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STUDENT REPORT

IMPACT OF UNMANNED SYSTEMS
ON TENETS OF AIRLAND BATTLE DOCTRINE

Major Thomas M. Harrison, USA 88 - 1165

"insights into tomorrow"

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REPORT NUMBER 88-1165

TITLE IMPACT OF UNMANNED SYSTEMS ON TENETS OF AIRLAND BATTLE DOCTRINE

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Submitted to the faculty in partial fulfillment of requirements for graduation.

AIR COMMAND AND STAFF COLLEGE
AIR UNIVERSITY
MAXWELL AFB, AL 36112-5542

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT **STATEMENT "A"** **Approved for public release; Distribution is unlimited.**
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 88-1165	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION ACSC/EDC 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS *(City, State and ZIP Code)* Maxwell AFB AL 36112-5542	7b. ADDRESS *(City, State and ZIP Code)*
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State and ZIP Code)*	10. SOURCE OF FUNDING NOS. PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE *(Include Security Classification)* IMPACT OF UNMANNED SYSTEMS ON TENETS	

12. PERSONAL AUTHOR(S)
Harrison, Thomas M., Major, USA

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Yr., Mo., Day)*	15. PAGE COUNT
	FROM ______ TO ______	1988 April	35

16. SUPPLEMENTARY NOTATION
ITEM 11: OF AIRLAND BATTLE DOCTRINE (U)

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB. GR.	

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Unmanned Systems technology has not impacted AirLand Battle doctrinal tenets because they are fundamental in nature. However, historical examples and an analysis of the tenets and sample missions of Unmanned Systems show that fine tuning organizational and environmental doctrine can lead to enhanced exploitation of the fundamental tenets of initiative, agility, depth, and synchronization.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☒ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL ACSC/EDC Maxwell AFB AL 36112-5542	22b. TELEPHONE NUMBER *(Include Area Code)* (205) 293-2867 22c. OFFICE SYMBOL

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

PREFACE

1. Unmanned Systems are generally thought of as those systems using disciplines like artificial intelligence and robotics which might replace or augment personnel in performing certain functions. Examples of Unmanned Systems include remotely piloted vehicles (RPVs), unmanned aerial vehicles (UAVs), and vehicles being developed through robotics programs like the Advanced Ground Vehicle Technology (AGVT) program. Unmanned Systems perform tasks normally performed by personnel through innovative technological applications. Technology now available and forecast to emerge through artificial intelligence and robotics enhancement makes Unmanned Systems application a challenge to current US Army AirLand Battle doctrine. This technology - doctrine link invites scrutiny to assess the impact of Unmanned Systems on AirLand Battle doctrinal tenets. Without valid doctrine, no technology can be employed to advantage.

2. The following acknowledgements indicate the extensive assistance provided in the preparation of this paper:

LTC Rodger Tunnell, Army Instructor Group, Maxwell AFB, AL.

Mr. Jim Shepard, Deputy Project Manager, Intelligence Electronic Warfare Unmanned Aerial Vehicle (IEW UAV) Project Office, Redstone Arsenal,AL.

Mr. Jeffrey D. Cerney, General Dynamics Corporation, Arlington, VA.

MAJ Daniel A. Nolan, Headquarters, Combined Arms Center and Fort Leavenworth, Fort Leavenworth, KS.

LT Noel T. Cowart, Army National Guard Bureau, Multi Media Branch (Aviation Division), Fort Rucker, AL.

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Major Harrison has served in Infantry, Cavalry, Aviation, Acquisition and Project Management assignments. His interest in doctrinal studies and technological innovations stems from consecutive assignments in the Army Training and Doctrine Command (TRADOC) and Army Materiel Command (AMC) relating technological improvement to doctrine at the developer and user level.

Major Harrison previously co - authored the article, "Aviation at the Infantry School", in the September, 1983 United States Army Aviation Digest.

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REPORT NUMBER 88 - 1165

AUTHOR(S) MAJOR THOMAS M. HARRISON, USA

TITLE IMPACT OF UNMANNED SYSTEMS ON TENETS OF AIRLAND BATTLE DOCTRINE

I. <u>Purpose:</u> To provide an assessment of the impact of Unmanned Systems technology on the doctrinal tenets of AirLand Battle.

II. <u>Problem:</u> At the program and project level, technical and programmatic personnel are often called upon to provide information that will be used by individuals who work in the requirements and approval areas at high levels. One incongruity of this type interchange is that the project personnel are often not conversant in any doctrinal application of their systems at any level. Since the Project Manager and the Deputy Project Manager cannot be everywhere at once, all the personnel who work in the project need to know that there is a bigger picture into which their particular system or subsystem fits.

CONTINUED

III. Data: By defining the doctrinal tenets of AirLand Battle in a concise manner and then applying typical Unmanned Systems missions to the tenets, an understanding of how the systems support larger scale operations is gained. Further, a comparison between examples citing the use of Unmanned Systems in combat and examples of combat action before Unmanned Systems became available provides background and an appreciation of the timelessness of fundamental doctrine. Most important, the necessity of keeping current organizational and environmental doctrine with respect to technological change is conveyed.

IV. Conclusions: The tenets of AirLand Battle doctrine are fundamental. Technological change does not impact them. Organizational and environmental doctrine need to be fine tuned and updated to ensure that technology has been incorporated and that the doctrinal tenets of AirLand Battle are being well served.

V. Recommendation: Personnel assigned to Unmanned Systems project offices read this paper. It is everyone's duty to help technology and doctrine stay linked. If individuals at all levels develop and maintain an appreciation for the technology - doctrine link, our forces will not suffer an incongruity between technology and doctrine. Just as tacticians attempt to maintain technical awareness, so should those on the technical side attempt to maintain an awareness of the doctrinal side.

IMPACT OF UNMANNED SYSTEMS ON TENETS OF AIRLAND BATTLE DOCTRINE

PROLOGUE

"Israel has used RPVs quite successfully of late. During the Lebanese invasion, Israelis flew RPVs against Syrian air defense positions overlooking the Bekka [sic] Valley, electronically simulating Israeli fighters. When Syrian radars locked onto the RPVs, their electronic countermeasure (ECM) payloads backtracked the beams and relayed transmitter locations and other data to Israeli AWACS aircraft, which in turn called in chaff dispensing rockets while informing incoming fighter pilots of the radar frequencies being used. Robot missles homed in on the surface - to - air radar guidance units, and fighter bombers followed up with conventional munitions to take out the SA - 6 and SA - 8 missile sites; the RPVs loitered overhead, relaying real time pictures and data to battle commanders. Not a single Israeli airman was lost during the operation; [in contrast] the U.S., during its peacekeeping mission in Lebanon lost one pilot and two aircraft worth $25 million during manned recon flights" (11:69).

