as they went by. He stood upright in the smoke and

rain, defying the enemy tankers, and cursing as his shots, all excellent hits by World War II standard, failed to cripple the tankers. Yet before his ammo was gone, Conner managed to knock out two or the tanks, a feat for which he later was awarded the Silver Star.

There were no live demolitions or mines to hinder the enemy. The tanks moved right through the ail of fire coming down on them from the hill.

"If one anti-tank crew had been able to pick off the lead and rear tank, the others would have been sitting ducks," reported Lt. Col. Miller Perry, the artillery commander, as he recounted the action. "Four or five tanks, all medium, just sat near our positions with their hatches battened down, blasting away at our line. The infantry took a terrific pounding as the other tanks came down the road. The tanks swung their turrets on our artillery positions, letting us have it. In a direct fire duel at 100 yards range, we struck back with our 105's and stopped four of them."

Battle Was Costly

Colonel Smith moved from company to company to make sure his men held their positions in the tank attack. It wasn't easy for some men. When Smith passed the gun emplacement of a young Iowan, Pfc. John Crespo, a 60mm mortarman, Crespo held up the bipod. It had been shattered by shell fragments, "What do I do now?" he asked. Crespo fought on as a rifleman, but following that engagement was reported missing in action.

Not far from Crespo, Bard Smith could see the rest of the 60mm mortar team, blasted by tank fire. Sgt. Calvin Patterson of Oregon had been struck in the neck with shell fragments, but refused evacuation to the aid station. "We won't get out anyway," he explained. He stayed with the small mortars until out of ammunition and then directed his platoon, including Crespo, as riflemen.

The hour-long tank battle had been costly. About 20 Americans had been killed and wounded holding their positions as the tanks went through and past them; leaving six burning hulls on the road. Task Force Smith had been ordered to hold. General Church had said, "All we need is an outfit up there that won't run when they see tanks." Task Force Smith did not run.

But the main attack had not yet been launched. On the road south from Suwon, 10,000 yards away, the Americans could see countless trucks loaded with troops. Why they did not dismount and fight with the tanks is a mystery to Smith. Had they fought as a tank-infantry team, Task Forces Smith would have been slaughtered in the first assault.

Forty-five minutes after the tanks had passed through Task Force Smith's position, the trucks started up. They rolled along the highway much as the tanks had. None of the troops got out ahead to scout the ground.

A column of enemy five miles long came out in the open, and when the leading elements were within 1000 yards, Task Force Smith "threw the book at them." The column was raked with machine gun, mortar and artillery fire. Trucks went up in flames. Enemy dead and wounded cluttered the road. Others fled in panic into adjacent rice paddies. This was not the war the Reds had been used to during the past several days.

The enemy's approach was slowed down, which gave Task Force smith a chance to consolidate its positions and move up more ammunition. They discovered then that the tanks had shot up many of the 19 jeeps, which had been pooled in the rear.

The tanks continued to speed down the main highway toward Pyongtaek while Task Force smith engaged the infantrymen to the front. As the T-34's rolled by they tore up the communications lines to the artillery batter. This destroyed the last communications Smith had, other than messengers. Most of his jeeps were gone, his radios, were inoperative from the constant rain, and now the tanks had chewed up his wire.

The artillery was 100 yards off the road in position when the tanks went by. They suffered only a few casualties, including Col. Perry, the artillery commander who received a shell fragment in the knee.

Reds Collect Their Wits

Once the tanks cleared, Task Force Smith never saw or heard of them again. What the advance guard of Americans did not know was that by this time the 1st Battalion, 34th Infantry of the 24th division commanded by Lt. Col. "Red" Ayers, was approaching a new line near Pyongtaek to fight the first in a planned series of long delaying actions. The T-34's were rolling head on into this force as the Red Infantry men, several miles behind the tanks, were collecting their wits. The initial shock against Task Force Smith had been severe for them. Losses were great.

"It seemed that we mowed down hundreds, but it was hard to tell, " Smith said. By 10:45 A.M., the Reds resumed the offensive, this time dismounted. Artillery and mortar fire began to fall on the U.S. position. From under this cover, swarms of communist soldiers 1000 yards form Task Force Smith fanned out in a wide enveloping movement, sweeping in from the east and west up the far sloes of the hill. Task Force Smith held tenaciously, fighting off wave after wave.

Smith decided that the only way to prolong survival was to bring his forces together on one side of the road and fight in a perimeter defense, Indian fashion, al long as he could. But getting his men across the road was difficult. The highway was covered by a screen of enemy fire, and the enemy had already set up machine guns on the slopes immediately below the American positions.

Dug in on the slopes overlooking the Reds was quiet, determined Pfc. Florentine Gonzales. He was a machine gunner who had always said he would never leave his machine gun. He had all but hand- carried the weapon from Japan to that hill, and now as the enemy came in his sights he splattered them with a fury of rime. As his buddies tried to close into the defense perimeter Gonzales covered them, yelling encouragement as he traversed his gun across the ranks of the attacking communists. By the time the last American dashed across the road under Gonzales' covering fire, they noticed that he was bleeding from head to chest. But his gun was still pouring out a volley of death. He clung to his gun, half-blind with blood and rage. All the strength he had left in his body was on the handgrip of his machine gun as the Communists swarmed his position. (He was later reported as a captive by the enemy).

The perimeter was established but by 1:30 in the afternoon, with one quarter of its force wounded or killed, very little ammunition left, no communications and no transportation, Task Force Smith was virtually surrounded. The only are from which it was not getting a heavy volume of fire was to the right rear.

Gets No Support

There was no air support, not even a liaison cub plane to guide Task Force Smith out of this hell. There was no hope of any ground support punching its way through to them, not while 27 Russian tanks were on the highway between Osan and Pyongtaek. The road was under fire, preventing any opportunity to open wire communications to the artillery.

Sergeant First Class Loran Chambers of Mt. Sterling, IL, was a rough-tough soldier. In World War II he had collected five Purple Hearts, and this was the day for his sixth combat wound. He was a platoon guide in "C" Company, directing all available fire on the attacking North Koreans. A gruff, profane, but colorful sergeant, Chambers called back over the sound-power telephone for some 60mm mortar support. The answer came back, "Won't reach that far."

"How about some81's?" Chambers shouted.
"We don't have any."
"Well, for C----- sake, throw in some 4.2's"
"We're out of that, too," came the plaintive response from the mortar platoon.
Then Cambers asked, "How about the artillery?"
"No communications."
"How about the Air Force?"
"We don't know where they are."
"Then, dammit, call the Navy!" Chambers demanded.
"They can't reach this far."

Chambers was exasperated but not undone. "Send me a camera," he yelled over the phone, "I want to take a picture of this."

A few minutes later Chambers was struck by mortar fragments, for his sixth Purple Heart. He went on to earn five more Purple Hearts and a commission and was rotated home before his luck ran out.

At 2:30 Colonel smith issued orders to his companies to fight their way through the light spray of fire to the right rear. "B" Company would cover the withdrawal as "C" Company with attachments, the medics, the walking wounded and Battalion Headquarters fought their way southward toward a smaller hill to the rear. From here "C" company would in turn support the withdrawal of "B" Company.

The positions were littered with American dead. There were many critically wounded men lying on litters, on the ground and in the air station. Use of the few remaining jeeps for evacuation purposes was impossible, as the enemy controlled the road, and the rice paddies were rich with mud and fertilizer. Litter bearers carrying

wounded through hip-deep mud in the rice paddies would have progressed so slowly that the bearers themselves would certainly have become casualties.

"That's the worst part of a deal like that," Smith said, "to leave wounded and dying men yelling for you to help them, and there was no way to help them. We had a lot of casualties getting out of that position, how many I don't know."

One of Smith's Lieutenants, hurt badly, was dragging himself to the rear. There were six men lying on the ground, unable to walk. "Lieutenant, what is going to happen to us?" one of them cried out. The lieutenant passed him a hand grenade. "This is the best I can do for you."

Machine Gun Is Silenced

The withdrawal was made more difficult by an enemy machine gun nest 40 yards away from the route. It sprayed the hillside and rice paddies every time one of the infantrymen tried to move.

This murderous gun wasn't silenced until Lt. Raymond E. "Bodie" Adams, of Baltimore, Maryland, star pitcher and captain of the regimental baseball team, tossed a grenade 40 yards directly into the gun nest and destroyed the position. Bodie Adams, who had to take considerable risk and fully expose himself, got the Silver Star for this action.

There was no indication of where the tanks had gone and Smith did not know how large a force he was fighting. Actually it was two divisions, led by the tank spearhead that hit him seven hours earlier. Now these two divisions-about 20,000 men-had already suffered thousands of casualties and were fully deployed along the strategic Seoul-Pusan highway.

"In an obviously hopeless situation with many casualties, no communications, no transportation, ammo gone and the enemy tanks now well behind me, I was faced with a decision: what the hell to do? To stand and die or try to get the remains of my task force out of there. I could last, at best, only another hour and then lose everything I had. I chose to try to get out in hopes that we would live to fight again another day," Smith said.

Smith gave orders to his men to try and find their way to friendly positions. Certainly other U.S. units were set up by now. He told his men to assemble in company groups. The situation on the distant flanks and rear were unknown. It seemed reasonable to expect that other enemy units were advancing down parallel roads. The ammunition was exhausted, and Smith felt that small groups of five or six unarmed men would have better chances of survival than company-size groups of unarmed men. "Meet me at Chonan 20 miles south of here. Keep off the main roads. Good luck."

Some Men Made It

Some men walked 60 miles, wading through muddy and malodorous rice paddies and over mountains to get to that position, but they made it. Others never made it. Lt. Col. Smith with four or five volunteers sloshed through open rice paddies in hip-deep mud to notify the artillery battery that the infantry was pulling out. Because of lack of

communications, there was no other way to notify the artillerymen who were still in good shape and had lost no equipment. This seemed a miracle, since Task Force Smith had observed the tanks firing at 100-yard range into the battery position.

For several days men of the battalion filtered back to the rear. Perhaps most unusual odyssey of escape was the story of Sgt. William F. Smith. Hiding out behind enemy lines, he worked his way with the aid or friendly South Koreans to the west coast, where fishermen took him south by boat. About two weeks later, he regained friendly lines where he was hospitalized with a case of pneumonia.

Captain William "Chief" Wyrick, a good infantryman with some Indian blood in him, took a small group south across the railroad tracks. Wyrick moved east with his group, which included the chaplain. They ran into a group of about ten Koreans. Not knowing whether they were South or North Koreans, they forced the natives to join them. They struck out for Ansong and from there south to Chonan. The further they went he more disorderly the march became. However, they managed to take care of the wounded, feeding them rice balls which were provided by the Koreans, who turned out to be friendly, and eventually made their way to Chonan.

The artillery battery moved out in its trucks, leaving in their wake destroyed equipment. En route over open country and back roads the trucks picked up all the infantrymen they could locate. On July 6 about 185 men from Task Force Smith had reassembled as instructed at Chonan, ready for what might come.

Not Yet Out of Trouble

Task Force Smith still wasn't out of trouble. As the men straggled into Chonan, they were directed to a schoolhouse where they hoped to rest and get cleaned up a bit. Just as Smith had gotten out of his dirty fatigues, he received word that the town was now "No-man's land" - in other words, in front of the front lines!

Smith hurriedly dressed and together with some of his men dashed into the town, hoping to scrounge some trucks. There he saw his "C" Company Commander, Capt. Richard W. Dashner, of Waco, Texas, with a group of 65 men who had just arrived. This brought the survival total to 250 exhausted men. Smith told them to stand fast right where they were while he continued on in search of trucks.

Going to the railroad station, Smith and his group were fortunate in securing four trucks from the South Koreans and were also able to borrow six more trucks from the Service Company of the 34th Infantry, which was in the process of moving supplies to the south.

Task Force Smith-now 250 strong-got on the trucks and on General Barth's order proceeded to Taejon for rest and equipment. About 155 men were killed, wounded or mission in the seven-hour fight at Osan.

But the enemy tanks, which sped down the main highway through Smith's positions while Task Force smith held its ground, were in far worse trouble. For one thing they had taken serious losses for the first time since they launched their aggression. Six tanks were a lot of casualties of the 33 tanks in the short fight. They did not know how large or small a force they had hit.

