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THESIS

A CONCEPTUAL FRAMEWORK FOR
PROVIDING REQUISITE VARIETY IN THE
FUTURE OPERATIONAL FORCES
OF THE UNITED STATES ARMY

by

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The future forces of the U.S. Army face a great variety of threats with unprecedented complexities. The American public demands a quick, decisive victory with minimal casualties. In order to accomplish this, the Army must have the capability to totally dominate and control the enemy. Requisite Variety is essential to this mission. This research shows that in order to totally dominate the battlefield, the variety of options available to the friendly commander must be greater than or equal to that of the enemy. However, concurrent with the dramatic changes in the global environment, the U.S. has significantly decreased defense spending. The competition for these dwindling defense dollars has increased the Army's risk of misallocating its scarce resources to a few "brilliant" systems without regard to the factor of variety. This research provides a conceptual framework that innovates the Requirements Determination process by utilizing variety as a factor. It reveals concrete ways to provide the commander with the necessary variety to dominate the battlefield: through regulation, information, and variety catalysts. By applying the framework to the concepts of Force XXI operations, the researcher develops the Time-Information Differential. This suggests that given the current budgetary constraints, the Army should focus its short term material acquisitions on C^3I and mobility assets. However, to achieve synergistic results, the Army should concurrently research other types of weapon systems using the framework as a guide.

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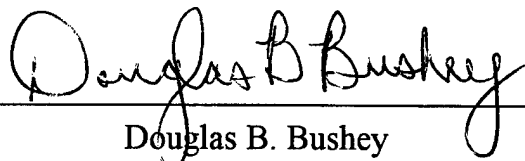of the requirements for the degree of

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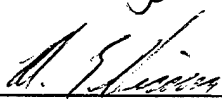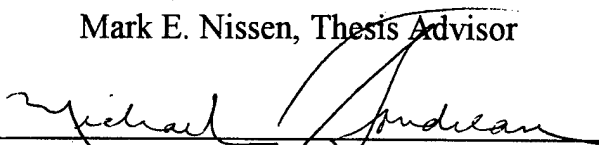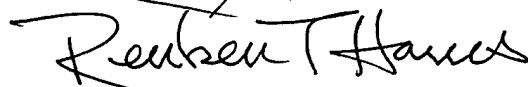## NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

The future forces of the U.S. Army face a great variety of threats with unprecedented complexities. The American public demands a quick, decisive victory with minimal casualties. In order to accomplish this, the Army must have the capability to totally dominate and control the enemy. Requisite Variety is essential to this mission. This research shows that in order to totally dominate the battlefield, the variety of options available to the friendly commander must be greater than or equal to that of the enemy. However, concurrent with the dramatic changes in the global environment, the U.S. has significantly decreased defense spending. The competition for these dwindling defense dollars has increased the Army's risk of misallocating its scarce resources to a few "brilliant" systems without regard to the factor of variety. This research provides a conceptual framework that innovates the Requirements Determination process by utilizing variety as a factor. It reveals concrete ways to provide the commander with the necessary variety to dominate the battlefield: through regulation, information, and variety catalysts. By applying the framework to the concepts of Force XXI operations, the researcher develops the Time-Information Differential. This suggests that given the current budgetary constraints, the Army should focus its short term material acquisitions on C^3I and mobility assets. However, to achieve synergistic results, the Army should concurrently research other types of weapon systems using the framework as a guide.

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I. INTRODUCTION

A. PURPOSE

The purpose of this research paper is to develop and examine a conceptual framework for prioritizing requirements for the future operational forces of the United States Army. The focus of the framework is on innovating the process of determining requirements so the Army can remain a superb force, capable of defeating any foe on the battlefield, subject to the current budgetary constraints and trends of downsizing. Requisite Variety is essential to this mission, and the Army risks misallocating its scarce funding to the development of redundant or superfluous weapon systems. Historic patterns of budgetary feast or famine are likely to return to famine if the Army cannot articulate the need for variety in addressing immediate needs. The Army's current process for determining requirements fails to directly assess requisite variety. The potential consequence of this oversight is that when new threats arise and the need for warfighting forces increases, the most effective mix of forces will be unavailable. This research paper provides a framework for utilizing variety as a decision factor in determining requirements. This is accomplished through a military application of Ross Ashby's theory of Requisite Variety. The current Requirements Determination process, and conceptual doctrine for the U.S. Army's Force XXI are examined with particular attention paid to the increased prevalence of software intensive weapon systems. Using this background information, the researcher applies the theory of Requisite Variety to develop a conceptual framework for innovating the requirements determination process. The framework presents guidance for how much variety is needed, and prioritizes research and development efforts in order to maximize the Force XXI efforts within budgetary constraints. Finally, the research analyzes an Advanced Warfighting Experiment with respect to the conceptual framework and examines the validity of the framework.

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B.   RESEARCH QUESTIONS

1.   Primary Research Question

How can the factor of requisite variety be incorporated in the Army requirements generation process, and how can this factor support process innovation?

2.   Secondary Research Questions

a.   What is the current process for Requirements Determination and what pathologies with respect to resource allocation exist with this process?

b.   What is the operational concept of land forces for the 21st Century and how does it impact the structure of forces in the future?

c.   What is the theory of Requisite Variety?

d.   What are the military applications of the theory of Requisite Variety and how might it impact the determination of requirements and structuring of forces in the future?

e.   Using the theory of Requisite Variety as a basis, how can a conceptual framework be developed for innovating the requirements determination process?

f.   What impact would this framework have on Joint warfare and other Services?

g.   What impact would variety have on funding and how can the Army articulate this to Congress?

C.   BACKGROUND

The world has undergone remarkable changes during this decade. During the late 1980's the 'Evil Empire" of communism stilled loomed throughout Eastern Europe and

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significantly challenged the security of the United States and other free nations. Today, the United States no longer faces a single galvanizing threat such as the former Soviet Union. Instead, there is an increased chance of our forces deploying to a number of limited regional conflicts. This creates a dilemma for our national security and defense spending. With the completion of the Cold War, the United States significantly decreased defense spending, but the need for a strong defense posture to meet the increased variety of limited threats is still valid.

To address this dilemma and define its approach to modernization, the Department of Defense (DoD) is emphasizing technological supremacy of the battlefield by seizing on breathtaking advances in information technology, maintaining strong missile defense and increasing mobility. These elements formed the cornerstone of Operation Desert Storm in which America showed the world the awesome power of its Information Age Forces. Smart weapon systems such as stealth aircraft and the PATRIOT missile system allowed the United States to employ precision strikes and save thousands of lives. The development of these weapon systems has changed the tactics, techniques and procedures for the future battlefield. Dominant maneuver, long range precision strikes and real time awareness across the entire spectrum of the battlefield are concepts which provide the basis of future doctrine. All of these sensational tactics have a critical commonality: software. Software-intensive systems provide the technological edge to compete and win in an ever-changing volatile world environment.

While software gives modern weapon systems enormous capability, operation near the state-of-the-art often greatly increases cost and risk. DoD has had a distressing history of procuring elaborate, high-tech software-intensive weapons that do not work, and cannot be relied upon, modified or maintained. [Ref. 27] Additionally, this temptation to flirt with the edge of the state-of-the-art encourages materiel developers to compete for scarce resources in search of the "silver bullet" weapon system that can do it all. Allocation of resources to these high cost systems might create a dangerous, uneven distribution of funds to a few of these systems which leaves no funds for others. This tendency to become "lean and mean" by focusing on a few, brilliant weapon systems could result in disaster, considering the uncertainty of threat that challenges the U.S. today. In

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the face of downsizing, shrinking defense spending, and the greater variety in the possible threats, DoD has to radically change the process of determining requirements and allocating resources.

Force XXI is the Army's effort to harness the change in world order and advance into the 21st Century with the most capable land combat force in the world. In order to make this work, DoD makes some critical assumptions about where to get the money for these initiatives. One of these assumptions in our defense planning is that significant savings will be achieved by overhauling our defense acquisition system. This is a system that has long had a dark cloud hanging over its head: a process that many perceive to be inefficient, and in light of today's grim procurement budget forecasts, does not work anywhere near as well as it must.

In an attempt to keep pace with these changes and acquisition reform, the Army Training and Doctrine Command (TRADOC) has been given the mission by the Chief of Staff of the U.S. Army to bring discipline to the Requirements Determination Process and become the "gatekeeper" for all requirements. TRADOC has proposed new ways to determine requirements based on desired Joint and Army capabilities as well as deficiencies deduced from mission area analysis. The concept based portion of this process involves experiment-based battle labs that take Force XXI operational concepts coupled with emerging new technologies to conduct warfighting experiments which become the basis for determining requirements. The problem with this approach is that each battle lab focuses on a distinct set of operational concepts. This enforces the competition for scarce resources between the material developers, and does not formally address the factor of variety in weapon systems and force structure. Instead of bringing discipline to the process, the new system encourages the tendency for the Army to "put all their eggs in one basket." In today's uncertain environment, the Army must determine requirements from a holistic perspective.

The researcher postulates the Army must invest in ways to cope with variety or have variety in its own force structure. By utilizing variety as a factor, the Army can maximize the utility of its force despite the conditions that currently face DoD today. Variety is a key element that provides the capability to achieve synergistic results on the

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battlefield. It is also a key factor in dealing with the uncertainty of the future threats that face the U.S. Variety on the battlefield equates to the possibility of "doing more" without the overwhelming number of forces that the U.S. had during the Cold War era. The problem is that the Army has no framework for evaluating the need for variety or how to contend with variety in the threat it is facing. The theory of Requisite Variety is an excellent way to analyze requirements because it provides a way to incorporate the factor of variety. The theory not only addresses the need for variety, but it also provides a basis for regulating uncertainty and coping with variety. The theory of Requisite Variety was postulated in the early 1950's by the British cybertician, Ross Ashby. Ashby studied techniques to control complex systems. He realized that the more complex a system, the more difficult it is to understand and control. Ashby discovered that in order to control the system, the amount of variety in the control mechanism has to be at least as much as in the system being controlled. The researcher intends to use this theory to develop a conceptual framework for determining requirements that incorporates the factor of variety.

D. SCOPE

This research addresses the future force structure of the U.S. Army subject to current budget constraints. Specifically, it analyzes the current requirements determination process and conceptual doctrine for the future of the Army with respect to the uncertain threat from the world environment. The research examines a way to innovate the current process using the theory of Requisite Variety as a basis. It includes a literature review of the current requirements determination process and the major themes of conceptual doctrine with the assumption that the reader has a basic knowledge of the overall acquisition process and current doctrine for the U.S. Army. No classified material will be addressed. While the research focuses primarily on the Army's process of requirements determination, by the very nature of joint warfare, this study should be relevant to all Services of DoD. The study examines the theory of Requisite Variety and develops a conceptual framework for its application. The conceptual framework is

examined with respect to an Advanced Warfighting Experiment conducted at Fort Knox, KY.

E.   METHODOLOGY

The first objective of this research paper is to provide an overview of the current Requirements Generation process and future warfighting concepts developed by the Army to take the force into the 21st Century. This is accomplished through a literature review of sources including periodicals, books, reports, DoD documents, and U.S. Army manuals. These materials were obtained from the Defense Technical Informational Center, the Defense Logistics Systems Information Exchange, and the Naval Postgraduate School Library. Additional information was obtained by exploring the Internet and the new Acquisition Deskbook for the most current publications and articles. Analysis of the current process identifies what pathologies exist with respect to providing variety in our future forces.

The next objective is to investigate whether or not the theory of Requisite Variety can be applied to innovate the Requirements Determination process. This is accomplished through an analysis and military application of the theory with respect to future operational concepts. The researcher uses the background information to develop a framework to innovate the process using variety as a factor.

The final objective is to examine the validity of the framework and see what impact it has on the Army and other Services. This is accomplished by observing and analyzing results of experiments conducted by the Advanced Warfighting Work Group and the Mounted Battlespace Battle Lab located at Fort Knox, KY. These organizations have been on the cutting edge of Force XXI concepts for the last five years and the researcher has worked with them in previous assignments. The choice of this method of research should preclude the bias obtained from conducting interviews.

F. ORGANIZATION
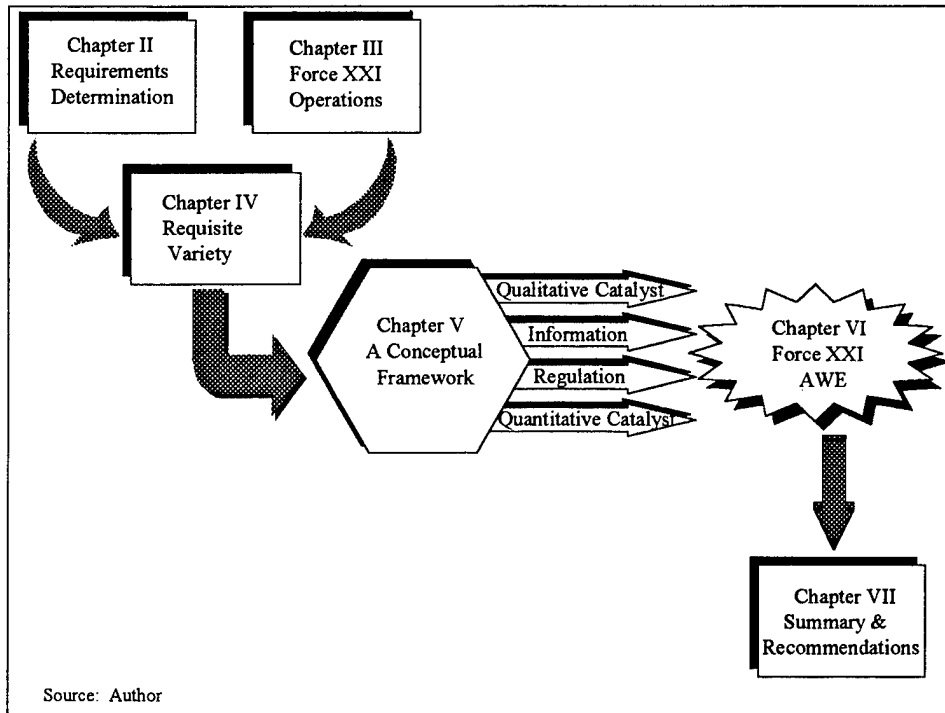
Figure 1-1. Road Map to the Study

Figure 1-1 orients the reader to the flow of this study. Chapter II provides an overview of the current Requirements Determination Process developed by TRADOC. The process is designed to discipline the system, identify requirements faster, improve products, and shorten acquisition time. An analysis of the process with respect to variety identifies what pathologies exist. The chapter concludes by examining how future operational concepts are integrated into the process.

Chapter III identifies and discusses future operational concepts for land combat in the 21st Century. The chapter examines the revolution in military affairs that is being driven by information age technologies. The major thrust of this chapter is to explicate the intentions of these key concepts, and lay the groundwork for the discussion of requisite variety

Chapter IV examines the theory of Requisite Variety. This is a theory that was derived from the study of cybernetics on how to control systems. The researcher gives basic examples of the theory, along with a military application of its underlying concept.

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Chapter V analyzes the results of the research to determine if the theory of Requisite Variety has any applicability to the study. It provides a framework for innovating the process of Requirements Determination. The framework presents guidance for how much variety is needed, and prioritizes research and development efforts in order to maximize the Force XXI efforts within budgetary constraints. The researcher identifies what implications the theory has on the Requirements Determination process and structuring of forces in the 21st Century. The chapter concludes with a discussion on how these innovations affect acquisition reform.

Chapter VI presents the data that were observed from experiments conducted by the Advanced Warfighting Workgroup and Mounted Battlespace Battle Lab at Fort Knox, KY. The researcher analyzes the experiments with respect to the framework presented in the previous chapter. The researcher analyzes the validity of the framework and explores other possible uses of the framework.

Chapter VII presents a clear and concise summary of the conclusions that can be logically drawn from the research. The researcher makes recommendations for action and proposes an implementation plan for the framework. Additionally, the chapter presents recommendations for Areas for Further Research.

G.   BENEFITS OF STUDY

This study presents a radically different paradigm for innovating the process of moving the Army into the 21st Century. The current process relies on the development of costly high-tech weapon systems that obviate the need to put "boots on the ground" through a variety of sources. Indeed, a utopian desire is to create a bloodless battlefield through the use of such weapon systems. However, in today's budgetary constrained and uncertain threat environment, this desire is laudable but naive. A better approach is to address the factor of variety and use it to provide a framework for structuring future forces.

This research effort should benefit DoD organizations that are involved in the process of acquisition reform and structuring of forces for the 21st Century. In this period

of shrinking defense spending, all Services need a process for prioritizing future operational needs, and more importantly the Services have to be able to intelligently articulate these needs to the organization that holds the "power of the purse," Congress. The military interpretation of the theory of Requisite Variety as applied to Force XXI will provide a common vocabulary from which "warfighters" and officials from the Office of the Secretary of Defense (OSD) may discuss the requirements determination of future forces. The study will specifically benefit TRADOC by providing insights to innovations in acquisition reform. In general, the study will provide a new paradigm for defending budget requests for the Armed Forces. Finally, the problem of developing a strong force in the future while maintaining the current operational level of the current force will be addressed.

The researcher does not believe that he will discover anything entirely new. What will be new is the degree to which the study extends existing concepts and recombines them with extensions of other concepts such as Ashby's theory of Requisite Variety. The study will create a new paradigm, based on existing building blocks, but essentially a new system with new internal dynamics. To properly examine and integrate new digital warfighting concepts with acquisition reform, DoD must have a framework and a vocabulary for intellectually examining the future battlefield. This study results from the researcher's efforts toward this objective.

II. REQUIREMENTS DETERMINATION PROCESS

A. INTRODUCTION

This chapter examines the Army's requirements determination process. The first section provides an overview from DoD's perspective. Following this macro level overview is a more detailed look at the Army's process. This is a new multifaceted experiential process that has evolved from the concept based system. Key elements of the process are identified and discussed. The final section analyzes the process with respect to variety, and identifies what pathologies exist.

B. PROCESS OVERVIEW

The method DoD uses to determine requirements is a deductive process that begins with the development of a National Security Strategy. Considering this strategy, the Services conduct a Mission Area Assessment and Mission Needs Assessment to determine what deficiencies exist that will keep them from accomplishing their respective missions. [Ref. 8: par. 6(a)] Guidance and policies for defining requirements place emphasis on translating operational needs into stable, affordable programs. [Ref. 12: par. D.1] Therefore, the first choice in resolving deficiencies is to change doctrine, tactics, or training. These nonmateriel alternatives are investigated first because of their relatively low cost and ease (i.e., speed) of implementation. Should nonmateriel alternatives prove incapable of resolving the deficiency, then materiel solutions are identified. The regulations specify two documents to describe requirements, the mission need statement (MNS) and the operational requirements document (ORD). [Ref. 13: part 2] The MNS is generated first and describes requirements in broad operational, not system specific, terms. Once alternatives to satisfy the mission need are studied and a system concept selected, an ORD is prepared to describe the system solution. The overall requirements generation process is depicted in Figure 2-1 at the top of the next page.

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Source: [Ref. 26: p. 41]
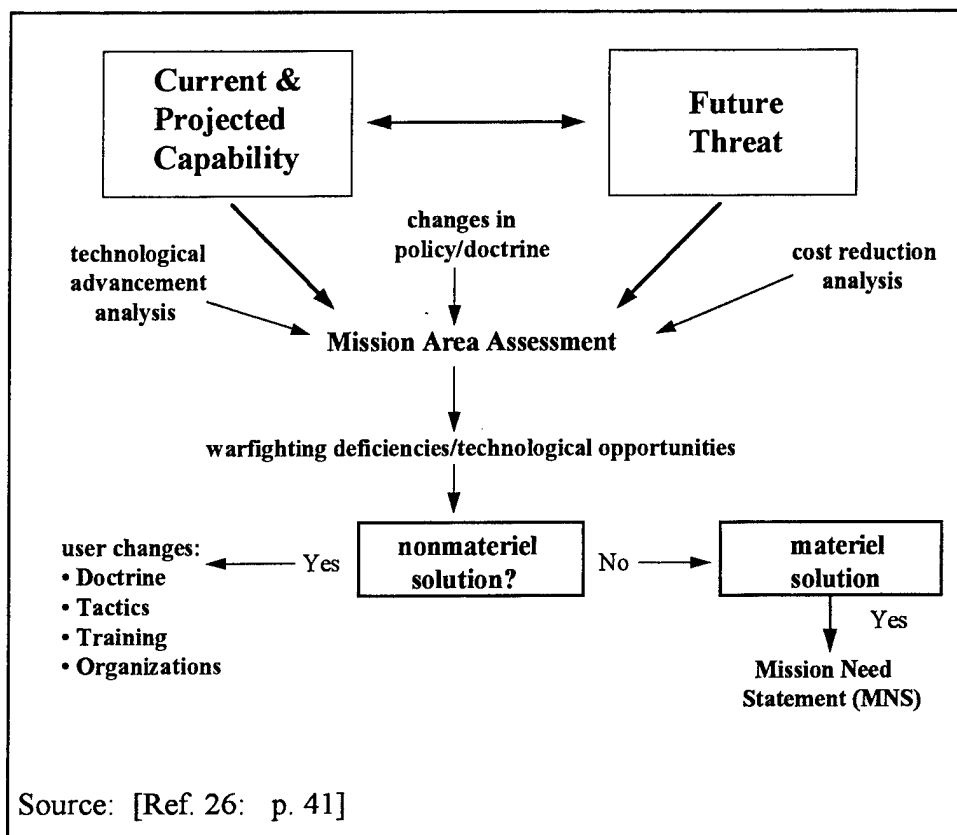
Figure 2-1. Mission Need Determination

It is noteworthy, that this process is not only based on threat and deficiencies, but also on opportunities for *new capabilities*. The US Army has fully adopted this Capabilities Based Requirements Determination System (CBRS). TRADOC is currently revising its requirements determination regulations to build upon the CBRS. One of these new Army Regulations (AR) that has come out in draft format is AR 71-9, Force Development Requirements. This document is a major revision of the previous AR 71-9 that was last updated in February 1987. Another important document is a TRADOC pamphlet that is entitled Requirements Determination. This TRADOC pamphlet is the third in a series of four pamphlets that TRADOC has issued in their 'Black Book" format. Elements of the 'Black Book" and the new AR 71-9 will be discussed in the following paragraphs.

Army Regulation (AR) 71-9 (Draft) defines requirements determination as:

...the process of identifying and analyzing warfighting required future operational capabilities (FOCs) for doctrine, training, leader development,

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organizations, and soldier development and executing solutions, within the context of the force development process. [Ref. 10: par. 1-4(b)]

The "Black Book," published in March of 1996, documents the impact that future warfighting concepts and advanced technologies have on requirements determination.

> The requirements determination process begins with a holistic future warfighting concept. The concept is influenced, but not driven, by an appreciation of future science and technology (S&T) possibilities....Warfighting concepts also document Army goals for the S&T communities. The goals are broadly descriptive in nature so as to provide sufficient leeway to examine experimental discoveries. [Ref. 31: p. 5]

From these statements it is clear that the Army is placing great importance on CBRS and future technology opportunities. The goal of this approach is to speed up the requirements determination process while at the same time improving its product. [Ref. 22: p. 26] To accomplish this goal, TRADOC has outlined five key elements that describe how the future warfighting concept focuses S&T research and warfighting experiments and leads to defined requirements.

