

Battlefield Distribution: A Systems Thinking Perspective

A Monograph

By

MAJ Paul W. Rodgers

United States Army



**School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas**

AY 04-05

Approved for Public Release; Distribution is Unlimited

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 052605	3. REPORT TYPE AND DATES COVERED Monograph	
4. TITLE AND SUBTITLE Battlefield Distribution: A Systems Thinking Perspective			5. FUNDING NUMBERS	
6. AUTHOR(S) MAJ Paul Rodgers				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College School of Advanced Military Studies 250 Gibbon Ave. Fort Leavenworth, KS 66027			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Command and General Staff College FT Leavenworth, KS 66027			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE A	
13. ABSTRACT (Maximum 200 Words) The purpose of this monograph is to analyze the U.S. Army battlefield distribution system from a "Systems Thinking" perspective. The method involves a holistic analysis of the distribution systems as it functions within its environment. Because identification of patterns and anomalies is an important aspect of Systems Thinking, the subject matter of this monograph reaches beyond Operation Iraqi Freedom (OIF) to historical precedent. Whether for tomorrow, or the more distant future, the object is to discover the leverage points within the system that will help the U.S. Army avoid repeating the logistics shortcomings of OIF. To assist in this endeavor, this monograph explores Peter M. Senge's "System Thinking" perspective. The intent is to apply his methodology to analyze the U.S. Army battlefield distribution system within the context of its enacted environment, in order to discover the leverage points within the system that afford effective and lasting solutions to current battlefield distribution problems.				
14. SUBJECT TERMS Battlefield Distribution, Logistics, Distribution System, Supply Velocity Management, Just in time Logistics			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT U	18. SECURITY CLASSIFICATION OF THIS PAGE U	19. SECURITY CLASSIFICATION OF ABSTRACT U	20. LIMITATION OF ABSTRACT none	

SCHOOL OF ADVANCED MILITARY STUDIES

MONOGRAPH APPROVAL

MAJ Paul W. Rodgers

Title of Monograph: Battlefield Distribution: A Systems Thinking Perspective.

Approved by:

Bruce Menning, Ph.D.

Monograph Director

Kevin C.M. Benson, COL, AR

Director,
School of Advanced
Military Studies

Robert F. Baumann, Ph.D.

Director,
Graduate Degree
Programs

ABSTRACT

BATTLEFIELD DISTRIBUTION: A SYSTEMS THINKING PERSPECTIVE by MAJ Paul W.

Rodgers, U.S. Army, 50 pages.

The purpose of this monograph is to analyze the U.S. Army battlefield distribution system from a “Systems Thinking” perspective. The method involves a holistic analysis of the distribution systems as it functions within its environment. Because identification of patterns and anomalies is an important aspect of Systems Thinking, the subject matter of this monograph reaches beyond Operation Iraqi Freedom (OIF) to historical precedent. Whether for tomorrow, or the more distant future, the object is to discover the leverage points within the system that will help the U.S. Army avoid repeating the logistics shortcomings of OIF.

To shed some historical light on the current problem with U.S. Army distribution, this monograph examines the German Army’s attempt at solving an identified battlefield distribution problem during the interwar period (1919 - 1939). The solution employed by the German Army was based on the assumption that a quick and decisive victory could substitute for sustained logistic support. This assumption was a major error, and in the case of Operation Barbarossa, it proved fatal.

Like the German Army of 1919-1939, the U.S. Army also identified and attempted to solve the challenges of battlefield distribution during its own interwar period. In the years between the Persian Gulf War and the present conflict in Iraq, the U.S. Army instituted a new logistics distribution system based on a successful business practice called “Just In Time” (JIT). The U.S. Army’s version of JIT was called Velocity Management or VM, and it initially seemed very promising. Unfortunately, when VM was put to the test during OIF, it failed to overcome the distribution problems that necessitated its creation. Thus, despite a massive effort since the 1991 Gulf War, the U.S. Army still has a battlefield distribution problem. According to the U.S. Army’s top logistician, LTG Claude V. Christianson:

Today’s Army is not able to respond rapidly and precisely when support requirements are identified. We do not have the battlefield distribution system that we need. We cannot provide time definite delivery schedules, and we cannot effectively control physical movements across the new battle environment.

One of the main reasons for the failure of VM is that like the German Army solution of 1919-1939, it is implicitly based on the assumption that victory will be quick and decisive.

Thus, as the U.S. Army address the challenges of the current distribution problem, it must employ a methodology that ensures it does not assume away the logistical realities of the current and future operational environment. To assist in this endeavor, this monograph explores Peter M. Senge’s “System Thinking” perspective. The intent is to apply his methodology to analyze U.S. Army battlefield distribution. By utilizing a “Systems Thinking” approach to search for patterns, and of relationships both internal and external to the distribution system, rather than snapshots of events, one is able to recognize feedback loops within the system itself. These patterns, when viewed within the context of space and time (dynamic complexity), present leverage points that afford effective and lasting solutions to the battlefield distribution problem.

TABLE OF CONTENTS

Introduction	5
Battlefield Distribution the Achilles Heel of Logistics	8
Historical Perspective	8
The German Army in the Inter-war period (1919-1939).....	8
The U.S. Army between the Gulf Wars (1991-2003).....	12
Systems Thinking	17
Learning Disabilities	19
Systems Thinking Skills and Tools	24
Systems Thinking Skills	25
Systems Thinking Tools	30
Systems Thinking and U.S. Army Battlefield Distribution.....	33
Fixes that fail	33
VM's reductive approach	34
VM and its environment.....	37
Applying Systems Thinking	38
Battlefield Distribution System Defined	38
Major components of the Battlefield Distribution System.....	39
Interrelationship of systems components	40
The environment.....	41
Leverage Points	42
Utility of Systems Thinking	45
Conclusion.....	46
Recommendations:	47
Recommendation for further research:	49
BIBLIOGRAPHY	51

TABLE OF FIGURES

Figure 1 Chain of Causality (USSR / US).....	25
Figure 2 Feedback Loop (USSR / US)	26
Figure 3 Balancing Feedback Loop.....	27
Figure 4 Chain of Causality (FSB).....	28
Figure 5 Balancing Feedback Loop (FSB).....	28
Figure 6 Balancing Feedback Loop with Delay (FSB)	29
Figure 7 Fixes That Fail Archetype.....	31
Figure 8 Fixes That Fail (FSB).....	32
Figure 9 Fixes That Fail (Velocity Management)	34
Figure 10 Battlefield Distribution System Archetype	40
Figure 11 Leverage in the Battlefield Distribution System Archetype	43
Figure 12 VM and Battlefield Distribution (Garrison and Stability and Support Operations).....	44
Figure 13 VM and Battlefield Distribution (Operation Iraqi Freedom).....	45
Figure 14 Battlefield Distribution System Archetype and ONA.....	48

Introduction

In the summer of 2004 the U.S. Army published a study of Operation Iraqi Freedom (OIF) entitled, *On Point, the United States Army in Operation Iraqi Freedom*. Among the many valuable lessons captured by this work was the observation that, “logistics in OIF was less than an unqualified success.”¹ Specifically cited was the difficulty that Combat Service Support (CSS) units experienced in distributing critical supplies to maneuver units. Although the Army was ultimately successful in OIF, success was achieved at great logistical risk. *On Point* reveals that during the campaign, most classes of supply functioned just barely above subsistence levels. Given this fact, it is probable that had the major combat operations phase of OIF lasted much longer than the few short weeks that it did, very serious constraints to U.S. operations would have resulted.

What makes the observations of On Point even more troublesome is the fact that over the past decade the Army has spent millions of dollars “fixing” distribution problems that were identified during the 1991 Gulf War. This realization constitutes an ominous warning to CSS planners, and is a serious indicator that something is fundamentally wrong with the way the distribution system is being viewed, and subsequently, the solutions being applied to fix it.

One question that needs to be asked before we begin is, should OIF be used an indicator of failings in the logistical system? Since OIF involved U.S. Army units moving record distances with unprecedented speed, it is possible that OIF was an aberration that will not be repeated in the future. Subsequently it could be argued that lessons learned from this operation should be taken with a grain of salt. However, according to the Joint Forces Command White Paper, *The Joint Operational Environment—Into the Future*, published 5 March 2004, the future operational

¹ Gregory Fontenot, E.J. Degen and David Thon, *On Point, The United States Army in Operation Iraqi Freedom*, (Ft. Leavenworth, Combat Studies Institute Press, 2004), 408.

environment will require the capability to move U.S. Military forces globally within increasingly compressed timelines. If Joint Forces Command is correct, it seems safe to assume that the lessons of OIF remain relevant to the future, and need to be addressed if the U.S. Army wants to avoid the same pitfalls on future battlefields.

The purpose of this monograph is to analyze the U.S. Army battlefield distribution system from a “Systems Thinking” perspective.² The method involves a holistic analysis of the distribution systems as it functions within its environment. Because identification of patterns and anomalies is an important aspect of Systems Thinking, the subject matter of this monograph reaches beyond OIF to historical precedent. Whether for tomorrow, or the more distant future, the object is to discover the leverage points within the system that will help the U.S. Army avoid repeating the logistics shortcomings of OIF.

This monograph is organized to reflect these concerns. To shed some historical light on the current problem with U.S. Army distribution, this monograph examines the German Army’s strategy for solving an identified battlefield distribution problem during the interwar period (1919 - 1939). There follows an explanation of why this strategy failed. Parallel analysis next extends to the U.S. Army’s attempt to solve the challenges of battlefield distribution in the years between the Persian Gulf War and the present conflict in Iraq. At this point Peter M. Senge’s “System Thinking” perspective is introduced. The intent is to apply his methodology to analyze U.S. Army battlefield distribution. The goal is to discover key leverage points within the U.S. Army distribution system that might facilitate lasting solutions to shortcomings identified during OIF. Once these leverage points have been identified, this monograph proposes recommendations to address the complex challenges of battlefield distribution faced by the U.S. Army today.

² “Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static snapshots.” Peter M.

Battlefield Distribution the Achilles Heel of Logistics

“Velocity Management dramatically improves the responsiveness and efficiency of the Army logistics system.” – *JP-4.0 Doctrine for Logistics Support of Joint Operations*, p.1.47

“In combat, however, effectiveness is the only true measure of success...” – *On Point the United States Army in Operation Iraqi Freedom*, p. xxviii

At the end of the Gulf War in 1991, army logisticians spent over 12 months opening thousands of 20-foot containers that had been shipped to the region in support of Operation Desert Storm (ODS). The contents of these containers were unknown, and had to be inventoried to account for their contents. Once accountability was established, the supplies could be shipped to U.S. Army installations around the world, or in some cases, stored in theater.³ The failure to effectively track inbound supplies that led to this “mountain of steel” was one failure among many attributed to a U.S. Army supply system that was organized for a major land war in Europe. A little over a decade later, the U.S. Army is again at war in Iraq, and as before, finds itself once again asking what has gone wrong with U.S. Army logistics?

Historical Perspective

The German Army in the Inter-war period (1919-1939)

One historical parallel between inter-war remedies and subsequent wartime shortfalls occurred within the German Army after the First World War. The technological revolution that both preceded and resulted from that war has been called the “Birth of Modern Warfare”.⁴ New

Senge, *The Fifth Discipline, the Art and Practice of the Learning Organization*, (New York, Currency Doubleday, 1990), 68.

³ Harvey L. Burnsteel, *A Logistics Think Piece, How far Have We Progressed?*, (PM Magazine, March-April 1996) p. 36.