Moreover, the Red tankers did not know what was holding up their infantrymen to the rear and therefore, did not dare attack without infantry the positions at Pyongtaek held by the 34th Regiment.

The 34th got a break then, in that it was able to move back to a position just south of Chonan with little trouble and there set up a better position for delay.

Task Force Loses Identity

Task Force Smith-what remained of it-was soon reunited with other units of the 1st Battalion and lost forever its identity as Task Force Smith. It became once again the 1st Battalion, 21st Infantry Regiment, 24th Division. Its valiant men went right back into battle, no longer green kids but bitter and hardened combat veterans. They now know what kind of an enemy they were facing in the swarming hordes of fanatical communists who were determined to drive them from Korea.

It was a long time before any of the men of Task Force Smith realized what they had accomplished. When they had time to reflect, or when some one who knew "the big picture" explained it to them, they could realize the magnitude of their success. With 406 men they had forced two North Korean tank-led divisions to slow down a drive that would have easily brought them to Pusan, for on July 5th no firm defense was set up anywhere behind Task Force smith to stop the Reds.

Two days later, when General MacArthur announced in Tokyo, "The enemy have lost their opportunity for victory in Korea by deploying too soon," he was thinking about Task Force Smith. He was thinking about the momentous decision which had sent a handful of men against 20,000 well-trained, well-equipped Communists. He was thinking about Brad Smith's decision to stand at Osan.

It was the seven-hour fight of Task Force Smith at Osan that gave the free world the margin of time it needed to get more troops to the Korean peninsula and stop the Reds.

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APPENDIX F

SCENARIO II

Excerpt from the website for the Battle of Midway
http://www.history.navy.mil/photos/events/wwii-pac/midway/midway.htm
BATTLE OF MIDWAY, 4-7 JUNE 1942

The Battle of Midway, fought over and near the tiny U.S. mid-Pacific base at Midway atoll, represents the strategic high water mark of Japan's Pacific Ocean war. Prior to this action, Japan possessed general naval superiority over the United States and could usually choose where and when to attack. After Midway, the two opposing fleets were essentially equals, and the United States soon took the offensive.

Japanese Combined Fleet commander Admiral Isoroku Yamamoto moved on Midway in an effort to draw out and destroy the U.S. Pacific Fleet's aircraft carrier striking forces, which had embarrassed the Japanese Navy in the mid-April Doolittle Raid on Japan's home islands and at the Battle of Coral Sea in early May. He planned to quickly knock down Midway's defenses, follow up with an invasion of the atoll's two small islands and establish a Japanese air base there. He expected the U.S. carriers to come out and fight, but to arrive too late to save Midway and in insufficient strength to avoid defeat by his own well-tested carrier air power.

Yamamoto's intended surprise was thwarted by superior American communications intelligence, which deduced his scheme well before battle was joined. This allowed Admiral Chester W. Nimitz, the U.S. Pacific Fleet commander, to establish an ambush by having his carriers ready and waiting for the Japanese. On 4 June 1942, in the second of the Pacific War's great carrier battles, the trap was sprung. The perseverance, sacrifice and skill of U.S. Navy aviators, plus a great deal of good luck on the American side, cost Japan four irreplaceable fleet carriers, while only one of the three U.S. carriers present was lost. The base at Midway, though damaged by Japanese air attack, remained operational and later became a vital component in the American trans-Pacific offensive.

U.S. FORCES ASSEMBLE FOR ACTION, 26 MAY - 3 JUNE 1942

By mid-May 1942 U.S. Pacific Fleet codebreakers, directed by Lieutenant Commander Joseph J. Rochefort, were reporting that the Japanese planned to attack somewhere in the Hawaiian area, as well as in the Aleutians. The carrier *Yorktown* (CV-5), damaged earlier in the month at the Battle of Coral sea, was already on the way back to Pearl Harbor for repairs. Now, Admiral Chester W. Nimitz, the Pacific Fleet's commander, recalled his other operational carrier group, Vice Admiral William F.

Halsey's Task Force 16 (TF-16), which had gone to the South Pacific after it launched the Doolittle raid on 18 April.

Halsey's two carriers, *Enterprise* (CV-6) and *Hornet* (CV-8), arrived at Pearl Harbor on 26 May, by which time intelligence was certain that Midway was the Japanese target. Rear Admiral Raymond A. Spruance relieved the ailing Halsey in command, as TF-16 busily got ready to steam the thousand miles up to the Midway area. When it left port on 28 April, the damaged *Yorktown* was receiving urgent repairs. In a remarkable feat, Pearl Harbor Navy Yard workers had her ready in time to sail with Rear Admiral Frank Jack Fletcher's Task Force 17 (TF-17) on the 30th. *Yorktown* received a new air group, formerly belonging to USS *Saratoga* (CV-3), though some elements of her previous air squadrons remained on board.

These late May departures beat the Japanese to the punch. They had planned to place submarines to watch for an American sortie from Pearl Harbor, but didn't expect that to happen so soon, and the Japanese subs were not yet on station. Admiral Nimitz, whose intelligence had given him the enemy's plans, took care to cover Midway and its approaches with a strong force of his own submarines.

After refueling at sea, TF-16 and TF-17 rendezvoused some three hundred miles northeast of Midway on 2 June and prepared to meet the Japanese. Search flights were sent out to guard against unexpected developments. Spruance and Fletcher planned to operate their forces separately, though never very far apart. Their presence unsuspected by the enemy, they were in position to make a surprise flank attack on the Japanese carrier force when it came into range two days later.

MIDWAY ATOLL

Midway is a small atoll nearly halfway across the Pacific, the westernmost inhabited member of the Hawaiian Island chain. Its two major islands, Sand and Eastern, have a combined area of only a few square miles. They are densely populated by several bird species, of which the most abundant is the Laysan Albatross, popularly nicknamed the "Gooney Bird".

First visited in 1859, Midway formally became a United States' possession in 1867. A trans-pacific cable station was established there in 1903. In 1935, Pan American Airways built a way station on Sand Island to support its new seaplane route between the U.S. and Asia. Midway was recommended as a patrol plane and submarine base in a 1938-39 study of national defense needs, and construction of a U.S. Navy base began soon thereafter. This included a seaplane hangar and other facilities on Sand Island and an airfield on the smaller Eastern Island.

Two Japanese Destroyers bombarded the new base on 7 December 1941, causing damage to some buildings and destroying one patrol plane. With the fall of Wake later in the month, Midway became the westernmost U.S. outpost in the Central Pacific. Land-

based bombers and fighters were stationed on Eastern Island. U.S. Marines provided defensive artillery and infantry. Operating from Sand Island and the atoll's lagoon, PBY "Catalina" seaplanes actively patrolled toward the Japanese-held Marshall Islands and Wake, checking on enemy activities and guarding against further enemy attacks on Hawaii. There were occasional clashes when planes from Midway and those from the Japanese islands met over the Pacific.

Pacific Fleet commander Admiral Chester W. Nimitz inspected Midway in early May 1942, conferring with the local commanders, Navy Captain Cyril T. Simard and Marine Colonel Harold D. Shannon. As the Japanese threat to Midway became known during that month, Nimitz increased its ground and air forces, the latter to the point where Eastern Island was crowded with Marine Corps, Navy and Army Air Force planes. Several PT boats were sent to improve seaward defenses. By 4 June 1942, Midway was as ready as possible to face the oncoming Japanese.

The Battle of Midway, 1942

The Doolittle Raid on Japan in April 1942 shook the Japanese military establishment that previously believed their homeland immune from air attack. To defend Japan they must extend their defensive perimeter eastward. Midway, a tiny island a thousand miles from Hawaii, became the target.

Dauntless Dive-Bombers Attack the Japanese Fleet

The Japanese threw almost the entire Imperial Fleet into the battle - six aircraft carriers, eleven battleships, thirteen cruisers, forty-five destroyers, assorted submarines, transports and mine sweepers. The Americans had cracked the Japanese code and knew something was up. The thin American defense consisted of three aircraft carriers (*Hornet*, *Enterprise* and *Yorktown*), eight cruisers, fourteen destroyers, and the aircraft stationed on Midway itself. The *Yorktown*, mauled in the Battle of the Coral Sea, limped into battle after band-aid repairs at Pearl Harbor.

The Americans had surprise on their side, and luck. On June 4, they discovered the Japanese fleet northeast of Midway. An air battle quickly developed. The turning point came at mid-morning. The Japanese fighters were drawn down to sea level by attacking American torpedo bombers, all of which were lost. Their sacrifice cleared the skies above for the American dive-bombers. Within minutes three Japanese carriers were ablaze. *Hiryu*, the fourth Japanese carrier retaliated with an air attack sinking the *Yorktown*. That afternoon American aircraft caught the *Hiryu*, inflicting serious damage. The Japanese fleet retreated. The one-day battle reversed the tide of war in the Pacific, six months after Pearl Harbor. From that point on, Japan would be on the defensive.

Under Attack

Alerted of Japanese plans through intercepted messages, an American Task Force awaited the enemy steaming towards Midway. The Japanese struck first with an attack on the island. The Americans located the Japanese fleet in the early morning and commenced a costly air strike that only 6 of the attacking 41 torpedo bombers survived. Mitsuo Fuchida witnessed the battle from the deck of the aircraft carrier Akagi:

"The first enemy carrier planes to attack were 15 torpedo bombers. When first spotted by our screening ships and combat air patrol, they were still not visible from the carriers, but they soon appeared as tiny dark specks in the blue sky, a little above the horizon, on *Akagi's* starboard bow. The distant wings flashed in the sun. Occasionally one of the specks burst into a spark of flame and trailed black smoke as it fell into the water. Our fighters were on the job, and the enemy again seemed to be without fighter protection.

Presently a report came in from a Zero group leader: 'All 15 enemy torpedo bombers shot down.' Nearly 50 Zeros had gone to intercept the unprotected enemy formation! Small wonder that it did not get through.

A Japanese aircraft carrier under attack during the battle of Midway

Again at 0930 a lookout atop the bridge yelled: 'Enemy torpedo bombers, 30 degrees to starboard, coming in low!' This was followed by another cry from a port lookout forward: 'Enemy torpedo planes approaching 40 degrees to port!'

The raiders closed in from both sides, barely skimming over the water. Flying in single columns, they were within five miles and seemed to be aiming straight for *Akagi*. I watched in breathless suspense, thinking how impossible it would be to dodge all their torpedoes. But these raiders, too, without protective escorts, were already being engaged by our fighters. On *Akagi's* flight deck all attention was fixed on the dramatic scene unfolding before us, and there was wild cheering and whistling as the raiders went down one after another.

Of the 14 enemy torpedo bombers which came in from starboard, half were shot down, and only 5 remained of the original 12 planes to port. The survivors kept charging in as *Akagi's* opened fire with antiaircraft machine guns.

Both enemy groups reached their release points, and we watched for the splash of torpedoes aimed at *Akagi*. But, to our surprise, no drops were made. At the last moment the planes appeared to forsake *Akagi*, zoomed overhead, and made for *Hiryu* to port and astern of us. As the enemy planes passed *Akagi*, her gunners regained their composure

and opened a sweeping fire, in which *Hiryu* joined. Through all this deadly gunfire the Zeros kept after the Americans, continually reducing their number.

Seven enemy planes finally succeeded in launching their torpedoes at *Hiryu,* five from her starboard side and two from port. Our Zeros tenaciously pursued the retiring attackers as far as they could. *Hiryu* turned sharply to starboard to evade the torpedoes, and we watched anxiously to see if any would find their mark. A deep sigh of relief went up when no explosion occurred, and *Hiryu* soon turned her head to port and resumed her original course. A total of more than 40 enemy torpedo planes had been thrown against us in these attacks, but only seven American planes had survived long enough to release their missiles, and not a single hit had been scored. Nearly all of the raiding enemy planes were brought down."

