Joint Experimentation: A Systems Approach

A Monograph
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ABSTRACT

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The Secretary of Defense charged the United States Atlantic Command (USACOM) on 1 October 1998 to conduct Joint Experimentation (JE) in support of the Defense of Department (DoD) *Joint Vision 2010* concept. Since a common definition of joint experimentation did not exist, the mandate not only required USACOM to conduct joint experimentation, but also to define exactly what it is. In response, USACOM, now United States Joint Forces Command (USJFCOM) established the J9 Directorate under its command to accomplish this task. It was given the objective of the JE program to provide recommendations to the Chairman, Joint Chiefs of Staff and the Secretary of Defense on how to improve the doctrine, organizational structures, training, material, leadership and personnel programs to provide the future joint force the capabilities of full spectrum dominance. The question this monograph addresses is how should the military go about joint experimentation – specifically should the joint experimentation program be based on systems theory.

The monograph initially examines what led to the requirement for the JE program, a description of the JE program as outlined in Joint Forces Command's JE Campaign Plan 2000 and a review of previous assessments of the JE program. After defining systems theory and addressing its benefits and criticisms, the monograph analyzes the use of systems theory in the joint experimentation process against three criteria. First, would the application of systems theory help achieve the stated objections of the JE program? Second, does systems theory reflect how the military intends to conduct warfighting? Finally, would the use of systems theory at the joint level provide any benefits not provided by other means?

The monograph concludes that systems theory should be the basis for joint experimentation. While some elements of systems theory exist within the experimentation program outlined in Campaign Plan 2000, there are several elements of systems theory not present. Finally, the monograph recommends several actions the Secretary of Defense should take in conjunction with the adoption of systems theory.

TABLE OF CONTENTS

Chapter One

Introduction

The Secretary of Defense charged the United States Atlantic Command (USACOM) on 1 October 1998 to conduct Joint Experimentation. [1] Since a common definition of joint experimentation did not exist, the mandate not only required USACOM to conduct joint experimentation, but also to define exactly what it is. USACOM ultimately defined joint experimentation as "an iterative process of collecting, developing, and exploring concepts to identify and recommend the better value-added solutions for changes to DOTMLP required to achieve significant advances in future joint operational capabilities."[2] The individual services already maintained extensive experimentation programs but joint experimentation was a new concept. It should not have been a new concept though, because joint operations were not new to the military.

Beginning with the National Security Act of 1947, the United States military has moved increasingly towards joint operations.[3] The term joint is defined as one that "connotes activities, operations, organizations, etc., in which elements of two or more Military Departments participate."[4] Subsequent amendments to the Act in 1949 and 1958 increased the power of the Joint Chiefs of Staff and belied the growing realization that future conflicts would need to be fought by a joint force and not by the individual services.

Even with the recognition of the value of joint operations, the military continually failed to fight as an integrated force. As an example, the air campaign in Vietnam was fought as separate and distinct campaigns by each of

the services. Coordination between the services was poor, despite all the services working towards a common objective.[5] All the services conceptually agreed to joint operations but execution remained problematic.

In passing the Defense Reorganization Act of 1986 by a nearly unanimous vote in both houses, Congress sent a clear message to the services that they were dissatisfied with the degree of "jointness" achieved to date.[6] Commonly referred to as the Goldwater-Nichols Act, the Defense Reorganization Act of 1986 is heralded as a fundamental change in how the military and Congress views the nature of joint operations. One effect of Goldwater-Nichols was to increase the authority of the Joint Chiefs of Staff, especially the Chairman, in addition to emphasizing the role of the combatant commanders. The later point is significant in that it indirectly decreased the role of the individual services. While still theoretically possible, it was clear that future military operations were to be joint in nature.

Between 1989 and 1997, twenty-five out of twenty-seven major operations were joint.[7] This is as much a reflection of the military's change in structure as it is a penchant for joint operations. Following the end of the Cold War, the reduction in military forces, especially those that duplicated the function of forces in another service, effectively eliminated the capability of the individual services from conducting major operations on their own. This transformation of the military to an integrated joint force is already a reality and joint doctrine espouses the necessity of joint warfighting in the future.

Joint Vision 2010 commits the military to fighting in a joint environment. Published in 1996, *Joint Vision 2010* provides the general direction the military will take to meet the challenges of the future. It specifically provides guidance on the types of capabilities the military must improve upon to meet those challenges.[8] The underlying principle of the document is future operations will be joint. However, it refrains from mandating which service is to achieve which specific capability.

Each of the services published their own versions of future warfare nested within the concept of *Joint Vision 2010.* The Army published *TRADOC Pamphlet 525-5: Force XXI Operations* in 1994. The Navy and Marine Corps published their operational concepts *Forward from the Sea* and *Operational Maneuver from the Sea* in 1997. The Air Force also published its conceptual manual AFDD-1: *Air Force Basic Doctrine* in 1997. Each vision emphasizes different methods of warfighting, but they all concede the premise of joint operations being both necessary and the norm for future operations.

Despite the trend towards joint operations, experimentation remained largely dominated by the individual services. Until the creation of a joint experimentation program under Joint Forces Command, there was no single, comprehensive effort to coordinate the experimentation programs of the individual services. There were a few limited joint experimentation programs relating to specific functions, such as the Advanced Concept Technology Demonstrations, but these efforts were both limited in scale and the functions they experimented upon. The net result was the majority of the experimentation

occurring was focused on increasing the ability of a particular service, as opposed to the joint force.

Since the end of the Cold War, the individual services increased their level of experimentation but their programs remain largely service oriented. Following Operation Desert Storm, each of the services created new organizations with the specific mission of conducting experimentation to achieve their vision of future warfare. For example, the Army created the Joint Venture office in 1994 to manage its series of Advanced Warfighting Experiments.[9] Due however to primarily fiscal reasons, the programs operated almost solely within the realm of the service conducting the experiment. The performance objectives of less than five of the seventy-three initiatives tested during the Army's Task Force XXI Advanced Warfighting Experiment in 1997 included joint interoperability.[10] Despite the service-oriented focus of existing experimentation programs, they have attained insights applicable to joint experimentation.

A major lesson learned from the service experimentation programs was the need for greater vertical and horizontal integration.[11] The necessity for interoperability at every level applied to almost every experiment, whether testing a specific weapons platform or a new doctrinal construct. If the same lesson were applied to the experimentation process, it may have indicated to the individual services to integrate their experiments in a truly joint context. Except for several specific instances, this did not happen.

Parochialism has kept the services from actively pursuing experimentation at the joint level. The power and influence of the individual services remains one

of the largest barriers in achieving a fully integrated joint force. Due to the fiscal process of each of service getting a separate budget, competition often results between the services for a finite amount of existing dollars. [12] Consequently, no service was willing to apply its money towards experimenting at the joint level, believing it should spend its money forwarding the needs of the service itself.

The increased level of experimentation conducted by the services has had the additional effect of firmly entrenching the experimentation process at the service level. After creating strong experimentation programs, the services' loss of those programs to the joint community would decrease their influence even further. In effect, joint experimentation is a threat to the services autonomy.

Joint Experimentation is critical at the start of the new millennium because it will have a large impact in determining the structure of the future force for two reasons. First, fiscal resources are finite, and second the military will place increased reliance upon experimentation as the basis for changing the force structure.

Appropriations drive changes in force structure. Reality is that almost any change within the military incurs an added cost. Even changes in doctrine result in an added cost to effectively train the personnel of the force. Change may be desired or planned, but without fiscal resources, they are not executed. Measured in 1996 dollars adjusted for inflation, the FY1999 defense budget is the eighth lowest since 1948[13] and the lowest when measured as a percentage of the Gross National Product. [14] The statistics do not measure whether defense spending is adequate to meet the perceived need, but it does indicate the

military has relatively less to work with than in the past. The actual dollar amount is not the only reason for concern though.