Chapter One

INTRODUCTION

Based on the technological potential and the apparent doctrinal validity of Israel's application of Unmanned Systems, a closer look at the U.S. Army's technological association with doctrine is warranted.

The purpose of this paper is to analyze what impact the evolution of Unmanned Systems will have on the tenets of AirLand Battle doctrine. These tenets are the cornerstone of current Army doctrine. "Doctrine and strategy are built on the interplay of contemporary theory, historical thought, and technology" (20:iii). This paper concentrates on the influence of technology on doctrine.

OVERVIEW

The Technology - Doctrine Link

The specific goal of this research project is to provide personnel associated with an Unmanned Systems office an assessment of the technological impact of Unmanned Systems on AirLand Battle doctrinal tenets. The assessment will examine the validity of the technology - doctrine link with respect to Unmanned Systems. The significance of this type assessment is substantiated by statements like the one recently made by Lt Gen Bradley C. Hosmer, USAF, current President of the National Defense University, in Air Power Journal. He said, "We must better focus new capabilities coming down the road .... Our service is built on innovation - - trying things out to see if they work and how they can be improved to work better" (10:10,13). An early step in the focus of new capabilities is the assessment of their impact on doctrine, so that doctrine can keep pace in its relationship with technology.

> "The modern strategist must also cope with a breathtaking rate of technological change, a rate that

> gives every indication of continuing to accelerate as times passes. The struggle to use available technology effectively or to cope effectively with the enemy's technology has become increasingly complex. Further, modern military forces have become so dependent on high technology weapon systems that vast research and development programs have become essential parts of modern great power strategies. No one, it seems, can afford to fall behind in the never ending race for the technological advantage. On the other hand, it has also become increasingly apparent that technology does not always provide appropriate solutions to military problems" (18:9 - 10).

This project addresses the technology - doctrine link to ensure that technology in the form of Unmanned Systems does not supersede or invalidate basic doctrine. The significance of this research is in its application to the link between technology and doctrine. Proper application will preclude the failure of technology to "provide appropriate solutions" as described above. It is intended for use by personnel associated with Unmanned Systems project offices in their relationships with operators, requirements initiators, and program approval authorities to augment requirement documents and provide an example of how technology impacts doctrine in its most general sense. It is a primer in the basic relationship between technology and doctrine for program management personnel untrained in doctrinal thinking. It is not a checklist or final document on the relationship between Unmanned Systems technology and the tenets of AirLand Battle doctrine. It is applicable to individuals who are trying to envision the relationship between their systems and doctrinal tenets in the most basic way, but now only have a complex requirements document or a first draft field manual to use. It is a first step in assessing the technology - doctrine link for Unmanned Systems. It fills the void left when project personnel are ungrounded in AirLand Battle doctrine.

To achieve the previously stated broad purpose of analyzing the impact of Unmanned Systems technology on AirLand Battle doctrinal tenets and to meet the specific goal of providing this assessment to personnel associated with Unmanned Systems programs, Unmanned Systems will first be defined and classified. Next, types of doctrine will be addressed, and the doctrinal tenets of AirLand Battle will be defined and analyzed. Third, potential missions illustrative of selected Unmanned Systems will be described, related to the tenets, and the impact of Unmanned Systems on AirLand Battle doctrinal tenets assessed so that conclusions can be reached.

Limitations/Assumptions

Space and time limitations preclude addressing all current potential Unmanned Systems in this paper. There are numerous systems on hand and more types of systems becoming available daily. The systems selected for illustrative purposes in this project were chosen because of their relation to AirLand Battle doctrine. "The technology for telerobotics is here. The technology for autonomy is being developed" (9:128). This paper assumes that development, deployment, and employment of all types of Unmanned Systems will proceed. This paper does not endorse any particular system. It uses systems to make specific points. "Robotics and artificial intelligence have actually been with us for quite some time. What is new, though, is the rush to apply robotics and artificial intelligence to the military" (11:67). It is for this reason that the assessment of impact of Unmanned Systems technology on U.S. Army doctrine is necessary now.

Definition and Description

Unmanned Systems do not have an official definition. They can encompass every imaginable system from munitions like SMART bombs to Cruise missiles to vehicular mounted robotics, as long as human activity is only pre - programmed or remote from the vehicle or weapon. While a specific definition is being refined, Unmanned Systems are being addressed in many ways. For the purposes of this paper, the working definition offered by Unmanned Systems magazine, " ... autonomous or semi autonomous vehicles or weapons which perform various functions as if a person were aboard. Unmanned vehicle systems include air, land, space and, seacraft ... " will be used (12:3). This paper has selectively chosen examples to illustrate relationships between technology and AirLand Battle doctrinal tenets. To narrow the scope, two general classes of systems, air and land, will be addressed. Within each class, specific example systems will be cited. In the air arena, Aquila remotely piloted vehicles will be discussed. Ground vehicles will be described by using Programmable Robot Observer With Logical Enemy Response (PROWLER). The appendix provides technical descriptions of the selected vehicles. Chapter 3 addresses missions. This method was chosen to preclude confusion between technical parameters and the real issue of mission capability assessment versus doctrinal tenets. Potential mission capability, not technical data, is the issue in this paper.

Data

Source material for this project has been assembled from various industrial, commercial, and military sources. The data represents numerous points of view on technical and doctrinal topics. Its intent is to provide well balanced source data for the assessment of the technology - doctrine link and to avoid a singular point of view.

Approach

Based on the premise that Unmanned Systems as defined above will be acquired, and on the analysis of selected Unmanned Systems and their associated missions addressed in Chapter 3, AirLand Battle doctrinal tenets need to be examined. The impact of Unmanned Systems on tenets can be assessed and conclusions reached after the tenets are analyzed.

Chapter Two

AIRLAND BATTLE DOCTRINAL TENETS

"Doctrine is indispensable to an Army ... "
GEN George H. Decker (5:95).

The purpose of analyzing AirLand Battle doctrinal tenets is to establish a baseline from which to assess the impact of Unmanned Systems. Initially, types of doctrine will be described to provide a foundation for definition and analysis of tenets. Each tenet will then be defined and analyzed using Army Field Manual (FM) 100 - 5 Operations and associated source material. Following the definition and description of tenets, Chapter 3 will describe missions associated with Unmanned Systems and relate them to the tenets of AirLand Battle doctrine, then assess the impact of Unmanned Systems on AirLand Battle doctrinal tenets.