Five Minutes That Changed The War

The Japanese were now caught in a logistical nightmare. Wanting to follow up on their earlier attack on Midway, they armed their bombers with bombs. However, in the midst of battle, scouts spotted the American Fleet, so the bombers were ordered refitted with torpedoes. Simultaneously, the Zeros defending the Fleet returned to their carriers for rearming and refueling. At this moment, more American attackers appeared, Commander Fuchida continues his story:

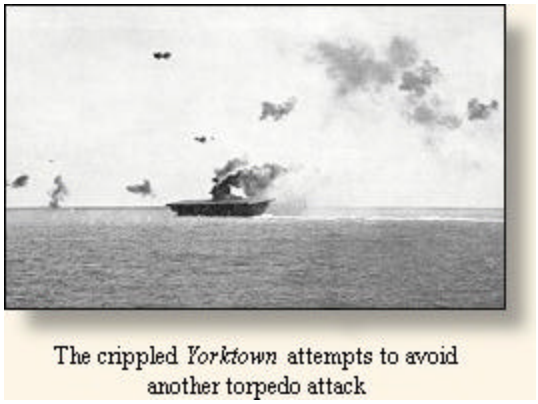
"Preparations for a counter-strike against the enemy had continued on board our four carriers throughout the enemy torpedo attacks. One after another, planes were hoisted from the hangar and quickly arranged on the flight deck. There was no time to lose. At 1020 Admiral Nagumo gave the order to launch when ready. On *Akagi's* flight deck all planes were in position with engines warming up. The big ship began turning into the wind. Within five minutes all her planes would be launched.

Five minutes! Who would have dreamed that the tide of battle would shift completely in that brief interval of time?

The Douglas SBD Dauntless

Visibility was good. Clouds were gathering at about 3,000 meters, however, and though there were occasional breaks, they afforded good concealment for approaching enemy planes. At 1024 the order to start launching came from the bridge by voice-tube. The Air Officer flapped a white flag, and the first Zero fighter gathered speed and whizzed off the deck. At that instant a lookout screamed: 'Hell-divers!' I looked up to see three black enemy planes plummeting toward our ship. Some of our machine guns managed to fire a few frantic bursts at them, but it was too late. The plump silhouettes of the American 'Dauntless' dive-bombers quickly grew larger, and then a number of black objects suddenly floated eerily from their wings. Bombs! Down they came straight toward me! I fell intuitively to the deck and crawled behind a command post mantelet (rolled mattresses providing protection from shrapnel).

The terrifying scream of the dive-bombers reached me first, followed by the crashing explosion of a direct hit. There was a blinding flash and then a second explosion, much louder than the first. I was shaken by a weird blast of warm air. There was still another shock, but less severe, apparently a near miss. Then followed a startling quiet as the barking of guns suddenly ceased. I got up and looked at the sky. The enemy planes were already gone from sight.



The crippled *Yorktown* attempts to avoid another torpedo attack

The attackers had gotten in unimpeded because our fighters, which had engaged the preceding wave of torpedo planes only a few moments earlier, had not yet had time to regain altitude.

Consequently, it may be said that the American dive-bombers' success was made possible by the earlier martyrdom of their torpedo planes. Also, our carriers had no time to evade because clouds hid the enemy's approach until he dove down to the attack. We had been caught flatfooted in the most vulnerable condition possible - decks loaded with planes armed and fueled for attack.

Looking about, I was horrified at the destruction that had been wrought in a matter of seconds. There was a huge hole in the flight deck just behind the amidship elevator. The elevator itself, twisted like molten glass, was drooping into the hangar. Deck plates reeled upward in grotesque configurations. Planes stood tail up, belching livid flame and jet-black smoke. Reluctant tears streamed down my cheeks as I watched the fires spread, and I was terrified at the prospect of induced explosions which would surely doom the ship."

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APPENDIX G

SCENARIO III

Excerpt from the website of the Battle of Kursk at
http://dspace.dial.pipex.com/town/avenue/vy75/

THE BATTLE OF KURSK

Following their disastrous defeat at Stalingrad during the winter of 1942-43, the German armed forces launched a climactic offensive in the East known as Operation Citadel on July 4,1943. The climax of Operation Citadel, the Battle of Kursk, involved as many as 6,000 tanks, 4,000 aircraft and 2 million fighting men and is remembered as the greatest tank battle in history. The high-water mark of the battle was the massive armor engagement at Prochorovka (also spelled Prokhorovka), which began on July 12. But while historians have categorized Prochorovka as a victory of improved Soviet tactics over German firepower and heavy tanks, new evidence casts the struggle at the "gully of death" in a very different light.

The Germans' goal during Citadel was to pinch off a large salient in the Eastern Front that extended 70 miles toward the west. Field Marshal Günther von Kluge's Army Group Center would attack from the north flank of the bulge, with Colonel General Walther Model's Ninth Army leading the effort, General Hans Zorn's XLVI Panzer Corps on the right flank and Maj. Gen. Josef Harpe's XLI Panzer Corps on the left. General Joachim Lemelsen's XLVII Panzer Corps planned to drive toward Kursk and meet up with Field Marshal Erich von Manstein's Army Group South, Col. Gen. Hermann Hoth's Fourth Panzer Army and the Kempf Army, commanded by General Werner Kempf.

Opposing the German forces were the Soviet Central Front, led by General Konstantin K. Rokossovsky, and the Voronezh Front, led by General Nikolai F. Vatutin. The Central Front, with the right wing strengthened by Lt. Gen. Nikolai P. Pukhov's Thirteenth Army and Lt. Gen. I.V. Galinin's Seventeenth Army, was to defend the northern sector. To the south, the Voronezh Front faced the German Army Group South with three armies and two in reserve. The Sixth Guards Army, led by Lt. Gen. Mikhail N. Chistyakov, and the Seventh Guards Army, led by Lt. Gen. M. S. Shumilov, held the center and left wing. East of Kursk, Col. Gen. Ivan S. Konev's Steppe Military District (renamed Steppe Front on July 10, 1943) was to hold German breakthroughs, then mount the counteroffensive.

The Accountability of the Battle of Kursk

Careful study of the daily tank strength reports and combat records of II SS Panzer Corps--available on microfilm at the National Archives in Washington, D.C.--provides information that forces a historical reappraisal of the battle. These records show, first of all, that Hausser's corps began with far fewer tanks than previously believed and, more important, that they suffered only moderate losses on July 12, 1943. As those

reports were intended to allow the corps commander to assess the combat strength of his divisions, they can be considered reasonably accurate. Considering that information, it seems that the Germans may have been near a limited success on the southern flank of the salient.

The number of SS tanks actually involved in the battle has been variously reported as high as 700 by some authorities, while others have estimated between 300 to 600. Even before the Battle of Kursk began, however, the II SS Panzer Corps never had 500 tanks, much less 700. On July 4, the day before Operation Citadel was launched, Hausser's three divisions possessed a total of 327 tanks between them, plus a number of command tanks. By July 11, the II SS Panzer Corps had a total of 211 operational tanks--*Totenkopf* had 94 tanks, *Leibstandarte* had only 56 and *Das Reich* possessed just 61. Damaged tanks or tanks undergoing repairs are not listed. Only 15 Tiger tanks were still in action at Prochorovka, and there were no SS Panthers available. The battalions that were equipped with Panthers were still training in Germany in July 1943.

On July 13, the day after the Battle of Prochorovka, Fourth Panzer Army reports declared that the II SS Panzer Corps had 163 operational tanks, a net loss of only 48 tanks. Actual losses were somewhat heavier, the discrepancy due to the gain of repaired tanks returned to action. Closer study of the losses of each type of tank reveals that the corps lost about 70 tanks on July 12. In contrast, Soviet tank losses, long assumed to be moderate, were actually catastrophic. In 1984, a history of the Fifth Guards Tank Army written by Rotmistrov himself revealed that on July 13 the army lost 400 tanks to *repairable* damage. He gave no figure for tanks that were destroyed or not available for salvage. Evidence suggests that there were hundreds of additional Soviet tanks lost. Several German accounts mention that Hausser had to use chalk to mark and count the huge jumble of 93 knocked-out Soviet tanks in the *Leibstandarte* sector alone. Other Soviet sources say the tank strength of the army on July 13 was 150 to 200, a loss of about 650 tanks. Those losses brought a caustic rebuke from Josef Stalin. Subsequently, the depleted Fifth Guards Tank Army did not resume offensive action, and Rotmistrov ordered his remaining tanks to dig in among the infantry positions west of the town.

Another misconception about the battle is the image of all three SS divisions attacking shoulder to shoulder through the narrow lane between the Psel and the rail line west of Prochorovka. Only *Leibstandarte* was aligned directly west of the town, and it was the only division to attack the town itself. The II SS Panzer Corps zone of battle, contrary to the impression given in many accounts, was approximately nine miles wide, with *Totenkopf* on the left flank, *Leibstandarte* in the center and *Das Reich* on the right flank. *Totenkopf*'s armor was committed primarily to the Psel bridgehead and in defensive action against Soviet attacks on the Psel bridges. In fact, only *Leibstandarte* actually advanced into the corridor west of Prochorovka, and then only after it had thrown back initial Soviet attacks.

Early on July 12, *Leibstandarte* units reported a great deal of loud motor noise, which indicated massing Soviet armor. Soon after 5 a.m., hundreds of Soviet tanks, carrying infantry, rolled out of Prochorovka and its environs in groups of 40 to 50. Waves of T-34 and T-70 tanks advanced at high speed in a charge straight at the startled

Germans. When machine-gun fire, armor-piercing shells and artillery fire struck the T-34s, the Soviet infantry jumped off and sought cover. Leaving their infantry behind, the T-34s rolled on. Those Soviet tanks that survived the initial clash with SS armor continued a linear advance and were destroyed by the Germans.

When the initial Soviet attack paused, *Leibstandarte* pushed its armor toward the town and collided with elements of Rotmistrov's reserve armor. A Soviet attack by the 181st Tank Regiment was defeated by several SS Tigers, one of which, the 13th (heavy) Company of the 1st SS Panzer Regiment, was commanded by 2nd Lt. Michael Wittmann, the most successful tank commander of the war. Wittmann's group was advancing in flank support of the German main attack when it was engaged by the Soviet tank regiment at long range. The Soviet charge, straight at the Tigers over open ground, was suicidal. The frontal armor of the Tiger was impervious to the 76mm guns of the T-34s at any great distance. The field was soon littered with burning T-34s and T-70s. None of the Tigers were lost, but the 181st Tank Regiment was annihilated. Late in the day, Rotmistrov committed his last reserves, elements of the V Mechanized Corps, which finally halted *Leibstandarte.*

Das Reich began its attack from several kilometers southwest of Prochorovka and was quickly engaged by aggressive battle groups of the II Tank Corps and II Guards Tank Corps. Fierce, somewhat confused fighting broke out all along the German division's axis of advance. Battle groups of 20 to 40 Soviet tanks, supported by infantry and ground-attack planes, collided with *Das Reich* regimental spearheads. Rotmistrov continued to throw armor against the division, and combat raged throughout the day, with heavy losses of Soviet armor. *Das Reich* continued to push slowly eastward, advancing into the night while suffering relatively light tank losses.

Meanwhile, on the left flank, Soviet First Tank Army elements unsuccessfully tried to crush *Totenkopf*'s bridgehead. The SS division fought off the XXXI and X Tank Corps, supported by elements of the XXXIII Rifle Corps. In spite of the Soviet attacks, *Totenkopf*'s panzer group drove toward a road that ran from the village of Kartaschevka, southeast across the river and into Prochorovka.

The fighting, characterized by massive losses of Soviet armor, continued throughout July 12 without a decisive success by either side--contrary to the accounts given in many well-known studies of the Eastern Front, which state that the fighting ended on July 12 with a decisive German defeat. These authors describe the battlefield as littered with hundreds of destroyed German tanks and report that the Soviets overran the SS tank repair units. In fact, the fighting continued around Prochorovka for several more days. *Das Reich* continued to push slowly eastward in the area south of the town until July 16. That advance enabled the III Panzer Corps to link up with the SS division on July 14 and encircle several Soviet rifle divisions south of Prochorovka. *Totenkopf* eventually reached the Kartaschevka–Prochorovka road, and the division took several tactically important hills on the north edge of its perimeter as well. Those successes were not exploited, however, due to decisions made by Adolf Hitler.

After receiving the news of the Allied invasion of Sicily, as well as reports of impending Soviet attacks on the Mius River and at Izyum, Hitler decided to cancel Operation Citadel. Manstein argued that he should be allowed to finish off the two Soviet tank armies. He had unused reserves, consisting of three experienced panzer divisions of XXIV Panzer Corps, in position for quick commitment. That corps could have been used to attack the Fifth Guards Tank Army in its flank, to break out from the Psel bridgehead or to cross the Psel east of Prochorovka. All of the available Soviet armor in the south was committed and could not be withdrawn without causing a collapse of the Soviet defenses. Manstein correctly realized that he had the opportunity to destroy the Soviet operational and strategic armor in the Prochorovka area.