Any mistakes made in force structure are amplified because research, development and procurement times are now measured in years. Even if fiscal resources are held constant, it will take longer to correct any poor decision made in force structure. Yearly fiscal decisions now retain a longer impact than in the past.

The second reason joint experimentation is critical at the start of the new millennium is that it is anticipated the Joint Readiness Oversight Council will increasingly rely more on the results of experimentation than service agendas when constructing the Integrated Priority List (IPL). The IPL is the military's recommendation as to what are the most important programs to fund. Previously the JROC was inundated with each service touting its own systems based upon their own experimentation programs. A joint experimentation program offers a means to base decisions on a more unbiased database.

In order for joint experimentation to be successful, the methodology used must be sound. For the reasons mentioned, it is critical that the process provide a means of achieving the objectives set for it. Systems theory provides one possible methodology. The primary question this monograph addresses is: should the joint experimentation process be based on systems theory?

The first section covers the history, purpose and the status of the Joint Experimentation program. A review of Congressional and Department of Defense documents will provide a foundation for understanding the defined role

of the JE program within the military. The section will also examine the status of program based on the FY 2000 Joint Forces Command (formerly USACOM) experimentation campaign plan. Understanding the evolution and status of the JE program provides a framework to which systems theory is applied later in the monograph.

The second section of the paper examines basic systems theory. It discusses the advantages and disadvantages of systems theory as it relates to the military. Finally, it examines whether or not it applies to the United States military in the context of warfighting.

The third section of the monograph answers the question of whether the joint experimentation process should be based on systems theory. Three criteria are used in evaluating the applicability of systems theory to the JE process:

(1) Would the application of systems theory help achieve the stated purpose of the Joint Experimentation process?

(2) Does systems theory reflect how the military intends to conduct warfighting?

(3) Would the use of systems theory at the joint level provide any benefits not provided by other means?

Finally, the monograph concludes with the answer to whether joint experimentation should be based on systems theory. The monograph provides recommendations that may aid in the joint experimentation process.

The environment in which the military must operate has changed since the end of the Cold War, and it will most assuredly continue to change. If the

United States military is to meet future challenges, it must develop and exercise a process to determine the best solutions to the potential threats. An effective joint experimentation process provides the means to accomplish this task.

Chapter Two

The Joint Experimentation Program

Joint experimentation is a reality. On 15 May 1998, in anticipation of its future mandate, Joint Forces Command established a J9 Directorate to develop and execute a joint experimentation program.[15] This chapter examines what led to the requirement for the program, how the program is organized and concludes with an assessment of the program.

The Requirement for Joint Experimentation

Prior to the congressional mandate in 1998, there was no specific requirement to conduct joint experimentation. Guidance for the military is located in numerous sources, but arguably the two most prominent sources, Goldwater-Nichols and *Joint Vision 2010*, do not contain any reference to joint experimentation.

Goldwater-Nichols implies, but does not require joint experimentation. The Act however notes that, "it is the intent of Congress... to provide for more efficient use of defense resources."[16] The Act provides an end-state of what Congress expects to achieve, but does not dictate a specific mechanism to achieve that end. It can be argued there is an implied requirement within several sections of the Act for experimentation to meet that end. Section 201 charges the CJCS with the responsibility of providing advice on requirements, programs and budgets.[17] The Act codifies the military's requirement to provide advice for

the ultimate efficient use of resources. Section 301 provides the closest language for a mandate of joint experimentation. It charges the CJCS with conducting joint operations and taking steps to improve performance of the units involved.[18] Goldwater-Nichols does not mention experimentation, but the intent for the military to conduct some type of joint experimentation to improve the force is arguably apparent.

Joint Vision 2010 does not specifically address joint experimentation. Like Goldwater-Nichols, *Joint Vision 2010* alludes toward the necessity for such a program. It notes that, "modeling, demonstrations, simulations, technology wargames, and joint exercises will help assess and validate these concepts, as well as assist in developing new operational procedures and organizations."[19] The document defines several organizations (e.g. the Joint Readiness Oversight Council) that will facilitate this process.[20] The organizations mentioned are executive level decision-making bodies, not ones with the resources to conduct an experimentation program. The actual experimentation process was left within the purview of the individual services.

There is evidence joint experimentation may have been implied within several documents, but there was no specific requirement to conduct it. Without the requirement, the military did not execute a comprehensive experimentation program, despite the apparent need for one.

Operations such as Desert Storm, Provide Comfort and Allied Force indicated the military still had problems working in a joint environment. If Goldwater-Nichols intended for the military to evolve more into a joint force,

operations conducted since its passage highlighted significant areas where the military failed to do so. In almost all cases, the failures were due to service differences. Probably the best-documented case arose during Desert Storm in the execution of air operations. Doctrine acknowledged the concept of a Joint Forces Air Component Commander, but a feasible method of disseminating the daily Air Tasking Order from JFACC to all services did not exist due to dissimilar automation systems.[21] It took actual operations to discover some of the problems with interoperability between the services that experimentation may have previously identified.

The perceived failure of the military to meet the intent of Goldwater-Nichols combined with the lack of any specific requirement for JE, led Senators Coats (R-IN) and Lieberman (D-CT) to call for the creation of a formal JE program. Senators Coats and Lieberman initiated legislation to provide the military additional guidance to reduce service parochialism and achieve the vision of Goldwater-Nichols. Senators Coats' and Lieberman's recommended solution was to amend Title 10 and create a standing Joint Forces Command as a unified combatant commander with authority over all continental based forces. This commander would additionally have the responsibility for all joint experimentation processes.[22] In other words, he would have the authority to directly task, as opposed to request, units to participate in the joint experimentation process. With respect to joint experimentation, Senator Coats argued that any experimentation left to the individual services should not be the basis for joint decisions because they are looking at different problem sets.[23] He

viewed experimentation as a necessary process, but one that should be done in the joint context. The initiation of their legislation led to the creation of the joint experimentation program under USACOM.

The JE Program

The JE program, as it exists in May 2000, is not the sweeping change envisioned by Senators Coats and Lieberman. Instead of a unified command in charge of all forces located within the continental United States with the additional charge of joint experimentation, the Department of Defense renamed USACOM to Joint Forces Command and gave it the mission of joint experimentation. The newly renamed Joint Forces Command still does not have direct tasking authority over units within the continental United States as Senators Coats and Lieberman proposed. The resultant J9 Directorate under Joint Forces Command is a compromise between Congress' desire for change and the Department of Defense's reluctance to change.

The size of the J9 Directorate is an indication of the priority the Department of Defense places on joint experimentation. There are two indications that the program is not as high a priority as Senators Coats and Lieberman desired. First, the J9 Directorate is a two star billet. In comparison, the Army places one star flag officers over the experimentation and procurement of single weapons systems (e.g. Comanche). Second, at full strength, the J9 Directorate is expected to achieve a manning level of fifty-two military and seventy-four civilian personnel.[24] In comparison, the Army used thousands of

contractors and military personnel during the Task Force XXI and Division XXI Advanced Warfighting Experiments. Regardless of its size, the J9 Directorate established a joint experimentation program.

Since its inception in 1998, the J9 Directorate of Joint Forces Command has published two annual Campaign Plans outlining the course the JE program will take. On a broad scale they identify the areas in which experimentation will take place and briefly describes the methods to be used to achieve the objectives of the JE program.

The objectives and scope of the JE program are not well defined though. The official stated purposes for the joint experimentation process are located in JE Campaign Plan 2000. There is also a stated mission and intent that while similar, have subtle differences. Additionally, several officers from the J9 Directorate indicated there is an additional purpose of the JE process.[25] All of the concepts fall within the same broad spectrum, but the differences are enough to provide confusion as to the intended direction the program should take.