TYPES OF DOCTRINE

It is important to the ultimate conclusion on impact of Unmanned Systems on AirLand Battle doctrinal tenets to comprehend that there are different types of doctrine. This point has been misunderstood in some circles. There are three types of doctrine. These are fundamental doctrine, environmental doctrine, and organizational doctrine (18:145 - 147). Fundamental doctrine is broad and deals with the nature of war. Environmental doctrine is applicable to a particular environment, that is, sea, air, land or space. Organizational doctrine concerns basic beliefs about specific military organizations (18:145 - 147). In this context, AirLand Battle doctrine has application to all three types of doctrine.

AirLand Battle doctrine cites four basic tenets which influence success on the battlefield. These tenets are initiative, agility, depth, and synchronization (16:15). An understanding of each of these tenets is basic to an analysis of the impact of Unmanned Systems on them.

Initiative

"The first blow is half the battle." Oliver Goldsmith (5:158).

FM 100-5 defines initiative as " ... setting or changing the terms of battle by action" (16:15). LTG Gerald T. Bartlett, Commander of the U.S. Army Combined Arms Center and Fort Leavenworth, Kansas, described initiative in an address to the American Defense Preparedness Association on the very subject of artificial intelligence and robotics by stating, "Initiative requires units structured and equipped for rapid maneuver and independent operations" (21:6). Initiative is not peculiar to offensive or defensive operations. From a defensive standpoint, initiative means wresting the initiative away from the attacker. This encompasses intelligence and audacity. From the standpoint of the offensive, the attacker should never let the defender recover from the initial onslaught (16:15). To be able to gain and maintain initiative, flexibility is important. The key to flexibility is the ability to shift forces and exploit weaknesses based on intelligence and audacity which deny time and concentration to the defender. The cornerstone of initiative in both offensive and defensive settings is decentralization (16:15). Decentralization can be enhanced when subordinates have access to intelligence and equipment which encourages audacious action. The ability to detect weakness in an opponent and the ability to exploit the detected weakness are the foundations of initiative.

Agility

"In small operations as in large, speed is the essential element of success. If the difference between two possible flanks is so small that it requires thought, the time wasted in thought is not well used." George S. Patton, Jr. (5:306).

Agility, another tenet, is defined as "the ability of friendly forces to act faster than the enemy - [agility] is the first prerequisite for gaining initiative" (16:16). The idea of agility is to stay one step ahead of the enemy, to force his hand and make him the reactor instead of the actor. Since the first instances of what we call friction, " ... the accumulation of chance errors, unexpected difficulties, and the confusion of battle ... ", agility has been a function of how leaders see the battlefield (16:16). LTG Bartlett said, "In exercising agility, we seek to concentrate superior combat power against critical elements of the enemy's plan" (21:6). This is achieved by deciding and acting faster than the enemy. In contemporary war, agility is a function of the utility of technology and equipment.

Depth

"He who knows when he can fight and when he cannot will be victorious." Sun Tzu (5:180).

FM 100-5 describes depth, the third tenet, as " ... the extension of operations in space, time, and resources" (16:16). LTG Bartlett said, "Operations in depth are intended to tear apart the cohesiveness of enemy formations and prevent him from concentrating his maneuver forces and supporting arms" (21:5). Depth is of particular importance on the conventional battlefield since potential enemies organize into echelons for offensive maneuver and into belts for defense in depth (21:5). The ability to observe enemy activity and protect friendly vulnerabilities is a key to the tenet of depth. Success can be exploited rapidly by a force that is prepared to act instantaneously by conducting operations in depth. By seeing beyond the obvious and employing every asset available, commanders use tailored forces to best exploit specific areas while freeing other forces for use in more advantageous areas.

Synchronization

"In military operations, time is everything." Duke of Wellington (5:325).

LTG Bartlett described synchronization as, " ... the essence of combined arms operations. It is the process of concentrating all available combat power; direct fire, indirect fire, and close air support, where and when it will have the greatest effect. Synchronization is, by far, the most difficult task our commanders face on the modern battlefield" (21:7). As defined in FM 100 - 5, synchronization is

> " ... the arrangement of battlefield activities in time, space, and purpose to produce maximum combat power at the decisive point. Synchronization is both a process and a result. Commanders synchronize activities; they thereby produce synchronized operations. Synchronization includes but is not limited to the actual concentration of forces and fires at the point of decision" (16:17).

Successful synchronization is dependent upon coordination based on information and timing. Information and timing on the modern battlefield are dependent on equipment and technology.

The tenets of AirLand Battle doctrine, initiative, agility, depth and synchronization, provide a foundation for success on the battlefield. "At both the operational and tactical levels, initiative, agility, depth, and synchronization are the essence of AirLand Battle doctrine" (16:27).

> "Perhaps the most ubiquitous doctrinal problem is the tendency to let doctrine stagnate. Changing circumstances, such as technological developments, can modify beliefs about the important lessons of experience. If current and projected circumstances do not affect the analysis of history's lessons, doctrine rapidly becomes irrelevant" (18:144).

An historical example of this type of negative impact is the French reliance on the Maginot Line (18:144). The French doctrine of defensive posture superiority had stagnated since World War I. German Blitzkrieg operations were dynamic, not static, and took into account the technological evolution of armor and airplanes. These incorporated technologies enhanced German doctrine and surpassed French doctrine when properly applied.

The preceding analysis of AirLand Battle doctrinal tenets included an overview of types of doctrine and a specific review of each tenet. The next step in assessing the impact of Unmanned Systems on doctrinal tenets is to analyze sample potential missions associated with the general vehicle system categories described in Chapter 1.

Chapter Three

UNMANNED SYSTEMS AND MISSIONS

"From time immemorial, men fought against men, and weapons were but accessories; in this and future wars, machines fight against machines and men are all but auxiliaries." Ely Culbertson (4:177).

The purpose of this chapter is to describe the missions associated with selected illustrative types of Unmanned Systems and relate them to the tenets of AirLand Battle doctrine. To do this, Unmanned Systems will be categorized as air vehicles and ground vehicles. The air vehicle segment will assess sample missions associated with the Aquila RPV. The ground vehicle section will assess sample missions associated with PROWLER. Following these mission descriptions, a relationship between the missions and the tenets of AirLand Battle doctrine will be drawn to demonstrate the relevance of mission capability to AirLand Battle doctrine. Lastly, the impact of these missions on tenets is assessed.