C. ELEMENTS OF THE REQUIREMENTS DETERMINATION PROCESS

1. Concept Development

The terms "vision," "concept" and "doctrine" are not synonymous, and are often misunderstood. The Army describes a "vision" as a rudimentary abstract description of a desired end state. A "concept" is a translation of a vision or visions into a more detailed, but still abstract description of some future activity or endstate. "Doctrine" is described as a body of thoughts that are the fundamental principles by which military forces guide their actions in support of objectives. Visions and concepts generate questions about the future, while doctrine provides answers about today. [Ref. 31: p.8]

The TRADOC commander develops the Army's future warfighting vision. He develops this vision with input from national security and military strategy, and also from current and future scientific and technological opportunities. The TRADOC Deputy Chief of Staff for Combat Developments (DCDSD) heads up an Integrated Concept Team (ICT) which translates the TRADOC commander's warfighting vision into an overarching warfighting concept. This overarching warfighting concept becomes the primary reference for all other concept development activities. [Ref. 31: p. 8-9]

More detailed operational and functional concepts are developed by TRADOC school commandants through their Directorates of Combat Developments (DCDs). The school commandants form their own ICTs to produce these concepts. All concepts developed by school commandants must be approved by the TRADOC commander. Concept development usually leads to further scientific and technological research or experiments. During this concept development analysis, requirements and other interesting ideas emerge. These ideas and requirements must support future warfighting concepts.

2.   Future Operational Capabilities

Future Operational Capabilities (FOCs) were previously known as Operational Capability Requirements (OCRs). FOCs are intended to provide a warfighting focus for the Army's Science and Technology investments. One set of FOCs is written for each Battle Lab and encompasses the battlefield dynamic for which the Battle Lab is responsible. They are employed during warfighting experiments to assess the value of Science and Technology (S&T) endeavors and to translate concepts into discrete, statements of need. An example of a FOC for the Battle Command Systems Battle Lab as written in TRADOC Pamphlet 525-66 is:

> **BC01: Battlefield Information Control**: To fulfill the vision articulated in TRADOC Pamphlet 525-5, <u>Force XXI Operations</u>, and the Battle Command Concept, the battle command system must have the capability to collect, process and disseminate in real- and near real-time information on

the friendly and enemy situation, command directives, and other essential information. [Ref. 30: p. 4]

3. Science and Technology

The Army Science and Technology (S&T) program is designed to develop innovative technological warfighting concepts. All sources of new technology such as Commercial Items (CI), and non-developmental items (NDI) as well as new-start programs are analyzed. These all assist in achieving the goal of rapid requirements determination. For example, if a CI or NDI item produces a Future Operational Capability, then we save the expense and time spent for research that is required by a new-start. [Ref. 31: p. 10] Research into new possibilities is not unguided, but is focused by a series of reviews. Annually, the Army assesses all proposed S&T projects. From this assessment, a list of the top 200 Army S&T Objectives (STO) is generated. The Army Science and Technology Working Group (ASTWG) approves each STO, and the approved STO is listed in the Army Science and Technology Master Plan (ASTMP). The ASTMP provides the basis for Advance Technology Demonstrations which are analyzed to determine if any have military merit. [Ref. 31: p.11]

4. Warfighting Experiments

Warfighting experiments are described as the "heart" of the requirements determination process. They are designed to provide Army leaders with future operational capability insights. Warfighting experiments are different from test and evaluation as they are designed to gain understanding about future warfighting, not just to measure an existing system, or new procedures.

Battle labs are responsible for planning and conducting warfighting experiments. The battle lab must first develop a hypothesis and then prepare detailed plans that describe objectives, measures of performance, measures of effectiveness, participants, milestones, data collection and resources. They are assisted by the TRADOC Analysis Center

(TRAC) which leads the analysis of every experiment. Their analysis and recommendations form the basis for the final experiment report. The experiment report yields insights through which the battle labs can make recommendations to invest in the concept, discard the concept, or experiment further with the concept.

There are two main categories of warfighting experiments. They are concept experiments, and advanced warfighting experiments (AWE). Most of the experiments are concept experiments. These pertain to individual operations or branches of the Army such as Air Defense, Infantry, or Armor. [Ref. 31: p. 12-13]

Larger experiments that focus on advancements to warfighting capabilities across multiple branches are part of the AWE program. AWE programs are sponsored by the TRADOC commander with the Chief of Staff, Army, approving and resourcing the experiment. Both types of experiments involve field soldiers and units in a field environment. As these experiments are expensive, attempts are being made to increase the amount of simulation involved. Interactive simulators and modeling are ways to reduce the cost and length of large experiments with actual soldiers.

5. Integrated Concept Teams (ICTs)

While the warfighting experiments are the "heart" of this requirements determination process, ICTs are the catalyst that make things happen. AR 71-9 (Draft) defines ICTs as "multidisciplinary teams formed throughout the Army representing appropriate Major Army Commands (MACOMs) and staffs, appropriate DoD organizations other Federal agencies, industry, and academia." [Ref. 10: par. 1-4(c)] The range of possible participants specified in the regulation includes personnel from the office of the Deputy Chief of Staff for Operations and Plans (DCSOPS) to personnel from the office of The Surgeon General. The intention of this methodology is to allow concepts to be looked at from many perspectives and solidify requirements more quickly. The ICTs "brainstorm" concepts from both visionary and practical perspectives with the goal of shortening the requirements determination "event" by providing it better early focus. This "brainstorming" is not constrained by costs as concepts are being explored, but potential

cost data are gathered so that they can be used as a baseline later in the process. The S&T community and industry participate to provide awareness of state-of-the-art technology and to preclude the pursuit of "dead end" requirements.

The ICT complements the existing Integrated Product Team (IPT) methodology used by materiel developers to manage system development. IPT methodology is discussed in detail in DoD Regulation 5000.2R. Formation of the ICT in the early concept development enables the team to transition to an IPT when a materiel solution is deemed necessary to satisfy a warfighting FOC. [Ref. 10: par. 1-2(b)] Thus, continuity is maintained from concept to fielding for a materiel solution.

D.   SUMMARY OF THE PROCESS

This section describes the Army's process for determining requirements. Figure 2-2 below depicts this process.
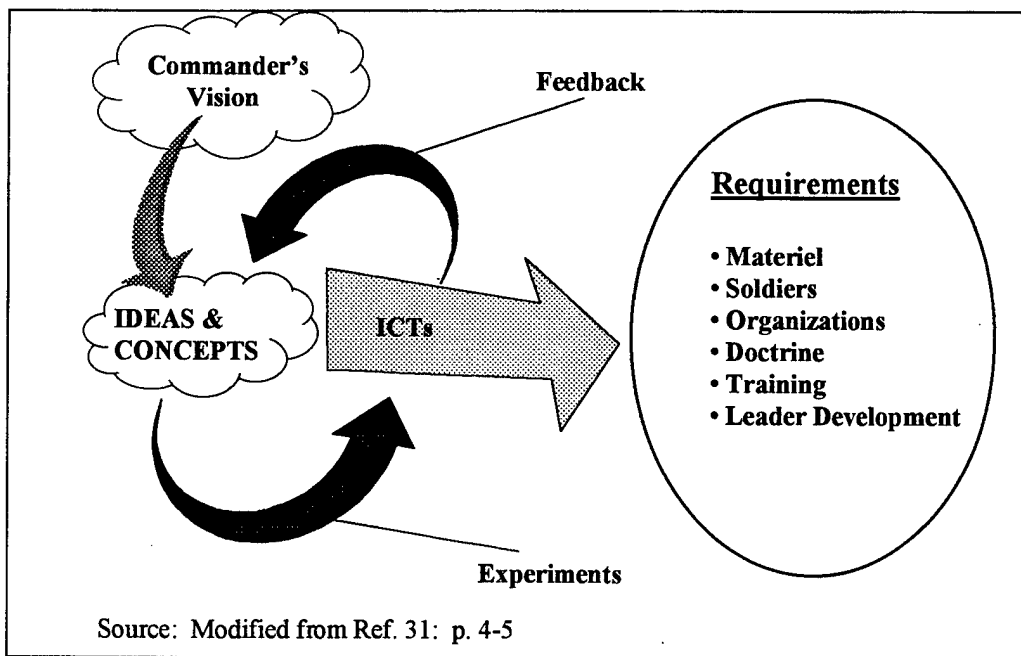
Figure 2-2. Army's Capabilities Based Requirements Determination

To summarize, the process begins with the TRADOC commander's vision which is then translated into FOCs. Then ICTs take these concepts and further define them into

capabilities and solutions. These capabilities are tested through a combination of live, constructive, and virtual experiments. Feedback from these experiments is used to refine the ideas and concepts and eventually develop requirements.

This process is designed to be flexible. It has multiple entry and exit opportunities and is easily tailored to support different types and levels of requirements. The ICTs are intended to provide thorough, concurrent consideration of desired warfighting capabilities and the means to achieve these capabilities. The Army feels this methodology will "enable leaders to make better and **faster** decisions." [Ref. 31: p.6]

An initial analysis suggests that this process does give the Army a wide variety of perspectives from which to "brainstorm" concepts. This increases the amount of options from which to meet requirements. The Army will be more aware from the perspective of both the technological and conceptual opportunities. Utilizing a variety of perspectives during concept formulation, however, does not directly translate into requisite variety in the operational forces. Nowhere in the process does the Army evaluate or access the necessity and importance of variety. The ORD does "skirt the edges" of this factor by addressing the Threat and Shortcoming of Existing Systems in paragraphs two and three, respectively. However, in this Post Cold War era, the threat is highly uncertain and addressing shortcomings of existing systems appears to act as a constraint in order to reduce duplication of effort. While on the surface, this approach may seem noble and frugal, the consequence of not directly addressing variety may be costly. Adding to the difficulty, these costs are hard to quantify without a framework for measuring variety. Instead of indirectly constraining variety, the Army should have some method for directly evaluating this factor in its decision-making process. Additionally, the current process is based on the FOCs which are assigned to different Battle Labs. Each Battle Lab concentrates on their specific set of FOCs. The researcher feels that this stovepipe process coupled with shrinking Defense dollars fosters a competitive environment in which each Battle Lab fights hard for funding of their specific projects. This in turn, impedes the amount of variation in our forces. In this context, there is a need to have a framework for conducting cost/benefit analysis of variety. Rather than merely analyzing the costs and benefits of variety, however, perhaps a more important question to answer is:

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Given that the current fiscal environment constrains the amount of variety in our forces, how can the Army prioritize weapon systems in order to mitigate this deficiency?

It is logical to presume that TRADOC considers the factor of variety. TRADOC has included this factor in its most recent version of its keystone doctrine Field Manual (FM) 100-5, Operations. In fact, this manual includes a discussion of variety as part of one of the five tenants of Army Operations, *Versatility*.

> Versatility is the ability of units to meet **diverse** mission requirements....Versatility requires competence in a **variety** of missions and skills....Versatility ensures that units can conduct **many different kinds** of operations, either sequentially or simultaneously, with the same degree of success. [Ref. 11: p.2-9]

It is interesting that the Army ranks variety (i.e., versatility) important enough to make it a tenet of Army Operations in the keystone doctrine manual, yet fails to address variety when determining requirements. The researcher postulates that the Army does not directly address variety in this respect, because variety is too hard to quantify and articulate. The Army lacks a sufficient framework to accomplish these tasks.

E.   CHAPTER SUMMARY

This chapter examined the Army's current requirements determination process. The process begins with a holistic future warfighting concept. This concept is formed from a wide variety of inputs, including the national security and military strategies, lessons learned from recent operational experiences and future conflict scenarios, and future S&T possibilities. This overarching concept is the basis for operations and functional concepts addressing the full spectrum of Army operations and functions. Together, the warfighting concepts are the Army's "blueprint" for determining requirements. By design, the process is very flexible. It accommodates spiral development and employs a variety of feedback mechanisms. However, there are some pathologies that exist with the process. Namely, the process does not directly address the importance of variety in the composition of forces. It does not assess or evaluate the need

for having a variety of weapon systems. Perhaps more important in today's environment of tight fiscal constraints, the process does not have the capability to prioritize weapon systems with respect to variety. The researcher will address these pathologies in chapters four and five of this study. First, it is important to understand some of the basic doctrinal concepts of Force XXI, because all materiel acquisition programs must be based on identified FOCs. The next chapter discusses the basic concepts and lays the groundwork for developing a framework for requisite variety.

III. FORCE XXI OPERATIONAL CONCEPTS

A. INTRODUCTION

As covered in the last chapter, material acquisition programs must be based on identified FOCs. These FOCs are generated as a direct result of continuing assessments of current and projected capabilities in the context of changing national military strategy and national defense policy. FOCs must first be evaluated to determine if they can be satisfied by nonmateriel solutions. Nonmateriel solutions include changes in doctrine, training, leader development, organizational issues or soldier issues. Only when a need cannot be met by such changes will a materiel solution, expressed in terms of a non-system specific, required operational capability be developed. It is important to note that the requirements determination process is not a support mechanism for a particular system or piece of equipment. Rather, it is a process that supports a holistic view of the Army's warfighting requirements. Determining how and why the Army fights is critical to this process. It is only from this determination that future warfighting operational capabilities can be validly identified. Thus we see that there is a dynamic tension between doctrinal concepts and materiel developments; they shape one another.

This chapter examines the Army's concepts for land combat in the 21st Century. It begins with an overview of the threat and future strategic environment that face the U.S. Army. Next, it outlines the recent history of doctrine and concept development. With this as a background, the characteristics and patterns of Force XXI operations are examined. The chapter concludes with a discussion of how these concepts impact the future organizational and materiel requirements.

B. THREATS AND FUTURE STRATEGIC ENVIRONMENT

> Rather than a single, focused threat, America's twenty-first century Army
> faces a broad range of challenges. [Ref. 25]

While FM 100-5 is the cornerstone doctrinal manual for Army operations, it is TRADOC Pamphlet 525-5, FORCE XXI OPERATIONS, that drives the concepts for future forces. It represents the baseline in the formulation of more definitive follow-on concepts for early twenty-first century Army operations. TRADOC Pamphlet 525-5 is not doctrine, rather a document of ideas. These ideas are expressed in a coherent concept that incorporates commander's vision and leads to FOCs. These FOCs are examined during Army Warfighting Experiments which lead to discovery of needed changes in requirements. TRADOC Pamphlet 525-5 is a "working document" subject to continuous improvement. As concepts become more definitized, they become the basis for doctrine. The most recent edition of TRADOC Pamphlet 525-5 was published in August of 1994. The next section of this study outlines the future trends and characteristics of future armies that are described in this Pamphlet.

1. Trends -- Elements of Instability

Following the end of the Cold War the world experienced many changes. This period of great transition created tension between nations and subnations on a variety of issues: economic, technical, societal, religious, cultural, and physical. While the end of the Cold War served as a catalyst for these changes, many scholars argue that the world would be caught up in revolutionary upheaval today even if the Berlin Wall had not fallen and the Soviet Union still existed. As Alvin and Heidi Toffler argue in their book, War and Anti-War, "We are witnessing...the sudden eruption of a new civilization on the planet, carrying with it a knowledge-intensive way of creating wealth that is trisecting and transforming the entire global system today." [Ref. 28: p. 242] There are many indicators that suggest this dramatic restructuring of the world's geopolitical framework will continue.

For the past three centuries the nation-state has been the basic unit of the global system. However, this building block for world order is changing. "The startling fact is that of all the present members of the United Nations roughly a third are now threatened by significant rebel movements, dissidents, or governments-in-exile." [Ref. 28: p. 242]

Although nation-states will continue to be the world's primary political unit, they are under attack in much of the world. Major powers face the temptation to intervene as the shifting and unstable power balances at the national and subnational levels threaten to engage their vital interests.

Nationalism has replaced communist ideology as the leading cause of interstate and intrastate conflict. Nationalist movements are based on many sources of mass identity: religious, tribal, ethnic, historical, or territorial, are supplanting older, ideologically based identities. These movements can erode the power and legitimacy of states. As regimes that have kept foreign political forms come under attack by these groups seeking to establish or reestablish their identity, instability ensues. This instability threatens not only Western interests within the state but often threatens to spill across borders. [Ref. 29: p. 2-1] The former Secretary of State Warren Christopher warned the U.S. Senate Foreign Relations Committee that 'if we don't find some way that the different ethnic groups can live together in a country...we'll have 5,000 countries rather than the hundred-plus we now have." [Ref. 28: p. 242]

The relevance of the conventional balance of power theory is questionable. This is particularly evident in the area of economics. Advances in production and marketing techniques have widened the gap between rich and poor states, yet national markets are becoming less important than local, regional, and global markets. For instance, it is nearly impossible to tell what country a particular car or computer comes from, since its parts and software come from many different sources. Questions of access to, or control of, strategic resources, lines of communications, and markets are likely to lead to conflict. The temptation to use military force to rectify perceived economic imbalances will be great.

Population growth, particularly in the less-developed world, will strain the resources and social structures of the states affected. Because much of the world's population growth occurs in areas prone to natural disasters and famine, such events can cause mass migrations of refugees. [Ref. 29: p. 2-2]

The ability of a government to govern effectively is being eroded in much of the world. Throughout the world, governments are less able to provide economic stability

and security for their populace. Even the most powerful governments and their central banks are having trouble controlling their own currency in light of the unregulated tidal waves of electronic money. Capitalism and the collapse of dictated economies are creating problems of distribution and structural unemployment. Immature government infrastructures in developing democracies cause expectations to be unmet and groups to turn to other outlets for hope, often leading to conflict. With this eroding security comes a rise in ungoverned groups or criminal organizations. When combined with nationalist groups, criminal groups have the potential to supplement, or even supplant, the state.

Rapid improvements in technology are disrupting established ways of doing business. Information technology is allowing businesses to reduce middle management and support staffs. Aside from the vast increase in unemployment worldwide, technology improvements enable companies and states to leapfrog some technologies. American technical superiority cannot be guaranteed. As in the past, a revolutionary advance in technology could result in reordering of economic or military power. [Ref. 29: p. 2-3]

Rapid advances will continue to be made in the way nations collect, communicate, and use information. The proliferation of microprocessing technology causes the "clock-speed" of public awareness to accelerate. Manipulation of the media to control public opinion can be practiced by all states and nations. This acceleration means that hot-spots and wars can materialize almost overnight in the homes of millions via news networks such as CNN. Dramatic events demand response before governments have had time to digest their significance. Politicians are compelled to make more and more decisions about things they know less and less about at a faster and faster rate.

All of these trends suggest that the world will continue its dramatic transition towards a complex new global system made up of regions, religions, nongovernmental organizations, and political movements. All of these have different interests and reflect different degrees of interactivity. Whether or not this was caused by the end of the Cold War is left for the scholars to debate. For the purposes of this study, these trends of instability indicate that the U.S. will face challenges of unprecedented complexity, diversity, and scope as we move into the 21st Century.

2. Characteristics of Future Armies

The Cold War paradigm of threat analysis is insufficient to capture the full spectrum of military capabilities that future threats may display. Consequently, TRADOC Pamphlet 525-5 developed a new model that attempts to capture the wide variety of threats that could face the U.S. The threat spectrum model shown in Figure 3-1 arrays potential threats across a spectrum from simple to complex in scope, organization, and abilities.
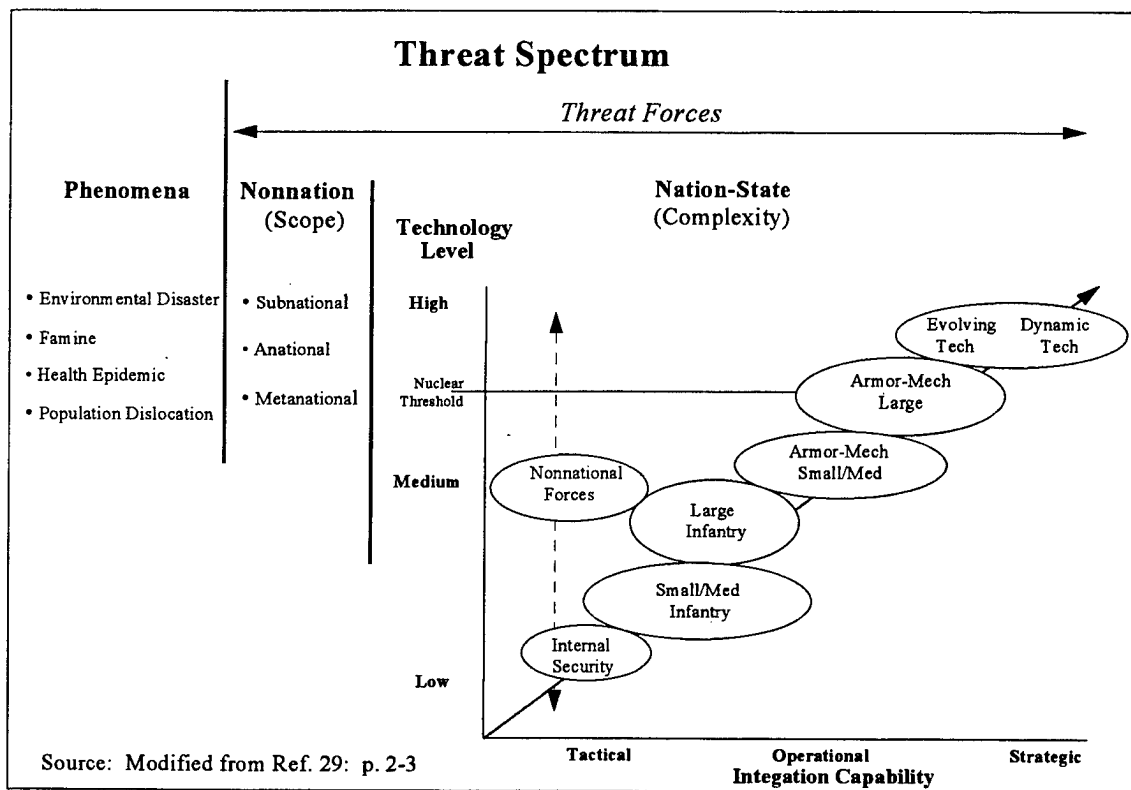
Figure 3-1. Future Threat Spectrum

a. Phenomenological Threats

Nonmilitary threats resulting from human occurrences, experiences and natural emergencies may require a military response. These phenomena can include environmental disasters, health epidemics, famine, major population dislocations, and illegal immigration.

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b.   *Nonnation Forces*

Nonnation security threats, using modern technologies that give them some capabilities similar to nation-states, are becoming increasingly visible. The nonnation forces present unique problems to the professional armies, particularly in terms of ethics and intelligence. They do not fight by the rules of conventional warfare. Their targets are not force-oriented but are the political will of the opponent. Their tactics include ambushes, terrorism, kidnapping, and criminal actions. The nonnational forces can be differentiated by their scope.

- **Subnational** threats include the political, racial, religious, cultural, ethnic conflicts that challenge the defining features and authority of the nation-state from within.

- **Anational** threats operate without regard to the authority of their nation-states. These entities are not part of the nation-state and have no desire to establish such a status. Regional organized crime, piracy, and terrorist activities comprise these threats.

- **Metanational** threats move beyond the nation-state, operating on an interregional or global scale. They include religious movements, international criminal organizations, and informal economic organizations that facilitate weapons proliferation.