Campaign Plan 2000 identifies two distinct purposes for the JE process. The first purpose is to sustain and widen the qualitative superiority of the joint force. The second is to prevent any potential adversary from surprising the United States by exploiting technology.[26] These definitions appear to focus on technology. These stated purposes alone may drive the JE program to primarily focus on material solutions.

The stated strategic objective of the JE program is broader than the stated purposes. The document defines the strategic objective of the program

as to provide recommendations to the CJCS and SECDEF on how to improve Doctrine, Organizational Structures, Training, Material, Leadership and Personnel (DOTMLP) programs for the future force.[27] The strategic objective aligns with Joint Forces Command's definition of joint experimentation.

The official mission of the JE program provides yet another direction for the program to take. Joint Experimentation's mission is to develop and assess high value concepts that will enable commanders to succeed across the full spectrum of conflict.[28] The mission broadens the potential scope of joint experimentation to the point where it could almost mean anything.

Journal publications indicate there is the additional purpose of avoiding duplication of effort inherent within the joint experimentation process. The Commander of Joint Forces Command, Admiral Harold Gehmen, indicated this in his cover letter to Campaign Plan 2000 that he forwarded to the CJCS.[29] Additionally, several of the staff officers assigned to the J9 Directorate specifically mentioned avoidance of duplication of effort as a key advantage of the joint process.[30] If valid, this additional purpose bounds the problem in a way not defined in the stated purpose, objective or mission.

Critics charge the ill-defined scope and nature of the problem to be solved will not allow joint experimentation to be a success. Senator Coats noted, "while there is a template in *Joint Vision 2010* to guide this quest it has failed thus far to effectively focus development efforts since it is regarded as being all things to all people."[31] The purpose, objective and mission are not contradictory, but they define the scope of the problem differently and none of the authoritative

documents define the relationship between JE and the services' experimentation programs. Even though the purpose of joint experimentation remains unclear, the Department of Defense is implementing a program to meet the Secretary of Defense's guidance.

The JE program is still in its infancy. The J9 Directorate selected an experimentation methodology for the program to use, but it has not been yet been tested. The methodology used in the experimentation process is critical because any results the program has must take into context how those results were obtained.

The JE process will utilize the Army's "spiral development process" as its basic methodology.[32] The spiral development process focuses on doctrine, organization and technology of increasing complexity through the means of multiple and iterative experiments. The intent is similar to the crawl-walk-run approach to training. One implication of using such an approach is that it is resource intensive, requiring a relatively large number of experiments per concept before valid conclusions are reached.

Campaign Plan 2000 frames the experimentation process on three axes associated with near, mid and far time frames. The first axis is intended to explore how off-the-shelf technology can immediately enhance current platforms. The second axis examines ways to implement *JV 2010*, while the third axis explores revolutionary concepts.[33] The intent is for experimentation to occur simultaneously on all axes using the same basic methodology.

The JE program is concept based. It identifies two separate types of concepts: integrating concepts and functional concepts. An integrating concept is one that describes how the Joint Force Commander integrates other concepts and capabilities while a functional concept amplifies a specific mission. The 2000 Campaign Plan identifies eight concepts for initial experimentation (e.g. Attack Operations Against Critical Mobile Targets).[34] These concepts are primarily derived from the Defense Planning Guidance.

The execution of the JE program to test the concepts identified relies heavily upon each of the services experimentation programs due to tasking authority and funding. Even with the establishment of a joint program, the individual services retain the authority to decide if their units will or will not participate. Due to the military's fiscal policies, the services also retain the vast majority of money that can be used for large-scale experimentation efforts. Faced with its initial inability to direct and fund its own experiments, Joint Forces Command decided to rely on the services programs for the short term.

The first major joint integrating experiment is not scheduled until FY2004. In the interim, joint experimentation is essentially service experimentation. One General Accounting Office report indicated that 37 of the 42 initial projected experiments are leveraged against experiments the services had already planned for themselves.[35]

Assessment of the JE Program

Even though the JE program is only a little over a year old in May 2000, there are several critical assessments of it thus far. These include in-house

evaluations done by Joint Forces Command, partial in-house evaluations conducted by other organizations within DoD, as well as independent evaluations conducted by the General Accounting Office and Congress. Each provides a slightly different view of the programs performance to date.

The General Accounting Office completed two assessments relating to joint experimentation in 1999, but had few findings due to their publication only months after the program was established. Neither report makes any serious findings, either pro or con, but both indicate potential problems with the process. The first report focuses on the changing role of he United States Atlantic Command. It specifically concludes that the concept of JE is good, but it will require the individual services to actively participate for the program to succeed.[36] The second report focuses on DoD's effort to transform its warfighting capabilities. In addition to also concluding the JE process will need the services help to succeed as well, it notes that a key component to success is the feedback from the process to the defense community at large.[37] Campaign Plan 2000's reliance on service experimentation indicates the GAO's findings are well founded.

The Defense Science Board Task Force 1999 report is the most comprehensive assessment of JE efforts to date. Given the mission of assessing DoD's Warfighting Transformation, the August 1999 report indicates several areas need significant improvement if the military is going to meet the demands outlined in *JV 2010*.

The report found that the service experimentation programs are well developed and have provided solid results, but the joint program suffers numerous faults. It cites four criticisms relating to the joint experimentation process. First, there appears to be a lack of a well-defined DoD-wide strategy to measure the progress of experimentation. The first JE Campaign Plan (1999) was deficient in this area. Second, the link between the experimentation process and implementing its results is weak. There currently is no specified guidance on how the results of experimentation will result in changes to the force structure. Third, there is no strong voice for joint experimentation. Even though the Joint Force Commander, Admiral Gehman, views one of his principle roles as a joint integrator, the importance of the joint program is not commensurate with the importance the services have placed in experimentation.[38] Lastly, there is no sense of urgency to develop the JE process.[39] It took congressional pressure to get the military to even establish a JE program.

Joint Forces Command's efforts do not meet the intent envisioned by Senators Coats and Lieberman. The senators desired a sweeping change to reduce the influence of the services by assigning most units directly to a joint headquarters. They concluded the power and influence of the services would remain a continual obstacle in the effort to achieve a more integrated and capable joint force.

Joint Forces Command own proof of process, completed in November 1999, assessed the JE program methodology to be adequate.[40] The iterative spiral development model was noted as the best method to achieve accurate

results. The report did stress the need for continued program development though, especially the necessity for more coordination between experiments at different levels.

All assessments stress the necessity for a sound methodology in order for the JE process to achieve measurable results.[41] It is apparent the United States military is placing more emphasis on experimentation as part of its decision-making process to develop the future force. All critics are concerned that the methodology used accurately models the nature of military operations.

Summary

This chapter indicates there is a valid necessity for joint experimentation and due to congressional pressure the Department of Defense established a program to meet the perceived need. The program falls short of what Senators Coats and Lieberman desired, but it is a significant increase over past experimentation programs. Early assessments of the program are mixed, with the controversy centering on how best to go about accomplishing the task. The following chapter examines systems theory as one possible theoretical construct to base the experimentation process on.

Chapter Three

Systems Theory

Joint Experimentation is a process designed to determine optimal solutions to problems facing the military. The problems joint experimentation is expected to solve are complex, involving numerous variables in constantly changing environments. The magnitude of the problems requires a sound theoretical construct for reducing them into manageable elements. Systems theory provides one methodology for solving complex problems. This chapter defines systems theory, addresses its benefits and criticisms, and discusses its applicability to military operations.

Systems Theory Defined

The father of systems theory, Ludwig Betalanffy, defined a system as a "set of elements standing in inter-relation."[42] An element is any discrete object that can be characterized as performing a certain function, or set of functions. Within the definition, elements can be anything from atomic particles to large, complex sub-systems of the system in question itself. It is the concept of "inter-relationship" though, that best describes a system. The acknowledgement of constant interaction between elements within a system is what ultimately distinguishes systems theory from other theoretical concepts. Where other theories are optimized to examine the individual parts, systems theory looks at problems from a larger perspective.

