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**ARMY AFTER NEXT,
AIRLAND BATTLE 2000,
FUTURISTIC CONCEPTS OR JULES VERNE?**

BY

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ABSTRACT

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The Army conducts concept studies, such as Army After Next, to craft a vision of future requirements. The combat systems and operational concepts described in those studies are not fiscally constrained; stress present day technologies; and challenge future technologies. To the uninformed, these concept studies often read like science fiction novels. Airland Battle 2000 was a concept study conducted in 1981 to guide future organizational alignments, doctrine, training, and materiel requirements for the Army of the 21st century.

This paper examines: Airland Battle's futuristic concepts and its requirements for the Air Defense Artillery branch; evaluates the Air Defense Artillery branch's progress towards meeting those requirements; and assesses whether or not long range, futuristic concept studies are a valid approach for determining future developments, or simply government sanctioned science fiction.

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AIRLAND BATTLE 2000, A FUTURISTIC CONCEPT OR JULES VERNE?

In 1869, Jules Verne wrote 20,000 Leagues Under the Sea, a novel about submarines and underwater operations.¹ Were Verne's writings pure science fiction or a visionary's efforts to define a new realm within the technological grasp of mankind?

Approximately 45 years later, German U-Boats demonstrated Verne's vision of undersea operations in modern warfare. Who was dreaming and who was thinking conceptually about the future in 1869?

The Army After Next (AAN) is a study the Army has embarked on to, " . . . craft a vision of future Army requirements."² The AAN lexicon resounds with futuristic terminology and concepts such as dominant maneuver, precision engagement, information dominance, and full dimensional protection.³ AAN commanders will employ, " . . . the surface to space continuum of interlinked unmanned aerial vehicle fields which provide an unblinking eye capable of constant surveillance over the battlespace."⁴ AAN units will, " . . . exploit terrain by maneuvering . . . within the folds and undulations of the earth's surface without suffering the restrictions imposed on mobility by contact with the ground."⁵ Is the Army After Next study a futuristic vision of the world in the year 2025 and beyond, or is it just unabashed, wild-eyed dreaming of science fiction buffs?

This is not the first time the Army has conducted long range, futuristic studies. In 1981, the Army conducted the Airland Battle 2000 study to, " . . . guide future organizational alignments, doctrine, training, and materiel requirements."⁶ What did this study, which projected 15 to 30 years into the future (1995 to 2010), accomplish?⁷ What predictions, directives, and recommendations did it make; and what doctrinal, organizational, and materiel changes have been or will be incorporated into the Army?

In the context of Airland Battle 2000 (ALB-2000), this paper assesses whether long range, futuristic studies are a valid approach for future developments. The paper examines ALB-2000's concepts; its requirements for the Air Defense Artillery (ADA) branch; and ADA's progress towards meeting those requirements. The study's value will be measured against those requirements the branch met vice those it could not meet.

AIRLAND BATTLE 2000

To understand how the ALB-2000 concept was developed we must examine the U.S. Army in the late 1970s and early 1980s. The Viet Nam War was over, and the Cold War again became the Army's focus and, with it, the realization the U.S. had lost most of its qualitative advantage over the Soviet Union. The U.S. expended tremendous resources in Viet Nam, while the Soviets undertook, " . . . the largest peacetime modernization in history . . . they

literally went from a walking and horse drawn army to a heavy, mechanized, mobile force with awesome firepower."⁸ The Soviet's expenditures for procurement and research and development in the 1970s exceeded the U.S. Army's by approximately 75 percent and 50 percent, respectively.⁹

To defeat a numerically superior and a technologically enhanced foe, the Army embarked upon a somewhat radical departure in doctrinal thinking. Heretofore, the U.S. Army's Active Defense doctrine was based on firepower and attrition. Some critics described it, " . . . as bankrupt . . . doomed to failure . . . [a doctrine that] impedes the U.S.' ability to fight limited conflicts in other key areas of the world."¹⁰

Airland Battle became the Army's new doctrine. An offensive doctrine, based on maneuver warfare, Airland Battle focused on seizing and retaining the initiative; striking deep into the enemy's rear area; and capitalizing on their mistakes. The 'Active Defense' and attrition warfare became passe and Airland Battle doctrine (initiative, agility, depth, and synchronization) became the catalyst from which the ALB-2000 concept grew.¹¹