Hitler could not be persuaded to continue the attack, however. Instead, he dispersed the divisions of the II SS Panzer Corps to deal with the anticipated Soviet diversionary attacks south of the BelgorodKharkov sector. On the night of July 17-18, the corps withdrew from its positions around Prochorovka. Thus, the battle for Prochorovka ended, not because of German tank losses (Hausser had over 200 operational tanks on July 17) but because Hitler lacked the will to continue the offensive. The SS panzer divisions were still full of fight; in fact, two of them continued to fight effectively in southern Russia for the rest of the summer.

Leibstandarte was ordered to Italy, but *Das Reich* and *Totenkopf* remained in the East. Those two divisions and the 3rd Panzer Division, which replaced *Leibstandarte*, were transferred to the Sixth Army area, where they conducted a counterattack from July 31 to August 2 that eliminated a strong Soviet bridgehead at the Mius River. Without pause, the three divisions were then transferred to the Bogodukhov sector in early August 1943. Under the command of the III Panzer Corps, they were joined by another unit, the Fifth SS *Panzergrenadier* Division *Wiking*. During three weeks of constant combat, the four divisions played a major role in stopping the main Soviet post-Kursk counteroffensive, Operation Rumyantsev. They fought Rotmistrov's Fifth Guards Tank Army, rebuilt to 503 tanks strong, and major portions of the First Tank Army, now at 542 tanks.

By the end of the month, Rotmistrov had less than 100 tanks still running. Katukov had only 120 tanks still in action by the last week of August. While at no time did any of the German divisions have more than 55 tanks in operation, they repeatedly blunted the thrusts of the two Soviet tank armies, which were also reinforced by several rifle corps.

Totenkopf repeatedly cut off and defeated all of the First Tank Army's thrusts toward the KharkovPoltava rail line. *Das Reich* threw back two Soviet tank corps south of Bogodukhov and blunted Rotmistrov's last major attack west of Kharkov, and the III Panzer Corps halted Operation Rumyantsev.

After Kharkov itself fell, however, the German front gradually collapsed. The Soviets regrouped, committed additional strong reserves and renewed their attack toward the strategically important Dnepr River. Army Group South was subsequently forced to abandon much of southern Ukraine in a race for the safety of the Dnepr. Despite the

remarkable efforts of the German army and *Waffen* SS panzer divisions during July and August, the Germans were too weak to hold the KharkovBelgorodPoltava sector after their summer losses.

It is apparent from their operations during the late summer that the SS panzer divisions were not destroyed at Prochorovka. This reassessment of the battle provides food for thought regarding possible German successes if Manstein's panzer reserves had been utilized as he had intended.

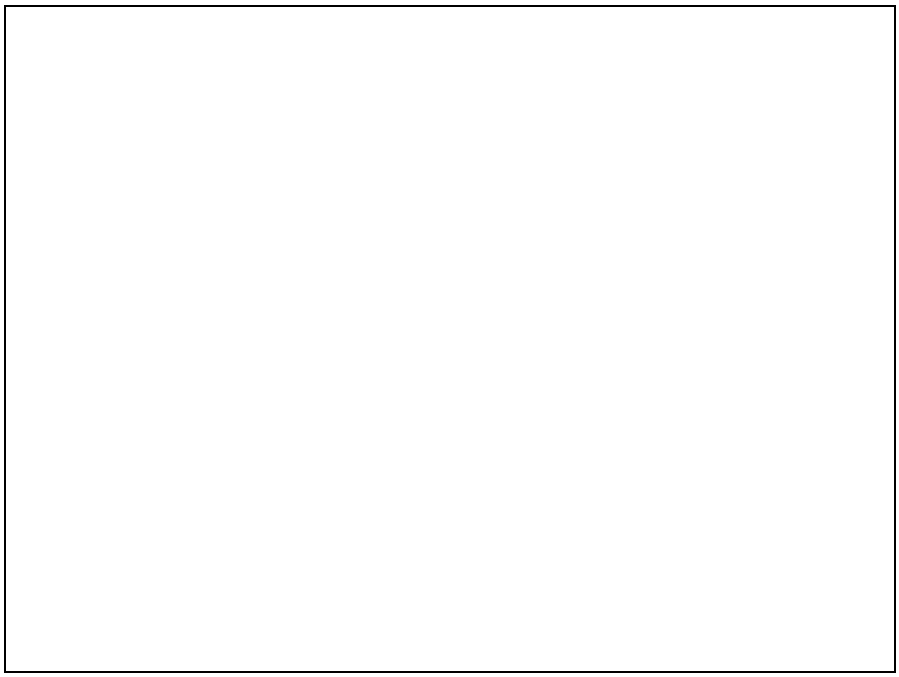
To what extent the course of events in Russia would have been changed is, of course, unknown, but it is interesting to speculate. If Army Group South's panzer reserve had been used to encircle and destroy the Fifth Guards Tank Army and the First Tank Army, the outcome of the war in Russia might have been significantly different. Although it was beyond the German army's capabilities to force a military end to the war by the summer of 1943, a limited victory in the south could have resulted in a delay of Soviet strategic operations for months or perhaps longer. It is doubtful, however, that this pause would have lasted long enough for the Germans to transfer enough forces to the West to defeat the June 6, 1944, D-Day invasion.

But one fact is beyond any question, regardless of the number of tanks possessed by the Germans or Soviets or what might have been possible. Due to Hausser's panzer corps' failure to take Prochorovka on July 12 and the subsequent misuse of German panzer reserves, the momentum of the Fourth Panzer Army was slowed dramatically. When Hitler abandoned Operation Citadel on July 13, the Germans' last opportunity to influence events on a strategic level in the East was lost.

It is interesting that the information regarding German tank losses at Prochorovka has not been made available before now. Due to the lack of crucial primary-source information--especially the records of the II SS Panzer Corps on the Eastern Front--there had been no evidence to correct the erroneous accounts and impressions given in previous studies of the Eastern Front.

Waffen SS formations' records of their Eastern Front operations were not declassified until 1978-1981. By that time, many of the major works about the Eastern Front had already been published. Later authors accepted the accounts of the battle as given in the earlier books and failed to conduct additional research. As a result, one of the best known of all Eastern Front battles has never been understood properly. Prochorovka was believed to have been a significant German defeat but was actually a stunning reversal for the Soviets because they suffered enormous tank losses.

As Manstein suggested, Prochorovka may truly have been a lost German victory, thanks to decisions made by Hitler. It was fortunate for the Allied cause that the German dictator, a foremost proponent of the value of will, lost his own will to fight in southern Ukraine in July 1943. Had he allowed Manstein to continue the attack on the two Soviet tank armies in the Prochorovka area, Manstein might have achieved a victory even more damaging to the Soviets than the counterattack that had recaptured Kharkov in March 1943.



T-34's advancing with Infantry

APPENDIX H

TASK FORCE SMITH SUMMARY SHEET

Node	Before	After
Training	**Trained no practice** - it has been noted that only one in seven of the men were combat veterans; the rest were green. Most had enlisted to escape boredom in small town America, yet 43% of the lower ranking enlisted soldiers scored in the two lowest categories of the Army's qualification tests, which denies enlistment to most candidates today.	**Trained no practice** - it has been noted that only one in seven of the men were combat veterans; the rest were green. By the time of engagement, there was no preparatory time for senior NCOs to train the junior enlisted. The soldiers would learn on the battle field.
Duration of Operation Under Harsh Conditions	**Less Than 24 hours** - expected to be less than one day because it was hoped that an arrogant display of strength would fool the enemy into believing that the US had a much greater resources at disposal for fighting.	**Six Days** - the North Koreans decided to stand their ground and fight.
Personal Factors	**Normal stress** level for soldier to experience going into battle	**High stress** level after experiencing live ammunition being fired at oneself
Leadership Effectiveness	**Good** - Consistent throughout battle - combat experience from WWII was about 1/3 (Great - 71%)	**Good** -Gen Dean admitted that the thought of failure never crossed his mind. Overconfidence bordering on arrogance was the prevailing mood in Far East Command, from Gen. MacArthur down to the greenest of COL Smith's riflemen.
Relationship with Superiors	**Great** -Consistent throughout battle - Gen Collins stated "Now matured and with combat experience back of him, he was well qualified to lead the first American army troops to fight in the Korean war."	**Good** -Consistent throughout battle - Gen Collins stated "Now matured and with combat experience back of him, he was well qualified to lead the first American army troops to fight in the Korean war."
Relationship with Subordinates	**Good** -Troops led to believe that they would face an ill-armed peasant army that would quit at the first appearance of an American uniform.	**Good** -Troops respected the battalion commander by volunteering to stay and complete the mission.
Relationship with Peers	**Average** - Supportive based on orders	**Average** -Supportive of each other because soldiers volunteered to stay and detain the enemy so that comrades could return to main post.
Level of Exertion	**Moderate** at the beginning of battle	**Difficult** as time progressed with less sleep
Fitness Level	**Fitness level 2**	**Fitness Level 3**
Sleep	**Sleep** deficit would plague the men since they were on alert for 48 hours prior.	**Rest**
Operational Tempo	**High** - preparing for deployment.	**High**
Threat	**ThreatCon D**	**ThreatCon D**
Mission Control	**Low Risk** (37.3%)	**High Risk**
Task Organization	**Organic**	**Attached**
Type of Operation	**Day Tactical**	**Night Tactical**
Planning	**Low Risk- Caution** (35%)	**High Risk** (68.8%)
Preparatory Time	**Adequate** - 4 hours to prepare for movement but had a 48 hour alert status to movement.	**Minimal** - Smith's men moved into positions rapidly. Foxholes were dug, communication wire was laid, and ammo and rations were unloaded and distributed.
Guidance	**Operation Order** guidance given by Gen Dean and Gen Church.	**FRAGO**

Node	Before	After
Soldier Endurance	**Caution** (40%)	**Caution** (40%)
Environmental Preparation	**Acclimated**	**Acclimated**
Soldier Preparation	**Minimal**	**Minimal**
Soldier Selection	**High Risk** - TF Smith required soldiers which were not available (50%)	**High Risk** - TF Smith took reinforcements if available and necessary (45%)
Task	**Routine**	**Complex**
Soldier Experience	**Untrained** - 66% of the soldiers were not combat qualified from the previous war and were not training in Japan.	**MOS qualified** - if soldiers survived the battle and granted they took a positive experience in training and tactics.
Weather	**High Risk** (50%)	**High Risk** (50%)
Visibility/Moisture	**Rain** - Monsoon season in Korea	**Rain** - Monsoon season in Korea
Temperature	**Range 60-79**	**Range 60-79**
Terrain	**High Risk** (50.7%)	**High Risk** (50.7%)
Trafficability	**Secondary roads** - possible ambush	**Secondary roads** - possible ambush
Type of Terrain	**Go** (mountains) - series of knolls rising to a height of 300 feet above the valley floor and straddling the main highway, which rose through a saddle between the hills.	**NoGo** (mountains) - series of knolls rising to a height of 300 feet above the valley floor and straddling the main highway, which rose through a saddle between the hills.
Sustainability	**High Risk** (50.1%)	**High Risk** (53.1%)
Type System	**Wheeled** vehicles primarily(wheeled vehicles left very little protection in movement and was weighed heavy as causalities) and moved by foot	**Wheeled** vehicles primarily(wheeled vehicles left very little protection in movement and was weighed heavy as causalities)
Percentage Personnel Fill	**Range 80 -100%** - 406 soldiers began in the battle without attachments.	**Range 0-65%** - 250 of the 406 soldiers came out alive - (lost 35% overall for entire duration of battle including the attachments and support).
Logistic	**Low Risk** (94%)	**High** (100%)
Fuel	**Green** - Maximum that could be carried/supplied	**Black** - no longer a priority as vehicles were destroyed
Maintenance	**Green** - Maximum that could be carried/supplied	**Black** - after salvaging vehicle parts then there were no vehicles left.
Ammunition	**Green** - Maximum that could be carried/supplied	**Black** - rapid expenditure of ammunition against the enemy
Food and Water	**Green** - Maximum that could be carried/supplied	**Red** - Started to look for food en route to camp
Risk Assessment	**Overall Low Risk** (39.2%)	**Overall High** (35%)
Stress	**A lot** - for anticipation of engagement (55%)	**A lot** - during the engagement (73%)
Performance	**Good Performance** (46.3%)	**Good Performance** (45%)

Notes:		
Nodes typed in blue feed into nodes stated above in black.	Cells filled are nodes not substantiated	Cells filled are nodes not substantiated
Nodes type in green are the primary nodes of concern	Bold words represent states spaces for that node.	Bold words represent states spaces for that node.