Systems theory can be defined as the science of "wholeness".[43] Systems theory maintains there is a fundamental difference in how any problem is approached. Where most theories attempt to explain how objects behave in relationship to other influences, systems theory attempts to analyze the whole by examining how the individual parts work together. Systems theory's focus on the whole, rather than on the individual parts, represents a dramatic departure from other theories.

Systems theory was designed as a rejection of naturalistic theories that failed to take the environment into account.[44] Naturalistic theories examine objects as they appear in nature. Objects are taken apart and reduced to their most basic elements to understand them. Rapid advances in technology within many disciplines resulted in a thorough understanding of the individual parts, but naturalistic theories still failed to explain how all the parts worked together. Systems theory recognized the shortcomings of naturalistic theories and evolved to take the changing environment into account. In order to take the environment into account, systems theory distinguishes between two types of systems.

There are two broad categories of systems: open and closed. Open systems are ones in which the individual elements have the ability to enter, exit or change at will. Closed systems are those in which the individual elements are already defined and do not change. In other words, closed systems are ones isolated from the environment. The number of elements interacting within the system, either open or closed, increases the complexity of the problem to be solved. Open systems are inherently more complex to model, but also are

infinitely more present in almost any discipline.[45] Naturalistic theories amply solve problems dealing with closed systems, but are unable to adequately model the more common open systems.

Systems theory was developed to solve complex problems in open systems. Bertalanffy recognized the need for a methodology to derive solutions to the problems that took the environment into account. The rejection of naturalistic theories did not result in a deviation from quantitative science though. Bertalanffy cited the aim of systems theory as "the formulation and derivation of those principles which are valid for "systems" in general".[46] The principles derived to solve problems associated with complex, open systems are based on quantitative analysis.

In its pure form, systems theory is mathematically based. Betalanffy contended any system could be modeled through the use of differential equations. It is the use of differential equations, instead of algebraic equations, that enables the modeling of the interaction between different elements of the system.[47] Many disciplines and fields of study have not adequately developed the differential equations to model specific systems thus far, but they arguably do exist. To aid in the development of the differential equations, Bertalanffy further delineated the components of a system.

To aid in the derivation of mathematical formulas, Bertalanffy proposed any system is made of three components. The first component is the quantitative, which accounts for the number of elements interacting within the system. The more elements there are, the more complex the system. The

second component is the elemental, which defines the composition of an element. The more variables each element has, the more complex the system. Finally is the substantive component, which defines the relationship of the elements within the system. The more inter-connected the separate elements are, the more complex the system.[48] These distinct criteria essentially allow the researcher to use separate mathematical equations to model manageable pieces of the overall equation. In the derivation of the mathematical models, several important concepts of systems theory must be realized.

An essential element of systems theory is the concept of feedback. Feedback, both positive and negative, provides the means for a system to continually adjust itself. Positive feedback reinforces behavior while negative feedback discourages that same behavior. Feedback is the mechanism of the substantive component of a system.[49] It is the presence of feedback that changes the mathematical model from simple algebraic equations into the complex differential equations that systems theory is based upon. To model feedback, systems theory assumes all systems are organized in a particular way.

Systems theory is based on the premise that systems are hierarchical in nature.[50] Both systems theory and naturalistic theory contend any system can be methodically broken down into continually smaller elements – but for different reasons. Naturalistic theory breaks down the elements in order to examine small discrete elements one at a time. In contrast, systems theory breaks down the elements in order to use a building block approach for ease in mathematical

modeling. This would not be possible without the premise that systems are hierarchical in nature.

There are innumerable derivations of systems theory. Peter Checkland describes systems theory in his book *Systems Thinking, Systems Practice* as a meta-science. In his view, systems theory is an all-encompassing concept that can be applied with other scientific methods in any discipline.[51] The prevalent use of general systems theory, since its wide spread introduction in the 1960's, is indicative of its perceived value. There are variations of systems theory though, which challenge some of the fundamental principles that it was originally built upon.

Some authors have de-emphasized the mathematical nature of systems theory, but retained the general concepts, in order to apply it to the softer sciences. Dietrich Doerner's book, *The Logic of Failure*, draws on the foundation of systems theory in his study of decision-making. While essentially defining a system the same as Bertalanffy, Doerner amplifies the importance of feedback in his work while challenging the importance of mathematical modeling.[52] The rejection of the importance of mathematical modeling expands the utility of systems theory to other sciences, like leadership and morale, which are of concern to the military. However, the importance of quantitative analysis is not the only premise being debated within systems theory.

Kevin Kelly introduced the concept of swarm systems in his book *Out of Control*. As a branch of systems theory, Kelly challenged the premise that all systems are hierarchical in nature. Kelly took the opposite approach claiming

that in the future, successful systems will not be hierarchical at all. [53] Within his model there are relatively few, strong relationships between elements. Consequently, each element of a system is free to experiment as long as it is towards the same basic goal. The concept of swarm systems retains the basic focus of general systems theory of examining the whole, but challenges one of its basic premises.

The Benefits of Systems Theory

Developed from a perceived need to provide more comprehensive solutions to complex problems, systems theory attained wide usage in many disciplines. Scientists shifted away from naturalistic and reductionist theories and moved towards systems theory because of its benefits. The four major benefits of systems theory are discussed below.

Systems theory accurately depicts real situations by modeling them as open systems.[54] Other theories that rely on modeling systems as closed, dismiss the reality that most systems are open. Naturalistic theories that only examine particular elements of a system may determine a wealth of information about a particular element, but they cannot predict how the element will ultimately work in its environment. Systems theory not only takes the environment into account, but also recognizes that the environment is constantly changing.

Systems theory is better suited to deal with complex problems because it examines the causal links between elements in a system. Where naturalistic theories model the inter-relationship between elements as fixed, systems theory

allows for the relationships between elements to change based on the environment.[55] The use of differential equations enables the concept of feedback to account for these changing relationships.

Systems theory takes into account second and third order effects. Failing to take the whole system into account diminishes the influence of "side effects and repercussions," which ultimately leads to failure. Dorner describes this as a common error because it generally saves time and mental energy. [56] Although more difficult, systems theory takes into account affects that might have never been considered by other theories.

Systems theory aids in decision-making. Effective decision–making requires recognition of how situations change. Gary Klein notes in his book, *Sources of Power*, that failure to adapt to a changing situation inevitably leads to poor decisions.[57] Changing situations, or a changing environment, is another way of describing an open system – the type that Bertalanffy developed systems theory to solve. While Klein does not specifically reference systems theory, his work is built upon the same principles that systems theory is derived from.

Criticisms of Systems Theory

Systems theory has several noted criticisms. There are strong arguments against the use of a holistic concept. The following section briefly discusses the major criticisms of systems theory, as well as systems theorists' general responses.

The first major criticism is systems theory's mathematical basis can lead to incorrect solutions if the equations are wrong. Because systems are so large and complex when compared to analyzing individual elements, critics argue the chance for mistakes in modeling of relationships are significant.[58] Systems theory advocates acknowledge this potential, but counter with two points. First, other theories do not examine the whole as systems theory does; thus it is better to have a poor model of the whole than none at all. Second, the mathematical modeling of systems will continue to improve over time.[59]

Another criticism is large, complex systems may result in meaningless analogies. This criticism is based on idea that too much information is being examined. As systems grow in size and complexity, it becomes increasingly more difficult to attribute the response of the entire system to any one particular element's behavior. Critics argue that without the ability to derive discrete solutions, systems theory only provides analogies that are difficult to quantify and subsequently react upon.[60] The response is that systems theory was never intended to explain a system by itself. It must be used in conjunction with other concepts to explain the behavior of the elements of the system.