One can see many examples of nonnational threats just from watching the news. Groups like the IRA, KKK, Neo-Nazi skinheads, and international drug cartels are but a few of these threats that exist today.

c.   *Internal Security Forces*

In most cases, these are the small, poorly trained and equipped forces of the less-developed world, that can maintain order within a country but would have difficulty defending its borders or conducting extended military operations. The forces in Somalia and Haiti are good examples of recent internal security forces. As with the nonnational threats, there may be a strong connection between these forces and local criminal activities.

d.   Infantry-Based Armies

Most of the less-developed world armies have some armor but are reliant upon dismounted infantry for the bulk of their force. Examples are the army of Afghanistan who faced the Soviet Union in the 1980s, and the Bosnian and Serbian armies of today. The skill of these armies to integrate high tech weaponry and conduct combined operations are marginal or basic (tactical on the horizontal axis of the threat spectrum).

e.   Armor-Mechanized-Based Armies

Armies of most industrial nations fall into this category. Armored units generally comprise 40 percent of their forces. Their ability to integrate weapons and conduct combined operations vary. There are two major trends that run throughout these types of armies. First, they develop or procure weapon systems to match or defeat those of their neighbors. Second, they tend to have hierarchical Command, Control, Communications, and Intelligence (C^3I) structures. These armies are not as technologically advanced as complex, adaptive armies, but they compensate with numbers and weight of metal. Examples are the armies of Iraq and Iran.

f.   Complex, Adaptive Armies

These most technically and tactically advanced armies come from developed nations. They will be smaller and increasingly more expensive to equip and maintain. Their complex forces give them greater flexibility to seize the initiative on the battlefield across the entire spectrum of situations. Future operations will involve increasingly high-tech equipment, joint/multinational forces, multidimensional maneuver, precision munitions, smart weapons platforms, and enhanced situational awareness. However, the multiplication of specialized units that allows flexibility also adds to their vulnerabilities. Threats from weapons of mass destruction and disruption of their key support elements can eliminate the "edge" these armies have over the less-advanced force. [Ref. 29]

g.   *The Impact of Proliferation and Modernization*

An examination of the Threat Spectrum Model shows that there are a great variety of threats that will face our nation in the future. The most serious challenge to U.S. military superiority, however, will not come from any one state or group but from a process: the proliferation of weapons and technology. During the Cold War, efforts at preventing the spread of mass-destructive weapons were based on ten key assumptions: [Ref. 28: pp. 199-200]

1. The new weapons could be monopolized by a few strong nations.
2. Nations seeking such arms would have to produce their own.
3. Small nations, in general, lacked the necessary resources.
4. Only a few weapons or types would meet the definition of weapons of mass destruction.
5. These weapons depend on a handful of raw materials that were monitorable and controllable.
6. They also depended on a few specific, identifiable technologies whose spread could also be watched and controlled.
7. The actual number of "secrets" needed to prevent proliferation would also be small in number.
8. Regulatory agencies could collect and disseminate information for use by the world nuclear industry without revealing knowledge that would help arms proliferators.
9. Existing nations would remain stable and not break apart.
10. Nation-states were the only possible proliferators.

Today, every one of these assumptions is demonstrably false. Threat forces of all variety will take lessons learned from the Gulf War and try to improve their armed forces relatively quickly. If they do not have the fiscal capability to procure new state-of-the-art systems, they will upgrade existing systems through strap-on technologies. The access to technology, however, does not equal force modernization. Although a nation can leapfrog technologies (e.g., space, nuclear weapons, ballistic missiles), improving integrative capability is more difficult. Those states that can fully integrate these weapon systems into all aspects of operations will achieve innovative results. This is similar to the concept of Soviet origin called Military Technical Revolution.

> A Military Technical Revolution occurs when the application of new technologies into military systems combines with innovative operational concepts or organizational adaptation to alter fundamentally the character and conduct of military operations. This produces a dramatic improvement

in military effectiveness and combat potential. What is revolutionary is not the speed with which the change takes place, but rather the magnitude of the change itself. Mere technological improvements do not constitute a Military Technical Revolution. In 1940, tanks, improved aircraft designs, and radios were available to both the French and the Germans. However, it was the Germans who adapted their organizations, procedures, and tactics to transform the trench warfare of World War I into the blitzkrieg. [Ref. 29: p. 2-8]

The Threat Spectrum Model described above successfully captures the multitude of diverse threats that might face the U.S. It certainly is more germane to the discussion of future operations than the antiquated Cold War paradigm of threat analysis. When coupled with the ongoing trends of instability, this immense variety of possible threats begins to provide a basis which suggests that U.S. forces must be more versatile than in the past. They still have the mission to fight and win the nation's wars. Yet, they must be able to transition from this state of readiness to conduct other operations then quickly transition back, perhaps in the same theater of operations. In order to postulate what is required to meet these challenges it is useful to examine what has been done in the past.

C.   RECENT HISTORY OF DOCTRINE

"Doctrine is the fundamental principles by which military forces guide their actions in support of national objectives." [Ref. 29: p. G-3] It is authoritative in nature but requires judgment in application. Doctrine provides the general rules that guide actions on the battlefield. It includes tactics, techniques and procedures (TTP) which steer the operations of individual soldiers and units. Doctrine has evolved quite dramatically over the last twenty-five years. In the early 1970s the U.S. had a relatively prescriptive Cold War strategy related to a single, focused threat. The Arab-Israeli War of 1973 highlighted an impressive Soviet operational doctrine and the realities of the Warsaw Pact. To counter these, TRADOC developed the Active Defense in the 1976 edition of FM 100-5. [Ref. 24] It reflected a U.S. force outnumbered and a force on the way to being technically inferior qualitatively on an armor-dominated European battlefield.

Over time, TRADOC reevaluated this doctrine with respect to the offensive firepower that technological weapon systems such as missiles, attack helicopters, and fighter jets brought to the battlefield. The 1982 and 1986 editions of FM 100-5 introduced and solidified the concept of AirLand Battle. This doctrine still reflected U.S. forces being outnumbered on the battlefield but no longer technically inferior because of procurement of these new systems. AirLand Battle was characterized by the synchronization of airpower and ground forces throughout a framework that delineated the close, deep, and rear battlefield that suited Central Europe. It emphasized a balance of the offense and defense, and controlled tempo of operations based on the echeloned attack of Soviet or Soviet-style forces. "AirLand Battle used a relatively prescriptive, fixed framework to focus combat power and it worked." [Ref. 29: p. 3-17] It was the foundation of the Army's successful 100-hour ground war in Operation Desert Storm in 1991.

As the troops returned home from Desert Storm, the nation entered into a radically different era. Unlike the relatively predictable environment of the Cold War, the U.S. faced the great uncertainty of a world marked by rapidly accelerating changes. Historically, there have been five categories that indicate that it is time to adjust to a changing environment: threats and unknown dangers, national military strategy, history and lessons learned, the changing nature of warfare and technology (See Figure 3-2).

Usually, only a few of these indicators are present. However, in the early 1990s all five indicators existed, suggesting that the world was entering a revolutionary era. General Fredrick M. Franks, the Commander of TRADOC at the time, described this phenomenon in an article he wrote in 1993.

> At times there may have been only one indicator, dimly lit. At other times, maybe two or three were glowing with some intensity. But today, and for the last few years, all of them have been burning brightly to announce that not only are we in a period requiring some significant change, but perhaps that we, too, are entering an entirely new era -- a period requiring some bold adjustments in how we think about warfare, warfighting and the conduct of operations other than war. [Ref. 15]

Threats & Unknown
Dangers

National Military
Strategy

History &
Lessons Learned

Changing Nature
of Warfare

Technology

How

We

Fight

Source: [Ref. 15: p.5]
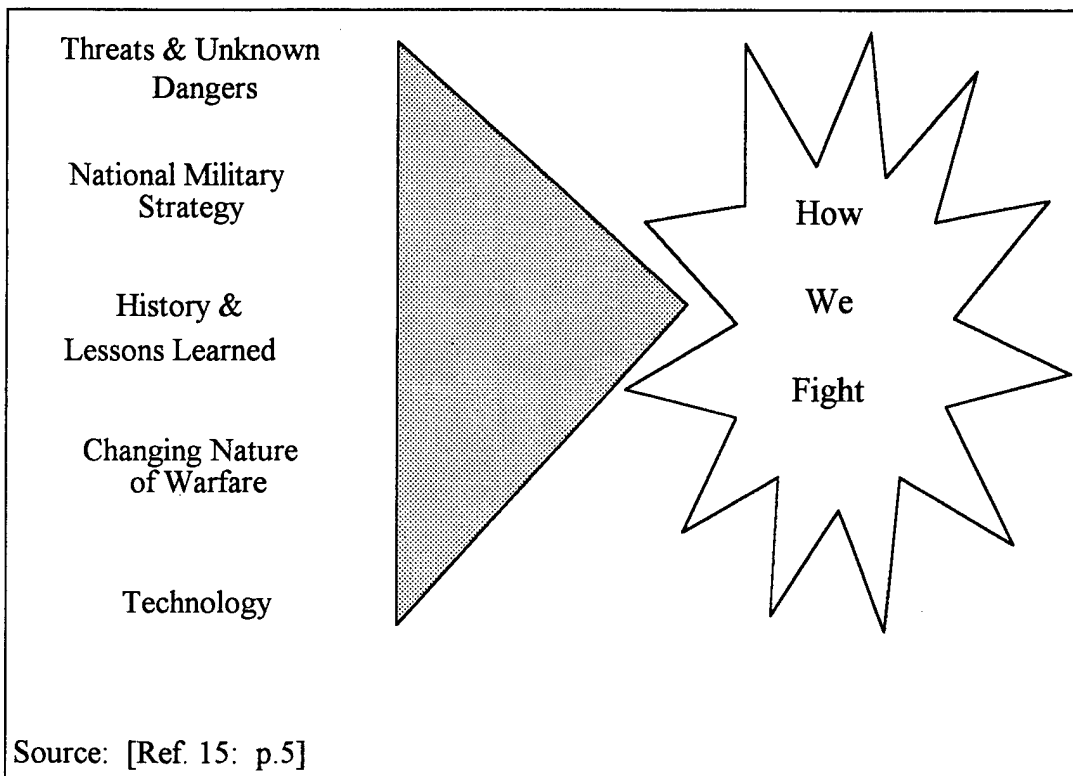
Figure 3-2. Indicators of Change

During the early 1990s the nation was facing a multitude of new threats and unknown dangers in an environment of proliferating warfighting technologies such as weapons of mass destruction. The public and national values demanded a change in national strategy which emphasized force projection and quick, decisive victories with minimal casualties. The availability of CIs and technological systems fueled the rapidly changing nature of warfare. Systems that were proven in Desert Storm, such as Global Positioning Systems (GPS) and satellite information, gave commanders on the battlefield unprecedented capabilities. All of these factors indicated that national military strategy needed dramatic changes.

As the strategy evolved from the prescriptive nature of the Cold War era, so did doctrine. In 1993, TRADOC published the current edition of FM 100-5 that contained significant changes. Reflecting the multipolar world, recent combat, and technological advances, doctrine was developed for a force-projection Army. Army operations expanded into wider joint and combined integration and also included Operations Other

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Than War (OOTW). This *capabilities-and-principles* based doctrine described how to think about operations with a *variety* of possible battlespace frameworks, to include simultaneous rather than sequential deep and close operations. (The concept of battlespace will be explained in the next section) It also reflected the blurring of levels of war, the beginnings of information operations, and the mix of war and OOTW in the same theater. [Ref. 11] This introduced full-dimensional operations and served as the basis for many of concepts of Force XXI operations that are described in the next section of this chapter.

D.   CHARACTERISTICS OF FORCE XXI OPERATIONS

The next evolution of doctrine will expand the 1993 evolution of full-dimensional operations into Force XXI operations. Reflecting advances in weapons and information technology, full-dimensional operations achieve force coherence through shared knowledge. With a shared common and timely perception of the battlefield, commanders can use a relatively unconstrained framework to organize and control the tempo of operations. These operations have the following general characteristics: multi-dimensional, precise, non-linear, distributed, simultaneous, and integrated.

1.   Multi-Dimensional

This characteristic is an expansion of the concept of battlespace which was first introduced in the recent edition of FM 100-5.

> Battlespace is a physical volume that expands or contracts in relation to the ability to acquire and engage the enemy. It includes the breadth, depth, and height in which the commander positions and moves assets over time. [Ref. 11: p. 6-12]

Historically the process that commanders used to plan operations was very constrictive. They were given a set area of operations (i.e., piece of ground) within which to plan and conduct operations. The notion of battlespace allows the commanders to expand their thinking to develop a vision for dominating the enemy and protecting the

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force before any mental constraints are emplaced, such as overlays depicting phase lines, boundaries, and arrows. It is an attempt to encourage commanders to "think out of the box" and brainstorm actions given the factors of Mission, Enemy, Troops, Terrain, and Time Available (METT-T). Instead of concentrating on just one piece of land, commanders must consider all factors that have an impact on operations.

Force XXI extends this notion of battlespace. Operations go beyond the traditional physical dimensions of breadth, depth, and height. Battlespace includes the electro-magnetic spectrum which affects the digital connectivity of high tech weapon systems and lines of communication. The battlespace is also expanded by the human dimension. Commanders must not only consider soldiers and leaders, but also the civilian population in which operations are being conducted, citizens and families in the U.S., and the peoples of the world. Finally, time is a dimension of the battlespace that must be mastered in order for commanders to synchronize all of the assets that can be brought to bear against the enemy. This does not mean simply acting faster than the enemy, but controlling the tempo of the battle to a speed which is best for execution of the plan. [Ref. 32: p. 16]

With the influx of software intensive weapon systems, the U.S. should be able to dominate this expanded battlespace. TRADOC Pamphlet 525-5 states that this expanded battlespace "...will give future joint commanders a coherent vision of fully integrated, full-dimensional [area of operations] and permit simultaneous engagement of targets by a greater variety of joint warfighting systems." [Ref. 29: p. 3-8] It is interesting to note the emphasis placed on the variety of weapon systems. It suggests that the U.S. should investigate the possibility of procuring systems that can take full advantage of the multi-dimensional characteristic of Force XXI operations.

2. Precise

Force XXI operations are characterized by the synchronization of multiple attacks across the entire battlespace. One of the factors that facilitates these actions is precision. Precision in decisive operations is enabled by three emerging capabilities. First,

digitization provides soldiers and leaders at each echelon the information required to make sound decisions. Second, a full entourage of sensors throughout the battlespace are linked to analysts that are able to translate the data into useable form. This will provide clarity to the battlefield and decrease the impact of "the fog of war." Third, simulations enable the Army to plan, rehearse, and repetitively train different scenarios yielding precision in the actual execution of operations.

Precision goes beyond precision strikes. It includes precision in the sustainment of forces. Total asset visibility, reduced variability in combat support demand, and the accuracy of GPS will enable logisticians to deliver the right support at the right place and time. Similarly, precision in force projection allows tailored forces to quickly move to centers of gravity from which they can dominate the battlefield. Precision in combat operations includes having the correct mix of offensive and defensive weapon systems in order to shape and control the tempo of battle while concurrently maximizing the protection of the force. All of these factors are empowered by increased situational awareness that is provided by new high tech weapon systems. [Ref. 32: p. 17]

3. Non-Linear

Force XXI operations are characterized by non-linearity, executing tasks across the entire battlespace rather than massing combat power at the Forward Line of Troops (FLOT). The Cold War paradigm prescribed a linear, contiguous battlefield that rigidly established the deep, close, and rear battle. In contrast, Force XXI operations utilize a battlespace that is fluid, changing as METT-T changes through the duration of mission preparation and execution. Units do not necessarily have to be arranged side-by-side in a linear fashion. Instead, they can be maneuvered into situations that can best take advantage of their capabilities (See Figure 3-3: Comparison of Linear and Non-Linear Battlefields). Non-linearity requires soldiers and leaders to possess greater situational

FLOT

DEEP

CLOSE

REAR

XXX

Contiguous and Linear

Non-contiguous and Non-Linear

Source: Author
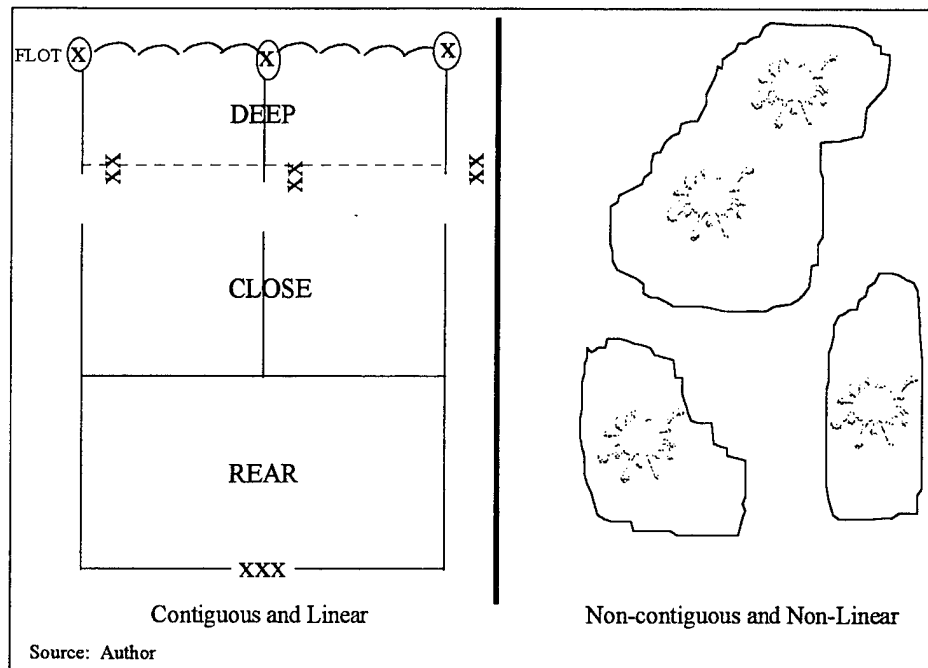
Figure 3-3. Comparison of Linear and Non-Linear Battlefields

awareness, because units may not be arrayed side-by-side as they are in the more traditional contiguous operations.

4.   Distributed Operations

Distributed Operations are closely related to the characteristic of a non-linear battlefield. It means that "operations are executed where and when required to achieve decisive effects vice concentrated at a possible decisive point." [Ref. 32: p. 18] Distributed Operations empower subordinate leaders to take the initiative and apply innovative ideas that are within the commander's intent of the operation. The result is a synergistic effect that has the potential to be much more efficient than if the operation was centrally synchronized by headquarters. There is a risk to Distributed Operations: chaos. Leaders must understand that certain functions are best executed centrally such as management of resources. There must be a continual effort to find the optimal mix of centralized and decentralized operations through testing, experiments, and simulations.

5. Simultaneous

The concept of decentralized operations that is multi-dimensional, precise, distributed, and non-linear yields the capability to conduct simultaneous operations across the battlespace. Simultaneous operations seize the initiative and present the enemy leadership with multiple crisis, but no effective response. Digitization creates the ability to plan, coordinate, and execute actions simultaneously. "Each of these actions creates an effect, the sum of which is greater than if they were discrete and sequential. Rather than a single concentrated attack, execute a series of attacks (lethal and non-lethal) as near-simultaneously as possible." [Ref. 32: p. 18]

Simply stated, simultaneous attack enables the commander to directly influence the enemy throughout the width, height, and depth of his battlespace to stun, then rapidly defeat an enemy. Indications of these possibilities were seen in both Just Cause and Desert Storm. By massing the effects of long and short-range area and precision fires, integrated with rapid combined arms maneuver, on the ground and from the air, a larger and less agile enemy force can be quickly and decisively defeated. Although these attacks may not be simultaneous in application from the enemy's perspective, they will appear seamless and nearly simultaneous in effect.

6. Integrated

The Army does not fight alone. Force XXI fully integrates operations with other Services, other national agencies, and often allied and coalition forces. Recent operations such as in Bosnia suggest that war and OOTW will continue to be a coordinated effort with NATO or other countries. Force XXI takes advantage of the increased variety of forces and maximizes their potential through shared information.

E. PATTERNS OF OPERATIONS

In addition to outlining the characteristics of Force XXI operations, the Army recognizes that operations will be executed through a series of deliberate patterns. These patterns incorporate all elements of operations, from initial receipt of mission through return to home station. The patterns are not phases nor are they sequential. The patterns serve to focus the many tasks armies have always performed in war and other military operations. The patterns of Force XXI operations are: project the force, protect the force, gain information dominance, shape the battlespace, decisive operations, and sustain the force. These patterns provide a basis for the organization of warfighting experiments and the discussion of concepts. Further, these patterns assist in assigning responsibilities or dividing FOCs to the particular branch schools and battle labs. For example, the Armor and Infantry branches concentrate on decisive operations, while the Intelligence branch concentrates on gaining information dominance. Since the purpose of defining these patterns is to focus the Army on the many tasks they have to accomplish, it is logical that these patterns also focus discussions on determining requirements. Therefore, the next section of this chapter provides a brief overview of these patterns.

1. Project the Force

Force XXI operations are based on the ability to project power. No longer does the Army have huge contingencies of soldiers forward deployed at strategic 'hot spots" around the world. Instead, most of the force is based in the U.S. and must deploy to the theater of operations. Projecting force is much more than deployment, however. First, with a streamlined organization of fewer soldiers, the Army no longer has the luxury to commit an overwhelming amount of units to a single conflict without risking security concerns in other areas. Instead, they must carefully plan which and how many units are needed for a particular conflict. Emphasizing modularity of organizations and units facilitates a rapid tailoring of forces according to METT-T. Concurrent to tailoring the force, is mission planning and rehearsal. "Automated systems and simulations provide the

capability to plan, coordinate and wargame, leading to team building and training that result in effective execution immediately upon arrival in theater." [Ref. 32: p. 20] This means the Army must be prepared to "hit the ground running" whether using early entry forces marrying up with prepostioned equipment, or forced entry with special combat units. The implication of this is that C^3I structure must be in place or usable on the move.

Project the force goes farther than just the initial entry. In order to conduct distributed operations on a non-linear battlefield, the Army must have the capability of quickly moving forces throughout the battlespace at any point in time during the operation. The battle will be more fluid with fewer stops to regroup than in the past. The tempo of Force XXI operations will be more similar to the actions of a soccer match, rather than the Cold War paradigm of a football game. Mobility and flexible are important aspects of force projection.

2. Protect the Force

Force XXI takes a holistic approach to protecting the force. Soldiers, equipment, and intelligence must be protected throughout all stages of operations. The common elements of force protection are: avoid detection, prevent acquisition, avert hit, survive, and preventive attack.

To avoid detection, forces need common situational awareness. This enables early and accurate Intelligence Preparation of the Battlefield (IPB) which optimizes the emplacement of security forces by estimating where enemy forces will appear. Situational awareness also facilitates greater dispersion, increasing enemy targeting difficulties. The traditional means of stealth, such as smoke and camouflage, will be combined with stealth equipment to help units avoid detection. If detected, the unit must prevent acquisition. Mobility, flexibility, and counter-radar devices all assist in preventing acquisition. If acquired, the unit must avert the hit through counter-missile systems or common skills such as Nuclear, Biological, and Chemical (NBC) decontamination. If hit, the unit must survive through combat lifesaving skills and telemedicine. [Ref. 32: p. 21]

3.   Gain Information Dominance

Gaining information dominance is an important aspect of Force XXI operations. It is defined as "...creating a disparity between what we know about our battlespace and operations within it and what the enemy knows." [Ref. 32: p.22] Better intelligence, shared among all elements and moved or retrieved rapidly on demand, will allow commanders to control and vary the tempo based on superior knowledge of friendly situation/location, enemy situation/location, and events shaping the overall battlespace. Information dominance is imperative in taking the initiative to shape the battlespace and dominate the enemy through decisive operations.

The importance of gaining information dominance cannot be understated. The Army recently devoted an entire Field Manual (FM 100-6) to the subject of Information Operations (IO). It emphasized that these operations require continuous efforts to obtain information on the enemy while denying them friendly information. There will be times when information parity exists and it is important to continue to fight for dominance. IO is more than just information warfare, however. It includes establishing and maintaining the means of using information (communications, nets, digitized networks). There is technology that exists today that can be useful in obtaining this goal. TRADOC pamphlet 525-5 emphasized this fact by stating:

> The manner of conducting joint land operations does not rely for its existence solely upon future technologies. Force XXI operations are possible with existing technologies; we are simply not yet sufficiently tactically adaptable nor have we changed some battle processes to take full advantage of such versatility....Our weapons can strike anywhere in our battlespace, but we cannot fully control them or sense their effects. Intelligence systems can provide detailed images, yet the full synchronization of all this capability is not realized. Evolving information technologies will almost undoubtedly unlock the full potential of Force XXI operations....This ongoing doctrinal development will place the Army in the lead of the revolution in military affairs. [Ref. 29: p. 3-20]

4. Shape the Battlespace

"The purpose of shaping the battlespace is to set the conditions for friendly success in decisive operations." [Ref. 32: p. 23] It involves proactively forcing the enemy to take action and posturing friendly forces to take advantage of this situation. The objective is to defeat the enemy's capability to fight coherently before committing friendly forces in decisive operations.

The key to successfully shaping the battlespace is, once again, intelligence. A precise IPB can identify enemy formations, equipment, and courses of actions. With this as a basis, commanders can use both lethal and nonlethal fires to eliminate enemy capabilities, and use sensors to assess the effects. Dynamic obstacles and countermobility assets can force the enemy into kill sacks, electronic warfare can disrupt their command and control, and concurrently, friendly forces can maneuver into advantageous positions. Simultaneously, economy of force operations including civil and public affairs, counter-intelligence, and military police allow decisive operations to mass effects against the enemy's main effort.