⁴ MacGregor Knox and Williamson Murray, *The Dynamics of Military Revolution* (Cambridge University Press, 2003), 132.

technologies, such as the machinegun and rapid fire artillery, made much of the prior military doctrine obsolete, resulting in a relative stalemate on the battlefields of Europe. Subsequent attempts to develop new tactics and techniques to break this stalemate saw the birth of such concepts as deep fires, armored warfare, and strategic bombing. While the Germans developed new technologies and tactics in order to return mobility to the battlefield, they failed to provide the corresponding logistical distribution systems for mobility sustainment. The result was predictable: At the outset of the Second World War II Germany was not prepared to conduct sustained logistical operations on the new battlefield.

At the conclusion of World War I the Germans under General Hans von Seeckt established 57 committees to “examine the broad and specific questions the war had raised”.⁵ Part of this effort expanded on the ideas of Lieutenant General Erich Ludendorff’s doctrine of “attack in depth,” and was influenced by the ideas of B. H. Liddell Hart, the tactical innovations of Heinz Guderian, and the encouragement of initiative fostered in the German officer corps after the war.⁶ By the outset of World War II the work of von Seeckt’s committees reaped a rich harvest. The Germans had developed a doctrine of combined arms warfare that would succeed in returning tactical mobility to the battlefield.

Although the German Army succeeded in returning mobility to the battlefield, various innovators failed to fully anticipate the significant logistical challenges (specifically distribution) that mobility would inevitably create. After the war of 1914-18, Colonel Walter Friedrich Adolph von Bergmann (Deputy Chief of Staff for Supply and Logistics in the German First Army) and General Herman Joseph von Kuhl (Chief of Staff of the German First Army) wrote a very incisive monograph detailing the distribution challenges associated with the war. The findings were remarkably candid. Two of these findings would prove to be critical factors in the

⁵ Williamson Murray and Allan R. Millett, *Military Innovation in the Interwar Period* (Cambridge University Press, 1996), 36.

German Army's fate during the next war. First, Bergman and Kuhl found that the German Army in World War I could not sustain itself beyond 25 miles of a railhead; and second, they found that the inability of the German Army to sustain operations over long distances had been a major contributing factor to the failure of Ludendorff's offensive in the spring of 1918.⁷ These two factors should have led the Germans to conclude that greater mobility for combat troops must be supported by a more agile distribution system. Subsequently the question arises: why did the Germans not address the issue of logistical mobility when developing new doctrine and equipment? Part of the answer can be found in a closer look at the assumptions made by Ludendorff during the World War I.

Ludendorff served as the first German Army Quartermaster General and he was keenly aware of the logistical predicament the Germans faced during the war. Ludendorff's understanding of the German logistical dilemma was a key factor in his development of new wartime doctrine for both defensive and offensive operations. Logistical concerns were one of the key reasons for the development of the doctrine of flexible or "elastic" defense that was employed by the German Army in 1917. This defensive doctrine was intended to ensure that the enemy expended a maximum amount of resources while Germany conserved hers.⁸ Offensively, the development of the "attack in depth" was brought about by a desire to bring a quick end to the war by forcing Great Britain to withdraw from the conflict before the Americans could arrive and before German resources expired.⁹ The case can be made that Ludendorff assumed that the new doctrine would bring victory quickly enough to avoid the need for protracted logistical support.

⁶ Geoffrey Parker, *Cambridge Illustrated history Warfare* (Cambridge University Press, 1995), 288.

⁷ LTC Timothy J. Jackson, *Forrest War....With a German Spin* (Marine Corps Gazett 2002 Archives).

⁸ Timothy T. Lupfer, *The Dynamics of Doctrine: The changes in German Doctrine During the First World War* (Leavenworth Paper #4, 1981) 11-12.

⁹ Geoffrey Parker, *Cambridge Illustrated history Warfare* (Cambridge University Press, 1995), 289.

Unfortunately for Ludendorff, without the means to quickly transport his infantry, the German Army lacked the mobility necessary to exploit its initial success, and it ultimately failed.

It is plausible that Seeckt and other officers operated under the influence of Ludendorff's assumption, namely that if an offensive had the proper mobility (speed), then victory would come quickly enough to nullify long-term logistical challenges. And subsequently, since the speed needed to exploit initial success was now available through the advent of motorized and mechanized infantry, the concerns raised by the Bergmann/Kuhl report appeared to have been addressed. Thus, as the German Army modernized, the primary emphasis was on maneuver forces, with little regard to the distribution system supporting them. Consequently, at the outset of World War II, Germany had the premier mechanized combat force in the world, but it was still supported by a logistical distribution system primarily made up of horse-drawn units.¹⁰

Initially the lack of a modernized distribution system seemed inconsequential. In the short span of nine months (September 1939 – June 1940), Germany overran all of Western Europe. For the Germans, the rapid victories seemed to validate new doctrine, and mute any previous operational logistics concerns.¹¹ As a result, very little in the way of improving the operational logistics structure was attempted. This oversight would prove fatal. On 22 June 1941 Operation Barbarossa, the German offensive against the Soviet Union, began. The German High Command intended to quickly destroy the Red Army at the borders before it could mount effective retrograde and counter-offensive operations. Initially the offensive was extremely effective, but the limited capabilities of the German battlefield distribution system could not support the rapid advances made by the German armored columns. By July, German divisions

¹⁰ Charles Winchester, *The Demodernization of the German Army in World War II*, (Osprey Publishing, 2001), 3. “The German army had a hopelessly inadequate transport fleet. There were just three transport regiments, with 6,600 vehicles and a total capacity of 19,000 tons to ship supplies from the railheads to the front-line units: more than 150 divisions on an 1800 km front. (By comparison, the Allied forces in France during 1944 had a transport fleet with a capacity of nearly 70,000 tons to supply 47 divisions and the universal complaint was 'lack of trucks'.)”

were barely receiving enough supplies to sustain offensive operations, and in August logistics induced operational pauses were occurring across key sectors of the front. Yet in spite of the clear fragility of the logistics support for the German Army in Russia, the German High Command continued to believe that it could achieve victory fast enough to mitigate the logistical dilemma. The German planners and logisticians were wrong.¹²

The U.S. Army between the Gulf Wars (1991-2003)

During its own inter-war period between 1991 and 2003, the U.S. Army has in many ways repeated the same mistakes that were made by Germany during the pre-World War II period. Although admittedly the U.S. Army attempted to modernize the logistical systems needed to support changing technologies and tactics, often “logisticians were second class citizens, [whose] programs took a back seat to the push to buy new stealth bombers and other high-tech weapons.”¹³ This second-class status was particularly felt at the operational level of logistics (battlefield distribution), where the capability and organizational structure of support units did not significantly change between ODS and OIF. The Persian Gulf War did much to highlight the challenges of the U.S. Army logistics system, but as we shall see, the resulting approaches to logistical distribution were (as in the case of Germany) still heavily dependant on swift decisive victory.

At the conclusion of the Gulf War in 1991, the U.S. Army was faced with an “iron mountain” of excess supplies and munitions. According to the Combined Arms Support Command (CASCOM), there were 27,000 unopened and unidentified shipping containers in the

¹¹ Geoffrey Parker, *Cambridge Illustrated history Warfare* (Cambridge University Press, 1995), 305.

¹² Ibid.

¹³ Michael R. Gordon and Bernard E. Trainor, *The Generals' War*, (Boston, Little, Brown and Co., 1995), 57.

theater at the end of the war.¹⁴ This massive excess at the end of the war only punctuated the significant logistical problems faced by the U.S. Army during the run-up to the war. According to General (Ret) Bernard E. Trainor, “Logistics was Central Command’s (CENTCOM) Achilles heel.” CENTCOM struggled to find a way to distribute the right equipment and supplies across the battlefield to effectively fight the war. In the end it took more than 120 days to move the force into position, much too long a time for the U.S. Army to feel comfortable about.¹⁵

The realization that the current logistics structure was ill-suited to supporting anything other than a conventional war in Europe led the Army to commission the RAND Corporation to research the challenges to Army logistics, and to recommend ways to resolve the problems identified by the Gulf War.¹⁶ The result of this extensive study was the birth of “Velocity Management” (VM).¹⁷ According to RAND, “Velocity management [was] a concept for dramatically improving the responsiveness and efficiency of the Army logistics system.”¹⁸ VM proposed to do this by substituting the “just in case” logistics system that produced the massive amount of excess supplies in the Gulf War with a “just in time,” or more efficient system. VM would accomplish this by “substitut[ing] velocity and accuracy for mass in the logistics system.”¹⁹ The “velocity” would be achieved by adopting proven business techniques similar to

¹⁴ Colonel Joseph L. Walden, *The Forklifts Have Nothing to do, Lessons in Supply Chain Leadership*, (New York, iUniverse Inc., 2003).

¹⁵ Gordon and Trainor, *The Generals’ War*, 57.

¹⁶ According to their webpage (<http://www.rand.org>) RAND is “a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world.”

¹⁷ JP 4.0 defines *Velocity management* (VM) is an Army-wide total quality management, process-improvement program. VM strives to provide world-class logistics support while providing a hedge against unforeseen interruptions in the logistics pipeline by leveraging information technologies and optimizing its processes. The overarching objective is to get supplies into the hands of the warfighter in days or hours, not weeks.

¹⁸ John Dumond, Rick Eden, and John R. Folkson, *Velocity Management: An Approach for Improving the Responsiveness and Efficiency of Army Logistics Processes*, (RAND Corporation, 1995), i.

¹⁹ *Ibid.*

those of Federal Express (FEDEX) and United Parcel Service (UPS).²⁰ The Army wholeheartedly accepted the RAND proposals, and they were implemented Army-wide in 1995.

The initial studies of the effects of VM conducted by RAND seemed to indicate terrific success. According to *Velocity Management: The Business Paradigm That Has Transformed U.S. Army Logistics (2001)*, between 1995 and 2000, the time it took a unit to receive supply requisitions dropped by over 50 percent and demand satisfaction improved from 5 percent in 1995 to just under 50 percent in 2000.²¹ What made these improvements seem even more impressive was that they appeared to be sustainable during operational deployments. For example, operations in Kosovo did not significantly reduce the efficiency of the VM logistics model.²² Even more impressive were initial indications from Operation Enduring Freedom in Afghanistan: “After Sept. 11, Operation Enduring Freedom became a critical test of [VM] ... early indications show that the distribution system is performing very well.”²³ Given the plethora of good news, it was easy for RAND to conclude (and the U.S. Army to agree) that, “as processes become faster and more reliable, the Army can redesign its logistics system to minimize its footprint in an area of operations, [and] as supply times become faster and more reliable, inventory levels can become leaner without increasing risk.”²⁴ It seemed that all was well in the world of VM and Army Logistics. Millions of dollars were being saved, and supplies were flowing more efficiently than ever before.

However, lurking beneath these successes were two nagging questions: The first (and perhaps more interesting) was: Why was RAND commissioned to assess the effectiveness of a RAND concept? And second, how would VM perform during a major deployment of U.S.

²⁰ Ibid.

²¹ Demand Satisfaction equals orders filled from on hand stocks; it is expressed as the percentage of orders filled from stocks on hand.

²² Drumond et. al, *Velocity Management*, 30.

²³ Rick Eden, Faster, Better, Cheaper, U.S. Army Manages a Logistics Revolution, RAND Review (Spring 2002).