A final criticism is systems theory fails to explain behavior. Most scientific endeavors not only want to predict behavioral patterns, but also to discern why they occur. Critics argue that systems theory does not fully meet their needs in that although it may provide the understanding of behavioral patterns, it does not attempt to answer the question of why.[61] Advocates of systems theory

somewhat concede this point, but respond that understanding how a system works is the first step in determining why it works the way it does.

Applicability of Systems Theory to Military Operations

Prior to evaluating the use of systems theory to military operations, the question of whether or not it applies must be answered. Without understanding if military operations resemble the type of problem systems theory is intended to solve, the theory could be misapplied and lead to inaccurate results in the joint experimentation process. Systems theory applies to military operations for the following reasons.

First, the military is a complex organization due to the number of elements and their degree of interaction. Within any military operation there are innumerable elements all working towards the same goal. Some elements are physical, such as particular weapons platforms, while others are cognitive such as the morale or leadership of a particular unit. In Bertalanffy's terms, there is a high quantitative element to military operations. Second, the inter-relationships between the separate components, the substantive element, are intricate. For example, the effect of leadership maintains a strong influence on almost every other element within the military system. These two factors make military operations complex in nature.

Second, military operations are best modeled as open systems. The actions of the enemy, the weather and even to some extent the actions of other friendly forces constantly change the environment in which the military must

operate. The military acknowledges working within an open system through its doctrinal requirement to continually perform mission analysis.[62]

Third, the military is a hierarchical organization. The organizational structure of military units is the obvious example of hierarchical organization, but there are others. The military's education system, its network of automation systems and its personnel rank structure are also examples of how the military is hierarchical in nature. Even more, the military's organizational structure is firmly established. Military operations satisfy this premise of systems theory.

Finally, systems theory is applicable to the operational level of war. Shimon Naveh relates in his book *In Pursuit of Excellence* that systems theory is the most applicable to the military at the operational level of war.[63] He notes the complexity of situations and the changing environment at the operational level of war are more profound than at other levels. The operational level of war is also the focus of joint experimentation.[64]

Summary

Systems theory attempts to examine how a particular system operates within the context of its environment. It is specifically designed to model open systems, the type other theories fail to adequately consider. Military operations, especially those at the joint level can be characterized as open systems. Consequently, systems theory applies to military operations and more specifically to joint experimentation. This chapter defined systems theory and its applicability to military operations, the next examines its viability.

Chapter Four

Systems Theory and Joint Experimentation

Systems theory provides an alternative methodology for the joint experimentation program. This chapter answers the question of should JE be based on systems theory. Three criteria are used to determine the viability of systems theory as the methodology for the joint experimentation program.

Would the Application of Systems Theory Help Achieve the Stated Purposes of the Joint Experimentation Program?

The first purpose of JE, to sustain and widen the qualitative superiority of the joint force, is difficult to measure against any methodology because there are no defined criteria to measure against. Campaign Plan 2000 does not distinguish any clear measures of success for the quality of the joint force, nor does the plan state against whom the qualitative superiority is to be measured against.[65] With such a vague purpose, the application of systems theory to help achieve the qualitative superiority of the joint force, must be measured relative to naturalistic theories abilities to achieve the same goal. From this perspective, systems theory would help the joint experimentation process in sustaining and widening the qualitative superiority of the joint force for two reasons.

First, systems theory would arguably improve the quality of the joint force whereas experimentation efforts in May 2000 only improve the quality of the

components. The separate service experimentation programs, based on naturalistic theories, are designed primarily to increase the quality of the respective service. The increase in capability of a single component may improve the quality of the joint force, but there is no guarantee of that. One service's increase in capability may actually decrease the capability of the joint force if it conflicts with the other services. The increase in the Navy and Marine Corps electronic warfare (EW) capability partially led to the Air Force's decision to retire its electronic warfare platform, the EF-111. While the Air Force supported the Navy and Marine Corps' increase in capability of its EW platform, the EA-6B, the decision arguably decreased the capability of the joint force to conduct electronic warfare.[66] The application of systems theory provides a methodology that looks at the broader perspective of the joint force.

Second, if the quality of a force is a function of its components, systems theory could increase the quality of the force by looking at all the components and the links between them. Systems theory also recognizes the need to improve the quality of the individual components, but it emphasizes the need to improve the causal relationships between them. An example of where the services failed is the evolution of digital message formats. Through successive experiments, the Navy and Air Force increased the capability of its digital format, Link 16. Likewise, the Army continually improved its digital message format known as Variable Message Format. Even though the two separate formats continued to improve, they are still fundamentally incompatible making joint operations more difficult.[67] This failure led to the integration of the two formats

as one of the nine concepts identified for initial experimentation in Campaign Plan 2000. Where naturalistic theories focus on the individual elements, systems theory focuses on the ability of the elements to work in concert, improving the quality of the overall force.

The second stated purpose of joint experimentation, to prevent any potential adversary from surprising the United States by exploiting technology, is also difficult to measure against a methodology because again there are no defined criteria for success. Campaign Plan 2000 does not define what technological surprise is, or any measures of effectiveness for the program in achieving the goal.[68] Without any defined measures of effectiveness, the application of systems theory to help achieve the qualitative superiority of the joint force must again be measured relative to naturalistic theories abilities to achieve the same goal. Compared with naturalistic theories, systems theory aids in the achievement of the second purpose.

Systems theory provides a stronger basis than naturalistic theories for evaluating more potential threats. The second stated purpose delineates the requirement to prevent technological surprise from any potential adversary. The exploitation of technology by any adversary to surprise the United States potentially includes a vast array of actions across the entire spectrum of conflict. Naturalistic experimentation only allows for a finite number of options to be explored. However, without the use of some other methodology, there is no assurance that use of naturalistic theory will result in experimentation in the most important areas. Systems theory's look at the whole force provides a means to

determine the areas the military is the most vulnerable and hence where experimentation should focus.

Use of systems theory would help achieve the unofficial purpose of reducing duplication of effort within the experimental community. Although experimentation efforts across the military are increasing, they are still guided by the parochial desires of the services, resulting in the competition for limited resources. This competition sometimes results in wasted effort due to duplication of effort. As an example, both the Marine Corps and the Army began new experimentation projects with Military Operations in Urban Terrain (MOUT) in the mid-1990's. Instead of wide collaboration between the two services to solve different parts of the problem, the two services conducted similar experimentation, competing for the same limited resources.[69] It was not until 1996, after two years of duplicated effort, the two services combined efforts as part of an Advanced Concept Technology Demonstration. Systems theory provides a methodology for organizing experimentation programs within the military to reduce unnecessary duplication.

Adherence to the systems theory principle of hierarchy would avoid duplication of effort. Adoption of systems theory would provide an organized structure to all military experimentation programs. Enabling the joint program to guide the efforts of the services towards achieving results, would help the whole force. Supporting experimentation programs would provide the foundation of results to base the joint program upon. The use of systems theory would not

prohibit duplication of effort, but limit it to only those areas where competition is desired.

Without any clearly defined measures of success, it is difficult to determine if systems theory helps achieve the two official purposes of the joint experimentation program. Even though systems theory is relatively better than the naturalistic theory alternatives, it still cannot be categorically claimed it will help achieve the objectives. Systems theory would help achieve the unofficial purpose of reducing the duplication of effort among experimentation programs.

Does Systems Theory Reflect How the Military Intends to Conduct Warfighting?

Joint doctrine presupposes the military will fight as a system. Authoritative by design, joint doctrine prescribes the planning of military operations to consider the use of all available forces to achieve the military objective. Those forces include all components of the individual services working together with a common purpose as part of the joint force. Joint doctrine, the fundamental principles by which military forces guide their actions, provides several indications the military will fight as a system.