As with information operations, shaping the battlespace is a continuous effort: commanders must plan, execute, assess, and plan again. It takes a coordinated effort between sensors, shooters, and maneuver elements. It cannot be assumed that friendly forces will always be able to shape the battlefield. Commanders must rely on real time intelligence in order to fully take advantage of all opportunities. When the battlespace is successfully shaped, friendly forces can dominate the enemy through decisive operations.

5. Decisive Operations

Decisive operations defeat the enemy's will to fight. In combat operations that means winning a battle, engagement, or campaign. In OOTW this means accomplishing military or national objectives. Within the patterns of operations, decisive operations are the means of achieving success.

Decisive Operations require the synchronization of all combat power and combat multipliers throughout the battlespace, attacking the enemy in all dimensions nearly simultaneously. Concurrently striking the enemy at multiple critical points in a specific sequence, appearing to the enemy as a simultaneous action, will destroy his critical forces and functions. This will lead to a quick, decisive defeat of his force as a whole.

Force XXI operations may utilize much of the same equipment as today: tanks, howitzers, helicopters and rifles. What will be significantly different will be the planning, coordination, and employment of these systems. Overmatching situational awareness, a product of digitization, will yield more precise, effective and efficient maneuver and fires. This will enable Army elements to mass effects without the risk of massing forces. Information dominance will enhance the ability to shape the battlefield so that the Army can fight when and where it wants to fight. The end result of decisive operations is to force the enemy to give up its will to fight. [Ref. 32: p. 24]

6. Sustain the Force

Sustainment is prevalent in all patterns of operations. It is the responsibility of all personnel and not just the logistician. The varied demands of war and OOTW require the development of a logistics system that is versatile, deployable, and expansible. Modular units in both active and reserve components will allow rapid force logistics tailoring. This future logistics system must be able to support both joint and multinational forces. The system must also be able to keep pace with the maneuver units

The key to successful sustainment in Force XXI operations is situational awareness. Total asset visibility, digitally tracking the location of supplies, maintenance items, and equipment from logistic bases to the user, will streamline the sustainment process and reduce the overhead of inventory control. Weapon systems with self-diagnostic capabilities that are tied directly into the sustainment system might potentially reduce the variability of demand and reduce required inventory levels. Commonality of parts between all Services of DoD will further facilitate the streamlining of sustainment. All of these actions will enable leaders to make informed decisions, allowing Army

elements to execute proactive versus reactive logistics. Integrating materiel capabilities with operational and organizational innovations into an overall sustainment concept is essential in order to maintain the fluid battlefield and the increased, yet controlled, tempo of Force XXI operations. [Ref. 32: p. 25]

F.   IMPLICATIONS OF FORCE XXI OPERATIONS

This chapter has broadly described the concepts of Force XXI operations. To identify the implications of these concepts, one must first analyze the validity of the Army's assumptions about the global trends and future threats. The Army contends that global trends of instability indicate that the U.S. will face challenges of unprecedented complexity, diversity, and scope as we move into the 21st Century. Further, it contends that the days of the all-purpose doctrinal threat template (i.e., Soviet Model) are gone. The U.S. faces a wide array of new threats and unknown dangers in an environment of worldwide proliferation of warfighting technologies, to include weapons of mass destruction.

The author researched numerous publications, informally interviewed many faculty members of the National Security Affairs and System Management Departments at the Naval Postgraduate School, and attended lectures by high ranking Government officials. Although specific thoughts about the future varied slightly from source to source, the general themes throughout all of the sources overwhelmingly validates the Army's assumptions.

This does not mean that the future threat spectrum, outlined previously, is completely accurate nor will it remain constant in the future. The U.S. must continually access the validity of the model and make improvements. However, in general, it is accurate enough to serve as a threat model for developing operational concepts for the future. In fact the Army is using this model not only for Force XXI operations, but also for its Joint Vision which looks out to the year 2010 and for the Army After Next which looks out to the year 2025 and beyond. [Ref. 20] Therefore, the researcher makes the

general observation that **the future forces of the U.S. face a great variety of threats in a global environment with unprecedented complexities.**

Given the validity of these assumptions, we can further discuss the implications of Force XXI operations. First, the doctrinal concepts state that the Army will be required to conduct a variety of missions (i.e., The Army must be versatile). The President of the United States, Bill Clinton, confirmed this belief in a commencement speech to West Point cadets in 1993: "You will be called upon in many ways in the new era to keep the peace, to relieve suffering, to help teach officers from new democracies in the ways of a democratic army, and still...to win our wars" [Ref. 7] Recent history has also confirmed this belief. Over the past decade, deployments ranged from conventional wars, like the Gulf War, to OOTW like hurricane and flood relief. Once again, President Clinton noted this increased variety in an article in the <u>Armed Forces Journal</u>:

> ...Our defense readiness is historically high and our forces' capabilities proven--whether they are restoring democracy to Haiti, deterring aggression in the Persian Gulf, saving lives in Rwanda or bringing stability to Bosnia. Some have doubted that our troops can simultaneously maintain their warfighting superiority and conduct peacekeeping and humanitarian missions. I say, just ask Saddam Hussein and the Haitian people. [Ref. 6]

Given this recent history of deployments and the global trends of instability, it is likely that the Army will continue to be called upon to conduct a variety of missions.

The characteristics and patterns of Force XXI operations place great emphasis on knowledge-based operations, mobility, and the ability to tailor forces. This has several implications on the organizational structure of the Army and the capabilities of materiel. In order to have the capability of rapidly tailoring organizations for operations, the Army is seriously considering a modular design of both combat and combat support units. The current organizational structure is based on brigade or battalion sized task forces that are deployed in a full-up, uniform fashion. A modular design will allow commanders to construct forces by picking and choosing different platoons to form a composite task force. While this disaggregation of units facilitates creating a force who's size is commensurate with its mission, the Army must fully understand all implications before blindly going to this ad hoc, modular design. For instance, what effects will a modular

design have on training or the cohesiveness and esprit de corps of units? Nonetheless, such an approach potentially contributes to the application of Requisite Variety.

In addition to being modular, the new doctrinal paradigm of knowledge-based operations emphasizes organizing around information processing and dissemination. [Ref. 29: p. 4-5] The emerging doctrine stresses the importance of increasing the speed and accuracy of the friendly decision cycle through enhanced command, control and intelligence. At the same time, the doctrine emphasizes the requirement to disrupt the enemy's decision cycle through attacks on his command, control and intelligence. The combination of attacking an adversary's use of information while enhancing and protecting friendly information should provide a decisive advantage.

TRADOC Pamphlet 525-5 provides a good summary of the implications of this new emerging doctrine:

> All Army forces must be rapidly deployable, highly survivable, lethal, agile, mobile, modular in design, and equipped to respond to the full range of military operations. Forces must be designed to enable rapid but flexible transition from War to OOTW or vice versa. The commander must be given the assets to include flexible, versatile organizations to dominate battle space. Commanders must have the capability to rapidly assemble, deploy, and employ a force with the required mix of capabilities. They must be provided the assets to dominate battle space. [Ref. 29: p. 4-6]

In addition to emphasizing *capabilities*, the Army states that Force XXI operations are based on *principles*. One can argue that Force XXI operations are still tied directly to the nine principles of war which provide an enduring bedrock for Army doctrine. The U.S. Army published its first discussion of the principles of war in a 1921 Army training regulation. These principles, although slightly revised, have withstood the test of time. The nine principles of war, as defined by the Army are: [Ref. 11: pp. 2-4 to 2-6]

- Objective. Direct every military operation toward a clearly defined, decisive, and attainable objective.

- Offensive. Seize, retain, and exploit the initiative.

- Mass. Mass the effects of overwhelming combat power at the decisive place and time.

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• Economy of Force. Employ all combat power available in the most effective way possible; allocate minimum essential combat power to secondary efforts.

• Maneuver. Place the enemy in a position of disadvantage through the flexible application of combat power.

• Unity of Command. For every objective, seek unity of command and unity of effort.

• Security. Never permit the enemy to acquire unexpected advantage.

• Surprise. Strike the enemy at a time or place or in a manner for which he is unprepared.

• Simplicity. Prepare clear, uncomplicated plans and concise orders to ensure thorough understanding.

Force XXI operations clearly maintain the integrity of all but one of these nine principles, mass. At first glance Distributed Operations seems to be the opposite of mass. However, mass should not be interpreted as a concentration of forces. 'Synchronizing all the elements of combat power where they will have decisive effect on an enemy force in a short period of time is to achieve mass." [Ref. 11: p. 2-4] Decisive effect is the key. Distribution provides agility which allows commanders to execute operations when and where required to achieve decisive effects. When combined with the characteristic of Simultaneity, Distributed Operations can achieve mass.

Many authors have attempted to go beyond the principles of war and identify features that have made the operational aspects of warfare through the ages basically the same in war after war. In his book The Evolution of Weapons and Warfare, Colonel Trevor N. Dupuy described the following thirteen fundamental operational features which he called the "timeless verities of combat." [Ref. 14: pp. 326-333]

1. Offensive action is essential to positive combat results.
2. Defensive strength is greater than offensive strength.
3. Defensive posture is necessary when successful offense is impossible.
4. Flank or rear attack is more likely to succeed than frontal attack.
5. Initiative permits application of preponderant combat power.
6. Defenders' chances of success are directly proportional to fortification strength.

7. An attacker willing to pay the price can always penetrate the strongest defenses.

8. Successful defense requires depth and reserves.

9. Superior strength always wins.

10. Surprise substantially enhances combat power.

11. Firepower kills, disrupts, suppresses, and causes dispersion.

12. Combat activities are slower, less productive, and less efficient than anticipated.

13. Combat is too complex to be described in a single, simple aphorism.

An analysis of the Army's conceptual doctrine suggests that Force XXI operations, although from a different paradigm, seem to incorporate or give consideration to all of these "timeless verities of combat." Force XXI operations emphasize the offense, seizing the initiative, and decisive operations using depth and simultaneous attacks throughout the battlespace. They not only focus on flank and rear attacks, but operations from many different dimensions.

Given these comparisons, the researcher concludes that Force XXI operations are arguably based both on *capabilities and principles*. This seems to suggest that most personnel involved with the Army's requirements determination process (materiel and doctrine) understand the process. However, the reality of the situation is exactly the opposite. In a study conducted in November of 1995, the General Accounting Office (GAO) found that the Army's Digital Battlefield Plan lacked specific measurable goals and contained numerous risks.

> The Army's plan to digitize the battlefield is expensive, contains many risks, and lacks specific, measurable goals for the series of large-scale experiment that are to be conducted. [Without specific, measurable goals] the Army is unnecessarily risking additional investments amounting to $397 million for digital systems needed to conduct increasingly larger scale experiments to fiscal year 1999. Based on Army estimates, the investment required to digitize a 10 division Army could be as high as $4 billion. [Ref. 16]

The GAO is not the only organization that is incredulous of this requirements process. In numerous informal interviews conducted from 1994 to present, the researcher

has found that service members of the US Army are also skeptical. Many feel that S&T is driving doctrine and that the Army is getting away from the basic *principles of war*. Others are encouraged, but feel that the Army is planning too far ahead. They believe that TRADOC is playing "Star Wars" at the expense of current conditions where battles are still "fought in the mud."

These findings suggest that the Army has not clearly justified its process for requirements determination to either Congress or its service members. To properly examine and integrate new digital warfighting concepts with S&T, the Army must have a framework and a vocabulary for intellectually examining and communicating future battlefield requirements.

G.   SUMMARY

This chapter discussed the Army's Force XXI operational concepts. The Army validly makes the assumption that the future forces of the U.S. face a great variety of threats in a global environment with unprecedented complexities. In order to deal with this complex environment, the Army has outlined warfighting concepts that emphasize knowledge-based operations: a shared common and timely perception of the battlefield. These knowledge-based operations are characterized by multiple dimensions, simultaneous attacks of precision fires that are distributed throughout the battlespace, and integration with other Services and nations.

These concepts contribute to the foundation of requirements determination. They must be clearly understood by all personnel involved in the process. The Army is looking towards future capabilities, yet claims Force XXI operations are firmly grounded to the principles of war. While this claim is arguably true, the researcher has found that many personnel do not understand these concepts and how they fit into future force requirements. The researcher postulates that the Army needs a framework to properly examine and integrate these future warfighting concepts with advanced technical capabilities and determine future battlefield requirements. The question is what kind of framework and how will it be applied?

The answer to this question lies in the pathologies that have been identified in this study. Chapter II identified that the current requirements determination process does not directly address the need for variety in our forces. Force XXI operations have a similar pathology. While they indicate there is an increasing amount of variety in the future threat spectrum, they do not indicate how much variety is needed in friendly forces, or if there is even a need for variety. The researcher posits that a framework can be developed using Requisite Variety as a base. The framework will innovate the requirements determination process and provide an intellectual foundation for discussing Force XXI operations. The next two chapters of this study present a conceptual framework to achieve this objective.

IV. THE THEORY OF REQUISITE VARIETY

A. INTRODUCTION

The remainder of this study presents a new paradigm, based on existing building blocks, but essentially a new system with new internal dynamics. It develops a conceptual framework based on the theory of Requisite Variety with which to innovate the requirements determination process and articulate future operational needs to all organizations. The initial efforts of this section define the theory of Requisite Variety and present a theoretical background. With this as a basis, chapter five forms a framework with which to analyze requirements with respect to requisite variety. Chapters six and seven examine the utility of the framework through an analysis of a TRADOC warfighting experiment and summarize the research findings. The researcher expects to find that Requisite Variety has a direct application to the military, and in fact, serves as a basis for many of the Force XXI operational concepts.

B. THE LAW OF REQUISITE VARIETY

The Law of Requisite Variety was discovered in the early 1950's by the British cybertician, Ross Ashby. Ashby studied techniques to control complex systems. He realized that the more complex a system, the more difficult it is to understand and control. Stafford Beer explained this concept in his book, <u>DECISION AND CONTROL: The meaning of Operational Research and Management Cybernetics.</u>

> The more complex a system, the more difficult it is to define its structure (its interrelationships) and consequently, the more difficult to predict its behavior. As the components of a system increase in number, the interrelationships typically increase, and the system is said to possess more variety than it did initially. [Ref. 4: p. 85]

Consider a relatively simple model in which a commander is responsible for controlling a system. There are two sides, friendly and enemy, each with conflicting objectives. The system is a campaign or battle where "controlling the system" means

defeating the enemy (see Figure 4-1). The commander may have the authority over the

Source Ref. 4: p.276
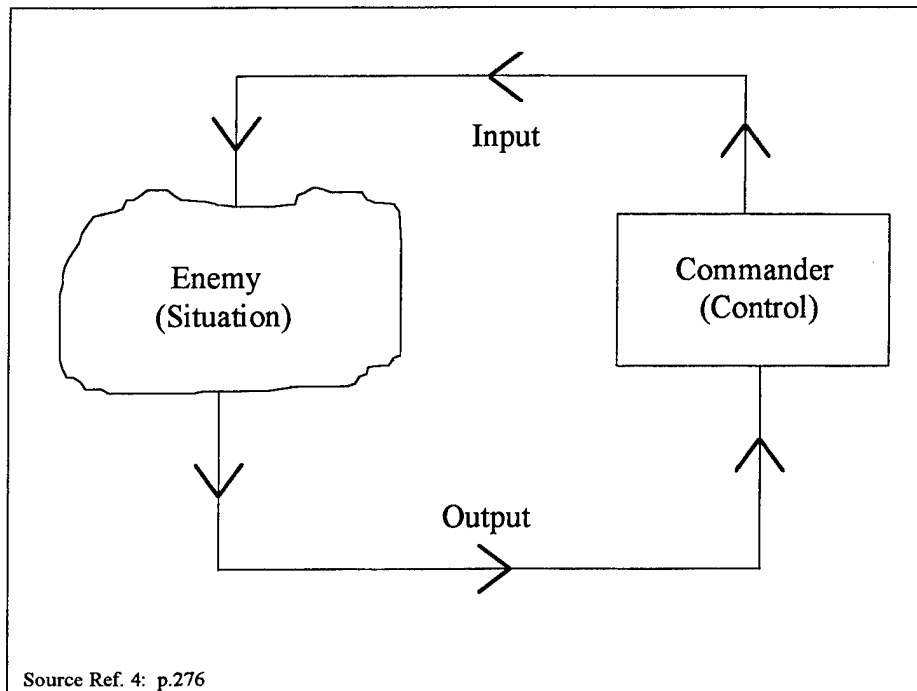
Figure 4-1. System Control

internal relationships found in the system, but outside factors influence the situation in a way the commander cannot control or sometimes even foresee. For instance, each side has a definite number of courses of action (COAs) from which to choose to fight the battle. The friendly commander has the authority and responsibility to choose from his COAs in order to "control the system" (defeat the enemy). He has the authority to control the timing of his forces' actions, the mix of soldiers and equipment, and the preparation of his forces before the battle. However, the commander does not have the authority to control the actions of higher headquarter forces, the type of terrain and weather, or other influences from the outside environment. For example, during OOTW and operations against Internal Security Forces there might be large numbers of civilians in the area which influence the system. The enemy itself influences the outside environment, initiating a chain reaction which the commander cannot control. The box containing the enemy is irregularly drawn to represent that the boundaries of real-life problems are not rectilinear, but sometimes indescribable.

In order to simplify the system we will assume that all the influences on the enemy will be channeled through a single input and all the effects it exerts will be channeled into a single output. The actions/information from the enemy passes to the commander who, in turn, passes instructions into the situation in order to control the system. A closed loop is thereby artificially created. As the situation grows in complexity the variety in the system proliferates. Given that sufficient information about this proliferation of variety can flow along the output channel, and that it reaches the commander, how is the commander going to maintain control?

The answer to this question is found in an important principle Ashby has called the Law of Requisite Variety. Ashby discovered that the amount of variety in the control mechanism has to be at least the same as in the system being controlled. In order to win the battle, the different types of COAs available to the friendly commander must be greater than or equal to that of his enemy. If there is enough variety to provide for a one-to-one transfer from the control mechanism to the system, then there is "requisite" variety. As Ashby states, "Only variety can destroy variety." [Ref. 2: p. 208]

At first glance Ashby's theory might seem entirely too obvious and simplistic to some commanders. They might state, "Of course if you give me more tanks or more soldiers I will defeat the enemy; I will overpower them!" However, the Law of Requisite Variety should not be confused with the size or number of COAs. Obviously, a greater amount of tanks and/or soldiers will generate more options for the commander because of the number of permutations that are generated. The researcher realizes that from the commander's perspective, this may represent more variety. But Ashby was concerned about qualitative variety not quantitative variety. For example, chapter three discussed one of the characteristics of Force XXI operations, that it is multi-dimensional. For purposes of review, multi-dimensional is a concept which expanded the notion of battlespace. Force XXI battlespace will include not only breadth, depth, and height, but also the dimensions of humans, time, and the electro-magnetic spectrum. If the commander has weapon systems that can fully exploit all of these dimensions, then he can dominate the battlefield. In Ashby's terms, the commander has the requisite variety to control the system. In fact, if the commander has requisite variety in weapon systems, he

could still dominate the battlefield even if his aggregate number of systems is less than the enemy's. Still, the skeptical commander may view Ashby's theory as too obvious and state that this fact has been known for quite some time. If this is true, then why does the Army fail to directly assess variety in its requirements determination process, and why do so many leaders fail to understand the basics of Force XXI operations? To answer these questions it is useful to understand the methods that commanders have used to "control situations" (defeat the enemy) in the past.

Generally, there are two schools of thought that have been captured in doctrine and taught to leaders at various TRADOC institutions. The first declares that a study of the enemy will reveal patterns and trends in his actions. These patterns will enable experienced commanders to feed instructions back to the situation through its input loop and modify its behavior. During the Cold War era the Army spent many years studying and analyzing Soviet doctrine and tactics. Intelligence Officers used enemy event templates to try to predict what actions the enemy might take. Acquisition of weapon systems, and the commander's choice of a COA depended on this intelligence.

The second school of thought, corresponding roughly to the position of operational research (OR), is more realistically aware of the magnitude of the problem. It says that there is too much information to control, and that the thing to do is to create an analytic model of what is going on. Therefore, the commander had his battle staff conduct force ratio analysis and use decision support templates to assist him in choosing a COA.

The two schools are identical in principle, but the OR approach insists that the processes utilized by the first approach can be far more efficient if modern scientific techniques are used. In practice, both schools of thought were utilized. Due to the fact that the U.S. had a single enemy for over fifty years, a great amount of information was available to the commanders. Soviet style doctrine revealed discernible patterns and trends. A commander could use this knowledge to control the battlefield. Further, he used his battle staff to help him quantify decisions and to choose between alternative COAs. Both of these schools of thought were successful, and although the concept of variety might have been known, it was not directly needed for success. However, the Cold War is over and, as we have shown in the previous chapter, the future forces of the

U.S. face a great variety of threats in a global environment with unprecedented complexities. This new environment injects a large amount of uncertainty and variety into the battle or campaign. The environmental disturbance can be quite arbitrary and unpatterned. From the standpoint of the commander trying to control the system, it might seem inexplicable. So as the complexity of the environment increases, as we have seen over the last decade, neither of these two strategies has any real hope of providing adequate control. A new paradigm, using the Law of Requisite Variety is needed to help control the system.

These standpoints may be examined in light of an analogy from the game of basketball. The basketball court can also be represented as an artificially isolated system like the one depicted in Figure 4-1. Five players in red uniforms constitute the first sub-system -- the enemy (situation). The purpose of this sub-system is readily identifiable because the rules of basketball are known. The object is to move the ball to the opposite end of the court and put it into the basket. Since each of the five men is free to follow any kind of route up the court, and since the ball may be passed freely among them, the variety of this sub-system proliferates to an enormous extent. Now control, in this context, means to contain the sub-system. That is, prevent the five players in red uniforms from scoring a basket. The question remains, how should this be done?

The commander from the first school of thought is inclined to watch the five players in action for a while. He notices that they adopt a rather predictable pattern of plays which, in practice, reduces the available variety. He notices that two of the men tend to dominate the ball handling. These two players initiate the plays by driving to the basket and passing off to a big man underneath the basket. The big man turns and lays the ball into the basket. The conclusion is simple: position a player between the big man and the basket so that he can block the shot. So an attempt is made to control the situation in this way. Unhappily, the attacking team outwits this defense by passing to different players and scoring from different positions. In recognition of this, other defenders have to be added, and by a process of pattern-seeking and variety-trapping, an extensive group of defenders is eventually built up.

The commander with the second approach sees at once that a large number of games will be lost before the patterns are recognized. Further, he realizes that the trial and error process for determining control succeeds in defeating the opposing team only half the time. Clearly, he needs a modern, analytic and scientific approach. Inspection of the nature of the system, rather than experience of it in operation, reveals that each of the five players in the system is governed by a control mechanism called a brain. Accordingly, our commander hires a group of scientists to study each of the players personalities and skills. The scientists develop a model of how the opposing team will play based on inputs such as time of day, environmental conditions, length of the game, and the physical condition of the players. A software analyst then designs a software algorithm for the model, and installs it on the commander's laptop computer. As the game begins, the commander types the input data into the laptop. The computer analyses what is going on, constructs a model of the strategy being employed, and makes predictions about the point where the ball will be shot. The commander is then able to direct a player to this point in time to block the shot. In the context of the example, this is a caricature. In real life, however, many commanders have tried many foolish things.

Ashby would view these massive arrangements with amusement. Certainly they are scientific: they recognize the proliferation of variety of which the attacking system is capable and take measures to deal with it. But of course Ashby knows that the best way in which to control the system of five men in red uniforms, is to put five men in white uniforms on to the court. This solution, Ashby contends, will be at least as effective as the last one. Moreover, if the white team can be trained to proliferate its variety a little more quickly, or to be less predictable in their patterns, the control is likely to succeed most of the time. In terms of the example just considered, the theory of Requisite Variety simply says that if each red-uniformed player is marked by a white-uniformed player then, on the average, whatever the actual play undertaken by the red team, sufficient variety can proliferate in the white team to match it.