APPENDIX I

BATTLE OF MIDWAY SUMMARY SHEET

Node	Before	After
Training	**Trained** in MOS but are not practiced	**Trained** in MOS but are not practiced
Duration of Operation Under Harsh Conditions	**Less Than 6 hours**	**Greater than 2 days**
Personal Factors	**Normal stress** level for sailor to experience going into battle	**High stress** level after experiencing live ammunition being fired at platform
Leadership Effectiveness	**Great** - Consistent throughout battle - combat experience lacking through the chain of command.	**Great** - consistent throughout battle - combat experience lacking through the chain of command
Relationship with Superiors	**Good -**Consistent throughout battle Spruance replaces Halsey after an skin eruption. Spruance had the respect of his seniors and peers. He was intelligent, adaptable and flexible. The correct mix to counterattack the Japanese.	**Good -**Consistent throughout battle Spruance replaces Halsey after an skin eruption. Spruance had the respect of his seniors and peers. He was intelligent, adaptable and flexible. The correct mix to counterattack the Japanese.
Relationship with Subordinates	**Good -** Sailors of the Yorktown in three days completed fixing the damage to the ship. Sailors supported the superiors.	**Good** - Sailors of the Yorktown in three days completed fixing the damage to the ship. Sailors supported the superiors.
Relationship with Peers	**Good -**Supportive based on orders	**Good -**Supportive of each other because it was their duty
Level of Exertion	**Difficult** because the sailors were working to fix the damaged Yorktown with no recovery time.	**Difficult** as time progressed and less sleep
Fitness Level	**Fitness Level 3**	**Fitness Level 2**
Sleep	**Rest -**Working around the clock to fix the carriers and ships, the sailors received rest and no deep sleep.	**Rest** - Working around the clock to fix the carriers and ships, the sailors received rest and no deep sleep.
Operational Tempo	**High**	**High**
Threat	**ThreatCon D**	**ThreatCon D**
Mission Control	**Low risk** by only 8% because of the preparation for battle. Time is a pressing factor that could make or break the battle.	**High Risk**
Task Organization	**Organic**	**Organic**
Training Event	**Day Tactical**	**Day Tactical**
Planning	**Low Risk**-Caution	**Low Risk** - Caution
Preparatory Time	**Minimal**	**Minimal**
Guidance	**Operation Order**	**Operation Order**

Node	Before	After
Sailor Endurance	**Caution**	**Caution**
Environmental Preparation	**Acclimated**	**Acclimated**
Sailor Preparation	**Minimal** - because the main platform was getting repaired by the sailors that work it.	**Minimal**
Sailor Selection	**Low** - sailors of the ships	**High Risk** - replacement after Midway
Task	**Routine**	**Complex**
Sailor Experience	**MOS qualified** - 90% of the sailors were not combat qualified	**Highly qualified** - if sailors survived the battle.
Weather	**Low Risk**	**Low Risk**
Visibility/Moisture	**Clear/Dry**	**Clear/Dry**
Temperature	**Range 60-79**	**Range 60-79**
Sea Lanes	**Caution**	**Low Risk**
Threat in vicinty of Operations	**Secondary** - sea lanes are crowded to engage in sea battle. Mobility still available.	**Congested** - platforms engaging Kamikaze and enemy ships.
Sea State	**Sea State 2** - ocean has movement	**Sea State 3** - ocean has movement and causing resistance against the platforms.
Sustainability	**Low Risk**	**High Risk**
Platforms	**Focus on Carrier**	**Focus on Carrier**
Percentage Personnel Fill	**Range 80-100%** - All sailors are accounted for	**Range 0-65%** -For overall battle range would be 66-79% fill
Logistic	**Low Risk** - can support sailors/pilots from a sinking ship	**Caution** - may have to support sailors/pilots from a sinking ship
Fuel	**Green**	**Yellow**
Maintenance	**Green**	**Green**
Ammunition	**Green**	**Yellow** - rapid expenditure of ammunition against the enemy
Food and Water	**Green**	**Green**
Risk Assessment	**Overall Low** (45.9%)	**Overall High** (54.9%)
Stress	**A Lot** - for anticipation of engagement (38%)	**A lot** - during the engagement (68.0%)
Performance	**Good** (50.1%)	**Good** (47.6%)

Notes:		
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APPENDIX J

BATTLE OF KURSK SUMMARY SHEET

Node	Before	After
Training	**Trained not Practiced**	**Trained not Practiced**
Duration of Operation Under Harsh Conditions	**7 Days**	**13 Days**
Personal Factors	**Normal stress** level for soldier to experience going into battle	**High stress** level after experiencing live ammunition being fired at oneself
Leadership Effectiveness	**Great** -Consistent throughout battle - Germans followed orders of Adolf Hitler (58%)	**Average** - German effectiveness was average at 45% because fear was the controlling factor with leadership.
Relationship with Superiors	**Average** - Consistent throughout battle	**Bad** - Consistent throughout battle but thoughts of Hitler and his methods were in the minds of the senior leaderships
Relationship with Subordinates	**Average** - Troops followed orders (out of fear)	**Bad** - Troops followed orders (out of fear)
Relationship with Peers	**Average** - Supportive based on orders	**Average** - Supportive of each other because it was their duty
Level of Exertion	**Moderate** to at the beginning of battle	**Difficult** as operation progressed and less sleep
Fitness Level	**Fitness Level 2**	**Fitness Level 3**
Sleep	**Sleep - Rest**	**Sleep - Rest**
Operational Tempo	**High**	**High**
Threat	**ThreatCon D**	**ThreatCon D**
Mission Control	**Low Risk** (39%)	**High Risk** (43%)
Task Organization	**Organic** - Hitler was trying to develop a perfect race, so there would not be any attachments with other countries. Germany would remain strong from within.	**Organic** - While Hitler was keeping his perfect race, he would solicit the country to recruit all German males even at young years such at 7.
Training Event	**Day Tactical** - began at first light or twilight which was usually around 0230 in the morning.	**Night Tactical** - Soldiers were being moved into place during the night.
Planning	**Low Risk - Caution**	**High Risk** (60%)
Preparatory Time	**Adequate**	**Minimal**
Guidance	**Operation Order**	**FRAGO**

Node	Before	After
Soldier Endurance	**Low Risk**	**Caution**
Environmental Preparation	**Acclimated**	**Acclimated**
Soldier Preparation	**Adequate**	**Minimal**
Soldier Selection	**High Risk** - because of the purity of the German race	**High Risk** - maintaining the number of soldier within the 3rd Reich
Task	**Complex**	**Complex**
Soldier Experience	**MOS qualified** - 100% to Reich's standards	**Highly qualified** - if soldiers survived the battle.
Weather	**High Risk** (45%)	**High Risk** (45%)
Visibility/Moisture	**Rain** during the parts of the day and then it would stop resulting in the secondary roads to become muddy.	**Rains** during parts of the day
Temperature	**Range 60-79**	**Range 60-79**
Terrain	**High Risk** (43.5%)	**High Risk** (43.5%)
Trafficability	**Secondary**	**Trail-Cross Terrain - possible ambush**
Type of Terrain	**Hills to take Hilltop 226**	**Hills**
Sustainability	**High Risk** (40.7%)	**High Risk** (47.5%)
Type System	**Tracked**	**Tracked**
Percentage Personnel Fill	**Range 80-100% fill**	**Range 0-65%** fill (soldiers were being slaughtered during this battle)
Logistic	**Low Risk** (85%)	**High Risk** (100%)
Fuel	**Yellow** - necessary for vehicles to move	**Black** - rapid use of fuel for tanks with no resupply available
Maintenance	**Yellow**	**Black** - salvaging the tanks was difficult
Ammunition	**Green**	**Black** - rapid expenditure of ammunition against the enemy
Food and Water	**Green**	**Red**
Risk Assessment	**Overall Low Risk** (40.2%)	**Overall High** (34.2%)
Stress	**A Lot** - for anticipation of engagement (55%)	**A lot** - during the engagement (73%)
Performance	**Good** (42.5%)	**Good** (35.6%)

Notes:		
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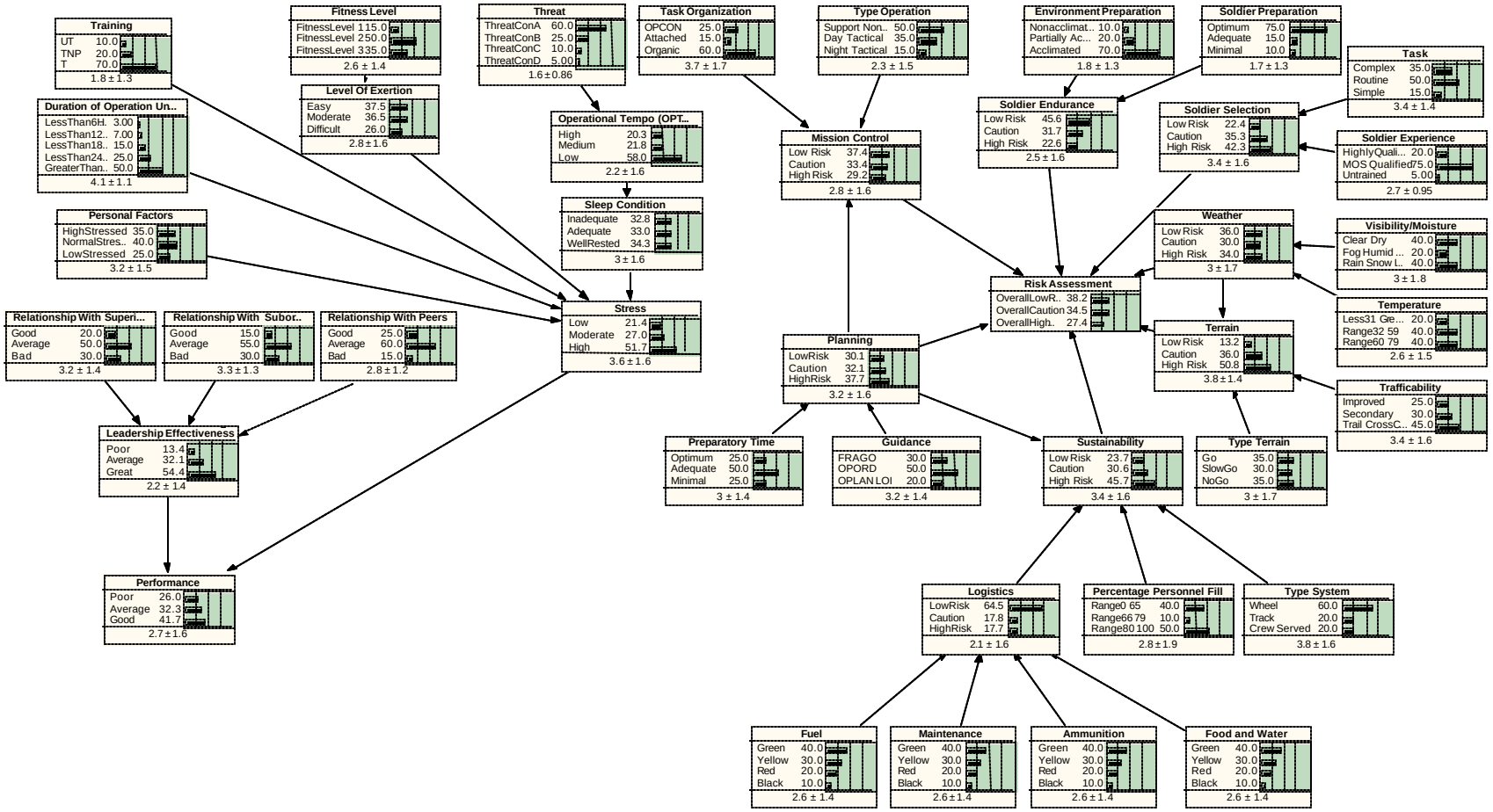
APPENDIX K TASK FORCE SMITH MODELS