The constant revision of doctrine at all levels is a reflection of the military's belief that it operates in an open system, subject to changes in environment. Both joint and service doctrine manuals are periodically revised. Each manual is revised on a different frequency though, based in large part on its applicability over time. The revision of doctrine with respect to changes in the environment,

reflect the military's acknowledgement that it operates in an open system, the type systems theory was designed to model.

Service doctrine supports the concept of the individual service components fighting as part of the joint system.[70] None of the services espouse conducting operations individually as the normal method of warfighting. All recognize their place in the hierarchical structure of the joint force. The nesting of service doctrinal concepts within the joint doctrinal framework is an example of the hierarchical organization systems theory addresses. Other key aspects of systems theory are also present in joint doctrine.

The use of centers of gravity in joint doctrine signifies the military's doctrinal acceptance of the importance of inter-relationships between separate elements. Doctrine states the focus of military effort should be to attack specific points in order to affect the enemy's center(s) of gravity.[71] This is acknowledgment that causal relationships between elements in a system allows for the defeat of some elements to have an impact greater than their intrinsic value. The use of centers of gravity is an example of how the military views itself and its adversaries as systems.

Systems theory reflects how the military intends to conduct warfighting. Elements of systems theory are present in both joint and service doctrine, representing how the military plans to conduct operations. Systems theory passes the second criteria.

Would the use of systems theory at the joint level provide any benefits not provided by other means?

This criteria is measured against both the other experimentation efforts existing in May 2000, and the implementation of a naturalistic theory approach to the joint experimentation process. Given that framework, systems theory provides three benefits not otherwise provided.

Systems theory provides a structured, hierarchical approach to the joint experimentation process, reducing duplication of effort. As of May 2000, experimentation programs are not hierarchical. Coordination exists between service programs on specific issues, but there is no overarching design intended to guide all experimentation programs.[72] A naturalistic theory approach to joint experimentation alone does not rectify this. Naturalistic theory focuses on improving specific elements, not improving the whole process. Systems theory's adherence to hierarchy at the joint level provides the context for other experimentation programs to work within, thereby reducing unwanted duplication of effort.

Use of systems theory considers second and third order effects applicable to the joint force which are not considered by service experimentation programs. Service experimentation tends to look at its own structure changing but the other services structure remaining constant. For example, when the Army looks at developing a new combat system for procurement in the future, it measures its transportability against what the Air Force currently has, or is in the process of fielding, not what it is looking at in the future.[73] The use of naturalistic theory at

the joint level magnifies this issue because of its focus on how the environment impacts a particular element instead of how the element will impact the environment. In contrast, systems theory provides a means to examine the second and third order effects of one experiment across all services.

Systems theory's modeling of military operations as an open system provides the joint experimentation program the flexibility to adapt to changing situations. Naturalistic theory isolates the element being experimented upon from the environment, which can result in an object optimized for specific situations. Unfortunately, naturalistic theories do not ensure optimization across a wide spectrum of changes in the environment. For example, the United States optimized the M1 tank and the M3 Bradley Fighting Vehicle for use in the Cold War in a European environment. Since the end of the Cold War, the military is increasingly faced with deploying forces to locations where the transportation infrastructure will not support the weight of those vehicles. Systems theory may have recognized a potential change in the environment in order to address that problem.

Systems theory provides benefits not provided by other means. Neither the existing experimentation programs nor application of a naturalistic theory at the joint level provides a hierarchical structure to reduce the duplication of effort, takes into consideration second and third order effects and readily adapts to changing situations.

Summary

Systems theory meets two of the three criteria it was examined against. It fails to meet the first criteria, the ability to achieve the stated purpose of joint experimentation, because there are no defined standards to measure against. Systems theory arguably could meet the criteria if and when any measures of merit are developed. Systems theory meets the other two criteria: reflecting how the military intends to conduct operations and providing benefits not provided by any other means.

This chapter examined the viability of systems theory as the basis for joint experimentation. It showed that systems theory provides a feasible methodology for joint experimentation. The final chapter draws conclusions and provides recommendations for implementing systems theory into the joint experimentation program.

Chapter Five

Conclusions and Recommendations

As of May 2000, Joint Forces Command is still formalizing the design of the joint experimentation program. This is a critical step in ensuring the program's ultimate success or failure. Without a viable methodology, the program may never achieve the objectives set for it. This chapter draws several conclusions and provides recommendations for the improvement of the joint experimentation program methodology.

Conclusions

Some elements of systems theory exist within the Joint Experimentation's spiral development methodology as defined in Campaign Plan 2000. The two theoretical constructs are not identical, but many concepts of systems theory are apparent in spiral development. The similarities between the two concepts are the strengths of the spiral development methodology.

The focus of experimentation identified in Campaign Plan 2000 on concepts, instead of weapons platforms, shows an understanding of systems theory. Each of the concepts identified in Campaign Plan 2000 selected for initial experimentation (e.g. attack against critical mobile targets) represent the experimentation on a multitude of elements designed to achieve a common aim. This holistic approach acknowledges that it takes a whole system to achieve the singular mission.

The iterative nature of the spiral development process accounts for the military as an open system. Spiral development's continual testing of the same concept under different conditions shows an understanding of the environment in which the concept is designed for, continually changes. Other research calls for the necessity of iterative experimentation on a single concept, as Campaign Plan 2000 is designed, before final conclusions are drawn.

The spiral development process also takes into consideration second and third order effects as prescribed by systems theory. Instead of conducting a singular experiment, each successive experiment adds complexity by increasing the number of elements in the system. The combination of additional elements and multiple experiments throughout the process increases the chance of recognizing second and third order effects that might have gone unnoticed.

The second conclusion is that adoption of systems theory can improve the JE program. The use of systems theory should not replace the already proven spiral development process, but complement it. Where the spiral development process provides a structure for testing an individual concept, systems theory provides a methodology for developing the experimentation process within the military. The use of systems theory can rectify the lack of coordination between the different experimentation programs existing in May 2000 by establishing a relationship between them.

Systems theory can provide a hierarchical structure to the military's experimentation programs, avoiding duplication of effort. The lack of defined roles for the joint and service experimentation programs retain the potential for

some concepts receiving too much attention, while other areas critical to the joint force not being explored at all. The hierarchical nature of systems theory provides the construct for an optimal expenditure of the limited resources available.

Systems theory also provides a methodology to experiment on the most critical issues facing the military. The holistic view systems theory provides enables experimentation on broad concepts instead of individual solutions to specific problems. Given there are finite fiscal resources, a logical approach to determining what experimentation should occur, is warranted.[74]

The final conclusion is the introduction of systems theory into the JE program would be problematic. The implications of adopting systems theory significantly affect the relationship between the joint community and the individual services. Resistant to change, the military has to overcome these obstacles if systems theory is adopted.

The adoption of systems theory may result in opposition by the services, which would have to subordinate their experimentation programs to the joint program. Joint experimentation was largely opposed by the services because it was perceived that it would indirectly decrease their influence. The adoption of systems theory, including its hierarchical approach to problem solving, is likely to garner the same type of opposition from the services.

Without a change in the funding structure, joint experimentation is still subject to parochial debates despite the methodology used. Campaign Plan 2000's reliance on the service experimentation programs to achieve joint

experimentation objectives creates the potential for conflict between the joint and service communities. Without adequate funding for the joint experimentation process, each service may attempt to expand their experimentation programs to the point where they are in undesired competition with each other. The adoption of systems theory by itself does not change the possibility for conflict.

Recommendations

The Department of Defense should incorporate systems theory as the base methodology for the joint experimentation program. While conceptually not a significant departure from the spiral development process, the use of systems theory requires several concrete changes within the Department of Defense. In order to accomplish this recommendation, two specific actions must occur.