ALB-2000 identified 16 trends that would change the geopolitical environment and present new challenges to the Army in the 21st century (see Appendix 1).¹² The following military implications were derived from these trends:

- The Warsaw Pact would pose the worst threat but not the most likely. The Army must prepare to fight anywhere, on any

terrain, in any climate, in any type of conflict, and fight as part of a coalition or unilaterally.¹³

- The Army must decisively win the land battle, not merely avoid defeat or maintain the status quo.¹⁴

- The U.S. must maintain at least weapons parity [with the Soviets] through better quality weapons not greater numbers; reliance on superior technology, tactics, and leadership; and national will.¹⁵

- The Army must avoid high combat losses and achieve victory through maneuver; minimum exposure of friendly forces to weapons effects; deception; and employing psychological efforts that erode the enemy's will.¹⁶

- Future wars must be short, and winning the first battles is critical. Increases in weapon lethality, the decline in the U.S. industrial base, and a decline in U.S. military-age population would not support long duration, attrition warfare.¹⁷

- Strategic mobility would be critical, as would a cooperative effort amongst all military services.¹⁸

These implications, coupled with the Airland Battle doctrine drove the ALB-2000 concept and with it, guidance for the doctrinal and materiel developments in the ADA branch.

AIRLAND BATTLE 2000'S REQUIREMENTS FOR AIR DEFENSE ARTILLERY

The doctrinal mission of ADA prior to ALB-2000 was,

. . . to nullify or reduce the effectiveness of attack or surveillance by hostile aircraft or missiles after they are airborne, thereby supporting the primary Army function of conducting prompt or sustained land warfare operations.¹⁹

ALB-2000 simplified this mission to, " . . . provide protection for vital assets and maneuver forces against air and space threats."²⁰

ALB-2000 defined air defense as, " . . . all efforts directed at destroying, disrupting, or degrading the effectiveness of enemy air breathing systems, tactical missile systems, and satellites."²¹ It expanded ADA's target set from fixed and rotary wing (FW/RW) aircraft, precision guided munitions (PGMs), cruise missiles (CMs), and tactical ballistic missiles (TBMs) to include strategic surveillance systems, remotely piloted vehicles (RPVs), unmanned aerial vehicles (UAVs), and satellites.²²

Successful mission execution required engaging the enemy, not only while it attacked friendly assets, but while still deep in the enemy's territory. This required extensive coordination, planning, synchronization of fires, and exploitation of all available intelligence.²³ This was a major departure from ADA operations in the 1980s.

ALB-2000's objectives required robust ADA command and control (C2) systems capable of integrating all source intelligence systems; providing alerting and fire distribution to air defense fire units and interceptors; and ensuring priority targets were engaged, simultaneous engagements were prevented, and horizontal information exchange occurred. These systems required netted sensors to: ensure integrated and continuous operational capability; enhance fire unit survivability; and provide for stealthy engagements. Targeting information would be provided directly from sensor to shooter and C2 systems would operate under the guiding principle of centralized control and decentralized execution.²⁴

ALB-2000's ADA weapons systems had to be capable of "continuous engagement of enemy air vehicles arriving or returning in any direction, speed, or altitude."²⁵ Weapon systems would include missiles, guns (with maneuvering projectiles), directed energy weapons, obstacles (anti-air mines), non-nuclear electro-magnetic pulses, electro-magnetic jammers, and obscurants. Weapons required minimum reaction and engagement times to counter the threat's increased speed, accuracy, and lethality.²⁶

The Close Combat Force (CCF; corps level and below) weapon systems would be highly mobile and agile systems oriented on countering the medium and short range threats. CCF air defense commanders would employ unmanned aerial platforms to attack enemy

air vehicles beyond the range of ground air defense systems; quickly mass air defense capabilities; and respond to unforeseen contingencies.²⁷

The Airland Force (ALF; theater level) weapon systems would counter low, medium, and high altitude threats and enemy surveillance systems. Integration of strategic (national) and joint intelligence, and counter-air efforts would occur at this level.²⁸