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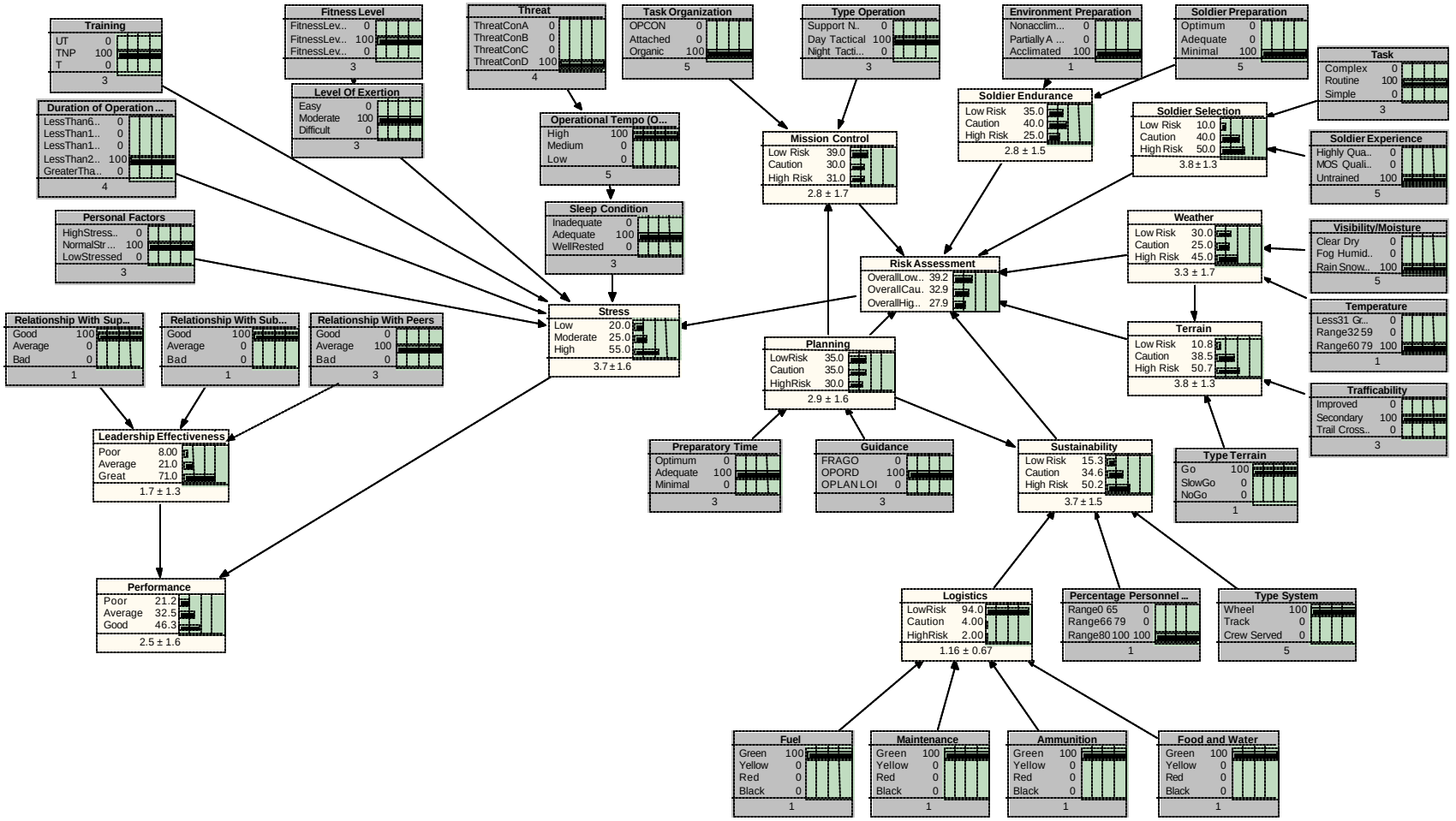
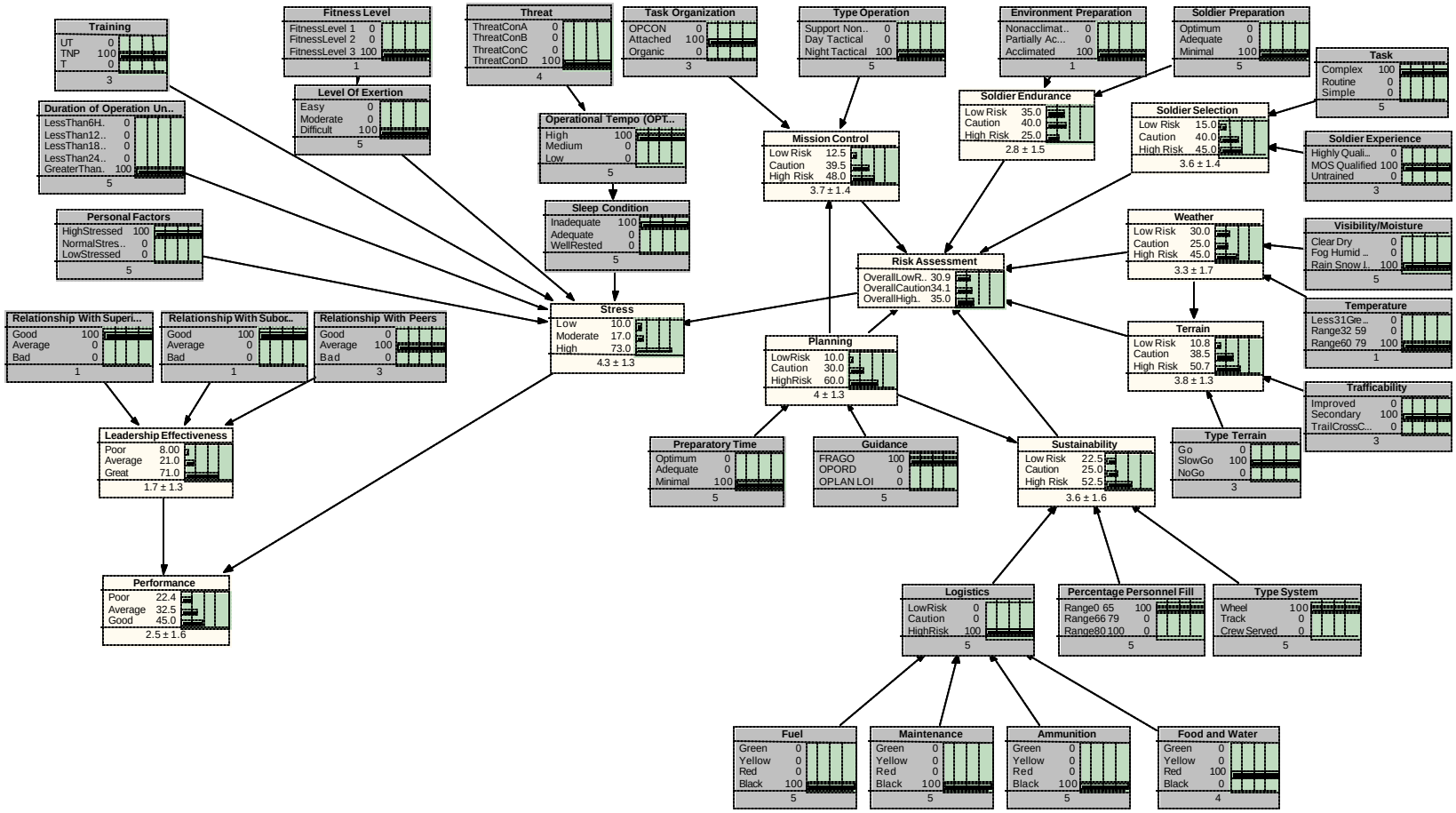