Once again, there should be a distinction between quantitative variety and qualitative variety. Consider once again our basketball analogy. In this scenario we will make the number of players the same for both teams. The white team consists of players

who are defensive specialists, but have limited offensive skills. The red team consists of multi-talented players who are skilled at playing both offense and defense. In this situation, the white team has limited its variety by relying on the defensive specialists. They have "put all their eggs in one basket." Once again, there is a high probability that the white team will lose the game. This scenario shows that it is the factor of variety, not end strength, that determines which team will most likely control the game. ADM Joseph Prueher, commander-in-chief, U.S. Pacific Command made a similar type of analogy in describing the importance of Joint Warfare:

> ...each service (Army, Navy, Air Force) brings a unique capability to the battlefield. It is similar to a football team. You can't have a team with all fast receivers with good hands. In addition you need strong, relatively slow lineman, defensive specialists, and a quarterback. This is the nature and strength of Joint Warfare. [Ref. 21]

Ashby's law can be illustrated in a simple matrix model of a game as shown in Table 4-1. In the first scenario, each side has an equal number of options from which to choose. The friendly commander's COAs are listed on the left (F1, F2, F3) and the enemy commander's COAs are listed on the top (E1, E2, E3). They both can see the table and the rules are as follows: The enemy must play first by selecting a COA, and thus, a particular column. The friendly commander, knowing this selection, then chooses a COA, and thus, a particular row. The outcome of the game is determined by the intersection of the selected row and column and is represented in the table by bold, italic letters. If the outcome is *a*, the friendly commander wins. If it is not *a*, the friendly commander loses.

	E1	*E2*	*E3*
F1	b	*a*	c
F2	*a*	c	b
F3	c	b	*a*

Table 4-1. Matrix Model One of Ashby's Law

In examining Table 4-1, it is evident that the friendly commander can dominate the enemy. Regardless of the enemy COA, the friendly commander can choose a COA which

the outcome becomes *a* (therefore he can always win). The friendly commander's dominate strategy options are:

If enemy selects E1, I shall select F2

If enemy selects E2, I shall select F1

If enemy selects E3, I shall select F3

Therefore, in this best case scenario where all moves are known, the friendly commander has "requisite" variety to control the game no matter what COA the enemy commander chooses.

Now consider a second, more complex scenario as depicted in Table 4-2. The rules of the game are the same as in the previous scenario: both commanders can see the COAs and outcomes, and the enemy commander must select first. However in this scenario the enemy commander has more COAs from which to choose and the outcomes are more complex.

	E1	E2	E3	E4	E5	E6	E7	E8
F1	f	k	m	b	g	c	*a*	h
F2	g	*a*	d	c	l	j	h	b
F3	l	h	c	*a*	j	b	c	d

Table 4-2. Matrix Model Two of Ashby's Law

This scenario clearly shows that the friendly commander cannot dominate or control the system. In order to control the system he must have the ability to choose a COA which will produce the outcome *a* for every enemy COA that is played. Since the enemy commander has COAs that do not produce the outcome *a*, the friendly commander cannot dominate the game. He cannot assure victory against the numerous COAs the enemy commander might choose. In fact, the friendly commander can only win if the enemy chooses COAs E2, E4, or E7. In this sense, the friendly commander does not possess the requisite variety needed to control the system.

Now let's consider our basketball analogy. This time we will allow the white team to field five players and we will limit the red team to three players. Clearly the white team has the requisite variety to control the game. This statement would be true if we were to consider only the quantity of players and not the quality. However, if the players on the red team are skilled in shooting both outside and inside shots, and the players on the white team can only defend against inside shots, then the outcome is different. This scenario is depicted in Table 4-3.

	E1 A	E1 B	E2 A	E2 B	E3 A	E3 B
F1	f	a	m	a	g	a
F2	g	a	d	a	l	a
F3	b	a	l	a	h	a
F4	c	a	d	a	c	a
F5	l	a	c	a	j	a

Table 4-3. Basketball Matrix Model

The players on the red team are listed on the top (E1 - E3). Each of them have two options: shoot from the outside (E1A) or shoot from the inside (E1B). The players on the white team are listed on the left side (F1 - F5). Recall that they are only adept at defending inside shots; thus they only have one option each. The table shows that the white team can only control the game 50% of the time. That is, despite having more players, the white team lacked the qualitative variety to completely stop the red team from scoring.

From the above examples, it is clear that an organization can better control a system when it has variety in the control system. In a complex system it is not realistic, from a practical or affordability sense, to assume that an organization can possess the "requisite" variety to control the system. Basically what occurs is the organization develops variety only for those COAs that have a high probability of occurrence. Beer suggests that the organization can improve its probabilities by regulating the system to

reduce uncertainty. How can uncertainty be reduced? The answer is through information. "Information extinguishes variety, and the reduction of variety is one of the techniques of control, not because it simplifies the system to be controlled, but because it makes the system more predictable" [Ref. 5: p. 87]

Consider once again the basketball team preparing for an important game. It will scout its upcoming opponents to determine the pattern of tactics which the team is likely to employ. The proliferation of variety which the opposing team is capable of employing is obviously great, but nevertheless, the scouting team will deduce some patterns with a high probability of occurrence. This would be especially true if the opposing team's "power" is centered around a few individuals. The scouting team, in an effort to control the situation (game), will try to counteract this variety by adjusting its own resources. In comparison, this is essentially the role of intelligence to the Army commander in battlefield operations. A unit will typically acquire (scout) environmental information (terrain, weather, enemy situation, political factors, the state of enemy weapon systems, enemy activities, and so on) in order to reduce the uncertainty of the operation.

The examples given above seem great, but they have a fundamental flaw. It is the same flaw that the commanders of the first school of thought have: when the environment has an overwhelming amount of complexity, it is nearly impossible to deduce the patterns. Therefore, the information from the "scout team" will not have much utility. This is because the variety that each team possesses is set and cannot be changed once the game starts. Information does not destroy variety; however, information can reduce the uncertainty of the situation and help to regulate the system. Consider the following scenario with our basketball teams. There are ten seconds left to play and the score is tied. The red team has the ball and has called a time-out to discuss their strategies. The coach of the white team sends his assistant over towards the red team's bench in an attempt to discover what play the red team will use. If the assistant is successful, the white team can use this information to plan their defense. In this example, the variety of each team has not changed. The information has simply reduced the uncertainty of what option the red team will choose. Similarly, if a commander can obtain real-time

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information about the enemy, he can use this information in order to reduce the uncertainty of the situation and regulate the variety of the operation or campaign.

The researcher will examine this concept, and its effects on Force XXI operations, in later chapters of this study. The concept is presented here in a general sense, to complement the previous analysis of the theory of Requisite Variety and make this important conclusion:

The theory of Requisite Variety has a direct application to military operations, future doctrine development, and requirements determination.

C.   SUMMARY

The act of engaging in war and OOTW is complex and contains a great deal of uncertainty. As systems such as these become more complex, the variety in the systems is said to proliferate and the systems are harder to control. The theory of Requisite Variety indicates that in order to control a complex system the amount of variety in the control mechanism must equal that in the system itself. In a military context, the different COAs available to the friendly commander must be greater than or equal to that of his enemy. There are two types of variety: quantitative and qualitative. The theory of Requisite Variety shows that a commander that possesses enough qualitative variety can dominate the battlefield even if he has inferior numbers when compared to his enemy. Finally this chapter demonstrated that information can reduce the uncertainty of the situation and assist in regulating the system.

Game theory was used in this chapter to analyze Requisite Variety. It is clear that game theory has a strong correlation to military operations; numerous studies have shown the relationship between game theory and military decision making. O. G. Haywood introduced this concept in 1954 by stating,

> The doctrine of decision of the armed forces of the United States is a
> doctrine based on enemy capabilities. A commander is enjoined to select

the course of action which offers the greatest promise of success in view of the enemy capabilities. [Ref. 18]

But how does the theory of Requisite Variety apply to determining future operational requirements? The next chapter of this study answers this question by developing a framework using requisite variety as a foundation.

V. A CONCEPTUAL FRAMEWORK

A. INTRODUCTION

This chapter directly applies the theory of Requisite Variety to the process of determining the future requirements of the Army. The first section describes a conceptual framework for providing commanders the necessary variety with which to dominate the battlefield. Next, the framework is applied to Force XXI operations suggesting a prioritization of weapon systems based on budgetary and global conditions. Finally, the chapter examines what impact the framework has on other Services.

B. VARIETY IS A FACTOR

The most significant finding of this study is that variety should be a factor in determining requirements for the future operational forces of the U.S. Army. We have seen that the future forces of the U.S. Army face a great variety of threats in a global environment with unprecedented complexities. Ashby's theory of Requisite Variety reveals that in order to control such complex systems, the amount of variety in the control mechanism has to be at least the same as in the system being controlled. In other words, in order to win the battle, the different COAs available to the commander must be greater than or equal to that of his enemy. Clearly the Army recognizes the importance of variety; for they have included the concept of versatility as a tenet of Army Operations in the keystone doctrinal manual FM 100-5. But this manual's focus is on unit and individual soldier skills, not overall requirements. It uses statements such as, "units must meet diverse mission requirements" and "versatility requires competence in a variety of missions and skills." Additionally, future warfighting concepts, such as those captured in TRADOC Pamphlet 525-5, allude to the importance of variety. Despite its recognized importance, the Army fails to use variety as a factor when determining requirements. The Army should directly apply the theory of Requisite Variety in its requirements determination process. TRADOC should make variety a factor in evaluating alternative

weapon systems and force structures. All stakeholders including ICTs, materiel developers, battle labs, and warfighters need to understand the concept of Requisite Variety. The researcher postulates that the Army does not directly address variety in this respect, because variety has historically been too hard to quantify and articulate.

For years, military planners have painstakingly developed complex, quantitative formulas that attempt to compare forces in terms of their numbers and hardware. Military literature is filled with detailed information on how many men, tanks, helicopters, vehicles, aircraft, rockets, or submarines are available to each of the world's armed forces. Attributes such as force ratios and combat strength have been integrated into complex algorithms for use in computer simulations of war. While undoubtedly providing valuable information, these methods offer few clues to the importance of intangibles such as variety. Over the last two decades, the Army has placed increasing importance on the value of intangible factors. If, as recent Army doctrine emphasizes, seizing the initiative, better intelligence and communications, and better trained soldiers, more strongly motivated, all count for more than sheer numbers, then the military balance may be determined more by intangible, hard-to-quantify factors than by the usual, easy-to-count factors to which previous military planners were accustomed. Such is the case with Requisite Variety.

Although variety is hard to quantify, there are some very concrete ways to provide commanders the necessary variety with which to dominate the enemy or situation. Consider the relatively simple model introduced in chapter four in which a commander is responsible for controlling a system. The system is a campaign or battle where "controlling the system" means defeating the enemy. Actions and information from the enemy pass to the friendly commander who, in turn, passes instructions into or acts upon the situation in order to dominate the enemy. The system is simplified by excluding any external factors from influencing the relationship between the enemy and the friendly commander. In reality, external factors from the environment could potentially have a significant impact on the system. Figure 5-1 shows an expanded model of the system which includes its environment. As shown, the internal controls and relationships between the commander and the enemy remain the same. Now however, the environment is
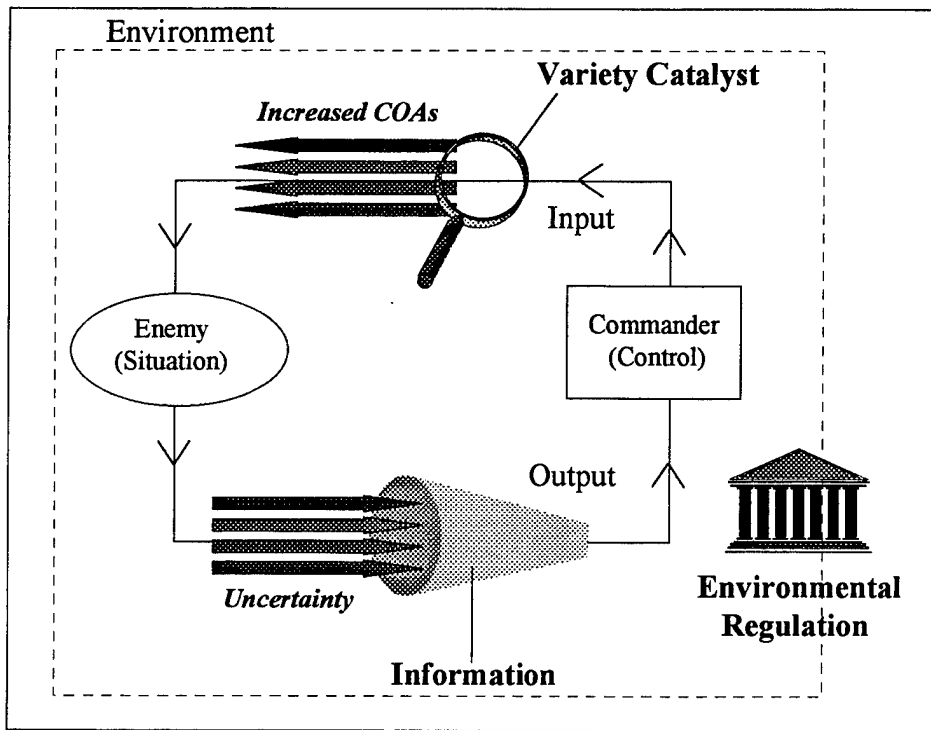
Figure 5-1. Framework for Providing Requisite Variety

depicted by the rectangle which encompasses the situation. This rectangle is drawn with dashed lines to indicate that in real life, the environment is fluid, rather than static. Highlighted in the model are the ways to provide commanders the necessary variety with which to dominate the enemy: through *regulation, information, and variety catalysts*.

1.   Regulation

Environmental factors can exert forces on the system which are out of the commander's control. In some instances, these factors can reduce the complexity of the system and therefore prevent the proliferation of variety. For instance, returning to the basketball analogy, the General Manager of our basketball team is not within the internal structure of the system, but he is clearly part of the environment. If the General Manager could devise a schedule that avoided playing teams with good outside shooters, then the variety of defensive skills that our players must possess is significantly decreased. In military terms, environmental regulation could be a change to the National Military Strategy (NMS) or Defense Planning Guidance (DPG). The U.S. could decide not to use military forces to counter phenomenological threats or conduct OOTW. This would

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reduce the variety of missions the Army has to perform and therefore, regulate the system. Other examples of environmental regulation can be seen in newspapers, journals, and televised debates. Many people argue that the U.S. should "bring home" the troops from abroad and let other nations worry about their own defense.

This debate on the allocation of national resources is, in itself, a higher level context model of the system depicted in Figure 5-1. The interfaces between these two levels are discussed later in this study in the section titled, Impact On Other Services. Theoretically, environmental regulation can succeed in reducing the complexity of the system. However, this type of regulation is normally out of the control of the commander on the ground. It is important, though, to realize that this option might exist.

2.   Information

Information assists the commander in obtaining requisite variety by reducing the uncertainty of the system. Figure 5-1 shows all the possible enemy COAs flowing from the enemy towards the commander. The enemy is limited by his own capacity and factors of METT-T to choosing only one of these COAs. However, until the commander can see or sense which COA the enemy will choose, the commander has to consider, plan for, or deal with the various options available to the enemy. Therefore, the variety of the enemy is constant and the commander must deal with the uncertainty of when, where, and how the enemy will strike. Information, shown as a funnel in Figure 5-1, acts a filter to reduce this uncertainty and facilitate proactive measures by the commander. This is one of the key aspects of Force XXI operations. Information dominance enhances the ability to shape the battlefield so that the commander can fight when and where he wants to fight. It allows the commander to mass effects of various weapon systems at critical points without the normally attendant risk of massing forces. It is key to understand that information does not reduce or destroy the enemy's variety. Rather, it reduces the uncertainty of the situation and helps the commander regulate the system. How information does this is discussed in the next section of this chapter titled, Prioritizing Weapon Systems.

The model depicts all of the uncertainty flowing out of the enemy subsystem. In reality, there is also a great deal of uncertainty flowing out of the commander subsystem:

not only to the enemy, but among the units and soldiers that are led by the commander. Some call this the "fog of war." To the soldier on the ground, it is the confusion or uncertainty of where he is on the ground, where other units are, and what is happening on the battlefield. Information can also help reduce this kind of uncertainty. This is what common situational awareness on the digital battlefield is all about: knowing where you are, where your buddies are, and where the enemy is. In this way, information significantly contributes to providing the commander requisite variety.

In the previous chapter we saw how the basketball coach used information to help win the game. He had his assistant coach monitor clandestinely the opposing team's plans. Therefore, the uncertainty about which play the opposing team would execute was reduced. Similarly, if the players had complete information on the location of their teammates at all times, they could make better passes, synchronize their movements, and outmaneuver their opponents. Many great basketball players attribute much of the their success to this uncanny ability to see the whole court...like they have eyes in the back of their head. So we see that information makes a significant contribution to the objective of providing the necessary variety with which to control the system.

Although information vastly improves warfighting capability, there are some considerations that the Army must address. First, information technology is turning over about every eighteen months. The Army must continue to streamline its process for acquiring this technology. Second, the Army must have the capability to distribute this information to soldiers who need it in order to maximize the utility of this technology. This means that the Army might have to reengineer some of its processes, and ensure there is connectivity between the platforms that pass this information. Finally, the Army must address information overload. Many studies have suggested that the human brain can only handle seven plus or minus two "chunks" of information at a time. Too much information can increase, rather than decrease, the complexity of the system. The Army must deduce a way to provide the right amount of information, to the right personnel, at the right time.

3. Variety Catalysts

The final way to obtain Requisite Variety is through variety catalysts. Variety catalysts directly increase the number of COAs available to the commander. They include changes in doctrine, training, organizations, leadership, and materiel. Figure 5-1 shows a set number of COAs flowing out of the commander towards the enemy. Variety catalysts, depicted as a magnifying glass, amplify the number and types of COAs and increase the commander's variety. There are two ways to increase variety: quantitatively and qualitatively.

a. *Quantitative*

Increasing quantitative variety means increasing the number of weapon systems, soldiers, or units. This method relies on massive force structures to overwhelm the enemy. It is not concerned with the types or kinds of weapon systems, but entirely on numbers. By enlarging the number of weapon systems, variety expands due to the increased number of combinations available to the commander. For example, if there are three players on our basketball team then there are three different ways in which the ball can travel:[1]

> between player one and player two,
>
> between player one and player three, or
>
> between player two and player three.

Now if we increase the number of players to four, then the number of different ways in which the ball can travel is increased to six:

> between player one and player two,
>
> between player one and player three,
>
> between player one and player four,
>
> between player two and player three,
>
> between player two and player four, or
>
> between player three and player four.

---

[1] Since we are comparing combinations, the ball traveling between players one and two, for example, is equivalent to a single combination of players regardless of whether the ball specifically moves from player one to two, or vice versa.

It can be shown that the number of different combinations can be derived by the formula: N(N-1)/2, where N is the number of players. Therefore, if there were six players then the number of different combinations would equal fifteen: 6(5)/2 = 15.

So increasing the number of weapon systems or forces will increase the commander's quantitative variety. While quantitative variety might seem attractive, there are two distinct disadvantages. The first is cost. Obviously, in today's environment, DoD is in no position to be asking for enormous increases to the defense budget. However, the researcher feels there are other opportunities to increase quantitative variety besides just 'buying more stuff', most notably, in the combat service support domain (reducing turnaround time, mean time to repair, etc.). The second is that overwhelming numbers do not directly translate to victory on the battlefield. In Chapter IV we saw that a basketball team, despite having superior numbers, could not completely dominate the game because they lacked the necessary defensive skills. In many instances, quality, not quantity, is the dominant factor in the system. In fact, this is the very premise that the U.S. and coalition forces used to win the Gulf War. Despite being hugely outnumbered in terms of weapon systems and force strength, the U.S. defeated Iraq by emphasizing quality equipment, soldiers, and training.

b. *Qualitative*

Qualitative variety concerns the amount of diversity in actions available to control the system. For example, in order to increase qualitative variety, our basketball team could recruit players with different skills. Some are quick and can shoot well from the outside, while others are tall and very effective around the basket, and still others are defensive specialists. A different option is to recruit players that are multi-talented. That is, they shoot well from all distances, have speed, and are great defensively.

From a military perspective, there are many possible ways to build qualitative variety into the force. One way is to build many different types of weapon systems. This is analogous to recruiting players with different skills. The commander could use these systems to attack the enemy from all the different spectrums of Force XXI operations. Once again, cost could be a disadvantage to this option. Different weapon

different inventories of spares, different mechanics, different ammunition, and different soldier skills. The overall lifecycle costs of training soldiers and maintaining the equipment have the potential to be relatively high. A derivative of this option is to have a family of vehicles or transporters, but with different weapon systems. For instance, a Bradley chassis can be used not only for an Infantry fighting vehicle, but also for an Air Defense Artillery system. The Army currently does this with the Family of Medium Tactical Vehicles. These trucks have a common chassis but different cargo variants: materiel handling options, dump, tractor, wrecker, and vans.

Another way to build in qualitative variety is to build weapon systems that are capable of performing many different missions. This is similar to recruiting a multi-talented player. For example, one weapon super system could be developed to not only shoot artillery fire, but also to destroy enemy aircraft and have enough mobility and direct firepower to be used as an Infantry fighting vehicle. While this super system obviously would give the commander more variety, this option would also have disadvantages. Building complex weapon systems that have multi-capable roles is difficult and sometimes costly. Not only does operation near the edge of the state-of-the art often greatly increase cost and performance risk, but it can also have a seriously deleterious effect on reliability. Norm Augustine, described this as the Law of Insatiable Appetites: "The last 10 percent of the performance sought generates one-third of the cost and two-thirds of the problems." He went on to write,

> Soon DoD will build an aircraft that is so expensive that it will have to be shared by the services. The Air Force will use it for three days, the Navy for two, and the Army and Marines will use it half the time for the other two days of the week. [Ref. 3: p. 47]

Another disadvantage is the impact of destroying one of these super systems. One artillery round or even a simple software virus could knock out a considerable amount of firepower. It would be like our multi-talented basketball player suffering an injury which prevents him from playing. Despite the potential disadvantages, the Army should continue to search for ways to increase its qualitative variety.

There are other ways to increase the qualitative variety of the force besides simply building new weapon systems. For example, through information dominance the Army can appear to be in multiple places at once, or invisible to radar in other areas. Through superior speed and mobility units can strike and move before detection or return fire. By utilizing all spectrums of the battle space the Army can exponentially increase its qualitative variety. Other areas such as doctrine, organizations, training, and soldiers all contribute to the system. While they do not directly increase the number of COAs available to the commander, they magnify the amount of variety by enabling the commander to more efficiently use his resources. In commenting on the success of one of the Army's latest warfighting experiments, General Dennis J. Reimer, emphasized the importance of these variety enablers in remarks following the digitization AWE at Fort Irwin in March 1997.

> There is tremendous power associated with the cohesion that comes from units working and training together. Clearly our doctrine will have to be updated but the doctrine writers were out there in great numbers and I think that is very doable. I also believe that our quality people are not only challenged but turned on by the Force XXI process. I took away from this exercise two clear impressions. First, the young men and women we are getting in the force today can handle the equipment necessary for the digitized battlefield and, secondly, I think we'll be able to retain them in sufficient numbers because they are challenged by this experience and feel good about the contributions they are making. For me, one of the biggest challenges is in organization. We did things in this experiment, such as provide the brigade commander with a brigade recon platoon and increased the number of dismounts with a 2X9+5 configuration for Bradleys. We also changed the [Combat Service Support] CSS structure significantly by, among other things, moving a number of mechanics back to the [Forward Support Battalion] FSB. Some of these things worked fine and others need additional work. In our analysis I think we have to take a hard look at this and see what we need to do....In my opinion, we have at least a 30% increase in capabilities through situation awareness at the present time and if we are able to develop it to its full potential it could be 50%-60% increase. [Ref. 23]

4. Summary

Although variety is somewhat intangible, the conceptual framework depicted in Figure 5-1 shows that there are many concrete ways to provide the commander with the

necessary variety to dominate the battlefield. Environmental factors can regulate the system and reduce the complexity, but these factors are out of the commander's immediate control and make up part of a different system. The other ways to ensure requisite variety that are within the commander's control are: information, quantitative variety catalysts (numbers), and qualitative variety catalysts. Each of these have distinct advantages and disadvantages. Optimally, a combination of all three alternatives should be utilized in order to achieve synergistic effects.