First, the Secretary of Defense needs to clearly define the role of experimentation at the joint and service level. Until there is a clear delineation of what the joint and separate service programs are to achieve, there will be confusion over who should conduct what aspects of experimentation. The 2001 Quadrennial Defense Review provides the means for the Secretary of Defense to delineate the role of experimentation at both the joint and service levels. The use of systems theory necessitates a specific role for joint experimentation as well its association with the service experimentation programs.

With the adoption of systems theory, experimentation within the military must be hierarchical with the joint experimentation program at the top. Each of the service experimentation programs while still belonging to its respective

service, requires subordination to the joint experimentation program for program oversight. This arrangement allows the services to continue their own experimentation programs as long as they support the experimentation goals of the joint force. The joint experimentation program must have the authority to direct, when necessary, what experimentation the services conduct.

Expanded authority of the joint program over the service programs requires Joint Chiefs of Staff oversight. Joint Forces Command should retain its executive agent role for the joint experimentation program, but any decision redirecting a service experimentation program has to be made at the JCS level. To provide JCS oversight, the Secretary of Defense should mandate the Joint Readiness Oversight Council (JROC) to serve as decision-making body for the joint experimentation program. The prioritization of joint and service level experimentation is a logical addition to the JROC, which is already responsible for recommending procurement priorities amongst the services.[75]

Joint experimentation should only experiment on systems. Virtually all resources the joint force employs are procured, maintained and trained by the individual services. Consequently, the joint force should focus solely on the integration of the service components to make the joint system more efficient. This conforms to how Admiral Harold Gehman, Commander of Joint Forces Command, sees the experimentation program.[76] This approach relies on the services to maintain their own robust experimentation programs.

The individual services should rely on a combination of naturalistic and systems theory based experimentation within the rubric of JE. Systems theory

acknowledges the need for testing of individual elements within a system. The service experimentation programs are the correct place for this to happen. The use of naturalistic and systems theory based experimentation allows for complete development of a concept that is ultimately used at the joint level.

The second major change is the requirement for joint experimentation to receive its own funding. As long as the joint program is reliant on the services, there is an inherent conflict as to whose goals take primacy given limited resources. Separate funding for the joint program provides the best means for alleviating any potential conflict between Joint Forces Command and the service conducting the experiment.[77]

The Department of Defense should apply systems theory as the basis for its joint experimentation program. Its application incorporates the strengths of the service experimentation programs by providing a means to coordinate all experimentation to meet the challenges of tomorrow.

Endnotes

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[1] Harold W. Gehman, Jr., "Transforming NATO Capabilities," *Joint Forces Quarterly* 21, (Spring 1999): 50. Admiral Gehman is the commander of Joint Forces Command, formerly United States Atlantic Command at the time the article was written.

[2] United States Atlantic Command. *Joint Experimentation Campaign Plan 2000*. Norfolk, Virginia: United States Atlantic Command, 1999, F-2. There are no other definitions of joint experimentation in military references other than those produced by Joint Forces Command.

[3] Douglas C. Lovelace, Jr. *Unification of the United States Armed Forces: Implementing the 1986 Department of Defense Reorganization Act* (Carlisle, PA: Strategic Studies Institute, 1996), vii.

[4] U.S. Department of Defense, *Joint Publication 1-02: Dictionary of Military and Associated Terms*. Washington D.C.: U.S. Government Printing Office, 1998, 236.

[5] Mark Clodfelter, *The Limits of Air Power* (New York: The Free Press, 1989), 128-130.

[6] Thomas: Legislative Information on the Internet. *Bill Summary and Status for the 99th Congress*. Thomas, 1986. Accessed 25 January 2000. available on-line: http://thomas.loc.gov/cgi-bin/bdquery/D. The Senate vote was unanimous while the House voted in favor of the bill 383-27.

[7] Dennis Reimer, "Leaping Ahead to the 21st Century," *Joint Forces Quarterly 17* (Autumn/Winter 1997-98): 22-23. General Reimer's perspective as the Army Chief of Staff is especially valuable because he was representing the Army and not a joint position. His article mentions the need for greater emphasis on joint operations, training, experimentation and integration.

[8] Department of Defense, *Joint Vision 2010*. Washington D.C., 1996.

[9] Force XXI Joint Venture Office. *Joint Venture Home Page*. Joint Venture Office, 1999. Accessed 6 December 1999. Available on-line: http://jointventure.monroe.army.mil. The Air Force organized the Air Force Experimentation Office in 1994. The Marine Corps established the Marine Corps Warfighting Laboratory in 1995.

[10] Center for Army Lessons Learned. *Task Force XXI Lessons Learned*. Center for Army Lessons Learned, 1997. Accessed 12 December 1999. Available on line: http://www.call.army.mil.

[11] Air Force Experimentation Office. *Air Force Exerperimentation Office Home Page*. Air Force, 2000. Accessed 29 March 2000. Available on-line: http://afeo.langley.af.mil/afeo. In coordination with the Army's Joint Venture Office, the Air Force tried to include the other services in its Expeditionary Force Experiment in 1999 to achieve the horizontal integration between services. However due to funding issues, the exercise remained primarily an Air Force experiment.

[12] Richard D. Hooker Jr. "Joint Campaigning in 2010," *Joint Forces Quarterly* 21 (Autumn/Winter 1999): 43.

[13] Center for Defense Information. *U.S. Military Spending , 1945-1996.* Center for Defense Information, 1996. Accessed 1 April 2000. available on-line: http://www.cdi.org/issues/milspend.html.

[14] Anthony H. Cordsman, "The Crises in US Defense Spending: A Reality Check," (Washington D.C.: Center for Strategic and International Studies, 1999), 8. The report also showed that national defense spending, as a percentage of the federal budget is at its lowest level since prior to 1940 (10). Military spending in FY00, as a percent of the federal budget is 55% of that in FY88 (11).

[15] U.S. Department of Defense, *J9 Homepage.* Joint Forces Command, 2000. Accessed 17 January 2000. available on line:http://www.acom.mil/jexp.nsf.

[16] *Defense Reorganization Act,* section 3.

[17] Ibid., section 201.

[18] Ibid., section 301.

[19] *JV 2010*, 36.

[20] Ibid., 32.

[21] Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington D.C.: U.S. Government Printing Office, 1993), 149.

[22] Congress, Senate, *Joint Warfighting Experimentation*, 105th Cong., S.B. 2132, Admendment 3407 (30 July 1998). S2132.

[23] Dan Coats, "Joint Experimentation: Unlocking the Promise of the Future," *Joint Forces Quarterly* 17 (Autumn/Winter 1997-1998): 17. Senator

Coats was not re-elected in the 1998 election and subsequently fulfilled his term in 1999.

[24] *Joint Experimentation Program, JROC.* United States Joint Forces Command, 1999. Accessed 7 December 1999. Available on-line: http://www.acom.mil.

[25] Mark A. Johnstone, Stephen A. Ferrando, and Robert W. Citchlow, "Joint Experimentation: A Necessity for Future War," *Joint Forces Quarterly* 20 (Autumn/Winter 1999): 15. All three authors are part of the J9 Directorate and indicate that eliminating duplication of effort is also a purpose of the JE program.

[26] United States Atlantic Command. *Joint Experimentation Campaign Plan 2000*, iii. The two official purposes highlighted in the executive summary on page iii do not appear any where else in the Campaign Plan. The strategic objective is listed in chapter one: Situation, and the mission is listed in chapter two: Mission and Guidance.

[27] Ibid., 1-1.

[28] Ibid., 2-1.

[29] Harold W. Gehman Jr., "Joint Experimentation Campaign Plan 2000,": Memorandum to Secretary of Defense / Chairman, Joint Chiefs of Staff. United States Atlantic Command, 1999.

[30] Mark A. Johnstone, Stephen A. Ferrando, and Robert W. Citchlow, "Joint Experimentation: A Necessity for Future War," *Joint Forces Quarterly* 20 (Autumn/Winter 1999): 15.