AIR VEHICLES

The best known RPVs, based on use by the Israelis in Lebanon and subsequent applications, are the Israeli Scout and Mastiff RPVs. These vehicles showed how Unmanned Systems could provide observation and targeting mission capability (8:21). These initial successes spurred the interest of numerous other nations in pursuing RPV technology (8:21). The U.S. RPV developed to perform missions like Scout and Mastiff as well as other missions, is the Aquila (6:846 - 7). Many RPVs and UAVs are either in production, refinement, or development. This paper discusses the Aquila RPV and potential short term enhancements. For the purposes of this paper, technical aspects of the vehicles are secondary to mission capability and are assumed to be as advertised. The appendix contains more descriptive material on Aquila. This section addresses mission capability of RPVs in the near term. These selected general missions are observation, targeting, and strike.

Observation

The use of observation mission capability was demonstrated by the Israelis in the Bekaa Valley in 1982 (11:69). Like the Scout, Aquila's observation capability allows missions to be planned with television or other sensors as payloads to perform surveillance and reconnaissance missions in all areas of the battlefield. This capability allows penetration of enemy lines and access to areas not normally available to friendly force observation. (13:409). The observation mission capability allows a target to be sought, found, identified, and verified (6:846). In addition to the finding of the target, the observation mission capability allows damage assessment to be accurately and rapidly completed without inflation of estimates or interference from threat after action has occurred (8:26). The observation portion of the mission is important to all RPV actions, since its other applications are at least, in part, dependent on observation.

Targeting

Through observation, the Aquila RPV can bring fire to bear against the found target by adjusting artillery fire or laser designating for missiles or artillery (13:409). This targeting capability handles range problems and enables operators to chose between conventional and laser guided munitions (6:846 - 7). Aquila's main utility lies in observation and targeting, but refinements in vehicle and payload can open the door to other capabilities already identified as requirements in the near term.

Strike RPV

The idea of unmanned tactical weapons is attributable to U.S. and British controlled glide bombs and explosive laden aircraft used in World War II. Those ideas seemed forgotten for many years. The Bekaa Valley action in 1982 changed that (12:24).. Mr. Milan Skrtic, LTV Missiles and Electronics Group, has compiled a Table of Recognized Lethal RPV Mission Needs - 1985 based on an Electronics Industry Association survey of U.S. Armed Services on potential application of lethal RPVs. The following data surfaced:

ARMY	MARINE	NAVY	AIR FORCE	MISSION DEFINITION
X			X	LETHAL ATTACK OF EMITTERS
X	X		X	SUPPRESSION OF ENEMY AIR DEFENSE
				AIR BASE ATTACK
				RELOCATABLE TARGET ATTACK
				ATTACK OF AIRBORNE TARGET
		X	X	AIR LAUNCHED DECOYS
X				LONG RANGE ANTI - TANK SYSTEM

FIGURE 1 (12:24)

Strike missions will afford the Army a mission capability that enhances RPV capability at a low risk. The RPV strike program seems logical based on the RPV observation and targeting capability. Possibilities are boundless. The international community is pursuing strike RPV technology. A good example is the SOARfly, a proposed Scicon Computer Services RPV that would combine observation and attack features (8:28). The observation, targeting, and attack features are very feasible for Aquila type RPVs in the short term. Other types of Unmanned Aerial Vehicles, notably those associated with the U.S. Intelligence Electronic Warfare Unmanned Aerial Vehicle (IEW UAV) Program, may well provide other capabilities in the realm of electronic warfare, signal intelligence, communication relay, meteorological data, and deception. The implication of this myriad of missions goes well beyond the scope of this work, but it is interesting to note that enhancement of Unmanned Aerial Vehicles and Remotely Piloted Vehicles is continuing (13:409 - 410).

GROUND VEHICLES

Just as in the aerial arena, ground vehicle technology in unmanned vehicles is limited only by imagination and time. Numerous vehicles and production prototypes could be used to illustrate mission capability. PROWLER has been chosen because of the relationship between its publicized demonstration version capabilities and the AirLand Battle doctrinal tenets. PROWLER production versions, including a defensive sentry patrol model, a reconnaissance model, and an offensive model have been reviewed by USAF and Israeli planners (1:65). Also, PROWLER was the initial working autonomous battlefield robot capable of following a pre - programmed path (1:66), so in essence it represents ground Unmanned Systems technology. Other examples of U.S. ground Unmanned Systems technology abound. The USMC continues work on its Ground - Air Tele Robotic Systems (GATERS), including the Tele - Operated Vehicle (TOV). U.S. Army efforts on Robotic Obstacle Breeching Assault Tank (ROBAT) (9:126) and the Advanced Ground Vehicle Technology (AGVT) Project and the work being done on the Teleoperated Mobile Anti - Armor Platform (TMAP) are other examples of Unmanned Systems ground vehicle technology with great potential (22: - -). PROWLER's inclusion here is for the sake of citing an example capable of conducting ground unmanned vehicle tasks now (9:125). For a more technical description of PROWLER, the appendix has incorporated a section on technical capability. Here, the paper deals with potential mission capability. A PROWLER type vehicle's greatest potential is in the surveillance area. It can send near real term information to locations to be used in intelligence compilations. On patrol, on guard duty, to detect and neutralize mines, and to deploy and employ weapons, PROWLER type vehicles provide reliably executed missions consistently and without fear of enemy fire (9:125). Sensors and tailored mission packages can be used to alter its capabilities. It can be described as having the capabilities associated with Aerial Unmanned Systems in a ground package. PROWLER type Unmanned Systems can provide observation, targeting, and engagement capability. They can provide an unmanned source for hazardous operations like mine laying/clearing, nuclear, biological, and chemical warfare surveillance and decontamination. Additionally, they can provide a source for augmenting personnel related tasks like security of airfields and rear area protection. Ground Unmanned Systems are force multipliers. PROWLER type vehicles have the potential to provide manpower economy and to enhance survivability. Crew size can be reduced from the current standards if operators are moved off site. Problems associated with vehicle size and profile will be minimized by smaller, lighter unmanned vehicles.

Unmanned Systems, ground and air, have numerous impressive capabilities. However, a balanced view of Unmanned Systems calls for a review of vulnerabilities and limitations associated with Unmanned Systems in general.

