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Abstract: While considerable work has been done on the topic of Agility over the past decade, the major case studies related to C2 have been conducted by NATO SAS Research Task Groups (065 and 085) as efforts to validate the concepts and relationships in their analyses and models of C2 approaches. However, there is a meaningful body of relevant work carried out by historians and analysts that document empirical and observable situations where Agility has proven important, not only recently, but also over time. This paper reviews the empirical evidence captured in some these efforts, focuses attention on the long term importance of Agility in military affairs and points out significant measurement issues that remain unresolved...

EMPRICAL AGILITY

INTRODUCTION

Most of the research and writing over the past decade dealing with Agility in the field of command and control (C2) has been generated by the Command and Control Research Program (CCRP), supported by the US Office of the Secretary of Defense, or NATO Research Task Groups (RTG) supported by NATO's Studies, Analyses, and Simulation (SAS) Panel. These are not fully independent efforts as the CCRP has provided the leadership of the two most relevant RTG, SAS-065 (NATO SAS-065, 2008) and SAS-085 (NATO SAS-085, 2013). Taken together, these efforts have generated substantial interest in Agility and have spawned considerable theoretical progress and some in-depth modeling and simulation related to the topic as well as documented case studies that have provided important validation for the theoretical work.

The idea that Agility is a crucial aspect of C2 arose in a bilateral technical session involving the US and UK. This was first articulated in a CCRP book, *Power to the Edge* (Alberts and Hayes, 2003), which appeared a decade ago, where Agility was defined only in terms of six key "dimensions" or activities by which it could be identified – Robustness, Resilience, Responsiveness, Flexibility, Innovation, and Adaptability. This formulation guided the work of SAS-065. That group also carried out some simulations and several case studies to examine the validity of the model it was developing and to ensure the language it was using communicated well across NATO nations. The community noted the need for a simpler, more integrative definition of Agility. That gap was addressed by SAS-085, which concluded that "Agility is the capability to successfully effect, cope with, and/or exploit changes in circumstances." That definition is used in this paper.

PRIOR QUANTITATIVE RESEARCH

Because Agility was not previously a specific focus of C2 research, virtually no relevant quantitative work deliberately focused on the topic before CCRP and SAS raised interest in the subject. Indeed actual quantitative work on C2 was quite rare before the 1980s, partly because of the strong assumptions among practitioners that command is an art (therefore presumably not subject to quantitative analysis), that communications are mechanical processes focused on messages (and therefore properly subject to engineering analysis separate from the art of command), and that command and control processes were determined by military cultures (captured in doctrine and training) and therefore not well suited to numerical analyses. As a consequence, Agility related to C2 was seldom found and never referred to in that language. However, there are two instances of rigorous quantitative analyses (both searching for explanations of force performance) where Agility emerged as an important factor.

Olmstead's work for ARI

During the 1970s, the Army Research Institute was tasked to support training by evaluating the performance of units during training exercises. The goal was to understand what observable factors differentiated high performing from mediocre or poor performing organizations. The

level of performance was rated based on reports from senior observers. The analytic techniques employed were drawn from operations research, which had been developed as the scientific community sought to aid the military during World War II. Joseph Olmstead was the lead analyst for a variety of U.S. Army brigade exercises intended to assess the readiness of units for deployment (Olmstead, Elder, and Forsyth, 1978).

These units were training to battle Soviet Bloc forces in Europe, where the US and NATO had studied Warsaw Pact Forces in detail and knew that these adversaries should be expected to conduct layered attacks into Western Europe – initial waves would be followed by a gap (in time and space) to permit evaluation of initial successes and to allow informed decisions about the focus of follow-on waves. Olmstead observed that the best performing brigades did their initial planning and preparations with an open structure, sharing information and ideas broadly, but shifted to tightly disciplined, narrowly focused C2 structures and processes during the fight with the first wave. However, once that wave was broken, their C2 approach (structure and process) opened up and used the time available to encourage sharing until it was time to engage the next wave, when they closed structure and process again. Olmstead and his colleagues did not use the term Agility, nor were they looking for it, but what they documented was clearly a change in the structure and processes of C2 – the very definition of Adaptation (one defining aspect of Agility) as it is used by the CCRP and NATO SAS communities today.