Task Force Smith Before



Task Force Smith After

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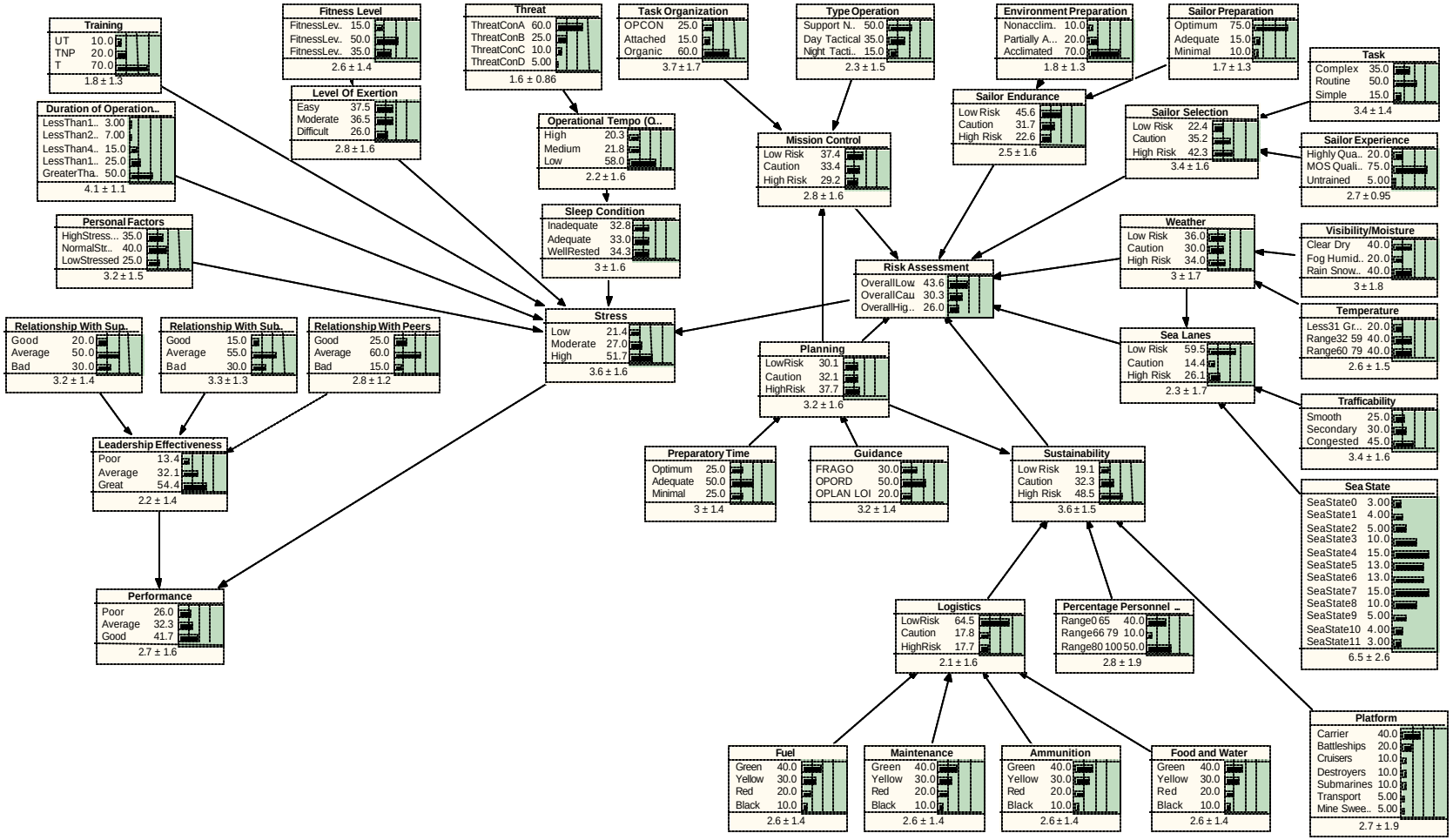
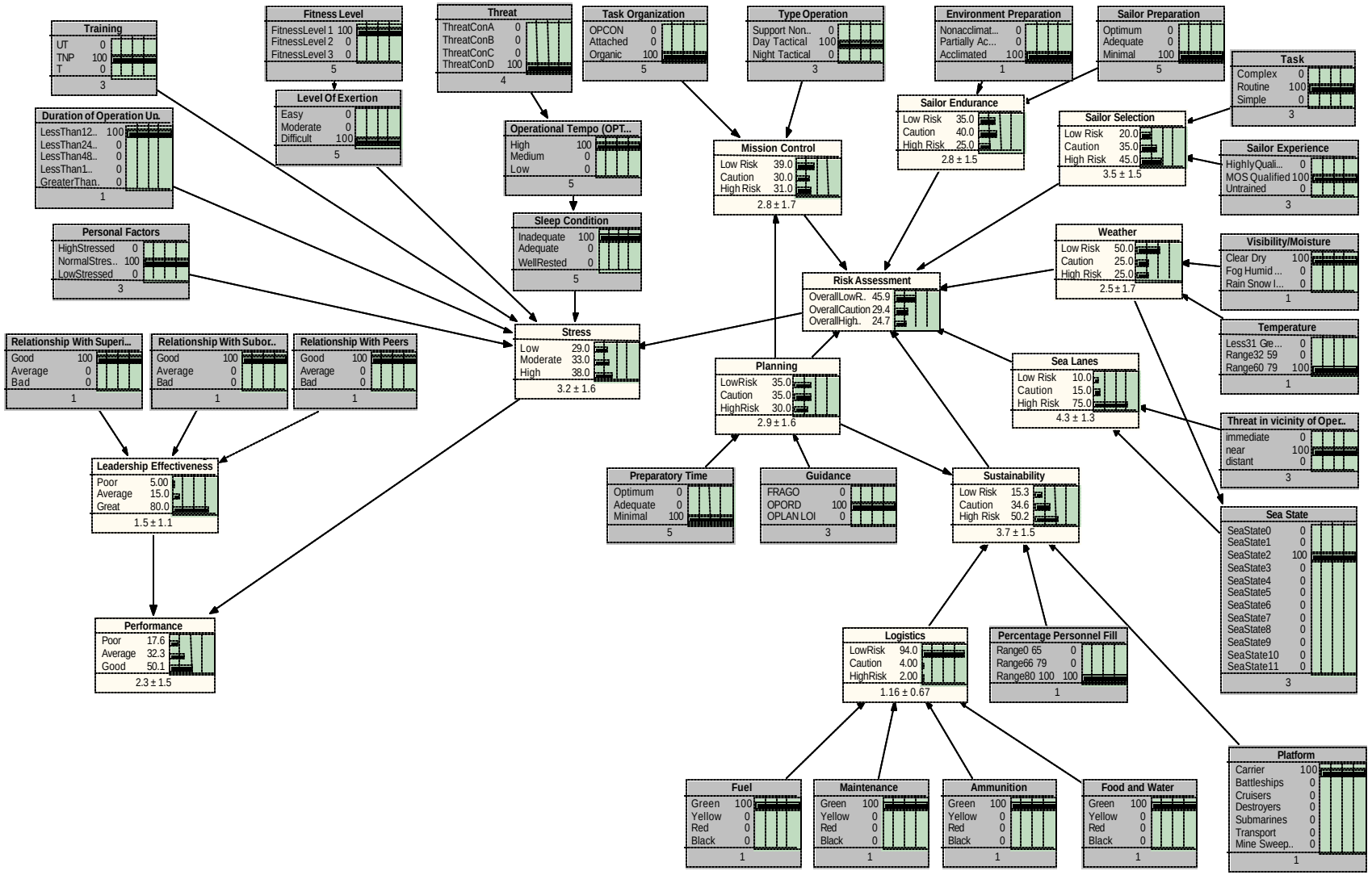
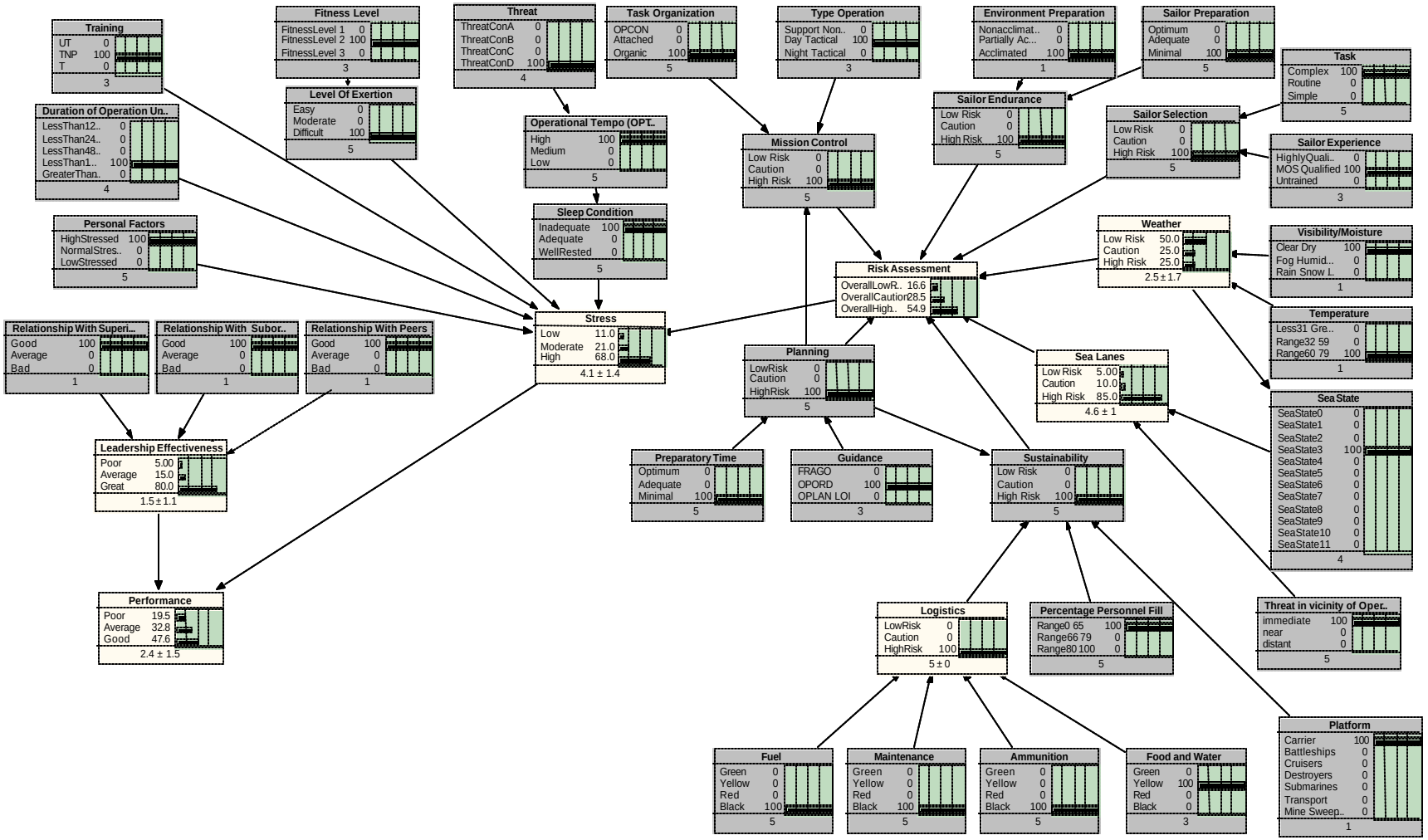
APPENDIX L BATTLE OF MIDWAY MODELS