VULNERABILITIES AND LIMITATIONS

As described above, Unmanned Systems, both ground and air, have some limitations. These systems are limited, primarily, by certain technological factors. Typically, sensors, robot control links, and programming techniques all require more research (17:187). These technological immaturities manifest themselves in problems with Unmanned Systems performance and control. The current unmanned vehicles do not perform in a manner which can constantly meet the rigid requirements of the modern battlefield. Communication links may be subject to disruption by enemy jamming. Unmanned Systems may be vulnerable to enemy deception activity. The systems may be initially prohibitively costly, though this problem may cure itself in time (7:129). Above all, since the systems by definition are autonomous or semi - autonomous, they lack the flexibility of manned systems with respect to short term actions and decision capability. Any treatment of Unmanned Systems should identify these limitations and vulnerabilities but not dwell on them. Unmanned Systems are the future in the military. Invariably, " ... front line military commanders will almost certainly use them in increasingly large numbers" (7:129). No systems are mature at inception. Most continuously evolve, like the tank and the airplane continue to do. The vulnerabilities and limitations of Unmanned Systems should not deter the study of the impact of unmanned vehicle technology on AirLand Battle doctrinal tenets.

Air and ground unmanned vehicles provide a source of observation, targeting, engagement, and hazardous duty mission capability that frees up human resources for application elsewhere and reduces vehicle size. Knowing this and bearing in mind the aforementioned vulnerabilities and limitations, the impact of Unmanned Systems upon AirLand Battle doctrinal tenets can be assessed.

IMPACT OF UNMANNED SYSTEMS ON AIRLAND BATTLE DOCTRINAL TENETS

> "The process of doctrinal assimilation of new weapons into compatible tactical and organizational systems has proved to be much more significant than invention of a new weapon, or adoption of a prototype, regardless of the dimensions of the advance in lethality."
> COL Trevor N. DuPuy (2:337)

The world's finest technology is worthless if doctrinally unsound. This section relates the tie between the previously described unmanned vehicle missions and the doctrinal tenets described in Chapter 2. The relationship between the tenets of AirLand Battle doctrine and unmanned vehicle systems will build a foundation for assessing the impact of Unmanned Systems on doctrinal tenets. To relate unmanned vehicle missions to doctrinal tenets, the tenets outlined in Chapter 2 will be assessed individually against the classes of Unmanned Systems missions, both ground and air, previously described. The doctrinal tenets can then be assessed. To assess the impact of Unmanned Systems on the tenets of initiative, agility, depth, and synchronization, a comparison between the tenets as illustrated by the World War II Battle of Flanders against the 1982 Israeli invasion of Lebanon will be made. These examples were chosen specifically for comparative purposes because both were offensive mechanized actions involving combined arms, but one was conducted using Unmanned Systems. The other, though obviously lacking Unmanned Systems, did incorporate the evolving tank and airplane into Blitzkrieg doctrine (15:221). Therefore, a comparison between these actions will yield an assessment of the impact of Unmanned Systems on doctrinal tenets. Beginning with initiative, each of the tenets is examined below.

Initiative

Remembering that " ... initiative is a condition to be produced ... ", unmanned vehicle missions can be related to this tenet (21:6). An advantage of Unmanned Systems with respect to initiative is the intelligence they can provide through observation, surveillance, and reconnaissance. For example, Aquila can transmit television quality pictures to provide intelligence data on potential targets (8:26). Commanders can then use intelligence to gain initiative. Another application of RPVs related to initiative is the likelihood of committing RPVs, like Aquila, to situations where humans might not be permitted due to the dangers involved (7:123). Compare and contrast the U.S. loss of personnel in Lebanon during reconnaissance missions to the Israeli use of RPVs cited in the Prologue (11:69). Additionally, Strike RPVs as described by Skrtic (12:23) provide another avenue that displays initiative by allowing RPVs to work together in a sort of hunter and killer role. In this sense, the RPV may be provided the intelligence to display its own initiative.

Potential ground vehicle missions can also be related to initiative. Two of the three proposed PROWLER missions are offensive in nature, providing intelligence to follow on attacking forces and engaging land threats based on pre - planned information themselves (1:67). Offensive missions are usually most readily identified with initiative. However, defensive missions are also related to initiative. Examples of defensive oriented initiative include aggressive security force operations, and operations to influence future action, and regain friendly freedom of action (16:137). Security defensive missions associated with PROWLER type vehicles display the tenet of initiative just as much as offensive missions. Ground vehicles like PROWLER encourage the commander's application of the tenet of initiative because they do not endanger human life.

Based on intelligence, offensive application, and the psychological impact on commanders, RPVs like the Aquila and ground vehicles like the PROWLER are clearly linked to the AirLand Battle tenet of initiative in a positive way. Unmanned Systems handled properly can produce initiative. "Initiative permits application of preponderant combat strength" (2:338). The following section examines real application of the tenet of initiative with and without Unmanned Systems.

Comparison of Initiative

Battle of Flanders

In October 1939 the Germans had asked that the Allies negotiate a peace (3:12). When this did not happen, Hitler determined to move against the West. Holland and Belgium retained neutrality, and Britain and France resolved to fight a defensive scenario based on fortifications like the Maginot Line until an offensive could be initiated (3:13). This being the case, it is difficult to imagine that German forces could gain and maintain the initiative, but they did. Early on 10 May, 1940, Germany moved against Holland and Belgium. The cross border ground attacks and airborne drops were preceded by aerial attacks versus Allied airfields based on previous intelligence work (3:13). This swift action using combined arms operations, supported by air, secured the initiative for the Germans. "Recovering from their surprise, the Dutch struck back at the airheads, but the Germans, superbly supported by the Luftwaffe held on to most of their gains" (3:13). The seizure of initiative by the Germans was a function of Blitzkrieg doctrine.

It displayed the best utilization of their equipment, tanks and aircraft, based on technology and lessons learned in the East. Initiative was seized through doctrinal application of available technology.

Lebanon 1982

The Israeli use of RPVs to gather intelligence with which to plan and execute preemptive strikes is illustrative of the AirLand Battle tenet of initiative (11:69). It is noteworthy that not only did technology provide a means of gaining the initiative, but also that doctrine employed it. "It is not Israel's development of the RPV so much as the unique way it was put to use that is of the greatest significance" (19:486). The concept of initiative is taken to its textbook limits by this operation. The attack never allowed " ... the enemy to recover from the initial shock ... " (16:15). The defender was not " ... given the time to identify and mass his forces or supporting fires against the attack because of the ambiguity of the situation presented to him and the rapidity [with which it changed] ... " (16:15). Most importantly, " ... retaining the initiative over time requires thinking ahead, planning beyond the initial operation, and anticipating key events on the battlefield ... ", something the Israeli use of RPVs exemplified (16:15). Israeli use of RPVs, much like the German Blitzkrieg, yielded the product of initiative.