Around the same time, DARPA and the Commandant of the US Marine Corps teamed up to fund and carry out detailed analyses intended to learn what made some USMC battalions perform better than others in combat. Unlike Olmstead's work that focused on training, this effort sought to analyze performance in actual combat. I had the opportunity to lead the research team assigned to carry out the project (Hayes, 1977). This effort was intended to inform and did inform, the development of a new system (Marine Corps Combat Readiness Evaluation System or MCCRES) to evaluate the training and readiness of individuals and units preparing to deploy. The project was well supported – five USMC officers were assigned to support the research effort, the rich archives of the Marine Corps were made available as source documents, DARPA provided the funding and contract vehicle, and a wide variety of USMC retired officers volunteered to support the effort.

The project design involved four classes of data. First, thirty-nine specific operations were selected based on the fact that an infantry battalion had been performing a mission that could be isolated for analysis and that was well documented. These came from a range of warfare environments, World War II, Korea, Vietnam, and independent actions. Each operation was described in a brief written narrative judged by the USMC team to be accurate and clear. The USMC archives were used to generate a variety of detailed empirical indicators about each mission (a large number of variables for each case) that were hypothesized to be influences on mission performance (for example, length and types of unit training, how long officers and non-commissioned officers had been with the unit, amount of artillery fired in support of the operation, presence of air support, etc.) These data were augmented by Likert Scale ratings about "soft" factors such as unit morale provided by the retired USMC officers (all of whom had commanded infantry battalions in combat) after they had read the summaries of each unit's operation. The dependent variable (unit performance in combat) was generated by having

veterans who had actually commanded USMC infantry battalions in combat rate mission accomplishment based on their reading of the individual unit operations. This question was worded in four different ways in order to ensure thoughtful assessment. All judgment variables were coded independently by three different veterans. Evaluations of unit performance were never made by the same retired officers who provided evaluations of the soft variables for that case, nor were the retired officers assigned to provide values for cases drawn from the USMC regiments where they had served. All judgment variables also allowed the raters to indicate that the summary provided did not have enough information to allow them to make a clear assessment. Factors that could not be assigned reliable values were eliminated for that case.

Given the complexity of the research design and the large number of volunteers required to provide the judgment data, the results were remarkably coherent. The R^2 for the key judgments on mission accomplishment was slightly above .81, indicating a raw correlation in excess of .90 for their Likert data. Given the large number of variables (about 270 variables per case, including judgment and empirical data) and the strong coherence of the mission accomplishment data, the results were subjected to factor analysis in order to determine which factors were most closely associated with success (mission accomplishment) in combat operations. The first solution that emerged was that success depended on the three classic determinants of combat performance – unit capability to move (maneuver), shoot (firepower) and communicate (share information, orders, and ideas). This provided some credibility (or face validity) to the results.

Factor analysis also allows an analytical team to examine a data set from more than one statistical perspective. The second solution, which was empirically slightly stronger than the first (explained the variance in the data somewhat better), was that those USMC Battalions that performed better in combat were those who (a) most quickly recognized that the fight they were in was not precisely the one they had expected and prepared for and (b) reacted most quickly to that knowledge. This was one of the early pieces of empirical research that demonstrated that the quality of situational awareness was crucial, but went beyond that finding to demonstrate that the ability to act promptly on that situation awareness was also crucial to combat effectiveness. Here, again, the analytic team was not explicitly looking for Agility, nor focused primarily on C2, but rather seeking to find empirical determinants of military performance. Nevertheless, the research clearly showed the importance of Agility – seeing and understanding changes in circumstances and responding effectively – in determining combat effectiveness, again a match to the SAS-085 definition.

PRIOR QUALITATIVE WORK

CCRP Literature

Prior to the insights offered in *Power to the Edge*, CCRP research and analysis had already reported on topics related to Agility in the C2 arena. Some of the earliest CCRP publications describe aspects of Agility as important.

Alternative Approaches to Successful C2

Both in the very early CCRP book *Command Arrangements for Peace Operations* (Alberts and Hayes, 1995) and the fundamental volume *Understanding Information Age Operations* (Alberts, *Garstka, Hayes, and Signori, 2001);* CCRP authors discussed a variety of alternative approaches to successful C2 during the 20th Century. This discussion was based on early research dealing with measuring the success of C2 (initially at the theater level, later at the operational and tactical levels) and emphasized the fact that different approaches to C2 had proven successful in different warfighting environments. The more heavily constrained (more centralized) approaches were shown to be effective in stable, predictable warfighting environments (for example, static warfare in World War I). However, less centralized approaches were demonstrated to be better suited to more dynamic and less predictable settings (particularly maneuver warfare). Of course, the work also showed that different C2 approaches were best suited to forces with different attributes – levels of education, training, and communication capability. For our purposes here, however, this relatively early C2 work also showed the need for greater Agility in less predictable, more dynamic warfighting environments.