²⁴ Ibid., 7.

forces? Since VM was implemented to fix a perceived failure during a major deployment (Desert Shield / Storm) the true measure of its effectiveness should have been made during a deployment of similar scale. In December 2002, as the Third Infantry Division began to deploy to Kuwait, Operation Iraqi Freedom was about to commence, and suddenly VM was given the opportunity to prove itself on much the same battlefield that had necessitated its creation.

According to the U.S. Army's recent study of OIF *On Point, the United States Army in Operation Iraqi Freedom*, VM did not live up to its original billing. Logistics was branded as "less than an unqualified success." Specifically cited was the difficulty that Combat Service Support (CSS) units experienced with distributing critical supplies to maneuver units. In fact, most classes of supply during the campaign functioned just barely above subsistence levels.²⁵ Had the campaign become protracted, very serious constraints to U.S. operations would likely have resulted.

How could this happen? Why did VM work so well in operations in the Balkans, and yet come so close to failure in OIF? Interestingly enough, RAND partially and unwittingly identified the answer to these questions in a study dating to 2001. In the Balkans the study asserted that "the Army was able quickly to develop a high-performing extension of its order fulfillment process (i.e., scheduled delivery to an airfield plus a distribution system within the area of operations) to support the deployed units."²⁶ In other words, VM works perfectly well as long as friendly troops can quickly secure an airfield and establish an effective battlefield distribution system. More succinctly, VM is based on the assumption that victory will be swift and decisive. Quickly securing an airfield is much more feasible in a permissive environment with relatively short lines of communication (LOCs), such as the Balkans, than in a non-permissive environment with long LOCs such as Iraq during OIF.

²⁵ Gregory Fontenot, E.J. Degen and David Thon, *On Point, The United States Army in Operation Iraqi Freedom*, (Ft. Leavenworth, Combat Studies Institute Press, 2004), 408.

Clearly, VM can be very effective in a garrison environment or in support of stability and support operations (SASO).²⁷ This is because VM is dependant on predictable pick-up and delivery schedules. This level of predictability is much more feasible in an environment where units are primarily operating from static locations (garrison and SASO for example). In contrast, VM has proven to be largely ineffective in the extremely complex and high-tempo environment of major combat operations.²⁸

In addition to reliance on quick victory, VM also raises other fundamental issues. For example, what if there is no airfield? Or, what if for political or other reasons we cannot secure an airfield? In these cases, is the operation doomed? It seems that in its analysis of U.S. Army logistics, RAND has almost inadvertently identified the battlefield distribution system as the “Achilles heel” of logistics.

The assumption that a quick and decisive victory will substitute for effective logistic support is a dangerous point of departure, and one that has proven fatal in the past. After the brilliant success of operations in Poland and Western Europe, the feeling of invincibility was very real in the ranks of the German Army and its planners. Subsequently, the German High Command “deleted the word impossible from its vocabulary.”²⁹ The U.S. Army must be sure that it does not assume away logistical realities as it attempts to address the challenges of operations in the current and future operational environment. This is a lesson that the German Army learned too late in the Soviet Union during World War II.

²⁶ Drumond et. al, *Velocity Management: The Business Paradigm That Has Transformed U.S. Army Logistics* (RAND 2001), 30.

²⁷ Stability and support operations (SASO) – The use of military capabilities for any other purpose other than war. (Counterinsurgency, domestic emergencies, humanitarian assistance, peace operations etc.) FM 101-5-1.

²⁸ Fontenot et. al., *On Point*, 409.

²⁹ Shimon Naveh, *In Pursuit of Military Excellence, the Evolution of Operational Theory*, (London, Frank Cass Publishers, 1997), 107.

Systems Thinking

“Only by changing how we think can we change deeply embedded policies and practices.” – Peter M. Senge, *The Fifth Discipline*, p. xiv

The idea that distribution is the Achilles Heel of logistics should not be seen as anything novel. Once the advent of the *levée en mass* and the resulting exponential growth in the size of armies rendered foraging as a means of supporting armies less effective, nations have wrestled with the question of how best to distribute the necessary supplies to armies in the field. The previous chapter highlighted the struggle and ultimate failure of the German Army in World War II, and identified distribution as a key problem within the U.S. Army today. Chapter one proposed examining this problem via a “Systems Thinking” approach to develop solutions for improved U.S. Army battlefield distribution. Such an approach necessitates outline of System Thinking.

Ludwig von Bertalanffy first introduced the world to systems theory in the 1950s. Bertalanffy hypothesized that technological change (progress) had exponentially increased the complexity of the world, thus rendering the analytical reductive (“mechanistic”) method of solving problems “insufficient.”³⁰ To address this cognitive crisis, Bertalanffy formed the Society for the Advancement of General Systems Theory (later called the Society for General Systems Research), and in 1968 he published his *General Systems Theory*. Systems theory is based on the idea that the whole is greater than the sum of its parts, and that only by studying the relationships between the parts can one gain the knowledge to find solutions to complex problems. Bertalanffy’s systems approach represented a scientific revolution akin to Thomas Kuhn’s later

³⁰ Ludwig von Bertalanffy, *General systems Theory, Foundations, Developments, Applications*, (New York, George Braziller Inc., 1968), 11.

concept of the novel paradigm.³¹ In other words, systems theory was not intended to augment existing scientific methods of thinking, but to replace them entirely.

In the early 1990s, Peter M. Senge, the founder and director of the Center for Organizational Learning at the Massachusetts Institute of Technology (MIT), introduced the world to a new way of solving complex problems called “Systems Thinking.” This concept builds upon the ideas of Bertalanffy, and is therefore based on the belief that a system cannot be understood by examining its individual components in isolation, and that understanding is only reached by considering the system as a whole. In other words, one must consider the components of a system as they relate to one another to begin to understand the system itself. To illustrate this point, Senge uses the example of an automobile. An automobile is a system made up of many components: the engine, tires, transmission, brakes, axles etc. Each of these components, when examined individually, may be working fine, but if the transmission is not linked to the engine, the automobile will not work properly.³²

However, understanding the components of the system and how they relate to one another is only half the battle when it comes to understanding systems. In order to fully understand a system, one must also consider the system and how it interacts with its environment. For example, let us examine Senge’s hypothetical automobile: assuming all the components are in good working order and interact with each other as they should, the automobile should run fine. However, if we assume that this same automobile is in Norway, and unfortunately becomes trapped in an avalanche, it is most likely that the automobile will not function properly, regardless of how well each of its components is functioning in relation to the others. Thus in Systems Thinking, seeing the system as a whole and how it relates to its environment are keys to solving problems and effecting lasting improvement.

³¹ Thomas Kuhn, *The Structure of Scientific Revolutions*, (Chicago, University of Chicago Press, 1962).

Systems Thinking represents a significant departure from a reductive, linear way of thinking and solving problems. The Western World has over time developed a linear way of problem solving based on Newtonian science. The Newtonian scientific method divides a problem into its component parts, examines the parts individually, and then draws conclusions that diagnose the problem as a whole.³³ This reductive methodology “only makes sense if one believes that the whole is a simple sum of its parts.”³⁴ Bertalanffy recognized this dilemma decades ago. He observed that, in systems not only did the whole consist of more than its parts, but that it also (and most importantly) consisted of the interaction of these parts.³⁵ In a world that is increasingly interconnected, mechanistic linear approaches to problem solving are ineffective. Mechanism and linearity in system analysis obscure the relationships between the components that make up the system as a whole. Thus, Senge hypothesizes that linear thinking leads to the development of certain kinds of “learning disabilities.”³⁶ These learning disabilities keep one from seeing the real consequences of actions taken (attempts to solve problems), and thus hinder the ability to enact effective solutions to identified problems.

Learning Disabilities

There are seven learning disabilities resulting from mechanistic/linear thinking: I am my position; the enemy is out there; the illusion of taking charge; the fixation on events; the parable of the boiled frog; the delusion of learning from experience, and the myth of the management team. Each of these learning disabilities impact individuals and organizations in distinct ways.

³² Fred Kofman and Peter M. Senge, Communities of Commitment: “The Heart of Learning Organizations”, *Organizational Dynamics*, Autumn 1993, 27.

³³ *Ibid.*, 18.

³⁴ David S. Alberts and Richard E. Hayes, *Power to the Edge, Command and Control in the Information Age*, (Washington, CCRP Publication Series, 2003). 57.

³⁵ Bertalanffy, *General Systems Theory*, 19.

³⁶ Peter Senge, *The Fifth Discipline, the Art and Practice of the Learning Organization* (New York, Currency Doubleday, 1990), 17-26.

And since these learning disabilities “pervade all organizations to some degree,” a closer look at each is warranted.³⁷

I am my position: Often people in large organizations tend to focus on their individual jobs without understanding how their jobs fit into the working of the organization (system) as a whole. When this happens, individuals tend to lack a “sense of responsibility for the results produced” by the entire organization. Since it is possible for individual components to work properly, and for the system to still fail (remember the example of the automobile), when things go wrong, it is difficult to identify the locus of the problem, and thus it is most often assumed that someone must have failed to do his or her job, even when this may not be the case at all.³⁸ For example, the Class III (bulk fuel) supply system within an Armored Brigade Combat Team (BCT) consists of three Class III Sections and one Class III Platoon.³⁹ Staff and executive officers (XO’s) at the company and battalion (BN) level, as well as the Support Operation Officer (SPO) in the Forward Support Battalion (FSB) coordinate the efforts of these organizations. If the BCT in question suffers from the “I am my position” learning disability, then each of the individuals in the fuel supply system will see his/her job in linear terms (much like a step on an assembly line – provide fuel and order fuel). This orientation obscures the impact that individual actions have on distant parts of the system.

Consider the following situation: 1st BCT has been ordered to conduct a movement to contact at 0600 (in twelve hours).⁴⁰ One of the BN staffs within the BCT coordinates to have the class III section of the Support Platoon re-fuel the BN at 0400. The staff also requests fuel from the FSB to replenish the support platoon fuel tankers. The FSB SPO coordinates to have the

³⁷ Ibid., 18.

³⁸ Ibid., 19.

³⁹ The US Army has categorized supplies into ten classes. Class III is used to denote petroleum fuels; lubricants; hydraulic and insulating oils; preservatives; liquid and compressed gasses; bulk chemical products; coolants; deicing and antifreeze compounds, together with components and additives of such products; and coal. In this example Class III is used to denote fuel. For a comprehensive explanation of the supply classes, see FM 100-16 Appendix E

Class III platoon (of the FSB) deliver fuel to the BN Class III section at 1100, so that it will coincide with the regularly scheduled fuel push that he has coordinated to be delivered to the FSB from the Main Support Battalion (MSB). At 0400 the BN vehicles receive all the fuel they can hold. At 0600 the BCT movement to contact goes off as scheduled. The action is a tremendous success, and within an hour, enemy soldiers are surrendering all over the BCT area of operations. The BCT Commander orders his unit to continue to push past the objectives in order to exploit this success. At 1000, the FSB is ordered to reposition forward in order to keep pace with the BCT. At 1100 the MSB has arrived at the FSB's previous position and is moving to catch up with the FSB. At 1110, the A company XO is calling for fuel, but there is none to be had in either the BN class III section or the Class III platoon of the FSB. The conclusion within the BCT is that somebody must have failed to do his or her job. However, in the strictest sense this is not the case: everyone did his or her job correctly (fuel was ordered and provided). Yet, as individuals failed to see how their own jobs influenced the system as a whole, failure of the system became a real possibility (if not probability).