Both the German attack in the Battle of Flanders and the Israeli action in Lebanon in 1982 displayed the tenet of initiative. Specific organizational and environmental doctrinal application of available systems had to be made to incorporate Blitzkrieg and Unmanned Systems, but the fundamental doctrinal tenet of initiative was not overcome by technological innovation in either case.

Agility

Agility in itself is a prerequisite for gaining and maintaining initiative (16:16). Unmanned Systems like the Aquila are applicable to the tenet of agility because of their speed and flexibility. The Aquila can loiter and search areas providing commanders with a look at areas of operation that precipitate agile action. Most applicable to agility is the speed with which RPVs provide intelligence and the ability to act offensively to commanders. The ability to see and act faster than your opponent is agility. From the ground standpoint, vehicles like PROWLER provide reconnaissance and surveillance which can allow continuous intelligence data to flow to the commander. The commander can then make decisions rapidly causing PROWLERs to respond quickly since they are on or near site and have no long response time.

Potentially, PROWLERs cannot only provide intelligence data, but can operate armament (1:67). Unmanned ground vehicles provide reliable, predictable responses even under fire. This allows commanders to exploit agility. "Napoleon recognized that of all the moral forces in war, surprise is perhaps the most effective, and the greatest multiplier" (2:163). The Syrians were surprised by Israel's agility in 1982.

Comparison of Agility

Battle of Flanders

By gaining the initiative, the Germans displayed their agility during the Battle of Flanders. Dutch, Belgian, British, and French forces, their misapplication of defensive posture now apparent, became reactors to German activity. For example, the Dutch " ... held [Grebbe Line] until the thirteenth, when events farther south forced their withdrawal ... " (3:13), and " ... on twelve May, General Maurice Gustave Gamelin had ordered divisions from his general reserve to the Ardennes area, but moving slowly, they had been too late ... " (3:13). The point is that the Allies were not able to take action, to take the initiative, because they were trying to react to German agility. The agility was not solely the function of tanks and airplanes, but of doctrine based on the capabilities of those systems. The agility was built on environmental and organizational doctrine that exploited technology without violating fundamental doctrine.

Lebanon 1982

The tenet of agility was shown by the Israeli utilization of RPVs to identify and subsequently assist in the engagement and destruction of Syrian air defense and radars. Simultaneously, other RPVs loitered on site to relay real time intelligence to Israeli staffs who could then continue to use agility by forcing the Syrians to react to other moves (11:69). The first move was always the Israeli's move. The Syrians were reacting to the moves much like the Dutch reacted to the Germans in 1940.

The tenet of agility is exemplified by Israeli action in 1982 and German action in 1940. Agility is not just a function of available technology. It is a product of the availability of appropriate doctrine that uses technology wisely in concert with basic principles. The tenet of depth will be examined next.

Depth

Aerial Unmanned Systems missions related to depth include potential strike missions versus enemy rear areas (12:24) which will serve to destroy the enemy's ability to concentrate forces. Even the more recognized intelligence gathering operations serve the tenet of depth by ensuring the availability of key data to the commander so he can address the principle of depth by using other forces. Depth is a relative tenet, encompassing all segments and echelons of the battlefield. This means that close, deep, and rear operations must be considered at all echelons. Striking the enemy deep influences how future operations will be conducted. Close operations concern the activities of committed forces. Rear operations are concerned with maintaining freedom of action for rear elements (16:11 - 20). Ground Unmanned Systems are also applicable to depth. PROWLER type vehicles are related because of the human psychological impact of operations in the enemy rear. Imagine a deep attack of PROWLER Air Assault forces against enemy lines of communications or assembly areas. Also PROWLER type vehicles could be used to protect friendly rear areas through sentry patrolling or rear area protection missions. "Successful defense requires depth and reserves" (2:330). The tenet of depth was illustrated in contrasting ways by the Battle of Flanders and the Bekaa Valley invasion.

Comparison of Depth

Battle of Flanders

The key tenet exemplified by the Battle of Flanders may well be depth. If any one element is illustrated by German Blitzkrieg doctrine, it is the ability to strike deep. Just how deep is best understood by studying portions of the battle.

> "By the nineteenth, infantry from the Twelfth and Sixteenth Armies had lined the southern flank of the breakthrough as far west as Montcornet, and OKH now lifted the restriction on Kleist's advance. Guderian, closely followed by the motorized infantry corps of Kleist's group, raced along the Somme River toward Abbeville. Late on the twentieth, that town surrendered, and the corridor to the sea, though tenuous, was a reality" (3:14).

This action was over 150 miles deep to sever key lines of communication against a foe who had based his defenses on doctrine derived from technology, equipment, and historical experience last valid over 20 years earlier when advances were measured in meters. Depth was illustrated in Lebanon in a different way.

Lebanon 1982

Depth as personified by Israeli RPV missions in Lebanon in 1982 is best appreciated by analyzing what type of systems the Israelis targeted with Unmanned Systems. The use of RPVs versus Syrian air defense positions in the Bekaa Valley constituted deep battle just as Guderian's drive to Abbeville did. The ability of RPVs to simulate fighters electronically (11:69) and then alert Israeli command and control centers as to the location of the sites meant that a Syrian capability was being erased. This capability loss swung subsequent action in Israel's favor, since without air defense protection, Syrians lost their freedom of action. Just like helpless Abbeville fell to Guderian, the Bekaa Valley became Israeli dominated airspace and terrain.

Neither Guderian's armor and combined arms nor Israel's RPVs are directly responsible for the gains made by their forces. In reality, the doctrinal application of the systems on hand to achieve depth meant success. Just as important as depth and related to all tenets is the tenet of synchronization.

Synchronization

Aquila type RPVs display the tenet of synchronization through timing and tempo. Preprogrammed actions can be overridden and opportunities exploited based on intelligence gathered through observation, targeting, and engagements. The communication capabilities associated with RPVs also can assist in synchronizing operations. PROWLER type ground vehicles display the same relationship with synchronization. PROWLERs can range find with lasers, measure distance, navigate, and communicate, making them adaptable for synchronization with other elements (1:67). Unmanned Systems can be synchronized among themselves through artificial intelligence or with other capabilities through semi - autonomous links. This includes synchronization with close air support and field artillery. The Battle of Flanders and the Israeli invasion of Lebanon both exhibit synchronization.