Case Reviews in *Understanding Information Age Warfare* (*UIAW*)

Published in 2001, *UIAW* went beyond suggesting language for C2 analysis and offering new theoretical insights to making an initial catalogue of evidence emerging about the impact of elements of Network Centric Warfare as they were emerging in the force. These included:

- The impact of LINK 16 (an improved C2 system that greatly improved the information available to pilots by linking individual aircraft radar pictures with those on larger platforms such as AWACS and sharing the results across friendly forces) on air to air combat performance in training missions. This new technology greatly improved combat metrics because it improved situation awareness, sped up decision making, and allowed new maneuvers. This proved to be a disruptive technology that improved responsiveness, flexibility and innovation.
- A Fleet Battle Experiment conducted with South Korea was shown to use new technology to greatly improve situation awareness and decision speed, enabling new tactics that defeated a special operations threat in record time with dramatically fewer friendly casualties, another case of improved responsiveness, flexibility, and innovation in a rapidly developing warfighting environment.
- In both US Army exercises and Operation Allied Force (air operations in Kosovo) the book documented the fact that Unmanned Aerial Vehicles (now more commonly called drones) added substantially to the quality of surveillance, resulting in better situation awareness and improved combat performance. This is another example of disruptive innovation having a major impact on mission accomplishment.

Here, again, the authors were not searching for Agility, but found it as a crucial consequence of improved C2 and the capacity of military forces to exploit elements of Agility, particularly flexibility, innovation, and responsiveness.

Admiral Nelson at Trafalgar

In P*ower to the Edge* Admiral Nelson's command and control for the battle of Trafalgar was used to demonstrate the concept of self-synchronization. However, the same engagement is also an excellent example of Agility in the C2 arena, most particularly innovation and flexibility. The tactics Nelson employed were not unprecedented – they were first created and exploited by a British Captain – George Brydges Rodney – who was defending British interests in the Bahamas in 1782, more than 20 years before Trafalgar. However, the dominant approach to fleet actions remained slugging it out in line of battle as the forces sailed parallel to one another exchanging broadsides. Believing these tactics would disadvantage his fleet of lighter and out-gunned ships, Nelson decided on a course of action that would instead provide advantage to his more maneuverable, better manned (in terms of both sailing prowess and gunnery) and better led ships. Nelson was able to rely on the opposing French and Spanish fleet to predictably form line of battle. He met with his captains a number of times aboard his flagship while searching for the enemy fleet, going over precisely how they would fight the battle.

When the time came to engage, Nelson divided his vessels into two columns and attacked directly at a 90 degree angle to the adversary battle line. This exposed the prow of each of his ships to broadsides from the enemy, but only briefly if each captain timed his attack and aimed at the gaps between enemy vessels. As the passed through the enemy line, each of the British ships had an opportunity to deliver its broadsides directly into the prow of one enemy vessel and the stern of another. These broadsides could travel the length of the enemy vessels, potentially doing great harm. The British ships were able to break the enemy's line and turn the engagement into a series of ship-to-ship battles where their superior maneuverability and gunnery proved to be decisive. These tactics worked in no small part because they were well adapted to the military situation and the professional quality of Nelson's forces. The British were thus able to create and exploit new circumstances in fleet warfare, benefitting from the Agility resulted from recognizing the way shipbuilding and superior training, disciple, and leadership had changed the circumstances of fleet actions.

Other Relevant Literature

Analyses of Theater Level C2 During World War II

Late in the Cold War, the US and NATO became concerned that their theater headquarters (EUCOM in Europe, PACOM in the Pacific, etc.) were large, cumbersome, and vulnerable to attacks by special weapons (nuclear, biological, and chemical). However, there was a perceived paucity of analytical work on the design and performance of these organizations, so decisions about how their vulnerability might be reduced without losing performance were very challenging. As a consequence, the Defense Communications Agency (DCA, later transformed into the Defense Information Systems Agency or DISA), commissioned a study of World War II theater level headquarters, with emphasis on structure, function, and performance (Hayes, Hainline, Strack, and Buccioni, 1983).The research design assumed that commanders and commands would learn over time, so it focused in large part on lessons learned and changes introduced over the course of the war. Analyses also looked at successful US commanders (particularly General Eisenhower, Admiral Nimitz, and theater level air commanders) to understand what adjustments they made as they gained experience. In Eisenhower's case, this

included learning across three major efforts – North Africa, Italy and Sicily, and Overlord and Europe. For Nimitz, of course, it was the PACOM command over time, while air command tended to change over time, making changes across individual leaders the more natural focus.