General design characteristics for ALB-2000 ADA systems follow:

- Simplicity. Systems must be modular, simple, durable, reliable and maximize component commonality; without sacrificing quality, quantity, or effectiveness. Systems must not be manpower intensive nor require operators or maintainers who are "super technical wizards"²⁹; and should maximize robotics.³⁰

- Supportability. The maintenance concept must facilitate rapid repair, forward; not require highly skilled personnel; support modular resupply; and maximize robotics, built-in test (BIT) and built-in-test equipment (BITE), and imbedded training devices. CCF systems must allow deep battlefield penetrations without rearming, refueling, resupply of parts, or expendables. Developers must design-in 'endurability' for crewmen.³¹

- Transportability/Mobility. Systems must be transportable on 1980s strategic lift aircraft and possess mobility commensurate with the force they support.³²

- Survivability. Mobility ensures survivability. On-board navigation aids will support mobility and survivability. Systems must be indistinguishable from others so as not to be singled-out for priority engagement. System survivability will be enhanced by: multi-mode, quiet, passive sensors; told-in alerting information; conducting engagements via remote cueing; suppressing electronic, acoustic, light, and thermal signatures; and projecting false signatures.³³

- Lethality. Rapid reaction time (target acquisition, identification, tracking, engagement, and kill) must occur before the threat releases ordnance. If it can not, the system must be capable of killing the ordnance after release. Systems must: be capable of high rates of sustained fire to counter mass raids; have large magazines of stored kills; expend few shots per engagement; have a high single shot kill probability; be capable of conducting multiple, simultaneous engagements; and not be constrained by multiple missile control limitations. CCF systems must be all weather, day or night systems; employ fire-and-forget ordnance systems; and have a shoot-on-the-move capability.³⁴

- Effectiveness. Close coordination between combat forces is essential. A system to provide real time threat and friendly disposition in terms of location, force characteristics, axis of advance, and other key tactical information is required. Each weapon system must have an on-board, near perfect, passive target identification and classification capability.³⁵

ALB-2000's operational and equipment concepts presented significant challenges to ADA system developers. In 1981, the Patriot, Stinger, Roland, and SGT York systems were under development and programmed for fielding by the mid-80s. ALB-2000 could not influence these near-term systems, nor could anyone predict Roland and SGT York would be canceled prior to reaching full production.³⁶ Their cancellation presented an opportunity to study industries' capabilities and develop requirements documents to meet ALB-2000's operational concept.

FORWARD AREA AIR DEFENSE ADA'S FIRST AIRLAND BATTLE 2000 REQUIREMENTS CHALLENGE

The cancellation of Roland and SGT York prompted two major studies resulting in the Forward Area Air Defense System (FAADS).³⁷ FAADS embraced many ALB-2000 concepts and took a systems of systems approach to defeating the CCF's air threat. FAADS consisted of five complementary components, "[forming] an array that could defeat any enemy attack option."³⁸ The FAADS components were:

- FAAD Command, Control, and Intelligence System (C2I)
- Line-of-Sight Rear (LOS-R) weapon system.
- Non Line-of-Sight (NLOS) weapon system.
- Line-of-Sight Forward (LOS-F) weapon system.
- Combined Arms Initiative (CAI).³⁹

FAAD C2I would fuse intelligence and targeting information from organic and nonorganic netted sensors or sources, and distribute it to FAAD fire units or the combined arms team. It would interoperate with allied, joint, and adjacent ground air defense forces; and exploit passive technologies to detect and identify air vehicles.⁴⁰

LOS-R would deploy in rear areas; be armed with fire and forget missiles, and a gun or gun surrogate; and employ a shoot-on-the-move capability to counter FW and RW aircraft. NLOS, a missile based system, would operate from defilade, off the forward line of troops (FLOT), to defeat threat RW aircraft operating beyond the FLOT and masked from combined arms or LOS-F weapon systems. LOS-F would shoot-on-the-move and employ a gun-missile mix of weapons to kill or suppress threat FW and exposed RW aircraft.⁴¹

All FAAD weapon systems would possess on-board, passive detection, acquisition, and identification sensors; be day/night, all weather systems; and possess survivability and mobility commensurate with their area of operations and supported force. NLOS and LOS-F were both capable of defeating aerial and armor threats. The Combined Arms Initiatives would improve non-air defense combat system ammunitions; sights; and tactics, techniques, and procedures.⁴²