The enemy is out there: This learning disability is usually a by-product of the non-systemic thinking that results from "I am my position." Often when things go wrong in an organization, people tend to look for causes outside their sphere of influence.⁴¹ The result is passing blame to another part of the organization, or other more nebulous "outside" influences. For example, using the situation above, the SPO might be tempted to place blame for the lack of fuel within the system by claiming the BN S4s failed to forecast fuel requirements properly (internal blame). On the other hand, the SPO could decide that there was no way to anticipate the amount of success experienced by the BCT (and the subsequent order to push past the original objectives) and thus decide that the failure is not within the system. In either case, non-systems

⁴⁰ Movement to Contact is a form of the offense designed to develop the situation and to establish or regain contact with the enemy (FM 101-5-1).

⁴¹ Senge, *The Fifth Discipline*, 19.

thinking results in an incomplete perception of the problem. An incomplete picture will most likely lead the BCT to conclude that the problem was an anomaly and that therefore no action to fix or change the system is necessary. Or possibly, the BCT could attempt to resolve the problem with only a partial understanding of the system, possibly resulting in more problems over time.

The illusion of taking charge: The difficulties that arise from non-systemic thinking, and thus envisioning problems as being caused by “the enemy out there,” can lead many organizations to seek proactive solutions. Unfortunately, “if we simply become more aggressive fighting ‘the enemy out there,’ we are reacting – regardless of what we call it.” Thus, “proactiveness is reactiveness in disguise;” although it may appear that someone is taking charge and implementing solutions, without a real understanding of the problem, any action taken is just shooting in the dark.⁴² The key to true proactive action is the ability to see the system as a whole, and to understand how the system itself contributes to the problem. Looking again at the example of the BCT, the commander may decide that the fuel problem requires a proactive solution. He might decide that the BCT will no longer exploit success beyond a certain point, or he could decide to task organize fuel-tankers down to BN or company level. Although it may seem like corrective action is being taken, neither solution gets to the heart of the problem. Worse yet, both “solutions” have unintended detrimental effects.

The Fixation on events: Mechanistic thinking forces one to focus on a “snapshot” of events in an attempt to show causality. This is problematic, because when an individual or organization focuses on a single event, or series of events, he or she can become blind to patterns behind the event, just like the fictional BCT commander from the example above. This myopia can result in “event explanations” such as: the sun came up because the rooster crowed. Or as in the example above, the BCT ran out of fuel due to poor task organization and or over-exploitation of success. Since events are the product of relationships between elements of a system and not

⁴² Ibid., 21.

the other way around, a fixation on events makes it nearly impossible for organizations or individuals to determine causality with any reasonable degree of accuracy. This failure to understand the underlying causes of events can lead organizations to embrace spurious correlations that further compound the original problem.

The parable of the boiled frog: A significant danger arising from the fixation on events is that it conditions organizations to recognize only those problems that arise suddenly, leaving them vulnerable to threats that evolve slowly over time. It has been shown that a frog will try to jump out of a pot of boiling water, but if the frog is placed in a pot of water at room temperature and then the heat is gradually increased to the boiling point, the frog will remain in the pot and die. Organizations that make changes in response to perceived problems based on snapshots are likely to be overcome by events (like the frog) long before they recognize the problem or develop a strategy to solve it. This “maladaptation” is one of the primary causes behind corporate failure today.⁴³

The delusion of learning from experience: Direct experience is one of the best ways to learn; in fact, from the earliest age humans learn most of the skills they need to survive (walk / talk) by trial and error or direct experience. Direct experience is characterized by the ability of an individual to take an action, evaluate the outcome, and take a new action. This act – assess – react cycle of direct experience learning is most effective when the result of the action is immediate. However, as the time between an action and its result is increased, learning becomes more difficult. Additionally, when a decision maker is separated from the direct effects of a decision, learning is next to impossible. The experience of General Launcelot Kiggell, the British Army Chief of Staff, who after the battle at Flanders (November 1917), visited the front for the first time and exclaimed, “Good God, did we really send men to fight in that,” illustrates this fact

⁴³ Ibid., 22.

rather well.⁴⁴ As the effects of time and distance separate the organization or individual from the outcome of action, it becomes harder to learn through the direct experience process. The point at which the consequences of our actions are delayed or located beyond one's ability to assess and learn from direct experience is what Senge calls the "learning horizon."⁴⁵ This is "the core learning dilemma" of organizations: they operate in an environment where the consequences of most of their key decisions are made outside of the learning horizon.

The myth of the management team: In order to overcome the learning horizon deficiency as well as confront the problems caused by the other learning disabilities discussed above, organizations have traditionally separated themselves into different components. Each of these components is led by its own manager. To synchronize and coordinate the efforts of each of these components, the managers form a management team. Unfortunately, this concept often leads to parochialism, where the main goal of managers is to give the impression of cohesiveness rather than teamwork.⁴⁶ The consequence is an atmosphere of advocacy for one's own position, rather than inquiry (search for the best possible solution). In this atmosphere, learning and inquiry are stifled, giving way to group-think (which can often be synonymous with not thinking at all). The focus of the organization thus becomes putting out fires (appearing effective), rather than examining the difficult questions that may be causing the fires in the first place (being effective). The net result is the creation of an organization full of "teams that are incredibly proficient at keeping themselves from learning."⁴⁷

Systems Thinking Skills and Tools

To overcome these learning disorders, Systems Thinking arms individuals and organizations with skills and tools that enable them to recognize and overcome the problems

⁴⁴ Geoffrey Parker ed., *The Cambridge Illustrated History of Warfare* (Cambridge, Cambridge University Press, 1995), 286.

⁴⁵ Senge, *The Fifth Discipline*, 23.

⁴⁶ *Ibid.*, 24.

inherent in linear reductive analysis. The skills associated with Systems Thinking help change the way individuals and organizations view the world, while Systems Thinking tools help them utilize this new perspective to make effective and lasting improvement.

Systems Thinking Skills

Effective Systems Thinking requires what Bertalanffy called a “reorientation.”⁴⁸ Senge called this reorientation “metanoia,” or a “shift of mind ... seeing interrelationships rather than things, seeing patterns of change rather than static snapshots.”⁴⁹ This shift of mind requires one to discard what Dietrich Dörner called “chains of causality” (a linear cause and effect based method of explaining events) in order to see “networks of causation.”⁵⁰ These networks, or “circles of causality,” represent feedback loops that reflect relationships among the components of a system.⁵¹ The arms race between the old USSR and the U.S. is an effective example of how this shift of mind helps provide lasting solutions to complex problems. Assuming that the purpose of building weapons by both countries was to reduce the threat to their homelands, the linear view of this problem from the U.S. perspective looks something like this (see figure 1):

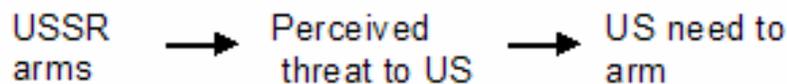


Figure 1 Chain of Causality (USSR / US)⁵²

⁴⁷ Ibid.

⁴⁸ Bertalanffy, *General systems Theory*, vii.

⁴⁹ Senge, 68.

⁵⁰ Dietrich Dörner, *The Logic of Failure, Recognizing and Avoiding Error in Complex Situations*, (Cambridge, Perseus Books, 1996), 33.

⁵¹ Senge, *The Fifth Discipline*, 73-79.

⁵² Ibid., 70

From this perspective, the U.S. action makes perfect sense (the intuitive action to a threat is to counter it). However when this same situation is viewed systemically, a new paradigm emerges (see figure 2):

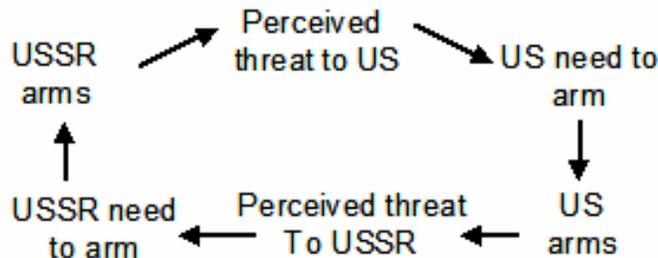


Figure 2 Feedback Loop (USSR / US)⁵³

When the arms race is viewed systemically (seeing the feedback loop), it becomes obvious that the intuitive solution suggested by the linear paradigm not only fails to achieve the goal (increased security), but has precisely the opposite effect.

Feedback loops can be either reinforcing or balancing. Reinforcing feedback is characteristic of events with amplifying relationships (such as the arms race above). Unimpeded reinforcing feedback leads to either exponential growth or decline. Balancing feedback in contrast, is characteristic of events with stabilizing or goal-oriented relationships. The cruise control on a modern automobile is a good example of a balancing system. If the cruise control is set to 50 miles per hour (MPH) on level ground, the vehicle will accelerate to 50 mph and remain at that speed. When the vehicle encounters a hill it will begin to slow (if ascending) or accelerate (if descending) due to the effects of gravity, thus creating a gap between the actual speed and the desired speed of 50 MPH. Sensing this gap, the cruise control will regulate the accelerator as required in order to keep the car's speed constant at 50 MPH (see figure 3).

⁵³ Ibid.

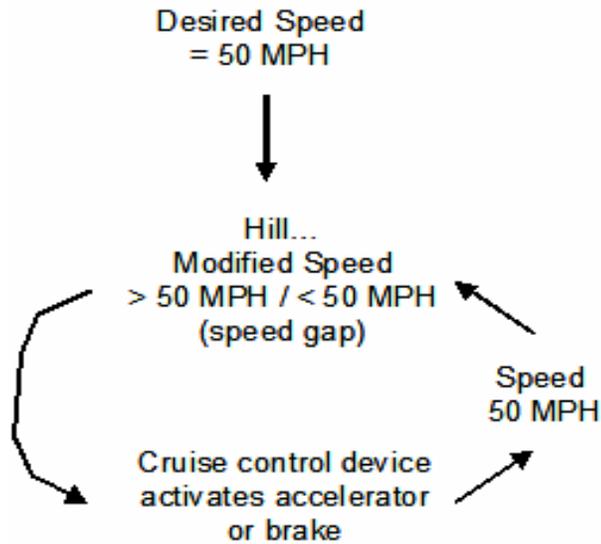


Figure 3 Balancing Feedback Loop

If the driver of the vehicle wants to change its speed, he or she must make a change to the system, through manually applying either the brake or accelerator, or by resetting the cruise control itself. Thus, without some form of intervention, balancing feedback leads to stability within the system.

Feedback loops are impacted by both space and time. Senge calls this impact “dynamic complexity.” Dynamic complexity consists of delay – the time between an action and its consequence; and location – the fact that an action can have one consequence (or set of consequences) locally, and a different consequence (or set of consequences) in another part of the system. The point(s) at which dynamic complexity impacts a system is its “leverage point,” or the location that “actions and changes in structures can lead to significant, enduring improvement.”⁵⁴ Thus, recognition of leverage points with reinforcing and/or balancing feedback loops, coupled with dynamic complexity is the key to effective Systems Thinking.

Another look at the notional BCT from the example given earlier provides a good example of the utility of Systems Thinking. In the example above, the FSB SPO most likely had

a very linear view of the BCT fuel supply system. This view could be portrayed as follows (see figure 4):



Figure 4 Chain of Causality (FSB)

In this linear perspective, everything appears to be in order. The BCT gets the fuel it needs, and the FSB fuel supply is replenished so that it is prepared to issue fuel again. Yet in the example, the BCT runs out of fuel, prompting a series of learning disabled reactions – someone failed, the problem is an anomaly, the need for someone to take charge etc.