Somewhat surprisingly, these analyses showed quite similar patterns of change cutting across warfare arena (land, air and water), individual leader, and geography. Among the key findings:

- Without exception, theater level headquarters staffing shifted from an initial emphasis on operations (G-3 as the majority assignment) toward intelligence (G-2 as the preponderance of assignments). By the end of the war, intelligence had a ratio of 3-2 over operations in the typical theater headquarters. This adaptation in structure reflected an increasing grasp of the key role of situational awareness at the theater level. By contrast, German staffing patterns did not change during the war, continuing to keep the percentage in intelligence low, which critics suggest explains why they were never able to correctly forecast the location of Allied landings in the North African and European theaters.
- Immediate subordinates in ground combat spent approximately one-third of their time at the theater level headquarters. Their primary activities during these visits were seeking to shape the missions their command might be assigned and seeking to increase their allocations of resources – military units, priorities for air resources and fires, desirable boundaries and road access, etc. This finding was surprising as many of these same commanders also stressed their need to be close to the action when their forces were engaged. However, the relatively weak communications systems and the fact that theater headquarters made every effort to remain physically close to the front lines made face to face visits more attractive than alternative ways to stay in touch. This was also made more practical because the Allies normally had the initiative and could, therefore, decide when crucial engagements might occur. The obvious exception, the Battle of the Bulge, actually resulted in a major face to face meeting called by Eisenhower to determine the Allied response.
- Successful theater level commanders consciously developed “work arounds” that moved information, guidance, and orders more rapidly than the large, Industrial Age, bureaucracies that characterized their organizations. Frequent face to face interactions with immediate subordinates were one such practice, including commanders who went forward to subordinate’s headquarters as well as willingness to host meetings at their theater headquarters. Interactions between functional specialists, particularly logisticians and intelligence officers, were also encouraged. Openness to ideas and thoughts proved important, both to ensure flexibility and to generate and maintain trust between echelons. Eisenhower also had a small group of trusted officers (often mid-ranking) who were dispatched to investigate and help resolve problems, whether interpersonal squabbles or organizational conflicts. Nimitz used a very small cadre of trusted officers to digest the massive output of his very large intelligence center, avoiding being overwhelmed by voluminous reports while providing a rapid channel for significant items to reach him.

Theater headquarters success during World War II demonstrated conscious efforts to create the conditions associated with Agility – flatter, more responsive organizations capable of adjusting to changing circumstances – despite the fact that the dominant organizational cultures were Industrial Age bureaucracies that tended toward de-conflicted C2. These adaptations, many of them informal changes in structure and function, provided the flexibility and responsiveness essential to military success.

Patton's Air Force

Air power was an emergent, powerful warfighting capability in World War II. One of its most effective applications is recorded in a very interesting little book entitled *Patton's Air Force* (Spires, 2002). This describes the cooperative efforts of Lieutenant General George S. Patton's Third Army and Brigadier General Otto P. Weyland's XIX Tactical Air Command (TAC). The Agility they demonstrated was visible in five specific ways.

- Even before the breakout from Normandy, Patton and Weyland recognized the dangers and difficulties of providing close air support – several instances of major Allied casualties from friendly fire and lack of timely and precise air support provided ample evidence of these problems. In response, they placed standard fighter-bomber radios (SCR-522) in the lead tanks of each armored column. These were manned by experienced pilots, acting as the first air controllers, an innovation that later became accepted doctrine.
- As Patton attacked eastward across France his right (Southern) flank along the Loire River was exposed – there were no friendly ground forces positioned to protect it. Rather than thin his attacking force, Patton used aggressive air patrols to monitor the flank, confident that no major threat could appear there without timely detection. This was an unprecedented economy of force tactic which worked flawlessly.
- Throughout this campaign, Patton urged the creation of forward air bases as close to the front lines as was possible. Often engineering operations began while the sound of battle was still in the air. This closeness enabled aircraft to have shorter response times and longer loiter times in place near the front. Operating from these forward positions, coupled with the practice of having a few aircraft aloft near Third Army forces, allowed rapid delivery of close air support. Response times for aircraft on stand-by at the forward bases were as low as 30 minutes, a standard equal to those experienced in Iraq and Afghanistan several decades later.
- Routine tasking for XIX TAC included looking for and blunting counter-attacks, a standard tactic when a position was lost by German forces. This included both using reconnaissance aircraft to determine whether a counter-attack was forming and diverting attack aircraft to disrupt preparations.
- Rather than the accepted doctrinal approach of centralized planning for air operations, Patton and Weyland decentralized their command and control in order to maximize responsiveness. This meant that Patton's headquarters oversaw broad planning and made its priorities clear to XIX TAC's operational command center,