Battle of Midway Generic



Battle of Midway Before



Battle of Midway After

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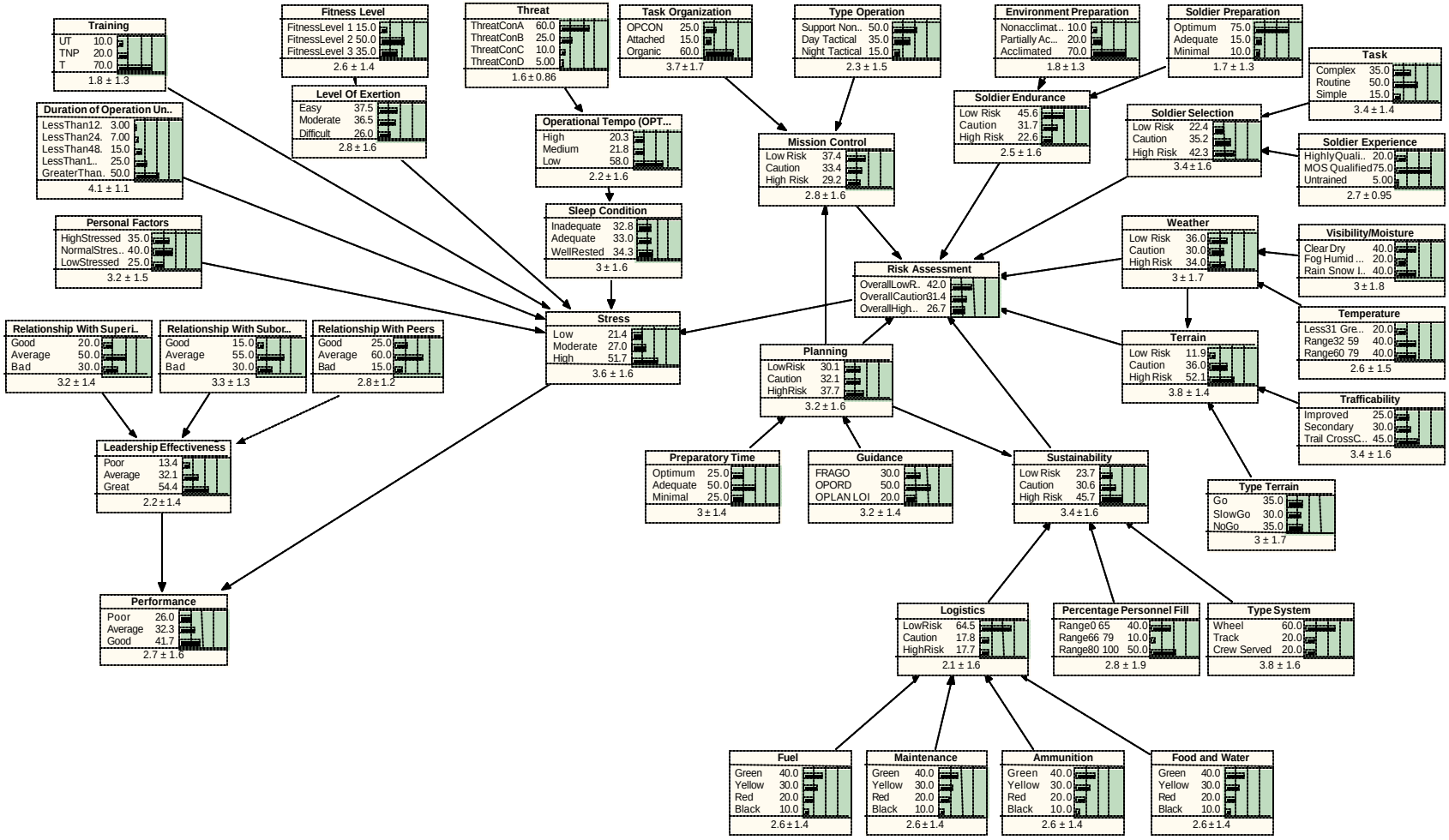
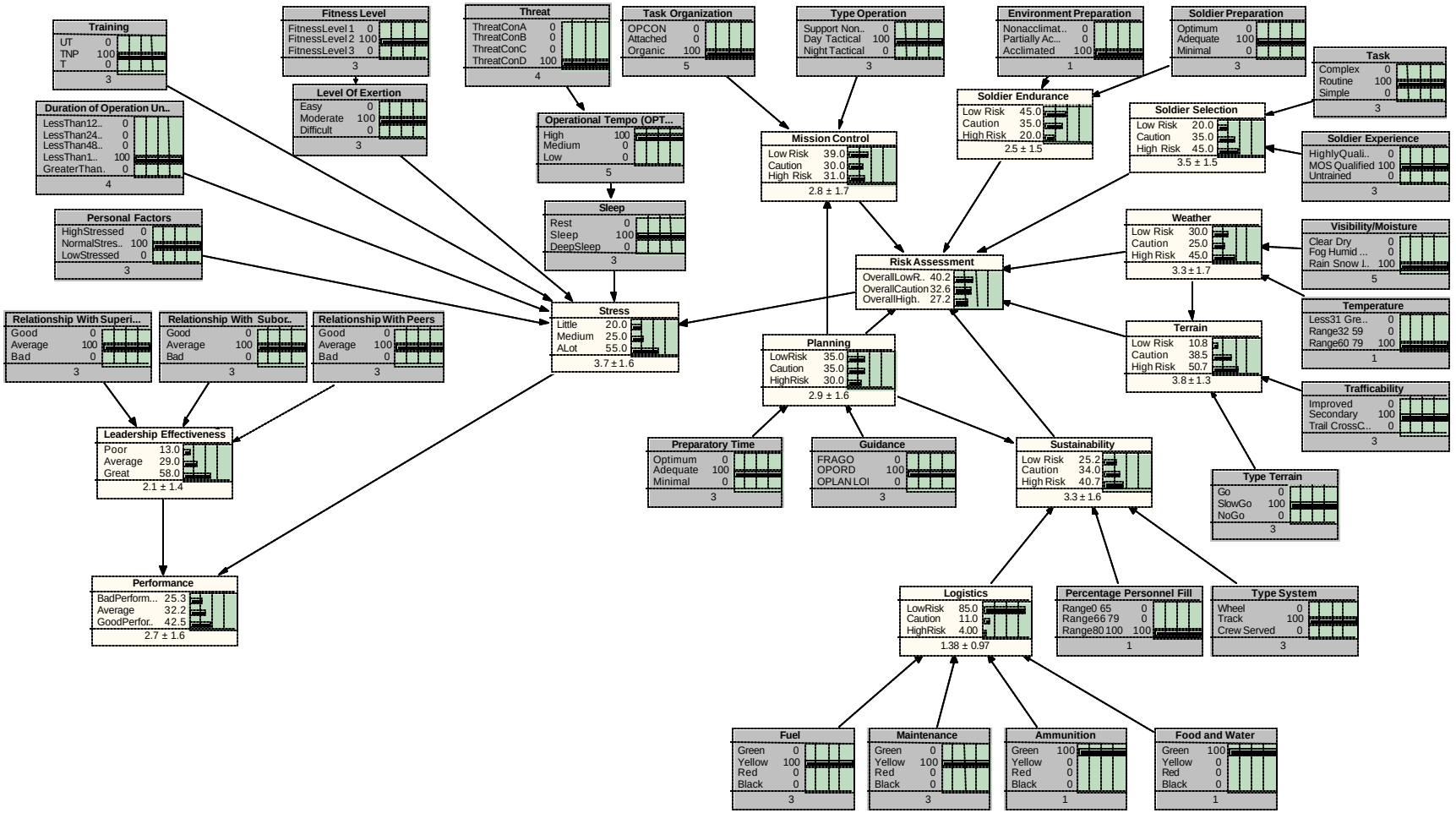
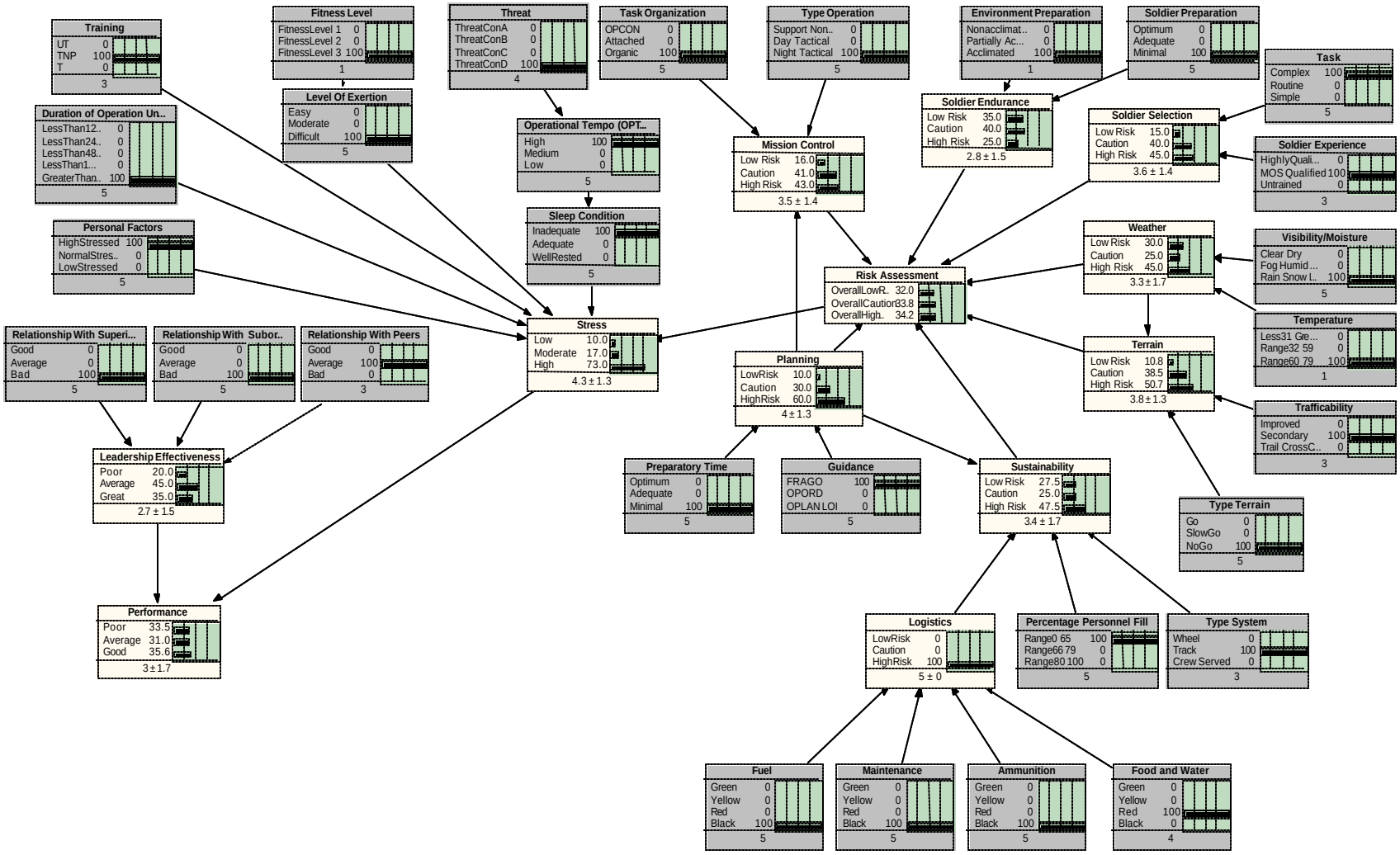
APPENDIX M BATTLE OF KURSK MODELS



Battle of Kursk Generic



Battle of Kursk Before



Battle of Kursk After

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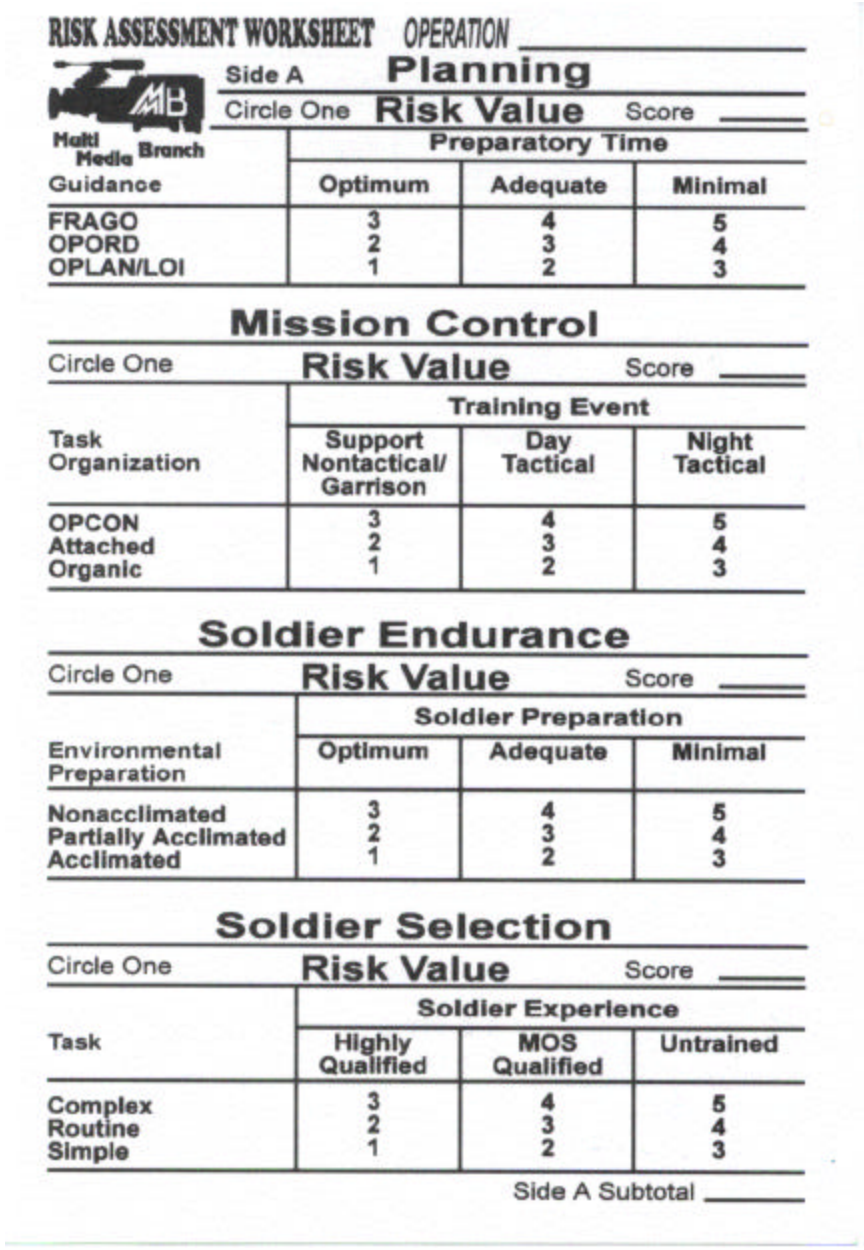
APPENDIX N

RISK ASSESSMENT WORKSHEET



RISK ASSESSMENT WORKSHEET OPERATION _____

Multi Media Branch

Side A **Planning**

Circle One **Risk Value** Score _____

Guidance	Preparatory Time: Optimum	Adequate	Minimal
FRAGO	3	4	5
OPORD	2	3	4
OPLAN/LOI	1	2	3

Mission Control

Circle One **Risk Value** Score _____

Task Organization	Training Event: Support Nontactical/ Garrison	Day Tactical	Night Tactical
OPCON	3	4	5
Attached	2	3	4
Organic	1	2	3

Soldier Endurance

Circle One **Risk Value** Score _____

Environmental Preparation	Soldier Preparation: Optimum	Adequate	Minimal
Nonacclimated	3	4	5
Partially Acclimated	2	3	4
Acclimated	1	2	3

Soldier Selection

Circle One **Risk Value** Score _____

Task	Soldier Experience: Highly Qualified	MOS Qualified	Untrained
Complex	3	4	5
Routine	2	3	4
Simple	1	2	3

Side A Subtotal _____

Side B

Weather

Circle One — **Risk Value** — Score _____

Temperature °F	Visibility/Moisture		
	Clear/ Dry	Fog/Humid/ Drizzle	Rain/Snow/ Ice/Dust
<31° or >80°	3	4	5
32° - 59°	2	3	5
60° -79°	1	2	5

Terrain

Circle One — **Risk Value** — Score _____

Type Terrain	Trafficability		
	Improved	Secondary	Trail/Cross Country
Mountain	3	4	5
Desert/Jungle	2	3	4
Hills	1	2	3
Flat/Rolling			

Sustainability

Circle One — **Risk Value** — Score _____

Percentage Personnel Fill	Type System		
	Wheel	Track	Crew Served
0 - 65%	4	5	5
66 - 79%	2	4	4
80 - 100%	1	2	2

Subtotal Side B ____ Subtotal Side A____ Total _____

0 to 12 Low Risk	13 to 23 Caution	*24 to 35 High Risk

* High risk operations assigned a value of 24-35 require coordination, before executing the mission, with the next higher level of command external to the organization making the assessment. When two or more areas are assigned a risk factor of 5, the overall rating is HIGH RISK.

June 1993

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