In contrast, if the FSB SPO viewed the fuel supply system utilizing a Systems Thinking approach, he or she would see a balancing feedback loop. This system would look something like this (see figure 5):

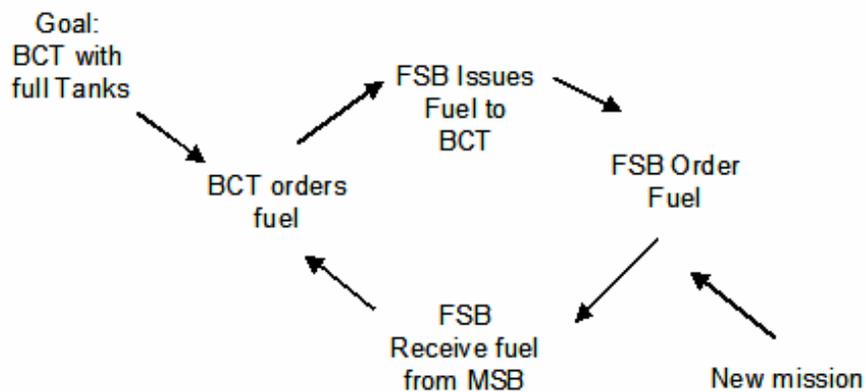


Figure 5 Balancing Feedback Loop (FSB)

⁵⁴ Ibid., 114

The goal is for the BCT to have full fuel tanks; the BCT orders fuel, the FSB issues fuel to the BCT and orders fuel from the MSB. The MSB then issues fuel to the FSB. In the interim, the BCT receives a new mission and needs fuel again. It was at this point in the example above that the BCT ran out of fuel. However, if we assume the FSB SPO reorients his perspective, he should be able to visualize how he affects and is affected by each component of the system. From this perspective, the real source of the problem (dynamic complexity) becomes apparent. By adding the element of time to the system, the FSB SPO should see a balancing feedback loop with delay similar to the example below (see figure 6):

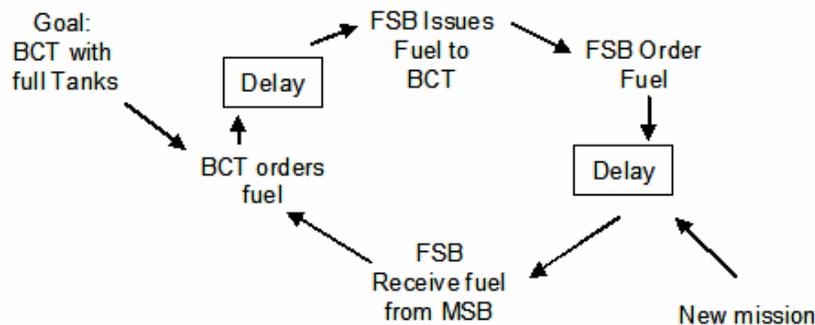


Figure 6 Balancing Feedback Loop with Delay (FSB)

When viewed this way, the leverage points (the points where dynamic complexity impact the system) become clear. Given this knowledge, the FSB SPO can anticipate delays and take measures to reduce or compensate for them. For example, the FSB SPO upon seeing that a new mission could cause the BCT to run out of fuel (due to the delay in the system), could develop a number of options designed to respond to this potential problem. For example, the SPO could re-route the MSB tankers to re-supply directly to the BCT, or reschedule the timing of the MSB delivery of fuel to the FSB. In either case, the SPO is targeting the leverage point within the system to improve its performance.

Systems Thinking Tools

The development of Systems Thinking skills enables one to visualize the reinforcing / balancing feedback loops, and the dynamic complexity that makes up systems. From these building blocks, certain patterns, or what Senge calls “Systems Archetypes,” emerge.⁵⁵ These Systems Archetypes are reoccurring patterns of relationships that take place in many different situations. As such they can be utilized as tools for recognizing systems and the leverage points within them. The concept of Systems Archetypes is not unlike the prototypes of Recognition Primed Decision making. During a time-constrained crisis, an experienced person recognizes a pattern within the situation and is then able to take appropriate steps to resolve the crisis quickly.⁵⁶ In much the same way, Systems Archetypes allow a person who thinks systemically to recondition their perceptions in order to “see structures at play, and to see the leverage in those structures.”⁵⁷

Of the nine Systems Archetypes, two have been shown in the examples above: The U.S. – USSR arms race is an example of the escalation archetype, and the BCT fuel supply system is an example of the balancing process with delay archetype. One additional useful archetype to examine within the context of this monograph is the Fixes That Fail archetype (see figure 7).⁵⁸

⁵⁵ Ibid., 92.

⁵⁶ Gary Klein, *Sources of Power, How People Make Decisions*, (Cambridge, The MIT Press, 1999).

⁵⁷ Senge, *The Fifth Discipline*, 95.

⁵⁸ For a comprehensive explanation of Systems Archetypes, see Senge, *The Fifth Discipline*, appendix 2.

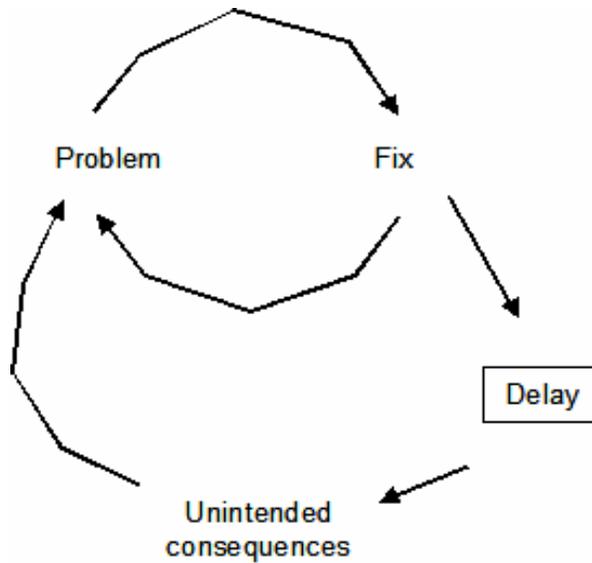


Figure 7 Fixes That Fail Archetype⁵⁹

The Fixes That Fail archetype is exactly what the title implies: a solution that fails over time. The Fixes That Fail Archetype is typified by a solution being implemented that seems to be effective in the short term, yet over time only serves to exacerbate the problem. As the model above indicates, after a problem arises a solution is implemented that is initially effective. However, over time unforeseen consequences arise that make the original problem worse. In this archetype, organizations are often tempted to apply the same fix repeatedly since the original fix seemed effective, resulting in an exponential increase of the original problem. A final look at the notional BCT's fuel problem is representative of this archetype (see figure 8):

⁵⁹ Ibid.

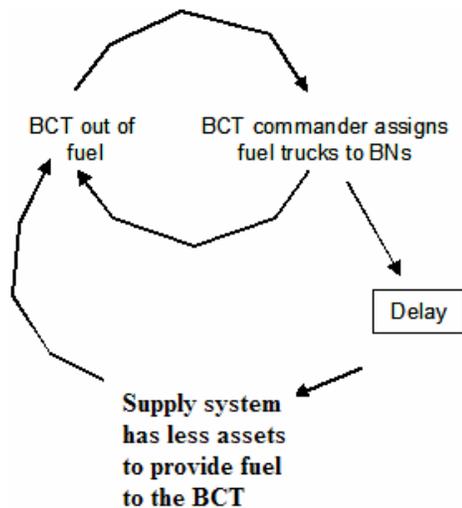


Figure 8 Fixes That Fail (FSB)

Problem: the BCT runs out of fuel. Fix: the BCT commander decides to assign the fuel truck from the FSB directly to the BNs (illusion of taking charge). The fix is effective in the short term, since the BNs now have more organic fuel assets and can go much further before requiring fuel. However, the fix has reduced the number of fuel trucks available to the FSB, and it can no longer provide effective replenishment to the BCT (unforeseen consequences). Thus, over time the original problem is exacerbated.

Systems Thinking appears to represent a promising method to examine a variety of systemic problems, including shortfalls within the U.S. Army battlefield distribution system. By searching for patterns of relationship, both internal and external to the distribution system, rather than snapshots of events, one should be able to recognize feedback loops within the system itself. These patterns, when viewed in the context of space and time (dynamic complexity), should present leverage points that may be utilized to find lasting solutions to these shortfalls.

Systems Thinking and U.S. Army Battlefield Distribution

“War is quite changed from what it was in the days of our forefathers; when in a hasty expedition and a pitch’d field, the matter was decided by courage; but now the whole art of war is in a manner reduced to money. Nowadays that prince who can best find money to feed, clothe and pay his army, not he that hath the most valiant troops, is surest to success and conquest.”
Charles Davenant, *Essay on Way and Means of Supplying the War*, 1695

The U.S. Army has a battlefield distribution problem. According to LTG Claude V. Christianson, the U.S. Army’s top logistician,

Today’s Army is not able to respond rapidly and precisely when support requirements are identified. We do not have the battlefield distribution system that we need. We cannot provide time definite delivery schedules, and we cannot effectively control physical movements across the new battle environment.⁶⁰

Clearly, VM (the logistics initiative that was supposed to provide this speed and precision), “did not work” during OIF.⁶¹

It is not the purpose of this monograph to provide a comprehensive explanation for the apparent failure of VM during OIF. However, in order to avoid the learning disability – “the illusion of taking charge,” and instituting the archetype - fixes that fail (see chapter III figure 7), it is necessary to understand the reasons for OIF logistics failure from a Systems Thinking perspective.

Fixes that fail

The Systems Thinking Fixes That Fail Archetype is a near perfect description of U.S. Army attempts to fix distribution between ODS and OIF. A problem was recognized (distribution in ODS), and a solution implemented (VM). Over time the solution had adverse effects (smaller stockpiles and limited flexibility) that served to compound the problem (OIF),

⁶⁰ LTG Claude V. Christianson, “Army Logistics White Paper,” *Army Magazine*, April 2004, 28.

prompting the organization to respond with more of the same fix. Clearly, VM represents a classic “Fixes That Fail” Archetype of Systems Thinking (see figure 9 below).

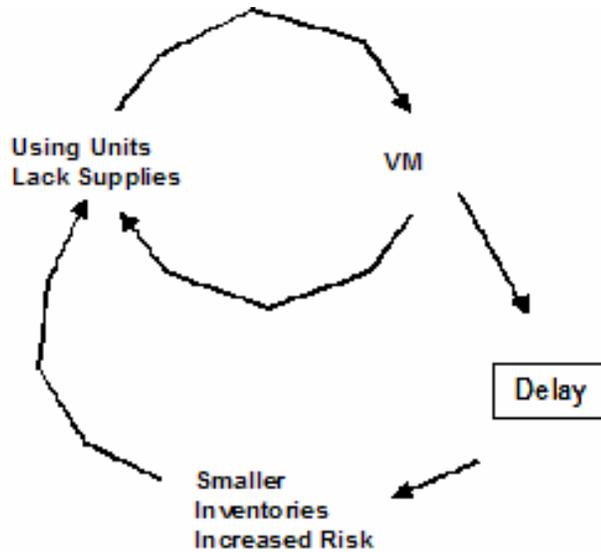


Figure 9 Fixes That Fail (Velocity Management)

Systemically, VM failed for two main reasons: First it took a reductive rather than holistic approach to solving the problems of ODS; and second, it did not fully consider the environment in which the U.S. Army battlefield distribution must operate.