This framework is a powerful tool. It provides an innovative way to determine requirements using Requisite Variety as a basis. The people of the U.S. are looking for ways to tighten the DoD budget, yet they still want a force that is capable of achieving a quick, decisive victory. Given these conditions, Requisite Variety is a nascent requirement. This framework takes Ashby's Law, a relatively simple but underutilized theory, and directly applies it to the military. It shows that complex systems, such as battles and campaigns, can be dominated by having the necessary variety and the framework provides the guidelines for understanding variety. Further, it provides a common vocabulary to explain weapon requirements and the concepts of Force XXI to both Congress and the warfighters on the ground. It helps explain the question, "Why?" Why is the Army spending millions of dollars on AWEs and high-tech equipment to digitize the battlefield? Why is the Army developing conceptual doctrine that seems more suitable for Luke Skywalker than Sergeant York? Requisite Variety is one of the answers and this framework facilitates its analysis and discussion.

The major weakness of this framework is that Requisite Variety is still hard to quantify. In these times of downsizing, cost has become an important factor. Further research is needed in this area. One angle that could be pursued is to run a series of exercises using the variety of weapon systems as an independent variable. Based on the outcomes of these experiments, a cost benefit analysis could be performed. This would be an attempt to quantify the effectiveness of requisite variety. A few considerations must be given to any research. First, there are going to be constraints involved. The researcher must look at the constraints of the problem, whether they be money, time, or some other factor. Second, the system of which DoD is part is continually changing (threat, budget,

etc.). Nonetheless, the theory of Requisite Variety can be useful. The Requisite Variety in a sense, is similar to an insurance policy. It can provide the framework for what the Army is able to do based on the variety of options. This aspect could be very useful in quadrennial or bottom up reviews. A third consideration is that the U.S. is in a unique situation with respect to world power. In terms of game theory, the U.S. is clearly in a position of leader and if other countries want to follow then they can. This is fine as long as the U.S. considers what long term effects current decisions have on other countries (e.g., what signals are we sending when we set force structures and equipment levels). Finally, any decisions must have the support of both the executive and legislative branches of our Government.

Given these considerations, the framework explained above provides a very powerful tool from which to launch further research in order to quantify the factor of Requisite Variety. However, due to the exponential number of permutations and combinations of weapon systems and force structures, these studies will be challenging and it might take years of analysis to obtain significant results. The researcher believes that the framework, although intangible in nature, can provide a way for the Army to analyze requirements and prioritize weapon systems given the current global conditions.

C.   PRIORITIZING WEAPON SYSTEMS

As covered in the previous section of this study, the theory of Requisite Variety provides three ways to increase the commander's ability to dominate the battlefield: increase the quantitative variety (number of forces and weapon systems), increase the qualitative variety (different types of weapon systems), and use information to reduce the uncertainty and regulate the system. Optimally, a combination of all three alternatives should be utilized in order to achieve synergistic effects. However, given the current global environment and budgetary constraints, the question remains: how can we prioritize what types of weapon systems to develop and procure?

Given the current push to balance the federal budget and the trend for right-sizing DoD, the first option, increasing quantitative variety does not seem feasible. The

researcher posits that of the other two alternatives, the Army should focus its short term efforts on acquiring C^3I and mobility assets. The reason for this assertion is twofold. First, the technology currently available today can give the Army tremendous capability to increase information sharing and mobility at a minimal acquisition cost. Second, the characteristics of Force XXI operations are knowledge-based concepts which leverage common situational awareness to achieve combat power. The following paragraphs provide a discussion of this reasoning.

Many studies have documented the technical explosion occurring throughout the world. The top of the line, high speed computer that is bought today may be antiquated, slow, and out-of-date by the year's end. The U.S. has the capability to field high-tech, information gathering systems without the high cost of research and development. This fact is captured in the following paragraph from TRADOC Pamphlet 525-5:

> The manner of conducting joint land operations does not rely for its existence solely upon future technologies. Force XXI operations are possible with existing technologies; we are simply not yet sufficiently tactically adaptable nor have we changed some battle processes to take full advantage of such versatility....Our weapons can strike anywhere in our battlespace, but we cannot fully control them or sense their effects. Intelligence systems can provide detailed images, yet the full synchronization of all this capability is not realized. Evolving information technologies will almost undoubtedly unlock the full potential of Force XXI operations....This ongoing doctrinal development will place the Army in the lead of the revolution in military affairs. [Ref. 29: p. 3-20]

This suggests that the Army can leverage existing technologies of C^3I and mobility assets at relatively minimal costs by changing doctrine, tactics, and processes on the battlefield. This was one of the driving factors for the genesis of Force XXI operations. In examining the characteristics of these operations (multi-dimensional, precise, non-linear, distributed, simultaneous, and integrated), one can see that the Army intends to fully exploit the principle of economy of force through the use of information.

> Economy of force rightly means, not a mere husbanding of one's resources in manpower, but the employment of one's force, both weapons and men, in accordance with economic laws, so as to yield the highest possible dividend of success in proportion to the expenditure of strength. Economy of force is the supreme law of successful war. [Ref. 17]

The digital battlefield is all about economy of force. The efficiency and precision gained by digital situational awareness produce opportunities to mass the effects of combat power as never done before. As seen in the previous chapter we cannot destroy the enemy's combat power (variety), nor can we create more combat power by simply gathering more battlefield information. Rather, we can *stretch* the potential combat power of our force by employing assets only where and when they are needed to accomplish tactical objectives. When we increase the force's awareness by providing relevant battlefield information, we reduce the effort it must exert on active security measures necessitated by uncertainty. Any combat unit has only a *finite* amount of time and energy available to it. Tactical units can expend time and energy by combat action, security activities or in non-combat activities including refueling, rearming, maintaining, planning, rehearsing, and resting. All of these activities are performed more efficiently and effectively when the burden of active security measures is reduced.

In order to explain how information enables us to do this, the researcher now introduces a central concept that emerges from Ashby's Law of Requisite Variety, that information can reduce uncertainty and help regulate the system. The researcher will call this concept the Time-Information Differential, or Delta TI (dTI).

It takes a certain amount of time (T) to maneuver a force from one point to another. We will assume that these points are tactical objectives, the accomplishment of which have decisive effects upon the enemy. Our goal is to diminish our units' time and combat power spent on non-objective oriented activities. Rather, we would like to have our units profitably engaged in activities directly related to decisive missions.

In order to accomplish this, we need information (I) that gives us sufficient time to maneuver our unit so that we arrive at precise positions of advantage in time to accomplish specified tasks. This information has a time component, which we will call (TI), which represents how much time our information gives us to act. For example, if our information determines an enemy unit five hours away from points at which we want to strike him, then we have five hours to take action. Further, if our information system indicates that an enemy unit cannot physically move to certain points of the battlefield,

then our equation would be TI = infinity, which may mean it is tactically insignificant and we would not commit our forces there in response.

So the question is, is TI greater than the time (T) required to maneuver forces to positions of advantage? That is essentially what battle commanders need to know when considering maneuver options and schemes. If TI - T is a positive number, in other words, dTI > 0, then we have the opportunity to maneuver our force in time to dominate the physical battle space. If however, dTI < 0, then we cannot maneuver our unit in time based on the available information we have, so perhaps we need to reposition ourselves closer to our critical points or task another unit to conduct the action.

The researcher postulates two methods of increasing the time-information differential to create advantageous battlefield conditions suited for *initiative*. The first method is to increase our information of the tactical situation. The more relevant combat knowledge one possesses of the situation, the more options can be generated or exploited. For example, this can be done by tasking all-source intelligence systems and employing organic or supporting sensors, such as Unmanned Aerial Vehicles (UAVs), aerial and ground reconnaissance. Another method is to decrease time (T) by designing faster units, moving units closer to where we might need them, or employing airlift, sealift or heavy ground transport assets to accelerate movement. Ideally we perform both methods and increase dTI by manipulating both TI and T variables simultaneously. The Army can leverage existing technologies of C^3I and mobility assets at relatively minimal costs by changing doctrine, tactics, and processes on the battlefield.

Historically, dTI has almost always been less than 0. Operational mobility has never matched the capability of intelligence to tell us what the enemy is trying to do. Wellington and Napoleon had intelligence that moved at the speed of horses and faced armies with approximately that same speed. Thus dTI was virtually nonexistent. More recently we have had access to better aerial and space-orbital reconnaissance, but the speed of dissemination of this material to field commanders limited its usefulness. Only now with software intensive systems are we achieving the means of delivering theater and national-level quality intelligence to tactical commanders. This means we are finally envisioning a battlefield where we expect dTI to be greater than 0 on a routine basis.

Figure 5-2 shows the historical evolution of dTI in the U.S. military. During the Civil War, the primary means of passing information was the courier and telegraph. This allowed the commander to orient forces in days, decide on a COA within weeks, and it took months to execute this plan. During WWI, radio and wire were
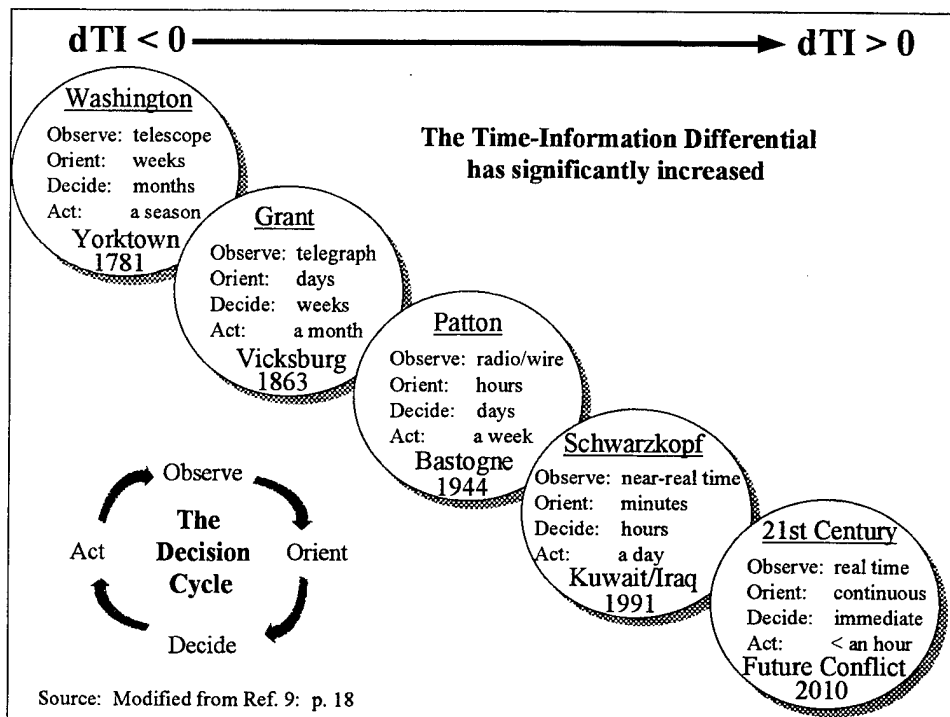
Figure 5-2. Historical Evolution of dTI

the available means of communication, with orientation of forces within hours, decisions in days, and execution within a week. Now, consider General Norman Schwarzkopf's capabilities during the Gulf War. He could observe in near real time, orient in minutes, decide in hours, and act the same day. Given the current budgetary constraints, global environment, and using the concept of the time-information differential, the researcher concludes the Army should focus its short term acquisition efforts on C^3I and mobility assets.

This prioritization covers all spectrums of the threat (phenomena through complex, adaptive armies) discussed in Chapter III. However, it is sensitive to the proliferation of weapons and technology. For example, if an emerging military power suddenly develops a new armor-piercing tank round, then the Army must shift its priorities to some kind of new protective armor to counter this threat. Therefore, the prioritization of weapon

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systems is an iterative process which requires intelligence, feedback, and continual updating.

In summary, the basis for this prioritization is the theory of Requisite Variety: only variety can destroy variety. Information reduces the uncertainty in the system, while mobility and situational awareness act as catalysts to increase the variety of friendly forces. Modernization of action (weapon) systems can further increase our variety. However, given the current financial health of the defense environment and using cost as an independent variable, this option does not seem prudent in the short term. This does not mean we should build all intelligence systems and no action systems. For then, we would be "putting all of our eggs in the same basket" much the same as our uninformed basketball coach did with his players. The bottom line is given current financial constraints, short term efforts should focus on C^3I and mobility systems. Concurrently, long term efforts should focus on parallel processes of prototyping action systems. These areas provide the best cost/benefit ratio for building a bridge to the 21st Century.

By using our basketball analogy we can come to the same conclusion. If the white team can continue to gain information on the red team (in the previous chapter this was accomplished by the assistant coach eavesdropping on the opposing team during a time out), the white team can gain a significant advantage without spending much money on additional players. Similarly, if all the players increase their mobility and quickness, they can further exploit this gained information by proactively disrupting the red team's game plan. This advantage, however, will not last indefinitely. Sooner or later, the red team will catch on to this strategy and counteract it by denying the assistant coach's access to their time outs or by drawing up "fake" or deceptive plays. Therefore, the white team should also take a long term perspective such as continually developing their skills or acquiring a quality, versatile player (a Michael Jordan perhaps).

D.   IMPACT ON OTHER SERVICES

The impact of these findings on other Services is that they all apply exactly the same. To understand this we must first understand how the other Services fit into the

model of our system. Earlier in this chapter the researcher introduced a simple model in which a commander was responsible for controlling a system (Figure 5-1). The model was simplified by assuming that all influences on the enemy were channeled through a single input and all the effects it exerts were channeled into a single output. A closed loop was thereby artificially created. In reality, there are outside factors that influence this system which are sometimes out of the immediate control of the commander. For example, changes in the NMS or DPG help regulate the system by reducing the proliferation of variety and complexity. Other factors include higher headquarters, terrain, weather, other units, other enemy units, and other Services. When examined from a different, more macro paradigm, these factors form the environment of a larger system which encompasses the model of our commander. Figure 5-3 shows that the commander is actually a subsystem of his higher headquarters control. Similarly, the enemy is a subsystem of its parent organization. Thus, a model of the larger system which utilizes the same closed loop interactions is formed.

Following the same logic, where each commander (control) is a subsystem of a parent system and each enemy (situation) is a subsystem of a parent system, forms a series of concentric rectangles. Each rectangle represents a simple, closed loop model of a
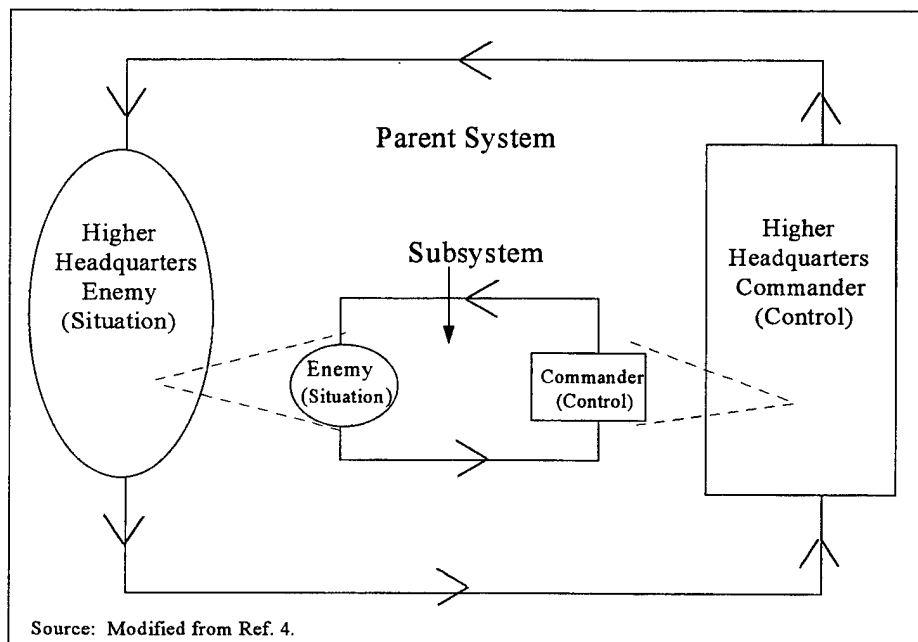
Figure 5-3. Hierarchy of Systems

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system such as the one introduced in Chapter IV. Therefore, Ashby's theory of Requisite Variety can be used to study each iteration of the models and the findings presented in this study is valid for each individual level.

For instance, at the highest level there is the National Command Authority (NCA) which seeks to control the system. The enemy, or situation, in this context encompasses the entire threat spectrum that was described in Chapter II. As a review, during the Cold War the U.S. faced a single, prescriptive threat. Today U.S. military forces are being projected to address a wider variety of objectives including peacekeeping, nation building, and humanitarian operations. Therefore, in order to completely control the system the NCA must have a variety of options that is greater than or equal to the variety of objectives. These options include all Services and must encompass all the missions for which U.S. forces must project power to further national interests. Joint warfare, using elements of the Air Force, Army, Navy, and Marines, significantly increases the qualitative variety available to the NCA. Increasing the qualitative variety of control responses is an excellent way to dominate the system and is a driving force behind using Joint forces at all levels of conflict.

So we see that Ashby's theory of Requisite Variety is valid not only at the Army level, but at all levels of conflict. But what about the prioritization of weapon systems? Do the findings in this study for the Army apply at the national level? The researcher believes the answer to this question is yes. The options available at the NCA level include international policy as well as military power. The NCA clearly wants effective options to maximize political leverage while minimizing the exposure of U.S. troops and limiting collateral damage. Since political leverage is closely related to the speed of involvement, the effectiveness of our early warning systems is critical to increasing our leverage. Timely and accurate information can facilitate the identification of potential crisis before they reach critical mass and assist in the decision process on how best to ensure that American interests are not only protected but enhanced. Again, this is primarily a question of process. The technology has long been available for gathering a wealth of information on unambiguous actions such as troop movements. But the U.S. still lacks the ability to

fuse disparate inputs to sort out the meaning to warnings and concealed intentions of an adversary.

So we see that the prioritization of systems is the same at the national level as for the Army. Similarly, the U.S. must not only look at the short term objectives. Long term objectives must include all aspects of the model: information, qualitative variety, and quantitative variety.

E.   CONCLUSION

This chapter directly applied Ashby's theory of Requisite Variety to the military. It provided a conceptual framework for using variety as a factor when determining requirements for the future forces of the U.S. Army. Although variety is somewhat intangible, the framework revealed concrete ways to provide the commander with the necessary variety to dominate the battlefield: through regulation, information, quantitative variety catalysts (numbers and force strengths), and qualitative variety catalysts (different types of COAs). The chapter also suggested that given the current budgetary constraints and the global world environment, the Army should focus its short term material acquisitions on C^3I and mobility assets. By applying the conceptual framework to the concepts of Force XXI operations, the researcher developed the Time-Information Differential. Based on this concept the Army will gain the most utility while at the same time minimizing its costs by prioritizing its short term efforts on these assets. However, to achieve synergistic results, the Army should concurrently research other types of weapon systems using the framework as a guide. Finally, the chapter showed that the framework and concepts of Requisite Variety are valid for other Services and DoD as a whole.

The next chapter presents an AWE conducted at U.S. Army Armor Center at Fort Knox, KY. The researcher applies the framework to the experiment and examines the validity and functionality of the findings that this study has yielded.

VI.   EXAMINATION OF THE FRAMEWORK

A.   INTRODUCTION

This chapter examines the conceptual framework developed in the previous chapter by applying it to an AWE conducted by TRADOC from July through December of 1995. The focus is to analyze the major findings of the exercise from the perspective of the Requisite Variety framework. These findings (not all-inclusive) were derived from the exercise documents, personal interviews with exercise personnel, and the author's own observations from participation in the actual conduct of the exercise.

The first section of this chapter covers the background of the exercise. It provides a description of the purpose, participants, and conduct of the exercise, along with a brief summary of the scenario. The next section examines the utility of the conceptual framework developed in Chapter V by analyzing the compelling innovations derived from the exercise with respect to Requisite Variety.

B.   BACKGROUND

1.   Conduct of the Exercise

The exercise, conducted from JUL-DEC 1995, was a General Officer Working Group project sponsored by TRADOC. The goal of this "sand table exercise" was to determine Force XXI requirements, structure, and conceptual doctrine for use in follow-on live and virtual exercises. The researcher chose this particular exercise because it served as the foundation for many TRADOC Force XXI conceptual doctrine publications and research studies. For all practical purposes, it was the genesis of the Army's new Requirements Determination process. The concepts in TRADOC PAM 525-5, described in earlier chapters of this study, served as the basis for this exercise. The objective of the exercise was to build upon these concepts and produce:

- a Division Operations and Organization manual for Force XXI units.
- warfighting tasks and TTP for Force XXI units, and

- a How To Fight manual for the Experimental Force (EXFOR).

[NOTE: The EXFOR is a Force XXI equipped division located at Fort Hood, TX. The EXFOR is the unit that participates in the "digital" NTC rotations and other AWEs to test new concepts and equipment.]

A major regional contingency set in the 21st Century served as the scenario for this exercise. The friendly forces consisted of a Force XXI designed and equipped division. This notional division was assigned the dominant mission of the Corps' decisive operation. The Commandant of each branch school was assigned the task of developing concepts for a specific Pattern of Operation. For example, the Commandants of the Armor and Infantry schools were responsible for developing a concept of operation for the Decisive Operation phase of the Force XXI Division Operations Plan. The Commandant of the Field Artillery school was responsible for developing concepts for the Shape the Battlespace phase of the operation. A series of "sand table" exercises involving all of the Commandants were used to discuss, test, examine, and build upon the concepts developed by each of the branch schools.

The outcome of the battle (i.e., who won or lost) was not as important as the concepts developed during the exercise. The Army wanted to start answering the How and Why questions for this revolution in military affairs. Therefore, the focus of this study is on the compelling innovations that were derived during the conduct of the exercise. To better understand the basis for these innovations, the next section of this chapter provides a brief description of the scenario used for the exercise.

2. Scenario

This exercise was geographically set on the fictitious island continent of Galacia in the Atlantic Ocean. Galacia is actually parts of Europe divided into five different countries. This allowed the Working Group to use existing maps and weather conditions for the planning and conduct of the exercise. Figure 6-1 shows the partitioning of Galacia:

- **Burgundy**: the primary friendly force of this scenario and an ally of the U.S., incorporates portions of France.