Comparison of Synchronization

Battle of Flanders

Synchronization was important to German offensive action in the Battle of Flanders because of the complex assemblage of combined and supporting arms inherent in Blitzkrieg doctrine (14:78). By attacking on three columns and linking up with the airborne forces, German synchronized activity forced Dutch surrender on 14 May 1940 (3:26). This time and place synchronization was a function of doctrine built on what its assets could do best. Remember that the technologies used by the Blitzkrieg were fairly new. To maximize the effect of the technologies, they had to be synchronized to ensure decisive action at the decisive point and time. The Battle of Flanders synchronized the aviation and armored capabilities of the Germans to allow them to provide a synergistic effect. The application of organizational and environmental doctrine made possible by a new technology and refined through practical experience exploited the fundamental and doctrinal tenet of synchronization.

Lebanon 1982

The integration of RPVs with artillery and offensive counter air and air interdiction indicated the achievement of synchronization by the Israelis as they engaged radar and air defense sites in the Bekaa Valley in 1982 (11:69). This synchronization occurred between both unmanned vehicles as they relayed information to other unmanned vehicles and from unmanned vehicles to manned command posts for command decisions. Radar backtracking information was passed rapidly and suppression missions initiated. The parallels between the synchronization of German combined arms in the Battle of Flanders in 1940 and Israeli use of Unmanned Systems in Lebanon in 1982 are not coincidental. The tenet of synchronization was not displayed just due to technology in either case. It was displayed because technology had been incorporated into organizational and environmental doctrine so that fundamental doctrine would be served.

> "During most of military history there have been marked and observable imbalances between military efforts and military results, an imbalance particularly manifested by inconclusive battles and high combat casualties. More often than not this imbalance seems to be a reflection of incompatibility, or incongruence, between the weapons of warfare available and the means and/or tactics employing the weapons" (2:341).

Chapter 2 of this paper dealt with the specific doctrinal tenets of AirLand Battle. These tenets are basic because they are fundamental doctrine. Like the Principles of War (14:77), like COL DuPuy's "Thirteen Verities" of combat (2:326), they are thought to be timelessly applicable, not normally impacted by technology or history. The tenets of AirLand Battle doctrine applied to war before Unmanned Systems. They applied to war before they were codified as AirLand Battle doctrine. They continue to apply to war as Unmanned Systems technology evolves. The German Army in the Battle of Flanders exemplified the tenets of initiative, agility, depth and synchronization. The Israelis exemplified the same tenets in the Bekaa Valley in 1982. In both cases relatively recent technological innovations were integrated into doctrine successfully versus enemies who had not turned the doctrinal corner even though technology was available to them. The mission capability of Unmanned Systems examined here in Chapter 3 illustrates this point. Initiative, agility, depth and synchronization can be exploited by Unmanned Systems, but not bypassed. As fundamental doctrinal tenets they are just as sound as they were before Unmanned Systems came on the scene. The important idea is to exploit the system through application of environmental and organizational doctrine. This translation of fundamental tenets into operational doctrine is the issue. It is what the Germans did in 1940 and the Israelis did in 1982. It is how we can avoid the "incongruence" cited above.

Chapter Four

CONCLUSION

"Forecast of future wars should be produced through the collaboration of military historians and military planners based on reasonable interaction between new technology and the 'Timeless Verities'." (2:343).

Conclusions concerning the impact of Unmanned Systems on the tenets of AirLand Battle doctrine have been reached based on the analysis of AirLand Battle doctrinal tenets and Unmanned Systems mission capabilities completed for this project. These conclusions are intended for use by personnel involved with Unmanned Systems from a program viewpoint who do not have a foundation in AirLand Battle doctrine. The conclusions apply to personnel seeking a big picture relationship between Unmanned Systems in general and fundamental doctrine. The target audience can use this information in dealing with operators, requirement initiators, and program approval authorities. Sometimes the big picture is omitted through oversight. This paper corrects that oversight by providing the audience a common ground from which to start.

The conclusions are:

Unmanned Systems technology does not invalidate AirLand Battle doctrinal tenets. It substantiates and amplifies their importance. Adjustment of organizational and environmental doctrine may be necessary to ensure exploitation of Unmanned Systems technology. The Germans in 1940 and the Israelis in 1982 both exemplified AirLand Battle doctrinal tenets. They did so by employing new and evolving capabilities using adjusted organizational and environmental methods. They did not try to force fit new technology into old doctrine, or omit new technology because it did not fit old doctrine.

The tenets of AirLand Battle doctrine are fundamental. Unmanned Systems technology does not alter fundamental doctrine. The author began research on this paper questioning whether or not technology, in the form of Unmanned Systems, had surpassed the tenets of AirLand Battle doctrine, making them invalid on the battlefield of tomorrow. Technology has not bypassed the tenets. They were valid in 1940 and remain valid. Organizational and environmental doctrine may be fine tuned, fundamental doctrine is timeless.

Technology, no matter how radical, cannot be used in a manner that violates fundamental doctrine without degrading the impact of the technology. Note that the Germans in 1940 and the Israelis in 1982 specifically tailored their activity to exploit the technical capabilities of combined arms and RPVs, respectively, all the while aligning their organizational doctrine with the tenets of AirLand Battle.

The original assumption this paper made about eventual employment and deployment of Unmanned Systems in the future is valid. A side benefit of research of this nature is that the author becomes familiar with a volume of material far greater than that needed to complete the project. This author, after in depth reading on the topic of Unmanned Systems from both doctrinal and technical perspectives, is convinced that Unmanned Systems are here to stay and will increase in numbers.

AirLand Battle doctrinal tenets are synergistic. Unmanned Systems, when used wisely, achieve initiative, agility, depth and synchronization. These tenets, taken as a whole, produce great results. The treatment of impact assessment in Chapter 3 isolated the tenets and missions for the sake of clarity. In truth, the tenets and mission capability run together. It is difficult to separate initiative from agility. It is important to synchronize all aspects of operations.

Perhaps J.F.C. Fuller described these conclusions best in 1945 when he said.

> "Indeed, we live in extraordinary times, in days of strange and violent possibilities. Daily, war is becoming even more a struggle between inventors than between soldiers. So much is this so that the highest inventive genius must be sought, not so much among those who invent new weapons as among those who devise new fighting organizations; who by shaping all instruments of war, old and new, round the dominant weapon, invent new fleets and armies" (4:158).