VM's reductive approach

At first glance, VM appears to take a holistic approach to improving “the speed and accuracy with which materials and information flow from providers to users.”⁶² However, a closer look reveals a different story. VM was modeled after a successful business practice called Just in Time (JIT). JIT was originally implemented by Taiichi Ohno of Toyota Motor Company in Japan.⁶³ In the simplest terms, a JIT system relies on three interdependent components: effective communications and asset visibility (processes), reliable timely production and

⁶¹ Fontenot et. al., 409.

⁶² Dumond, et. al., *Velocity Management*.

transportation (capabilities), and reasonably predictable demand and delivery (environment).⁶⁴ A holistic approach to implementing a JIT system would necessarily address each of these interdependent components, and the manner in which they interact. However, according to RAND, “VM views the logistics system as a set of interlinked processes—a supply chain—that delivers products and services (such as spare parts and equipment maintenance) to customers. System performance is assessed in terms of the agility and responsiveness of logistics processes.”⁶⁵ In other words, VM is almost exclusively process oriented.

When assessing what went wrong with logistics during ODS, it is hard not to conclude that lack of asset visibility was a major contributing factor to the advent of the “iron mountain.” Thus, it is easy to understand how the process-centric approach of VM seemed logical. RAND and the U.S. Army correctly concluded that poor communication and out of date networks were severely hampering the supply process, resulting in extremely limited asset visibility. Subsequently, the U.S. Army invested millions of dollars to modernize and procure various computer-based systems called STAMIS (Standard Army Management Information Systems).⁶⁶ To the credit of RAND and the U.S. Army, the investment in STAMIS was an initial success. However, by neglecting to consider the other components (environment and capability) of the JIT system, the success of VM was necessarily limited.

With the advantage of hindsight, it is very easy to see how this “fixation on events” (lack of asset visibility) learning disability led to the spurious correlation that perfect asset visibility somehow causes perfect distribution. This correlation is not even remotely logical, even if one assumes that the STAMIS were to provide perfect visibility of all assets, as well near perfect prediction of future requirements. None of this knowledge is a guarantee that the capability will

⁶³ Norman Bodek, *Kaikaku, The Power and Magic of Lean - A Study in Knowledge Transfer*, (PCS Press, Vancouver, 2004)

⁶⁴ James P. Womack and Daniel T. Jones, *Lean Thinking*, (Simon and Schuster, New York, 1996).

⁶⁵ Dumond, et. al., *Velocity Management*.

be there to move the assets. For example, imagine that an infantry battalion needs three Bradley Fighting Vehicle (BFV) engines, and that there are three BFV engines in a warehouse that supports the battalion. Also imagine that STAMIS is working to perfection. Given this situation, everyone working within the supply system supporting the infantry battalion would know that the infantry battalion needs three BFV engines, and where to get the needed engines (an ideal situation). However, if no trucks are available to move the engines, the infantry battalion will still not get them. Lack of transportation was one of the major reasons that distribution was such a challenge in OIF. Thus, even if the STAMIS had worked to perfection during OIF, “there [still] were not enough trucks to move supplies forward.”⁶⁷

Unfortunately, the U.S. Army seems to still be suffering from a “Fixation on Events”, by fixating on the failures of the STAMIS and related communications processes as it examines the reasons behind the logistics problems of OIF. In the April 2004 issue of *Army Magazine*, LTG Christensen outlined his top priorities for logistics. The theme throughout his message was that the U.S. Army must push harder to modernize the STAMIS and other communications systems, along with a structural overhaul in order to create “a distribution system that reaches from the soldier at the tip of the spear to the source of support, wherever that may be ... by increasing visibility and establishing flexible, responsive distribution capabilities.”⁶⁸ At the time of the writing of this monograph, the U.S. Army has yet to propose buying large quantities of new trucks. The U.S. Army’s logic appears to be, VM seemed to work before, so more and better VM will work again. This is a classic example of the Fixes That Fail archetype.

⁶⁶ STAMIS is a computer network based system of systems that tracks maintenance statistics and status, requisition of supplies, shipping and storage of supplies and inventory management functions.

⁶⁷ Fontenot et. al., 410.

⁶⁸ Christensen, *Army*, 28

VM and its environment

Hand in hand with the concept of capabilities is the operational environment. If the U.S. Army of today and the future will be operating in “noncontiguous environments with widely distributed units functioning at different tempos and in various phases of operations,” how can it achieve reliable timely delivery without a serious analysis and improvement of its capabilities? It is obvious that if the U.S. Army’s battlefield distribution capabilities cannot meet the demands of the current operational environment, then even near perfect asset visibility is of little value.

A key assumption made by the proponents of VM was that JIT could translate effectively into a military environment. It should be remembered that JIT depends on fixed and dependable delivery times and locations. Thus, the assumption that JIT could be effective in a military setting is mostly valid, as long as the army operates in a garrison or SASO environment where delivery sites are relatively fixed. However in a combat environment, this is generally not the case. In OIF for example, supplies that were loaded on trucks for delivery to units on the move never caught up with them.⁶⁹ It is hard to imagine Federal Express (FEDEX) or United Parcel Service (UPS) guaranteeing overnight delivery to an address that is to be determined at the time of delivery. This type of unpredictability can wreak havoc with a JIT system. This is a lesson U.S. companies learned the hard way. The terrorist attacks of 11 September 2001 seriously disrupted the operations of UPS, FEDEX and other shipping companies. This disruption in turn caused serious problems for the customers of these companies, who relied on them to sustain their JIT logistics systems.⁷⁰ This should have been a clear indicator to the U.S. Army that JIT and a combat like environment are a poor mix.

⁶⁹ Ibid.

⁷⁰ Joseph Martha and Sunil Subbakrishna, “When Just-In-Time Becomes Just-In-Case”, *The Wall Street Journal*, Oct 22, 2001 p. A18.

Applying Systems Thinking

If the future of the U.S. Army is one of conducting “joint expeditionary operations [that] require the Army to respond...with forces that can be deployed, employed and sustained immediately and simultaneously upon arrival in distant, austere theaters of operations,” then an understanding of the leverage points of the distribution system are critical to effective and agile logistics.⁷¹ Systems Thinking may hold the key to seeing and understanding these points.

However, in order to assess the utility of Systems Thinking in solving the shortcomings of the U.S. Army battlefield distribution system, it is necessary to identify four critical factors: First, what is battlefield distribution; second, what are the major components of the battlefield distribution system; third, what is the relationship between these components; and finally, what is the environment within which the system must function? From this analysis one should be able to discern the leverage points that allow for lasting improvement of the system.

Battlefield Distribution System Defined

The U.S. Army defines the distribution system as follows: “That complex of facilities, installations, methods, and procedures designed to receive, store, maintain, distribute, and control the flow of military materiel between the point of receipt into the military system and the point of issue to using activities and units.”⁷² This definition is sufficient, and mirrors the Process (methods and procedures that control) - Capability (facilities and installations) - Environment (point from receipt to issue) paradigm of JIT. However, the use of the word “maintain” in the definition is confusing. If it is intended to convey the concept that supply inventories need to be maintained it is redundant, as the word “store” adequately conveys this concept. However, if the word implies that maintenance activities are part of the distribution system, then the definition is

⁷¹ Joint and Expeditionary Logistics For a Campaign Quality Army, (draft date 12 Aug 04 / photocopied).

flawed, because maintenance activities occur primarily within using units, and are not associated with the distribution of materiel.

The Combined Arms Support Command (CASCOM) definition of Battlefield distribution is much more problematic. CASCOM defines Battlefield Distribution as: “a fully integrated distribution management methodology that utilizes existing and emerging technologies; limited organizational restructuring; improved doctrine; and reengineered procedures/business practices to enhance distribution operations.”⁷³ This definition, like VM, is process centric and neglects the capabilities and environmental factors that must be accounted for within a JIT based system.

Taking into consideration the previous definitions, a more effective definition of the battlefield distribution system is: The interaction of means and procedures designed to receive, store and distribute military materiel from the point of entry into a theater of operations to the point of issue to using units and activities. For the purposes of this monograph, this definition of battlefield distribution will be used throughout.

Major components of the Battlefield Distribution System

Based on the above definition, the Battlefield Distribution System has three major components: Process, Capabilities, and Using Units or Activities, all operating within a given Environment. Process includes the management practices (command and control/organization), communications/STAMIS, and inventory activities that provide the necessary asset visibility for effective distribution. Capabilities are the physical facilities and equipment needed to receive, issue, store and move materials on the battlefield. Using Units and Activities are those entities that generate requirements and expend material. The Environment is a composite of the conditions, circumstances and influences within which the distribution system must function.

⁷² *FM 101-5-1 Operational Terms and Graphics*, (Department of the Army: Washington D.C., 1997) 1-55.

⁷³ *USACASCOM Pamphlet on Battlefield Distribution*, (United States Army Combined Arms Support Command: Ft. Lee, 1996) 4.

When diagrammed, the system forms a typical “Balancing Process With Delay” archetype (see figure 10).

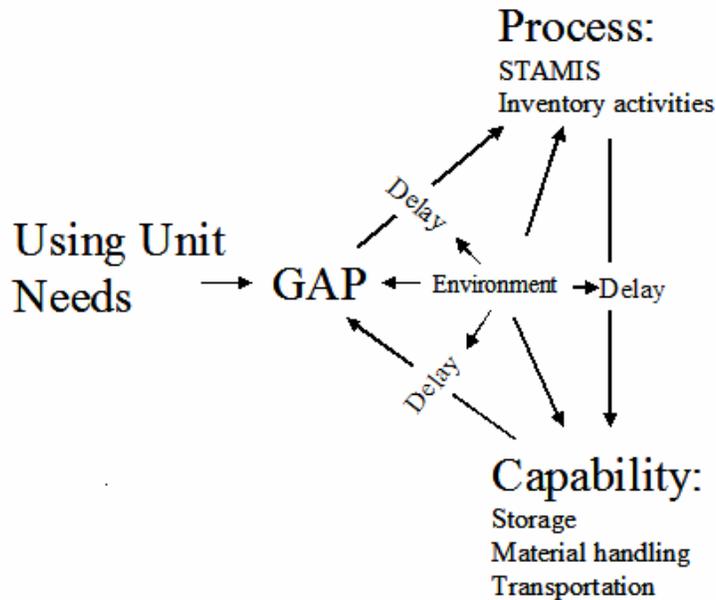


Figure 10 Battlefield Distribution System Archetype

Interrelationship of systems components

From the diagram in figure 10 it is easy to see the interaction of the major components of the distribution system. Using Units expend resources and generate requirements creating a gap between the desired state (fully supplied units) and reality. The Using Units utilize the process to request supplies, the process through inventory management practices etc. locates the supplies needed to fill the gap, and passes the request to the capability component to physically move the supplies to the Using unit. Throughout the entire process, various conditions in the environment create delays within the system. It must be noted here that the model of the battlefield distribution system depicted in figure 10 is not intended to be a comprehensive map of U.S. Army

distribution, rather, it is a Systems Thinking tool (an archetype) that allows one to “see structures at play, and to see the leverage in those structures.”⁷⁴

The environment

It would be difficult to overstate the importance of the environment on the distribution system. As indicated by figure 9, the environment has a direct impact on every facet of the system. The Army defines the specific environment in which the U.S. Army Battlefield Distribution System must function in as:

“An environment of difficult terrain, adverse weather and adaptive enemies, all within a social, physical and economic context of failed states, fractured societies, rampant crime with international linkages, and religious and ethnic tension... A campaign quality Army is required to meet these challenges, meaning the Army must win decisive operations and sustain those operations for as long as necessary while quickly adapting to unpredictable changes in the context and character of the conflict. U.S. forces must be able to conduct distributed, simultaneous, joint operations in multiple theaters and multiple locations across the full range of military operations. Today, combat forces routinely operate in fluid, nonlinear, noncontiguous environments with widely distributed units functioning at different tempos and in various phases of military operations.”⁷⁵

From this perspective it may be tempting to identify the environment as the key leverage point within the system. However, this is not consistent with a Systems Thinking approach, and would lead to a critical error, the same mistake that the German Army made during the inter-war period (1919-1939): Identifying the environment as a leverage point assumes that one can shape

⁷⁴ Senge, *The Fifth Discipline*, 95.

or control it to fit the system. The Germans thought that they could achieve decisive victory quickly enough to shape the environment in a manner favorable to their distribution system. The U.S. Army made the same error when it adopted VM by assuming that the battlefield would be shaped quickly enough to assure the availability of airfields etc. The environment is not a leverage point; however, understanding the environment allows one to identify the leverage points one needs to affect in order to shape the system in a manner favorable to the environment.