- **Mercia**: another ally of the U.S., covers the area of England.
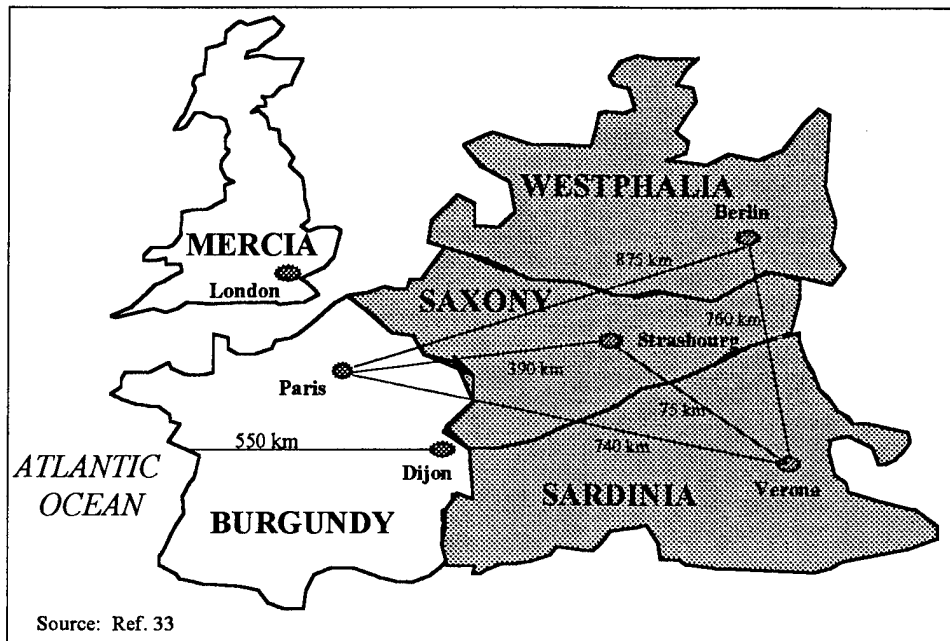
Figure 6-1. Scenario Map

- **Saxony**: the primary hostile force in this scenario, covers portions of Germany and Eastern France.

- **Westphalia**: another hostile force that supports Saxony, incorporates Northern Germany and Denmark.

- **Sardinia**: a neutral force in this scenario, covers Southern Germany, Austria, and portions of Italy.

a. History

This section provides a brief history of what led to the scenario conflict. Appendix B: AWE ROAD TO WAR, provides a complete listing of the events that led to the conflict. The nation of Burgundy was established by the Allied Powers following World War II as a constitutional monarchy. The nation encompassed the original country of Burgundy in the south, and an industrial region annexed from Saxony as reparations following World War II. The royal family was well established in pre-war Burgundy, and was highly involved in the partisan effort during the war. During the Cold War era, the tension increased between Burgundy and Saxony. The monarchy of Burgundy crumbled

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as inter-party rivalries spurred violence and destabilized the government. The countries of Saxony and Westphalia formed an alliance in 1994 and now threaten to invade Burgundy to reclaim "their rightful" land and resources.

The U.S. deems the escalating conflict on the island continent of Galacia a direct threat to the following vital interests:

- Mercia and Burgundy, traditionally staunch U.S. allies, are directly threatened.

- Vital European sea lanes are at risk should Saxony and Westphalia control the entire island.

- Control of recently discovered undersea oil fields.

The NCA decides to commit U.S. military forces, under United Nations Charter, as part of a multinational force to conduct combat operations to deter invasion while supporting diplomatic efforts to terminate the conflict. The military objective is to project forces into theater to deter a Saxon/Westphalian Alliance attack; should deterrence fail, conduct offensive operations to rapidly destroy attacking forces. End state is deterrence of attack or the destruction of all enemy offensive capabilities and the restoration of Burgundian territorial sovereignty.

b.   *Force Comparisons*

The focus of General Officer Working Group was on the 25th Division which was part of the Combined Joint Task Force. It was a Force XXI equipped unit with a mission to attack and destroy the follow-on divisions of the combined Saxon/Westphalia forces. The immediate enemy forces consisted of a Tank Division with a high-technological capacity of weapon systems and a Motorized Rifle Division with a mid-technological capacity of weapon systems. Figure 6-2 shows a comparison of the major weapon systems for each unit. It is interesting to note that the 25th Division was outnumbered in almost all weapon system categories. To overcome this deficiency in quantitative variety, the Working Group had to be very innovative in developing the concept of operations for this scenario. With this as a background, the next section of this

Weapon Systems	25th FXXI Div		3rd MRD		15th Tank Div	
Tank	171	M1A2	214	T72	322	T 80U
Infantry	180 71	M2A3 AGS	312 10	BMP-2 BRM-1K	274 10	BMP-2 BRM-1K
Scout	247	FSV	152	BTR-80	6	BTR-80
Artillery	6 18 36 18	HIMARS M119 PALADIN MLRS	72 54 54 18	2S1 2S2 2S3 BM21	72 30 36 18	2S1 2S2 2S3 BM21
Attack Helos	24	AH-64D	18	HIND D	18	HIND E/F
Anti-Tank	36 36	LOSAT AT	36 12	AT-5 MT12	9 18	AT-5 RAPIER
Air Defense	8 24	BSFV AVENGER	24 183 24 20	ZSU-23-4 SA-18 SA-13 SA-8	24 147 24 20	ZSU-23-4 SA-18 SA-13 SA-8

Source: Ref. 33

Figure 6-2. Force Comparisons

chapter examines the compelling innovations that were derived from the exercise with respect to the conceptual framework for Requisite Variety.

C. EXAMINATION OF KEY FINDINGS

1. The Impact of Requisite Variety

One of the most significant findings of this exercise is: **"The decisive force must be capable of producing, integrating and orchestrating all of the required effects determined to cause decision."** [Ref. 1: p.2] The group discovered that the 25th Force XXI Division was not the decisive force within this scenario. The decisive action for this conflict was defined as the destruction of the enemy's 1st Combined Arms Army. Based on the military and strategic end states, and the established success criteria, the 10th U.S. Corps (25th Division's Higher Headquarters) was the force capable of performing this decisive action. However, the group noted that within the 10th U.S. Corps' decisive operation, the 25th Force XXI Division performed the dominant action, relative to all

other actions within the Corps, that is intended to cause terminal or culminating effects upon the enemy.

From the perspective of the Requisite Variety framework, the 25th Force XXI Division did not have the Requisite Variety needed in order to dominate, or control, the situation. The General Officer Working Group realized that despite having the capability to significantly contribute to the operation, it was their higher headquarters (10th Corps) that possessed the Requisite Variety to perform culminating actions. This circumstance illustrates the Hierarchy of Systems explained in Chapter V and depicted in Figure 5-3. The 25th Force XXI Division was merely a subsystem of the parent system, and was not capable of totally controlling the situation.

The implications of this finding are either the Corps should be the focus of the operation, or the Army should increase the variety of the Division. The General Officer Working Group recommended increasing the variety of the Division through a modular organizational design and through streamlined doctrine and tactics. There were two main reasons for these recommendations. First, the Division did not possess assured capabilities required to dominate the battlefield. They chose the word "assured" because many of the needed assets were not organic to the Division. Rather, the needed assets belonged to Corps and the Division commander did not have control of them. Two examples of this are mobility assets for the Light Brigade and air defense assets. The ideal plan of attack included the use of light infantry in combination with armor forces. However, the Division lacked the air-lift or truck capability needed to fully exploit this option. This mobility differential made it difficult to synchronize infantry with armor, and left infantrymen vulnerable to counter-attacks with no capability for self-extraction. Additionally, the extended range of the operation left the Division vulnerable to air attacks and surveillance by UAVs. Without sufficient dedicated air defense assets, the enemy could exploit this weakness. In other words, if the enemy commander chose this COA, the friendly commander did not have the requisite variety to control the situation.

The second reason why the Division was not conducting a decisive operation was that the Corps operation plan prescribed tasks that limited how the 25th Force XXI Division intended to fight. For example:

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- Corps planned fire strikes on the 15TD and 3MRD prior to the 25th Division contact with the enemy.

- Corps emplaced dynamic obstacles to fix the 15TD and 3MRD.

- Corps assigned an Aviation Brigade to attack the lead regiments of the 15TD and 3MRD.

These examples show that while environmental regulation can be used to reduce the complexity of the situation, it also can have the opposite effect. In this case, the environmental regulation reduced the variety of friendly COAs and limited the options available to the friendly commander.

This finding has a significant impact on our Conceptual Framework for Providing Requisite Variety. The framework highlighted three ways to provide commanders the necessary variety with which to dominate the enemy: through regulation, information, and variety catalysts. The warfighting exercise illustrates that these methods must be used correctly in order to achieve the desired result. Further, the enemy commander can, and most likely will, use these methods to increase his variety. For example, information dominance can range from information supremacy to information inferiority. It can change over space and time, and it also may vary by echelon. Therefore, achieving a positive Time-Information Differential is not something that the Army can simply design into its force structure and modernization plans. It must be fought for and won through a deliberate process that is synchronized with the other methods of achieving Requisite Variety.

2.   The Increasing Complexity of Force XXI Operations

Another significant finding derived from the exercise is that full dimensional operations meld strategic, operational and tactical levels; future Force XXI Operations have the possibility of eliminating any distinction between the levels. This was an important realization during the exercise, because the strategic objective was to restore the control of a country that had been taken over by a hostile enemy. In the scenario, total destruction of the enemy was not an option unless the U.S. wanted to maintain a long-term presence in the area to restore the infrastructure (roads, water sources, buildings,

etc.). The friendly commander at the tactical level must understand what conditions must be set in order to achieve strategic objectives. Figure 6-3, illustrates this relationship.
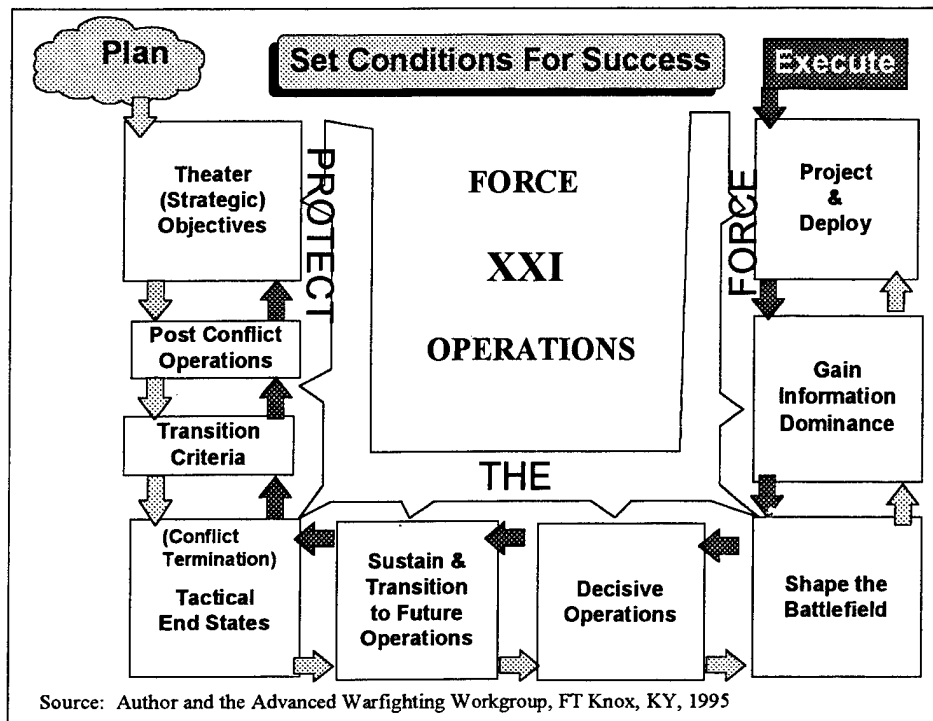
Figure 6-3. Force XXI Operations

Before executing the patterns of operations, the friendly commander must first utilize backwards planning to ensure that strategic objectives are met, and what post conflict operations are needed in order to facilitate attaining these objectives. The commander must also understand the criteria for transitioning from conflict termination to post conflict operations.

This is another illustration of how environmental regulation affects the system. The General Officer Working Group discovered that the dramatic increase of speed, optempo, and distance generated by Force XXI Operations required tactical commanders to fully understand the strategic objectives. In the exercise, the division commander wanted to strike the enemy and his supporting structure in a simultaneous manner. Therefore, the enemy would be isolated from its support structure while it was getting slammed by friendly maneuver forces. The tactical commander could not execute these actions in isolation, however. Many key targets had (some kind of) strategic importance. For example, an airfield, segments of a highway, water facilities, and part of one city were

all priority targets that could not be executed (i.e. destroyed) because of strategic objectives. These objectives specified a quick, decisive victory, with minimal casualties and minimal destruction of local infrastructure. The goal was to restore control of the country, which meant the local infrastructure could not be totally destroyed. This not only decreased the tactical commander's qualitative variety, but it made the operation much more complex. Friendly forces could not simply deploy massive air strikes to totally destroy key targets, because of the many restrictions. The commander had to meticulously plan operations to dominate his opponent

Given the future threat spectrum and the prevalence of peace enforcement objectives of the U.S., the researcher feels that this trend towards melding the levels of war will continue in the 21st Century. Commanders at lower levels will be called upon to execute missions that are currently being handled by Corps. The commanders will be responsible for understanding and achieving strategic, operational, and tactical objectives. The result is the system these commanders must control becomes increasingly more complex and will possess more variety. To facilitate success, these commanders must be armed with the requisite weapon systems and soldiers in order to control the system. This places even greater importance on understanding and correctly utilizing the framework for providing Requisite Variety.

3. Application of Information and Variety Catalysts

So far the analysis of this exercise has demonstrated that units that lack Requisite Variety cannot truly conduct Decisive Operations and that environmental regulation can increase the complexity of the system. To overcome these facts, the General Officer Working Group had to come up with some innovative ways to defeat the enemy. The researcher found that the group used both information and variety catalysts in order to control the system.

Information was used to both decrease the uncertainty of enemy actions and increase the situational awareness of friendly units. The concept of the operation portion of the 25th Division's Operations Plan illustrates the emphasis the group placed on information.

The Force XXI Division defeats or destroys the enemy by a combination of moving and striking. After crossing points of departure, the division uses dispersed formations to maneuver to close with the enemy from multiple points of contact. The division maneuvers to positions of advantage or appears from an unexpected direction to simultaneously strike the enemy with direct and indirect fires to destroy him. The division moves dispersed and with stealth so as to mask its intentions from enemy observers. Battalion-size units utilize dispersed formation and routes to maneuver, using the digital battle command system to maintain situation awareness and control. Lethal fires are used to destroy specific enemy capabilities such as reconnaissance which allows the division to retain the element of surprise and sets the conditions for success. [Ref. 1: p. 4]

The group made exhaustive efforts to maintain good intelligence on the enemy while maximizing stealth techniques to deny the enemy the true intentions of the friendly forces. However, they realized that information dominance is a temporary condition achievable only through a deliberate process. In order to take full advantage of these windows of information dominance they emphasized two features that are essential to the process. First, the commander must identify critical information requirements to control information, lest it will dominate him. Second, the time devoted to the tactical decision-making process and execution must be dramatically compressed. These "features" are identical to the information considerations identified in the conceptual framework: the Army must address information overload and the Army might have to reengineer some of its processes.

In addition to information dominance, the General Officer Working Group placed great emphasis on increasing the different COAs to defeat the enemy (i.e., qualitative variety). Listed below are some the compelling innovations developed over the course of the exercise. They cover the myriad aspects of future forces: system requirements, organization, doctrine, tactics, and techniques. However, they all have one thing in common: providing the commander the Requisite Variety to control the situation.

- Decisive Operations require the precise integration and application of combat power and combat multipliers throughout the enemy formation in depth--and in all dimensions to quickly defeat him.

- Overwhelming combat power is relative to the local conditions at the multiple points of contact--not a global correlation of forces.

- Overwhelming combat power can be achieved by employing deep strikes, maneuver, air mobile operations, special operation forces, and electronic warfare in an integrated fashion.

- Sequential, nested, tactical planning must change to reduce the amount of prescriptive tasks (environmental regulation) placed upon subordinate units that constrain the intellectual development of concepts of operation and the freedom to employ every tool at the commanders' disposal for maneuver--this includes planning and executing operations with few restrictive control measures and boundaries.

- The employment of air assault forces to attack and control enemy rear areas.

- The employment of dynamic autonomous obstacles to achieve countermobility and psychological effects.

- Combat service support activities on the move.

- Mounted attack of mobile enemy forces that strike concentrated, moving forces without fixing.

- Force oriented missions for attack helicopter units to take advantage of their mobility.

- Planning and conducting non-linear egress out of theater to eliminate the requirement to reverse the onward movement cycle upon conflict termination.

- Modular organizational designs that allow force tailoring based on METT-T for versatility.

- Shaping the battlespace by influencing (i.e., destroy, defeat, delay, divert, deny, deceive, limit or attrit) an enemy capability, force or decision.

- Shaping all dimensions of the battlespace: depth, width, height, time, the electro-magnetic spectrum and the human dimension.

- Engaging the enemy with lethal and non-lethal fires from dispersed locations.

As shown above, the General Officer Working Group developed many different ways to increase the amount of variety within their control subsystem. However, among

the disparate array of ideas, ran two common themes that continued throughout the exercise. First, the group made maximum use of the Time-Information Differential. This is obvious from the amount of time and effort spent on obtaining information dominance, and once this dominance was achieved, putting it to good use. The group continually took advantage of information superiority to proactively shape the battlespace. They did this through the use of attack helicopters, and other highly mobile assets. Additionally, they utilized long-range precision strike munitions to "reach out and touch the enemy." This introduces another dimension to the author's Time-Information Differential. As a review, the author postulated two methods of increasing dTI: through information and mobility. The results of the exercise shows that long-range precision strike munitions can also increase dTI by decreasing the time it takes units to engage the enemy.

The second general observation is there was an interesting metamorphosis in the attitudes of the individual group members. Initially, each branch commandant took a very parochial view towards the weapon systems. Each commandant seemed to view the exercise as a "turf battle," or an opportunity justify their weapon systems concepts. However, as the exercise continued, the group members realized that each branch added some kind of value to the operation. They realized that in order to control the enemy who had superior numbers (quantitative variety) they had to have the flexibility to utilize a number of different options (i.e., they had to have qualitative variety). Therefore, the attitudes changed and a more teaming effort formed.

D.   SUMMARY

The AWE validated many aspects of the Conceptual Framework for Providing Requisite Variety. Overall, the General Officer Working Group recognized that without Requisite Variety, the Force XXI Division could not conduct Decisive Operations. That is, they could not totally dominate the battlefield without the necessary means to do so within the control system. The lack of Requisite Variety in this exercise was primarily caused by two reasons. First the Force XXI Division did not have the "assured" capabilities required for the operation. That is, they lacked sufficient qualitative variety.

Second, the environmental regulation imposed by higher headquarters limited the number of COAs available to the Division.

The exercise also suggests that as the capabilities of future forces increase, the forces will be called upon to take on more responsibility. Commanders at the tactical level will have to understand and execute operations in order to achieve strategic objectives. This melding of levels of war increases the complexity of the system. It represents an implosion of the series of concentric rectangles that represented the parent and subsystems in our model, and places an even greater importance on the need for our forces to have Requisite Variety.

Next, the exercise demonstrated that information, environmental regulation, and variety catalysts are all valid ways to increase the commanders' options on the battlefield. However, these methods to increase variety must be used correctly and in an integrated fashion to achieve maximum results. Two prime examples illustrated in the exercise involved environmental regulation and information. Environmental regulation in the exercise decreased the friendly commanders' options, and therefore, increased instead of reduced the complexity of the system. The group of General Officers deemed this point as so significant that one of their key findings was that higher headquarters must reduce the amount of prescriptive tasks dictated to subordinate units. Information dominance was a valued commodity that had to be planned for and efficiently utilized to be effective.

Finally, the exercise demonstrated the importance of qualitative variety. The group devised many different ways to increase their variety. One significant method was maximizing the Time-Information Differential which the author introduced in Chapter V. The group made continual efforts to maintain information superiority, and utilized highly mobile assets to decrease the time it takes to proactively influence the battle. In addition, the group supplemented the dTI concept through the use of long-range, precision strike munitions which further decreased the time to shape the battlespace.

VII. SUMMARY AND RECOMMENDATIONS

A. SUMMARY

The decade of the 90's has been one of change for the U.S. Army. There is no longer a single, dominant threat such as the former Soviet Union. Instead, there is an increased chance of our forces deploying to a number of limited regional conflicts. As one Task Force Commander states,

> Operations other than war, low-intensity conflict, peacekeeping, peacemaking, peace enforcement--by whatever name, such missions are performed more frequently by a post Cold War Army. As vital as these are, the Army's primary mission remains to fight and win the nation's wars.
> [Ref. 19]

The result is that the future forces of the U.S. face a great variety of threats in a global environment with unprecedented complexities.

The American public demands a quick, decisive victory with minimal casualties. In order to accomplish this, the Army must have the capability to totally dominate and control the enemy. Requisite Variety is essential to this mission. This research shows that in order to control such complex systems, the friendly commander must have a variety of options. In fact, to totally dominate the battlefield, the variety of COAs available to the friendly commander must be greater than or equal to that of the enemy. However, concurrent with the dramatic changes in the global environment, the U.S. has significantly decreased defense spending. The competition for these dwindling defense dollars has increased the Army's risk of misallocating its scarce resources to a few "brilliant" systems without regard to the factor of variety.

Figure 7-1 shows how this study attacks this problem. It begins with an anlysis of the Army's Requirements Determination Process and Force XXI Operations with respect to variety and resource allocation. Next the author reviews the theory of Requisite Variety and develops a conceptual framework for its military application. The framework is examined through an AWE and the author presents findings derived from the experiment. This chapter provides a summary of the study, recommendations, and areas for further research.
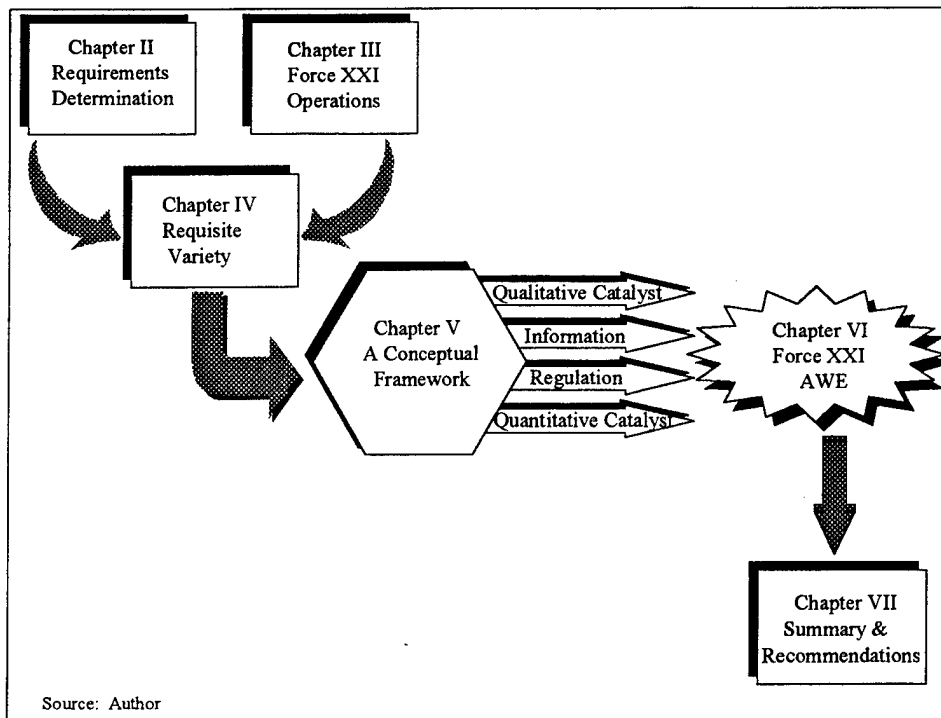
Figure 7-1. Road Map to the Study

1.   Requirements Determination Process

In order to overcome the complexities of the 21st Century, the Army has implemented a new Requirements Determination process and developed unique concepts for land combat called Force XXI Operations.   The new Requirements Determination process investigates the slew of Science and Technology opportunities in addition to meeting operational deficiencies identified through a Mission Area Analysis.   The process begins with the TRADOC commander's vision which is translated into desired Future Operational Capabilities and delegated to the branch schools and battle labs.   The branch schools utilize Integrated Concept Teams to transform these desired capabilities into solutions across the domains of doctrine, training, leader development, organization, materiel, and soldiers.   These solutions are examined and tested through live, virtual, and conceptual warfighting experiments.   Feedback from these experiments funnels back into the process in order to further define the product until a requirement is determined.   The process is designed to be flexible.   The Integrated Concept Teams include personnel from a wide spectrum of disciplines and have the potential to facilitate a smooth transition to Integrated Product Teams should a materiel need be identified.   However, including a

variety of views in the process of determining requirements does not translate to variety in our future forces. The Army does not directly address variety as a factor in the process. They have no means to evaluate the need for variety and therefore, have no instrument for prioritizing requirements with variety as a basis.