BIBLIOGRAPHY

A. REFERENCES CITED

Books

1. Cardoza, Anne and Vlk, Suzee J. Robotics. Summit, PA: TAB Books, Inc., 1985.

2.. DuPuy, Trevor N., COL USA (Ret.). The Evolution of Weapons and Warfare. New York: Bobbs - Merrill, Co. Inc., 1980.

3. Esposito, Vincent J., BG USA (Ret.). The West Point Atlas of American Wars. Volume II, Section 2. New York: Praeger Publishers, 1972.

4. Fuller, J.F.C., Major General. Armament and History. New York: Charles Scribner's Sons, 1945.

5. *Heinl, Robert D. Colonel*, USMC (Ret.). Dictionary of Military and Naval Quotations. Annapolis, MD: United States Naval Institute, 1981.

6. Jane's All the World's Aircraft 1986 - 1987. Edited by Taylor, J.W.R. New York: Jane's Publishing, Inc., 1986.

7. Logsdon, Tom. The Robot Revolution. New York: Simon and Schuster, Inc., 1984.

Articles and Periodicals

8. Dodd, Norman L., Colonel, South African Defense Force. "Look Behind the Hill Remotely Piloted Vehicles." Armed Forces (South Africa), May 1987, pp.21 - 28.

9. Finkelstein, Robert., "Combat Robotics: The Silicon Soldier is Coming.", Armed Forces Journal International, Vol 125, No. 3 (October 1987), pp. 124 - 128.

10. Hosmer, Bradley C. Lt Gen, USAF. "American Air Power and Grand Tactics." Airpower Journal, AFRP 50 - 2 (Summer 1987), pp. 9 - 14.

11. Poyer, Joe. "High - Tech Battlefield." International Combat Arms, Vol. No. 5, No. 3. (May 1987), pp. 66 - 71, 92 -94.

12. Skrtic, Milan et al. "RPV and UAV Strike Weapons." Unmanned Systems, Vol. 6, No. 1 (May 1987), pp. 23 - 30.

13. "The 1987 - 88 Green Book." Army, Vol 37, No. 10 (October 1987), p. 409, 430.

Official Documents

14. Great Thinkers. Air Command and Staff College, Air University, Maxwell AFB, AL, August 1987.

15. Great Warriors. Air Command and Staff College, Air University, Maxwell AFB, AL, August 1987.

16. Headquarters, Department of the Army. FM 100 - 5 Operations. Washington, D.C., 5 May 1986.

17. Hearings Before the Subcommittee on Investigation and Oversight of the Committee on Science and Technology. U.S. House of Representatives, 97th Congress, 2d Session, June 2, 27, 1987. No. 148. U.S. Government Printing Office. Washington, D.C. 1983.

18. Snow, Donald M., Dr. and Drew, Dennis M., Colonel, USAF. Volume 6 Making Strategy. Air Command and Staff College, Air University, Maxwell AFB, AL. August 1987.

19. Spiegel, Steven L. "U.S. Relations with Israel: The Military Benefits." Current News Special Edition, 28 July 1987, No. 1611 reprint of ORBIS Vol. 30, No. 3 (Fall 1986) article, Foreign Policy Research Institute Washington, D.C., pp 475 - 497.

20. Volume 7 Thinking About War. Air Command and Staff College, Air University, Maxwell AFB, AL. August 1987.

Unpublished Material

21. Bartlett, Gerald T. LTG, USA. "Artificial Intelligence/Robotics." Keynote address to the American Defense Preparedness Association on 16 June 1987, text provided and authorized by MAJ Daniel A. Nolan, 30 September 1987.

Other Sources

22. Cerny, Jeffrey D. Corporate Director, Land Systems, General Dynamics Corporation, Arlington, VA 22202. Letter dated 8 September 1987 and accompanying packet.

B. RELATED SOURCES

Books

Minsky, Marvin. Robotics. Garden City, New York: Anchor Press/Doubleday, 1985.

Taylor, John W.R. (ed.) Jane's Pocket Book of Remotely Piloted Vehicles, MacMillan Publishing Co., Inc. 1977.

APPENDIX

The Aquila RPV is a highly mobile system designed primarily to acquire and locate targets for engagement by artillery. The Aquila is composed of an Air Vehicle, a Ground Control Station, a Launch Subsystem, and a Recovery Subsystem.

The Air Vehicle, with fuel for 3 hours and a 60 pound payload, weighs 260 pounds, is less than 7 feet long, and has a wing span of less than 13 feet. Navigation is through an onboard autopilot that flies the vehicle using intermittent updates from ground stations. The mission payload system onboard the Air Vehicle utilizes a daylight TV camera, a laser range finder and designator, stabilized optics, and moving turret. The TV camera has 3 fields of view. For command and data link, 3 transmitting and 2 receiving antennas are on the Air Vehicle.

The Ground Control Station is mounted on a truck compatible with Army mission equipment. The Ground Control Station includes mission planning facilities, display consoles, video and telemetry instrumentation, computer and signal processing equipment, and control equipment.

The Launch Subsystem is made up of a hydraulic catapault, structural base, air vehicle engine starter, control console and communications equipment. These elements are palletized on a 5-ton truck. The Launch Subsystem can accomodate vehicles weighing up to 300 pounds.

The Recovery Subsystem uses a vertical net mounted on a 5-ton truck. Upon entering the net for recovery, the vehicle is decelerated by extending lines, then retrieved by a crane on an air vehicle handler truck. The barrier itself is 5.4 meters high and 7.0 meters wide. When deployed, the top is approximately 10.9 meters above the ground. For backup, a parachute system is provided.

"This attachment is taken from Lockheed Missiles and Space Company's Aquila Information Package provided by Lockheed Austin Division in January 1988, edited by Major Harrison."

CONTINUED

SUMMARY

Name:	PROWLER
Manufacturer:	Robot Defense Systems, Inc. 3860 Revere St. Denver, CO. 80239 (303) 373-4984
Physical Description:	Small, 6-wheeled vehicle shaped like a military armored personnel carrier, weighing 800 to 1200 pounds and standing 4 to 5 feet tall. A variety of sensory hardware and armament is available.
Primary Use:	Patrol and sentry duty, hazardous travel, reconnaissance and tactical surveillance, transportation, decoy activities, mine detection and laying, search and rescue, and weapons deployment.
Significant Sales Point:	The PROWLER can operate without radio control links in many types of hostile environments.

"This section is quoted from ROBOTICS, by Anne Cardoza and Suzee J. Vlk, pages 68 and 69."