Leverage Points

Systems Thinking identifies a leverage point as the place at which dynamic complexity impacts a system, or the location that “actions and changes in structures can lead to significant, enduring improvement.”⁷⁶ In Systems Thinking, dynamic complexity consists of delay – the time between an action and its consequence; and location – the fact that an action can have one consequence (or set of consequences) locally, and a different consequence (or set of consequences) in another part of the system. From this perspective, the leverage points in figure 9 become clear: The delay between the moment the using unit has the need for an item and the supply process becomes aware of the need; the delay between the moment the supply process is aware of the need for an item, and that item is located; and finally, the delay between the moment the needed item is located, and it is physically moved to the using unit (see figure 11).

⁷⁵ The United States Army Logistics Transformation Operational and Organizational Concepts White Paper, 12 Aug 2004, (Department of the Army: Washington D.C., 2004) 3-4.

⁷⁶ Ibid., 114.

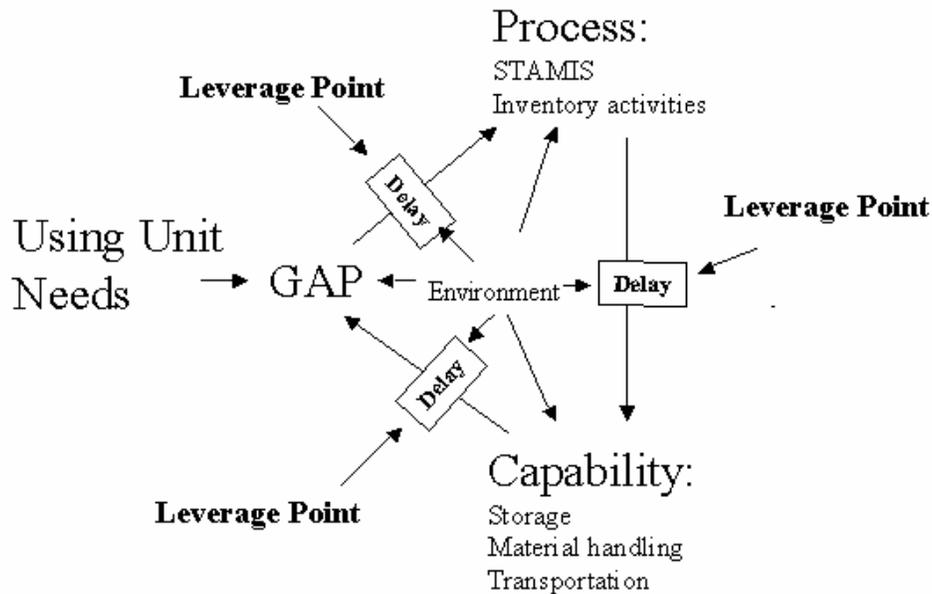


Figure 11 Leverage in the Battlefield Distribution System Archetype

From a Systems Thinking perspective, it is easy to see why VM was initially so successful. It directly impacted two of the three leverage points in the battlefield distribution system – specifically, the delay between using unit and process, and the delay between process and capability. The third leverage point (the delay between capability and the using unit) was not directly addressed by VM; however, the U.S. Army did attempt to influence this leverage point by hiring civilian carriers and warehouse activities (FEDEX / UPS / KBR). This approach worked relatively well as long as the environment (relatively static location for using units, short fairly secure LOCs) did not significantly change (see figure 12):

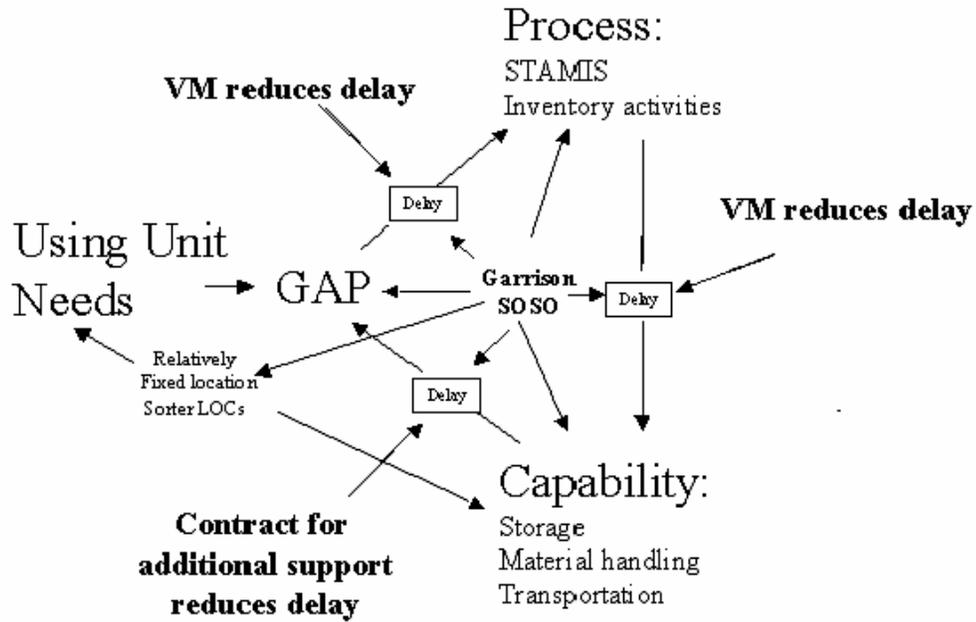


Figure 12 VM and Battlefield Distribution (Garrison and Stability and Support Operations)

Thus, by not directly addressing the third leverage point, the Army found itself reliant on a distribution system that had been fine tuned for a specific environment. Not surprisingly, much like a fine tuned Formula One race car, the vehicle struggles when taken off the track. Thus, when there is a significant change in the environment (as in OIF), VM becomes much less effective (see figure 13).

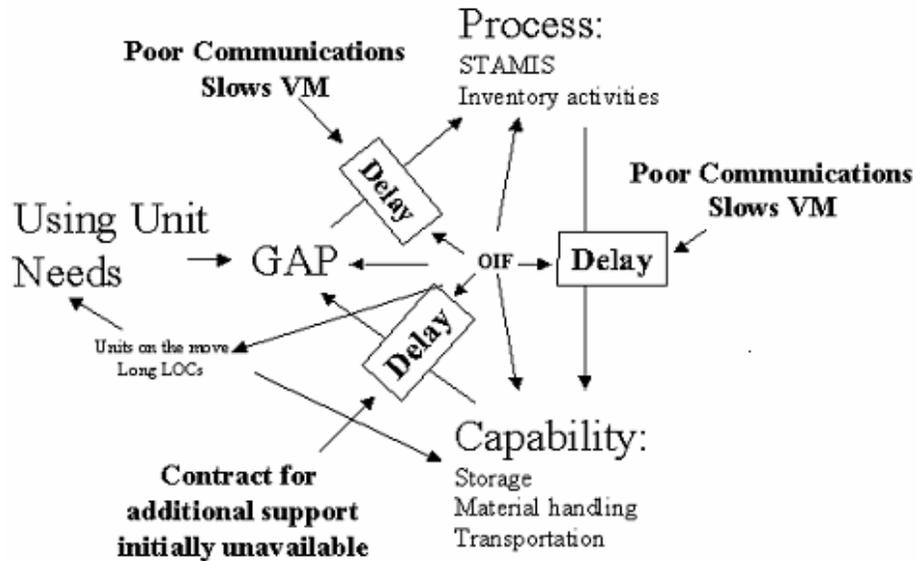


Figure 13 VM and Battlefield Distribution (Operation Iraqi Freedom)

By comparing figures 12 and 13, the utility of Systems Thinking in identifying a system's leverage points, as well as assisting in identifying the locus of problems that arise becomes clear. If the U.S. Army had looked at distribution from this perspective prior to implementing VM, the problems encountered in OIF might have been mitigated.

Utility of Systems Thinking

From the basic application of Systems Thinking above, one can appreciate the potential it represents as a tool for understanding the interactions of the components that comprise the U.S. Army distribution system. This understanding is a key to analyzing and correcting current distribution problems, in addition to anticipating change that could lead to future distribution problems. A rudimentary application of Systems thinking has shown that VM is only a partial solution (a Fix That Fails), and can only be successful in its current state in limited circumstances. Systems Thinking has also served not only to provide the logistician with a better understanding of the U.S. Army distribution system, but also to identify the critical leverage points within the system that will allow development and implementation of effective and lasting solutions to current and future distribution challenges.

Systems Thinking may also have utility in the development of a planning tool for U.S. Army logisticians. Given a thorough Operational Net Assessment (ONA) of the battlefield (environment), U.S. Army logistics planners could marry this assessment with the Systems Thinking archetype depicted in figure 11.⁷⁷ This combination would allow logisticians to predict with a reasonable degree of probability the adjustments (via leverage points) that need to be made to the distribution system in order for it to function effectively within the expected operational environment outlined by the ONA. This hyper-analysis would help logistical planners develop the best possible distribution systems for each given operation, and thus provide the level of flexibility that the *Joint Forces Command White Paper, The Joint Operational Environment – Into the Future (5 Mar 04)*, indicates is needed to support operations on the future battlefield. The U.S. Army’s current distribution system lacks this level of flexibility. This fact is not surprising, as predictability and precision rather than flexibility, are the hallmark of JIT systems.

Conclusion

“Preparing for the future will require us to think differently and develop the kinds of forces and capabilities that can adapt quickly to new challenges and to unexpected circumstances. An ability to adapt will be critical in a world where surprise and uncertainty are the defining characteristics of our new security environment.” – Secretary of Defense Donald Rumsfeld, speech to the National Defense University, Ft. McNair, Washington, DC, 31 January 2002.

“Only by changing how we think can we change deeply embedded policies and practices.” – Peter M. Senge, *The Fifth Discipline*, p. xiv

Systems Thinking has great potential to improve both the U.S. Army’s understanding of battlefield distribution, and the manner in which logisticians plan and execute operations to sustain combat forces. Systems Thinking also allows the logistician to take a much more holistic approach to battlefield distribution system development. This holistic approach is critical to

⁷⁷ ONA is a "system-of-systems" analysis of a potential adversary's political, military, economic, social, infrastructure, and information (PMESII) war-making capabilities. Of critical importance to the logistician is an understanding of how the Economic, Infrastructure, and Social aspects of ONA interact with each other as well as the remaining elements of PMESII.

effecting lasting improvement. As has been seen in the past, it is not enough to simply improve one aspect of battlefield distribution, such as STAMIS and communications infrastructure. Rather, these efforts must be made in conjunction with other efforts to improve and increase distribution capability, as well as other components of the system. Systems Thinking is an effective tool for understanding that allows for a sound holistic approach to battlefield distribution. On the basis of the forgoing analysis, the following recommendations are in order:

Recommendations:

First, for the U.S. Army to fully harness the potential of Systems Thinking it must train logisticians, particularly logistics planners, in the art of systems thinking. The general theory and methodology of Systems Thinking should be incorporated into the logistician's basic and advanced officer training schools. Graduate level Systems Thinking should be taught in the U.S. Army's Support Operations Course (SOC). The current SOC course corresponds with the old linear battlefield paradigm, and should be entirely rewritten. The updated course should be designed to teach logisticians the Systems Thinking process, systems theory, and utilization of the distribution systems archetype (see figure 14) in conjunction with an ONA to design a distribution concept applicable to specific types of operation and their various environments.