2.   Force XXI Operations

In contrast, Force XXI Operations, the Army's operational land concept for the 21st Century, make numerous direct and indirect references to the need for variety in our forces. These operations are knowledge-based which exploit information technology and leverage other technological opportunities to achieve a new level of effectiveness in joint warfighting. They call for soldiers to be versatile, capable of performing a number of different missions. They emphasize multi-dimensionsal operations -- attacking the enemy across myriad spectrums, and decisive operations -- causing the enemy to do our will. These features, along with other Force XXI concepts described in Chapter III of this study, require commanders on the ground be fully equipped with a variety of weapon systems. However, Force XXI Operations have been criticized by some who believe that the conceptual doctrine is too abstract, pushing the level of "Star Wars." In addition, the Army has not adequately explained their vision to Congress, and as a result, has received much criticism on costly warfighting experiments.

3.   Requisite Variety

This research provides a conceptual framework that helps explain aspects of Force XXI Operations and innovates the Requirements Determination process by utilizing variety as a factor. It is based on the theory of Requisite Variety developed by cybertician Ross Ashby. Ashby postulated the theory while studying the dynamics of complex systems. He observed that as systems become more complex, the variety within the system proliferates. He found that in order to command these systems, the variety in the control mechanism must be equal to, or greater than, the variety within the system itself. In Ashby's words, "Only variety can destroy variety." [Ref. 2: p. 208] This theory has a direct military application where the commander is the control mechanism and the enemy

is the subsytem which proliferates variety. From this paradigm, in order to dominate the enemy, it is necessary for the commander to have at least as many different options as are available to his enemy. A careful distinction must be made between pure numbers and the different types of options. Pure numbers, or quantitative variety, is just that: number of soldiers, number of weapon systems, or other factors used to determine the size of the force. Qualitative variety is not concerned with aggregate totals, but with the number of different types of soldiers, weapon systems, and missions of the force. This study shows that a commander with the requisite qualitative variety can defeat an enemy with superior quantitative variety. One of the difficulties with this concept is that variety is hard to quantify and measure.

4. A Conceptual Framework

Although variety is somewhat intangible, the framework developed in this study reveals concrete ways to provide the commander with the necessary variety to dominate the battlefield: through regulation, information, and variety catalysts. Regulation concerns controlling the environmental factors that influence the system in order to reduce the variety of actions the commander must control. For example, environmental regulation could be a change to the National Military Strategy or Defense Planning Guidance. The U.S. could decide not to use military forces for disaster relief or Operations Other Than War. Information assists the commander in obtaining Requisite Variety by reducing the uncertainty of the system. Knowing where you are, where your buddies are, and where the enemy is, facilitates proactive measures by the commander and soldiers on the ground. Variety catalysts directly increase the number of options available to the commander. These include changes in doctrine, training, organizations, leadership, and materiel. The framework clearly distinguishes between quantitative variety catalysts (numbers and force strengths), and qualitative variety catalysts (different types of COAs), however, both types of catalysts can be used to increase the commander's variety. Each of these has distinct advantages and disadvantages. Optimally, a combination of all three alternatives should be utilized to achieve synergistic results.

This study suggests that given the current budgetary constraints and the global world environment, the Army should focus its short term material acquisitions on C^3I and mobility assets. By applying the conceptual framework to the concepts of Force XXI operations, the researcher developed the Time-Information Differential. Increasing the situational awareness and reducing the time it takes to act on the battlefield creates advantageous conditions suited for initiative. Based on this concept the Army will gain the most utility while at the same time minimizing its costs by prioritizing its short term efforts on these assets. However, to achieve synergistic results, the Army should concurrently research other types of weapon systems using the framework as a guide.

This research also shows that the framework and concepts of Requisite Variety are valid for other Services and DoD as a whole. The Army and other Services are subsystems of DoD. This larger, or parent system, acts as the control mechanism to defend our nation against the various threats that exist. Therefore, this parent system exhibits the same characteristics as the model for the Army, and there is no reason to suspect that the conceptual framework would not be even more applicable at this higher, DoD level.

5. Force XXI AWE

The framework was examined by applying it to an AWE conducted by TRADOC. The AWE validated many aspects of the Conceptual Framework for Providing Requisite Variety. Overall, the General Officer Working Group recognized that without Requisite Variety, the Force XXI Division could not conduct Decisive Operations. That is, they could not totally dominate the battlefield without the necessary means to do so within the control system. The lack of Requisite Variety in this exercise was primarily caused by two factors. First the Force XXI Division did not have the "assured" capabilities required for the operation. That is, they lacked sufficient qualitative variety. Second, the environmental regulation imposed by higher headquarters limited the number of COAs available to the Division.

The exercise also suggests that as the capabilities of future forces increase, the forces will be called upon to take on more responsibility. Commanders at the tactical level

will have to understand and execute operations in order to achieve strategic objectives. This melding of levels of war increases the complexity of the system. It represents an implosion of the series of concentric rectangles that represented the parent and subsystems in our model, and places an even greater importance on the need for our forces to have Requisite Variety.

Next, the exercise demonstrated that information, environmental regulation, and variety catalysts are all valid ways to increase the commanders' options on the battlefield. However, these methods to increase variety must be used correctly and in an integrated fashion to achieve maximum results. Two prime examples illustrated in the exercise involved environmental regulation and information. Environmental regulation in the exercise decreased the friendly commander's options, and therefore, increased instead of reduced the complexity of the system. The group of General Officers deemed this point as so significant that one of their key findings was that higher headquarters must reduce the amount of prescriptive tasks dictated to subordinate units. Information dominance was a valued commodity that had to be planned for and efficiently utilized to be effective.

Finally, the exercise demonstrated the importance of qualitative variety. The group devised many different ways to increase their variety. One significant method was maximizing the Time-Information Differential which the author introduced in Chapter V. The group made continual efforts to maintain information superiority, and utilized highly mobile assets to decrease the time it takes to proactively influence the battle. In addition, the group supplemented the dTI concept through the use of long-range, precision strike munitions which further decreased the time to shape the battlespace.

This framework is very powerful. It provides an innovative way to determine requirements using Requisite Variety as a basis. The people of the U.S. are looking for ways to tighten the DoD budget, yet they still want a force that is capable of achieving a quick, decisive victory. Given these conditions, Requisite Variety is a nascent requirement. This framework takes Ashby's Law, a relatively simple but underutilized theory, and directly applies it to the military. It shows that complex systems, such as battles and campaigns, can be dominated by having the necessary variety and the framework provides the guidelines for achieving this level of variety. Further, it provides

a common vocabulary to explain weapon requirements and the concepts of Force XXI to both Congress and the warfighters on the ground. It helps explain the question, "Why?" Why is the Army spending millions of dollars on AWEs and high-tech equipment to digitize the battlefield? Why is the Army developing conceptual doctrine that seems more suitable for Luke Skywalker than Sergeant York? Requisite Variety is one of the answers and this framework facilitates its analysis and discussion.

B.   RECOMMENDATIONS

1.   Incorporate Variety as a Factor

The most significant finding of this study is that variety should be a factor in determining requirements for the future operational forces of the U.S. Army. We have seen that the future forces of the U.S. Army face a great variety of threats in a global environment with unprecedented complexities. Ashby's theory of Requisite Variety reveals that in order to control such complex systems, the amount of variety in the control mechanism has to be at least the same as in the system being controlled. In other words, in order to win the battle, the different COAs available to the commander must be greater than or equal to those available to his enemy. Clearly the Army recognizes the importance of variety; for it has included the concept of versatility as a tenet of Army Operations in the keystone doctrinal manual FM 100-5. But this manual's focus is on unit and individual soldier skills, not overall requirements. It uses statements such as, "units must meet diverse mission requirements" and "versatility requires competence in a variety of missions and skills." Additionally, future warfighting concepts, such as those captured in TRADOC Pamphlet 525-5, allude to the importance of variety. Despite its recognized importance, the Army fails to use variety as a factor when determining requirements. The Army should directly apply the theory of Requisite Variety in its requirements determination process. TRADOC should make variety a factor in evaluating alternative weapon systems and force structures. All stakeholders including ICTs, materiel

developers, battle labs, and warfighters need to understand the concept of Requisite Variety.

At the national level, the executive and legislative branches should use the conceptual framework developed in this study to assist them in understanding the complexity of the requirements placed on the Army. If the American public wants the Army to continue to perform a variety of missions, Government officials should give the Army the tools with which to achieve these objectives. If cost must be held as an independent variable, then the framework gives Government officials the flexibility to regulate the system, prioritize requirements, and then resource the Army accordingly.

2. Aggressively Pursue Intelligence on Future Threats

During the Cold War the U.S. had very robust intelligence efforts to gain and interpret information about the former Soviet Union. However, as defense spending has dwindled, so have these intelligence efforts. This study shows that the U.S. should continue to pursue robust intelligence efforts focused on determining valid threats. Doing so will reduce the uncertainty, variety, and complexity of the systems DoD is required to control. Therefore, the Services may not require as much variety in their forces as they do today facing a great variety of threats with unprecedented complexities.

3. Prioritization of Weapon Systems

Given current financial constraints, the Army's short term requirements efforts should focus on C^{3}I and mobility systems. Concurrently, long term efforts should focus on parallel processes of prototyping action systems. These areas provide the most benefit to cost ratio for building a bridge to the 21st Century. Information reduces the uncertainty in the system, while mobility and situational awareness act as catalysts to increase the variety of friendly forces. Modernization of action (weapon) systems can further increase our variety. However, given the current financial health of the defense environment and using cost as an independent variable, this option does not seem prudent in the short term. With the quality of intelligence assets that exists, the Army can make great strides by simply re-engineering the process of obtaining and distributing

information. This does not mean we should build all intelligence systems and no action systems. For then, we would be "putting all of our eggs in the same basket" and risk not having the Requisite Variety to conduct Decisive Operations.

4. Continue the push for Joint Warfare

Using the capabilities of all the Services in Joint Warfare is excellent way to provide Requisite Variety. The U.S. should continue to train and fight as a Joint team. Efforts should be made to increase the connectivity of weapon systems and doctrine to achieve synergistic results.

5. Higher Headquarters should reduce the amount of prescriptive tasks to subordinate units.

This is an interesting finding that came from applying the conceptual framework to the AWE. Prescriptive tasks from higher headquarters act as regulation which reduces the variety of the subordinate commander. This constrains the intellectual development of concepts of operation and the freedom to employ every tool at the commanders' disposal for maneuver. Higher headquarters should focus on what the requirements are, not how to perform them.

C. ANSWERS TO RESEARCH QUESTIONS

1. What is the current process for Requirements Determination and what pathologies with respect to resource allocation exist with this process?

Reference: Chapter II.

The Army's Requirements Determination process is based on the threat, identified deficiencies, and opportunities for new capabilities. It begins with the TRADOC commander's vision and holistic future warfighting concept. This concept is formed from a wide variety of inputs, including the national security and military strategies, lessons learned from recent operational experiences and future conflict scenarios, and future S&T possibilities. Then a multidisciplinary ICT translates this concept into future capabilities

and solutions. These capabilities are tested through a combination of live, constructive, and virtual experiments. Feedback from these experiments is used to refine the ideas and concepts, and eventually develop requirements. By design, the process is very flexible. It accommodates spiral development and employs a variety of feedback mechanisms. However, there are some pathologies that exist. Namely, the process does not directly address the importance of variety in the composition of forces. It does not assess or evaluate the need for having a variety of weapon systems. Perhaps more important in today's environment of tight fiscal constraints, the process does not have the capability to prioritize weapon systems with respect to variety.

2. What is the operational concept of land forces for the 21st Century and how does it impact the structure of forces in the future?

Reference: Chapter III.

The Army validly makes the assumption that the future forces of the U.S. face a great variety of threats in a global environment with unprecedented complexities. In order to deal with this complex environment, the Army has outlined warfighting concepts that emphasize knowledge-based operations: a shared common and timely perception of the battlefield. These knowledge-based operations are characterized by multiple dimensions, simultaneous attacks of precision fires that are distributed throughout the battlespace, and integration with other Services and nations.

These concepts contribute to the foundation of requirements determination. They must be clearly understood by all personnel involved in the process. The Army is looking towards future capabilities, yet claims Force XXI operations are firmly grounded to the principles of war. While this claim is arguably true, the researcher found that many personnel do not understand these concepts and how they fit into future force requirements. This research indicates that the Army needs a framework to properly examine and integrate these future warfighting concepts with advanced technical capabilities and determine future battlefield requirements.

3.   **What is the theory of Requisite Variety?**

Reference: Chapter IV.

The theory of Requisite Variety was discovered in the early 1950's by the British cybertician, Ross Ashby. It indicates that in order to control a complex system the amount of variety in the control mechanism must be greater than or equal to that in the system itself.

4.   **What are the military applications of the theory of Requisite Variety and how might it impact the determination of requirements and structuring of forces in the future?**

Reference: Chapters IV and V.

The theory of Requisite Variety has a direct application to military operations, future doctrine development, and requirements determination. The act of engaging in war and OOTW is complex and contains a great deal of uncertainty. In order to conduct decisive operations, the different COAs available to the friendly commander must be greater than or equal to that of his enemy. There are two types of variety: quantitative and qualitative. The theory of Requisite Variety shows that a commander who possesses enough qualitative variety can dominate the battle field even if he has inferior numbers when compared to his enemy. Further, information can reduce the uncertainty of the situation and assist in regulating the system.

5.   **Using the theory of Requisite Variety as a basis, how can a conceptual framework be developed for innovating the requirements determination process?**

Reference: Chapter V, specifically Figure 5-1.

Although variety is somewhat intangible, the conceptual framework depicted in Figure 5-1 shows that there are many concrete ways to provide the commander with the necessary variety to dominate the battlefield. Environmental factors can regulate the system and reduce the complexity, but these factors are out of the commander's immediate control and make up part of a different system. The other ways to ensure

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requisite variety that are within the commander's control are: information, quantitative variety catalysts (numbers), and qualitative variety catalysts (different types of COAs, weapon systems, and soldiers). Each of these have distinct advantages and disadvantages. Optimally, a combination of all three alternatives should be utilized in order to achieve synergistic effects.

6. What impact would this framework have on Joint warfare and other Services?

Reference: Chapter V, Paragraph D.

Although the framework was developed from an Army perspective, the characteristics hold true for other Services. In fact the framework, given slight modifications, can apply to any complex system. For example, Joint warfare is an excellent example of a qualitative variety catalyst. The use of different weapon systems and platforms provides the Joint Commander a great deal of variety. From this paradigm it is clear that the Army and the other Services are subsystems of a larger, parent system.

7. What impact would variety have on funding and how can the Army articulate this to Congress?

Reference: Chapter V.

The most significant finding of this study is that variety should be a factor in determining requirements for the future operational forces of the U.S. Army. In the 21st Century, the Army faces a great variety of threats in a global environment with unprecedented complexities. The framework reveals that in order to dominate the battlefield, commanders must have as many different options as the enemy. Therefore, if the American public wishes to remain a dominant world leader, the nation must fund its military forces so that commanders have the Requisite Variety to accomplish this mission. This does not necessarily mean that defense funding needs to be increased to all-time highs. Rather, the framework provides a vehicle to discuss the allocation of scarce resources from a different paradigm. It indicates there are many ways to provide the commander the necessary variety to dominate the battlefield. This study suggests that

given the current budgetary constraints and the global world environment, the Army should focus its short term material acquisitions on C^3I and mobility assets. However, to achieve synergistic results, the Army should concurrently research other types of weapon systems using the framework as a guide.

D. RECOMMENDATIONS FOR FURTHER STUDY

1. Quantify the Factor of Variety

Investigate alternatives to model and quantify the factor of Requisite Variety. In these times of downsizing, cost has become an important factor. Further research is needed in this area. One angle that could be pursued is to run a series of exercises using the variety of weapon systems as an independent variable. Based on the outcomes of these experiments, a cost benefit analysis could be performed. This would be an attempt to quantify the effectiveness of Requisite Variety.

2. Logistical Impact

Examine what impact Requisite Variety has on logistics in terms of life-cycle costs, schedule, and performance. Determine the factors that contribute to successful integration of a variety of weapon systems. Develop a list of specific logistic issues that must be addressed by the Army to assist in obtaining Requisite Variety efficiently.

3. Variety Catalysts

Research different possibilities for variety catalysts. Explore across the domains of doctrine, organizations, training, leadership, materiel, and soldiers. For example, can improving the turnaround time or operational availability of a certain weapon system increase the commander's quantitative variety? Determine which catalysts are the most effective in increasing variety and compare this to which ones are the most cost efficient. Develop a prioritized list of variety catalysts based on effectiveness and efficiency.

4.   Apply Requisite Variety to a Program Office

Explore how the conceptual framework for providing Requisite Variety can be applied to a Weapon System Program. Determine what factors contribute to the uncertainty and complexity of the program. Investigate how Program Managers can use information and regulation to reduce the complexity of the program. Develop a list of possible variety catalysts that are available to Program Managers to increase the Requisite Variety in their control mechanism.

5.   Modular Divisions

Examine the concept of modular organized divisions. This was an interesting recommendation from the General Officer Working Group as a result of the AWE. An initial analysis shows that this concept will increase the variety of the division. However, at what cost? Will unit cohesion and morale decrease? Will standard operating procedures have to be modified to accommodate all units? Discuss the advantages and disadvantages of a modular organization and its utility for providing Requisite Variety.

APPENDIX A. ACRONYMS AND ABBREVIATIONS

AR   Army Regulation

ASTMP   Army Science and Technology Master Plan

ASTWG   Army Science and Technology Working Group

AWE   Advanced Warfighting Experiment

AWWG   Advanced Warfighting Work Group

CBRS   Capabilities Based Requirements Determination System

CI   Commercial Item

C^{3}I   Command, Control, Communications, and Intelligence

COA   Course of Action

CSS   Combat Service Support

DCD   Directorate of Combat Developments

DCDSD   Deputy Chief of Staff for Combat Developments

DCSOPS   Deputy Chief of Staff for Operations and Plans

DoD   Department of Defense

DPG   Defense Planning Guidance

dTI   Time-Information Differential

EXFOR   Experimental Force

FLOT   Forward Line of Troops

FM   Field Manual

FOC   Future Operational Capability

FSB   Forward Support Battalion

GPS   Global Positioning System

ICT	Integrated Concept Team
IO	Information Operations
IPB	Intelligence Preparation of the Battlefield
MACOM	Major Army Command
METT-T	Mission, Enemy, Troops, Terrain, and Time Available
MNS	Mission Need Statement
NBC	Nuclear, Biological, and Chemical
NCA	National Command Authority
NDI	Non-Developmental Item
NMS	National Military Strategy
NTC	National Training Center
OCR	Operational Capability Requirements
OOTW	Operations Other Than War
OR	Operational Research
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
S&T	Science and Technology
STO	Science and Technology Objective
TRAC	TRADOC Analysis Center
TRADOC	Army Training and Doctrine Command
TTP	Tactics, Techniques and Procedures
UAV	Unmanned Aerial Vehicles

APPENDIX B. AWE ROAD TO WAR

The nation of Burgundy was established by the Allied Powers following World War II (WWII) as a constitutional monarchy. The nation encompassed the original country of Burgundy in the south, and an industrial region annexed from the country of Saxony as reparations following WWII. The royal family was well established in pre-war Burgundy, and was highly involved in the partisan effort during the war.

Nov 1984 -   Sales of Burgundy wine, the nation's chief export, decline for the fourth straight year due to rising popularity of wine exports from America. Licensed wineries have decreased 22% over the last 5 years.

Jan 1985 -   Burgundy Ministry of Trade directs massive technological upgrade of the industrial base. Publishes 10 year plan. Export tariffs on wine increased 25%. National capitol moved to Calais.

Nov 1992 -   Liberal Industrial Party captures 40% of parliament. Promises increased resources for industry. Urges closer ties with Saxony. Agrarian Conservative Party vows any opposition to any initiative which further hampers agricultural exports, and retains 45% of Parliament.

Mar 1993 -   Rioting broke out in the rural towns of Cahors, Bourges, and Blois. Government offices ransacked.

Apr 1993 -   National Guard units form the north are dispatched to southern regions to maintain order.

Oct 1994 -   Queen Chablis calls for dissolution of Parliament. Royal Family leaves Calais, returns to ancestral home in Paris. Christine Amanpour reports from Paris that the local citizens are overwhelmingly in support of the Agrarian Conservative faction.

Nov 1994 -   Liberal Industrial Party wins 55% of popular vote. Agrarian Conservative Party claims election fraud, stating that votes from southern regions were not counted.

Feb 1995 -   U.N. establishes 6 supply points east to facilitate distribution of food and medical supplies.

Mar 1995 -   Atrocities by both sides documented by U.N.

Mar 1995 -   6 motorized brigades of member nations sent to Burgundy to conduct
              Peacemaking operations under U.N. control. 3 Safe Areas established for
              each factions.

Apr 1995 -   3 members of royal family assassinated in Paris. Queen Chablis blames
              Liberal Industrial Party leaders. National Guard units from both regions in
              conflict. Saxony petitions U.N. for permission to enter Burgundy and
              safeguard citizenry in north. Petition denied.

May 1995 -   Popular consensus in U.N. member nations favors action to remedy
              situation without alignment to any faction, or the commitment of ground
              forces.

May 1995 -   6 Civilians killed in artillery raid in southern region. Pro-Conservative
              forces retaliate in kind.

May 1995 -   Air Strikes have resulted in loss of 13 aircraft in the last 2 months. Both
              sides are emplacing artillery positions near hospitals and orphanages.

May 1995 -   Fist Safe area falls to Liberal faction.

May 1995 -   Westphalia issues policy statement calling for partitioning of Burgundy
along   pre-WWII boundaries.

May 1995 -   U.N. Resolution 422 requests Security Council intervention to conduct
              Peace Enforcement operations and prevent widening of war in Burgundy.

May 1995 -   Westphalia provides advisors to Saxony.

Jun 1995 -   CJTF Atlanta established. NCA directs implementation of ACO Campaign
              Plan STILL WATERS. "Enter Burgundy and conduct actions as required
              to establish conditions for peace-building operations under U.N. auspices.

Jun 1995 -   Secretary-General directs development of new air campaign. 3d U.N.
              commander of forces resigns. States to world press that "...never in
              history has dominance of the air achieved control of the ground." - cites air
              campaigns of the Germans against the British, Allies against the Axis, and
              Vietnam. States that peace will only be achieved by introduction of ground
              forces and forcible disarming of factions.

Jun 1995 -   Second Safe Area falls to Liberal faction.

Jun 1995 -   U.N. Brigades abandon Safe Areas to concentrate on security of supply
              distribution points.

28 Jul 1995 - Saxony moves forces towards border with Burgundy citing concerns over welfare of Saxony descendants in Burgundy.

020100 Jun 95 N Hour.

7 Jun 1995 - M Day.

18 Jun 1995 - Saxony mobilizes reserves.

19 Jun 1995 - NCA directs ACOM CONPLAN RAGING TORRENT. "Conduct operations necessary to maintain the territorial integrity of the nation of Burgundy."

21 Jun 1995 - C Day. 10th Corps departs CONUS.

28 Jun 1995 - Allied Atlantic Division (Multinational) closes in FAA vic Paris.

15 Jul 1995 - 2 MEF closes into Calais.

23 Jul 1995 - 10 Corps closes into FAAs vic Paris.

29 Jul 1995 - 2 Corps embarks at Beaumont Texas.

30 Jul 1995 - Unarmed U.N. observer team engaged by Saxony forces: 4 KIA.

4 Aug 1995 - Allied Atlantic Division fuel truck hits mine and is destroyed.

18 Aug 1995 - 2 Allied Atlantic Division helicopters on border trace flight engaged and destroyed by Saxony forces.

20 Aug 1995 - 10th Corps patrol ambushed vic Saxony border: 6 KIA.

24 Aug 1995 - D Day

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