[31] Coats, 13. Almost all of Senator Coats remarks indicate that his primary focus in the experimentation process is fiscal related.

[32] *JE Campaign Plan 2000*, 3-9.

[33] Ibid., iii.

[34] Ibid., 3-7. Campaign Plan 2000 lists eight concepts for initial experimentation: Attack Operations Against Critical Mobile Targets, Common Relevant Operational Picture, Adaptive Joint Command and Control, Joint Interactive Planning, Information Operations, Focused Logistics: Enabling Early Decisive Operations, Forcible Entry Operations, and Strategic Deployment.

[35] United States Government General Accounting Office. *Military Operations: Status of DOD's Efforts to Develop Future Warfighting Capability.*

Washington D.C., 1999. Report to the Chairman, Committee on Armed Services, U.S. Senate, GAO/NSIAD 99-64., 24-25.

[36]*U.S. Atlantic Command: Challenging Role in the Evolution of Joint Military Capabilities,* 57.

[37] *Military Operations: Status of DOD's Efforts to Develop Future Warfighting Capability.*

[38] *U.S. Atlantic Command: Challenging Role in the Evolution of Joint Military Capabilities*, 51.

[39] Defense Science Board Task Force., 17-19.

[40] David Robinson, Interview by author, 31 March 2000. Major Robinson works on the J9 staff at Joint Forces Command.

[41] Office, United States Government General Accounting. *Military Operations: Status of DOD's Efforts to Develop Future Warfighting Capability.* Washington D.C., 1999. Report to the Chairman, Committee on Armed Services, U.S. Senate, GAO/NSIAD 99-64.

[42] Ludvig von Bertalanffy, *General Systems Theory* (New York: George Braziller, 1968), 38. Many of the concepts used in systems theory were not developed by Bertalanffy. Authors such as Marx and Hegel proposed the idea of looking at problems holistically. Bertalanffy however was the first prominent author to use the term "systems theory" and apply it to more than a single discipline.

[43] Ibid., 37.

[44] Peter M. Senge, *The Fifth Discipline* (New York: Currency Doubleday, 1990), 185. Senge uses the term "reductionism" as a synonym for the naturalistic theories that most other authors describe.

[45] Bertalanffy, 39.

[46] Ibid., 32.

[47] Ibid., 18-19.

[48] Shimon Naveh, *In Pursuit of Military Excellence* (London: Frank Cass, 1997), 4. Naveh describes systems theory as the basis for his examination of operational art in both Soviet and Western military culture.

[49] Dietrich Dorner, *The Logic of Failure* (New York: Metropolitan Books, 1989), 74-75. Dorner further defines two separate types of variables within a system based on the impact that their feedback has. Critical variables are ones that have a major influence on the whole system due to the number of other elements it interacts with. Indicator variables are ones that depend on other variables within the system but have little influence on the system itself.

[50] Peter Checkland, *Systems Thinking, Systems Practice* (New York: John Wiley & Sons, 1981), 19, 74-82.

[51] Ibid., 9.

[52] Dorner, 73-75.

[53] Kevin Kelly, *Out of Control* (New York: Addison-Wesley Publishing Company, 1994), 307-309.

[54] Naveh, 5. Naveh is specifically cites that the military should be modeled as an open system. Other authors, like Churchman, also contend that systems theory provides a stronger representation of reality (Churchman, 8).

[55] Bertalanffy, 45.

[56] Dorner, 86.

[57] Gary Klein, *Sources of Power* (Cambridge: MIT Press, 1998), 155-156. Klein uses several empirical case studies to show that individuals who actively accounted for changes in the scenario performed better than those who did not take outside influences into consideration.

[58] C. West Churchman, *The Systems Approach and Its Enemies* (New York: Basic Books, Inc., 1979), 11. Churchman's book applies systems theory to the study of ethics. He cites the enemies of systems theory as politics, morality, religion and aesthetics because each of those areas are founded in reductionism.

[59] Bertalanffy, 14.

[60] Ibid., 35.

[61] Ibid., 36.

[62] Joint Publication 5-0. Joint doctrine notes that mission analysis is a continuous process that does not end until the mission is completed.

[63] Naveh, 9. Naveh makes this claim based on his analysis that the operational level of war, instead of either the tactical or strategic levels, that most approximates the military system.

[64] *JE Campaign Plan 2000*, 3-2. Campaign Plan 2000 notes that JE will primarily focus on the operational level of war, but will also address some strategic concepts.

[65] Ibid., iii. The only reference to the stated purpose is in the executive summary on page iii. Campaign Plan 2000 does not further address the purpose or any measures of success.

[66] Bruce Rolfsen, "Was the EF-111 Raven retired too soon?" *Air Force Times,* 6 September 1999, 22. After officially supporting the decision to increase funding for the EA-6B and retire the EF-111, all Air Force publications indicate that in hind-sight, critical capability was lost.

[67] U.S. Department of Defense. *Link 16*. Advanced Systems & Concepts homepage, 2000. Accessed 18 April 2000. Available on line: http://friends.acq.osd.mil/at/link16.htm.

[68] *JE Campaign Plan 2000*, iii. The only reference to the stated purpose is in the executive summary on page iii. Campaign Plan 2000 does not further address the purpose or any measures of success.

[69] U.S. Department of Defense, *MOUT ACTD,* Advanced Combat Technology Demonstration homepage, 2000. Accessed 2 April 2000. available on line: http://friends.acq.osd.mil/at/mout.htm. The Army and Marine Corps started independent experimentation into MOUT in 1994 and 1995 respectively. In 1997 an Advanced Concept Technology Demonstration on MOUT integrated many aspects of both programs. MOUT is one of the few areas where inter-service cooperation on experimentation has already occurred. It is important to note that it did not occur until after a 1996 Joint Warfighting Science and Technology Plan cited the individual programs as needlessly duplicating effort.

[70] Steven Rotkoff, interview by author, telephone, Fort Leavenworth, KS, 18 April 2000. COL Rotkoff is a doctrine writer for Field Manual 100-5. He notes that an underlying premise of the manual is that that the Army is subordinate to the Joint Force Commander for most operations.

[71] U.S. Department of Defense, *Joint Publication 5-00.23-52: Joint Task Force Planning Guide and Procedures* (Washington D.C.: U.S. Government Printing Office, 13 January 1999), IX-42.

[72] Robert P. Haffa Jr. and James H. Patton Jr., "The Need for Joint Wargaming: Combining Theory and Practice," *Parameters*, Autumn 1999, 108.

The authors conclude that until wargaming/experimentation reflect the realities of the joint battlefield, they will not succeed. Colonel (Retired) Haffa is a former Air Force Officer and Captain (Retired) Patton served in the Navy.

[73] The requirements for the new medium armored vehicle were all based on the ability to transport it in the C-130 aircraft.

[74] Stephen P. Aubin, "Stumbling Toward Transformation: How the Services Stack Up," *Strategic Review,* Spring, 2000, 47. The article highlights the decreasing expenditures on research and development as a trend whose impact will be felt ten to twenty years from now. The article cites that R&D funding, measured in FY2000 dollars, decreased from a high of $49 billion in 1987 to $34 billion in 2000.

[75] William A. Owens, "JROC: Harnessing the Revolution in Military Affairs," *Joint Forces Quarterly* 5 (Summer 1994): 56. At the time the article was written, Admiral Owens was the Vice Chairman of the Joint Chiefs of Staff.

[76] Harold W. Gehman, Jr., "Transforming NATO Capabilities," 50.

[77] Wayne M. Hall, Lecture to the Advanced Military Studies Program, School of Advanced Military Science, 20 April, 2000. Brigadier General (Retired) Hall is a former military intelligence officer who has dealt extensively with experimentation and procurement issues.

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