which, in turn, allocated air assets and priorities to the Army Air Corps tactical units who were in direct contact with the ground forces.

This book reads more like a battle history than a C2 analysis and includes detailed tactical maps, but it is a rich source for those seeking to understand the need for Agility and how it was created within this command.

Freedman's History of Strategy

In a very recent book, Lawrence Freedman, an established British scholar, claims to have created a history of strategy, beginning in its primitive form (Chimpanzee behavior) and down through the ages including Biblical, Greek, Chinese, Italian, German, French, British, American, Russian, and other military writing as well as business and decision making thinking (Freedman, 2013). His definition of strategy is very broad; including thinking and practice at both the operational and tactical levels of warfare and conflict. As a consequence, his writing includes important insights valuable to those considering Agility, including:

"Strategy is expected to start with a description of a desired end state, but in practice there is rarely an orderly movement to goals set in advance. Instead, the process evolves through a series of states, each one not quite what was anticipated or hoped for, requiring a reappraisal and modification of the original strategy, including ultimate objectives."

This is the professorial version of "No plan survives first contact with the enemy," Von Moltke the Elder's famous statement about military operations or, as Freedman quotes Mike Tyson in the preface of his book, "Everyone has a plan 'till (sic) they get punched in the mouth." These thoughts emphasize the fact that virtually all successful military efforts involve Agility, if only because the fog and friction that characterize them, the uncertainties inherent in them and the actions of adversaries during them require it.

From a broader perspective, substantial military operations, whether the mission is combat, large scale humanitarian assistance, or peacekeeping, is a complex problem, often called wicked problems in the literature (Rittel and Webber, 1973). As a consequence, there is generally no single or isolated activity that leads to success. Moreover, the "problem" or situation (read circumstances) is changed by any meaningful effort to resolve it, and a continuing process of ensuring updated (current) situation awareness and recognizing the adjustments needed to move toward or continue success is essential. Complex problems have long been understood in the CCRP and NATO SAS literatures to be a major challenge in 21st Century C2 as reflected in *Understanding Information Age Warfare, Power to the Edge, Understanding Command and Control* (Alberts and Hayes, 2006), and the NATO SAS-065 and -085 Reports. Identifying Agility as a key factor is therefore a significant improvement in the field of command and control.

INSIGHTS

1. Far from being unique to the modern or Information Age, Agility has long been a desirable attribute of both C2 and military forces. Indeed, the evidence examined indicates that Agility has long been associated with successful command and control.
2. Agility can be consistent with established doctrine and practice as can be seen in Olmstead's research on US Army Brigades and the DARPA supported work on USMC battalion effectiveness.
3. Agility can also take the form of disruptive innovation that violates doctrine and existing practice as was demonstrated in Nelson's tactics at Trafalgar and in Patton's use of air power during World War II. Indeed, in *Power to the Edge,* Alberts and Hayes argued that, "Agile organizations need to be able to tolerate (even embrace) disruptive innovation."
4. While analytically distinct, Agile C2 and Agile forces are empirically closely linked. Neither is observable without the other and neither makes sense without the other. This problem underlies the difficulty of estimating "potential" rather than actual Agility – unless effective performance or mission accomplishment is documented, Agility cannot be said to be unambiguously present.
5. While progress to date on the study of Agility has been important, a great deal more needs to be done. The primary successes have been making the C2 and military communities aware of the importance of Agility and learning how to recognize it. However, measurement of Agility (for example, what does more or less Agility mean?) remains weak. The state of the art in Agility measurement is literally stuck at the nominal rather than the ordinal level.
6. The question remains, are any and all innovation, responsiveness, flexibility, resilience, adaptation, or robustness indicative of Agility? Alternatively, how much of each or what combinations of them are essential to make the capability meaningful?