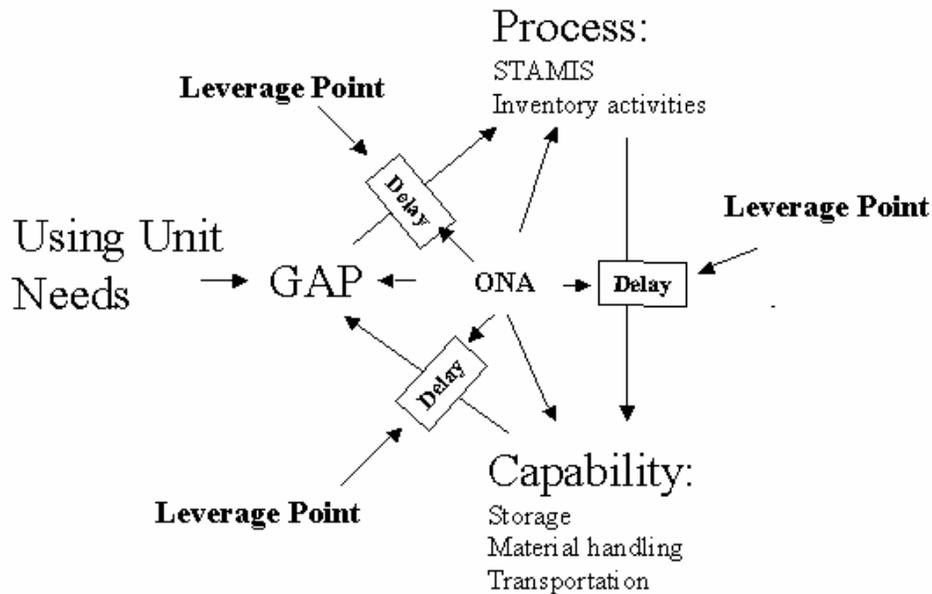


Figure 14 Battlefield Distribution System Archetype and ONA

Second, VM has proven its worth in a garrison environment, and should continue to be the preferred process for that and other relevant environments. However, VM must evolve into a more flexible process. It must be able to shift seamlessly between an efficiency-centric system while in a garrison environment and an effectiveness-centric system during high intensity conflict operations such as OIF. To do this, VM must abandon some of the more rigid principles of JIT, specifically, the principles of maintaining lower inventory levels and strict delivery schedules. For example, higher inventory levels must be accepted in many cases to prepare for the chaotic environment of the current and future battlefield. Additionally, an excess of distribution capability (trucks / trailers etc.) must be kept on hand to give the distribution system the ability to make unscheduled and/or replacement deliveries.

The need to maintain excess distribution capability leads to a third recommendation: The U.S. Army must procure and maintain more distribution assets, specifically heavy equipment lift trucks, cargo trucks, and trailers. The U.S. Army cannot afford again to make the assumption that increased efficiency will result in increased capability. The “efficiency equals capability” assumption was a key component of VM, and in spite of the increased efficiencies created by

VM, one of the key lessons learned from OIF was that the U.S. Army lacked the distribution assets to support a highly mobile high intensity conflict.

Recommendation for further research:

However, simply recommending that the U.S. Army buy more trucks would be repeating the same reductive error that has been made in the past. Any effective improvement to battlefield distribution must be made with all of the individual components (capabilities, processes and units) in mind. Thus, in order to effect lasting improvement, adjustments must be made across the spectrum of doctrine, organization, and materiel. Accordingly, further research should be conducted in the following areas:

Doctrine: Current U.S. Army distribution doctrine was developed to support operations on a linear battlefield. This construct presupposes several conditions, such as a relatively secure rear area and LOCs, neither of which necessarily exists in the current operational environment. Therefore, new U.S. Army distribution doctrine must be developed to account for changes to the operational environment as outlined in *The Joint Operational Environment – Into the Future (5 Mar 04)*. Additionally, this new distribution doctrine should be developed to incorporate the Systems Thinking principles outlined in this monograph.

Organization: The current transformation of U.S. Army units to more modular and multifunctional formations is a positive step toward creating the organizational structure needed to maximize the benefits of a Systems Thinking based distribution system. However, further research should be conducted to determine the exact composition and capabilities of the logistics units needed to meet the requirements of these new formations.

Materiel: Research must also be conducted to determine the optimal number of trucks that should be added to the U.S. Army inventory, and to what level of command they should be allocated. Further, research must be conducted to determine the level to which supply inventories

at every echelon of the logistics structure should be increased, in order to create the greatest level of flexibility to U.S. Army operations.

This additional research is critical to developing a systemic solution to the current battlefield distribution problem facing the U.S. Army. Clearly, a holistic approach is the key to effecting lasting improvement. As has been seen in the past, it is not enough to simply improve the firepower and maneuver capabilities of an army to overcome logistical challenges. Rather, these efforts must be made in conjunction with other innovations aimed to improve the force as a whole. Systems Thinking is an effective tool for planning, implementing and assessing these improvements, as it fosters the understanding that allows for sound holistic approaches to the challenges of battlefield distribution.

BIBLIOGRAPHY

- Alberts, David S. and Hayes, Richard E. *Power to the Edge, Command and Control in the Information Age* Washington: CCRP Publication Series, 2003.
- Bertalanffy, Ludwig von. *General systems Theory, Foundations, Developments, Applications*, New York: George Braziller Inc., 1968.
- Bodek, Norman. *Kaikaku, The Power and Magic of Lean - A Study in Knowledge Transfer*, Vancouver: PCS Press, 2004.
- Burnsteel, Harvey L., *A Logistics Think Piece, How far Have We Progressed?*, (PM Magazine, March-April 1996.
- Christianson Claude V., "Army Logistics White Paper," *Army Magazine*, April 2004.
- Department of Defense. *JP 4-0, Doctrine for Logistic Support of Joint Operations*, Washington D.C.: 2000
- Department of the Army. *FM 100-7, Decisive Force: The Army in Theater Operations*. Washington D.C.: 1995.
- _____. *FM 100-6, Army Operational Support*. Washington D.C.: 1995.
- _____. *FM 3-0, Operations*. Washington D.C.: 2001.
- _____. *FM 3-90, Tactics*. Washington D.C.: 2001.
- _____. *FM 63-20, Forward Support Battalion*. Washington D.C.: 1990.
- _____. *FM 63-2, Division Support Command, Armored, Infantry and Mechanized Infantry Divisions*. Washington D.C.: 1991
- _____. *FM 100-15, Corps Operations*. Washington D.C.: 1996.
- _____. *FM 100-16, Army Operational Support*,. Washington D.C.: 1995.
- _____. *FM 101-5-1, Operational Terms and Graphics*. Washington D.C.: 1997.
- _____. *Joint and Expeditionary Logistics For a Campaign Quality Army*, (draft dated 12 Aug 04 / photocopied).
- _____. *The United States Army Logistics Transformation Operational and Organizational Concepts White Paper, 12 Aug 2004*, Washington D.C.: 2004.
- Dörner, Dietrich. *The Logic of Failure, Recognizing and Avoiding Error in Complex Situations*, Cambridge: Perseus Books, 1996.
- Dumond, John, Eden, Rick, and Folkson, John R. *Velocity Management: An Approach for Improving the Responsiveness and Efficiency of Army Logistics Processes*, Santa Monica: RAND Corporation, 1995.
- Eden, Rick. "Faster, Better, Cheaper, U.S. Army Manages a Logistics Revolution", *RAND Review*, Spring 2002.
- Fontenot, G. COL(Ret), JTC E. J. Degan and LTC D. Thon. *On Point, The United States Army in Operation Iraqi Freedom*. Ft. Leavenworth: Combat Studies Institute, 2004.
- Gordon, Michael R. and Trainor, Bernard E. *The Generals' War*, Boston: Little, Brown and Co., 1995.

- Grau, Lester W. *Road Warriors of the Hindu Kush: The Battle for Lines of Communication in the Soviet-Afghan War*. Ft. Leavenworth: Foreign Military Studies Office, 1995.
- Jackson, Timothy J. LTC. "Forrest War...With a German Spin," *Marine Corps Gazette* (2002 Archives). On-line. Available from <http://www.mca-marines.org/Gazette/2002/02arch.html>
- Klein, Gary. *Sources of Power, How People Make Decisions*, Cambridge: The MIT Press, 1999.
- Knox, M. and W. Murray. *The Dynamics of Military Revolution*. Cambridge: Cambridge University Press, 2003.
- Kofman, Fred and Senge, Peter M., Communities of Commitment: "The Heart of Learning Organizations", *Organizational Dynamics*, Autumn 1993.
- Kuhn, Thomas. *The Structure of Scientific Revolutions*, Chicago: University of Chicago Press, 1962.
- Lupfer, T. T. *The Dynamics of Doctrine: The changes in German Doctrine During the First World War*. Ft. Leavenworth: U.S. Army Command and General Staff College Press, 1981.
- Lutes, LeR. LTG. *Logistics in World War II: Final Report of the Army Service Forces: A Report to the Under Secretary of War and the Chief of Staff*. Washington D.C.: War Department, 1947.
- Magruder, Carter B. GEN (Ret.). *Recurring Logistics Problems as I Have Observed Them*. Washington D.C.: U.S. Army Center of Military History, 1991
- Murray, W. and A. R. Millett. *Military Innovation in the Interwar Period*. Cambridge: Cambridge University Press, 1996.
- Naveh, Shimon. *In Pursuit of Military Excellence, the Evolution of Operational Theory*, London: Frank Cass Publishers, 1997.
- Parker, Geoffrey. *Cambridge Illustrated history Warfare*. Cambridge: Cambridge University Press, 1995.
- Polmar, Norman and T. B. Allen. *World War II America at War 1941-1945*. New York: Random House, 1991.
- Senge, Peter M. *The Fifth Discipline, the Art and Practice of the Learning Organization*. New York: Currency Doubleday, 1990.
- Spiller, Roger J. *Sharp Corners: Urban Operations at Century's End*. Ft. Leavenworth: U.S. Army Command and General Staff College Press, 2004.
- Turbiville, Graham H. "Soviet Logistic Support Concepts Change". *Army Logistician* (March – April 1997).
- United States Army Combined Arms Support Command. *USACASCOM Pamphlet on Battlefield Distribution*, Ft. Lee: 1996.
- United States Joint Forces Command. *The Joint Operational Environment – Into the Future*. Coordinating draft, 2004.
- Walden, Joseph L. *The Forklifts Have Nothing to do, Lessons in Supply Chain Leadership*, New York: iUniverse Inc., 2003.
- Womack, James P. and Jones, Daniel T. *Lean Thinking*, New York: Simon and Schuster, 1996.