Illustration from History

I have largely avoided using my personal experience in writing about C2 issues. First, that experience dates from the 1960s and much has changed over that time. Second, there is a great deal of evidence that memory fades and becomes distorted with time. However, as I reflected on this article my memory returned to letters I had written from Vietnam. At the time I wrote this, I was the Fire Direction Officer (FDO) of A Battery, 1st Battalion, 7th Artillery (105mm howitzers) in the First Infantry Division in 1966.

"The VC are trying very hard to get a good strike in on Ben Hoa air strip, our second largest in the country and soon to handle most international traffic, including newly arriving troops…. As the air base is expanded and new facilities are added, it becomes a more and

more lucrative target for a mortar attack or a quick raid. For this reason, the 1st Division has assigned one infantry battalion and one artillery battery [mine] to cover the area while the remainder of the Division operates up north. The ARVIN (Army of the Republic of Vietnam) have quite a few troops in the area, so our primary job is gathering all the available intelligence and predicting VC (Viet Cong) attempts to hit the base, then using our artillery or spoiling attacks by our infantry to prevent their attacks form getting started. My main task is to coordinate the artillery portion of this including (1) moving 1 or 2 gun sections around so we can cover all approaches to the air strip without shooting directly across aircraft paths, (2) coordinating with air traffic so none are at risk from friendly fire, (3) obtaining clearances for all artillery fire from local ARVIN forces, and (4) keeping maps current, including movements by local villagers.

So far we have been pretty successful thanks to some pretty good intelligence and the fact that we have been able to use our imaginations and vary our tactics considerably. We have done everything form infantry raids to seize [weapons] caches…a couple of days before we figured they would be used to plastering all tracks in an area we felt was to be used as an assembly point to ambushing heavily (up to 10 interconnected ambushes at once) to ….very active harassment and interdiction fires throughout the approaches to the base. I really think our success has arisen from this variety of tactics so that Charlie (nickname for the VC) can't get organized above the level of slipping a few snipers up to the edge of the airfield, which the local protective force handles very well."

Note that this description emphasizes flexibility – using a variety of means to keep an enemy off balance and achieve a specific tactics mission in the short run. None of the tactics were particularly innovative and all of them were doctrinaire. The measurement issues are (a) is this agility and if it is, (b) is this slightly agile, moderately agile, very agile, or is the level of agility indeterminate with our current tools?

BIBLIOGRAPHY

Alberts, David S. and Richard E. Hayes, *Command Arrangements for Peace Operations.* Washington, DC: CCRP Publications Series. 1995.

Alberts, David S. and Richard E. Hayes, *Power to the Edge: Command and Control in the Information Age.* Washington, DC: CCRP Publications Series. 2003.

Alberts, David S. and Richard E. Hayes, *Understanding Command and Control.* Washington, DC: CCRP Publications Series, 2006.

Alberts, David S., John J. Garstka, Richard E. Hayes, and David T. Signori, *Understanding Information Age Warfare.* Washington, DC: CCRP Publications Series. 2001.

Freedman, Lawrence, *Strategy: A History.* Oxford University Press: NY, NY. 2013

Hayes, Richard E., Mark Hainline, Conrad Strack, and Dan Buccioni, *Theater Headquarters Effectiveness: Its Measurement and Relationship to Size, Structure, Functions, and Linkage.* McLean, VA: Defense Systems, Inc. 1983.

Hayes, Richard E., *Measurement of Unit Effectiveness in Marine Corps Infantry Battalions*. CACI Inc.-Federal, Arlington, Virginia. 1977. DTIC Accession Number ADA123481.

Olmstead, Joseph A., B. Leon Elder, and John M. Forsyth, *Organizational Process and Combat Readiness,* Technical Report 468. US Army Research Institute for the Behavioral and Social Sciences, 1978.

Rittel, Horst W. J. and Melvin W. Webber, "Dilemmas in a General Theory of Planning" in *Policy Sciences,* Volume 4, pp 155-169, Elsevier Scientific Publishing Company, Amsterdam. 1973.

Spires, David N, *Patton's Air Force: Forging a Legendary Air-Ground Team.* Smithsonian Institution Press, Washington, DC. 2002.

NATO SAS-065 Research Task Group. *NATO NEC C2 Maturity Model.* Washington, DC: CCRP Publications Series. 2010.

NATO SAS-085 Research Task Group. *C2 Agility and Requisite Maturity.* Pre-publication release, Washington D.C.: CCRP Publication Series. 2013.