FAADS' acquisition strategy was based on non-developmental items and off-the-shelf technology to minimize cost and

accelerate acquisition. Components with 'initial required capabilities' were to be fielded by 1990 and 'grown' to full ALB-2000 capabilities through product improvements.⁴³

FAADS embraced ALB-2000's concepts but its acquisition strategy was flawed. ALB-2000's requirements were unconstrained and FAADS was constrained fiscally, by short timelines, and 1980's technology. Only LOS-R (Avenger), FAAD C2 (with the Sentinel radar), and the CAIs were fielded with the majority of ALB-2000's capabilities. System integration problems, cost overruns, and immature technologies kept NLOS and LOS-F from being fielded.⁴⁴

The Air and Missile Defense systems fielded in the 1980s and currently under development greatly parallel ALB-2000's concepts. These systems are still fiscally and, in some cases, temporally constrained but they are pursuing the technologies to meet ALB-2000's requirements.

AIR AND MISSILE DEFENSE SYSTEMS AIRLAND BATTLE 2000'S REAL CHALLENGE

ALB-2000's impetus is present in today's air and missile defense (AMD) systems. AMD operations, like FAADS, are holistic and based on a 'tiered battle space' (an upper and lower tier). The systems employ netted and distributed C4I, and their normal mode of operation is centralized control at battalion level with decentralized execution at the fire unit (battery). The Patriot, Theater High Altitude Area Defense, and Medium Extended Air

Defense System are netted systems, interoperate with joint and combined systems through a standardized C2 system, and exploit national intelligence assets through joint support systems. An Army Air and Missile Defense Command has been established to synchronize joint and combined air defense efforts and optimize synergism.

PATRIOT

Patriot was designed to counter high-speed, FW aircraft conducting saturation raids. Through a phased product improvement program (see Appendix 2) it evolved into a combat proven, lower tiered AMD system.⁴⁵

Planned improvements will: introduce robotics for ammunition reload, provide joint connectivity to the firing battery, enhance lethality and effectiveness against TBMs, CMs, and low observable targets, and provide integrated diagnostic automated maintenance support systems.⁴⁶

THEATER HIGH ALTITUDE AREA DEFENSE (THAAD)

THAAD is an upper tier AMD system with exo and endoatmospheric intercept and a kinetic energy kill capability.⁴⁷ THAAD will achieve initial operating capability by the year 2000 and field a fully operational battalion in 2006.⁴⁸

MEDIUM EXTENDED AIR DEFENSE SYSTEM (MEADS)

MEADS is designed to fight the ALF and CCF commander's AMD battle. It is described as,

. . . the critical lower tier component of the active [missile] defense pillar . . . required to provide low-to-medium altitude air and tactical missile defense in early entry, movement to contact, and decisive Army operations and [to meet] the rapid force-projection needs⁴⁹

MEADS will be modular and provide a 360° defense against multiple and simultaneous attacks by air breathing and tactical missile threats. Its first unit equipped date is fiscal year 2006.⁵⁰

AIR AND MISSILE DEFENSE PLANNING AND CONTROL SYSTEM (AMDPCS)

AMDPCS provides horizontal, vertical, joint, and multinational interoperability within AMD units and across the Army. It has three components: standardized tactical operations centers, AMD workstations (AMDWS), and AMD brigade fire control capabilities.⁵¹ These components are automated C2 force multipliers, which achieve ALB-2000's requirement for intelligence integration.

JOINT TACTICAL AIR-GROUND STATION (JTAGS)

JTAGS is a strategically deployable and tactically mobile, joint ground system that exploits space-based sensor information for tactical ballistic missile (TBM) defense. It provides a direct 'sensor-to-shooter' link via the AMDCPS and a theater missile defense communications network. JTAGS reflects

ALB-2000's requirement for joint systems and the tactical exploitation of national, space-based assets. Five JTAGS are in operation today.⁵²

ARMY AIR AND MISSILE DEFENSE COMMAND (AAMDC)

The AAMDC is a new organization reflecting ADA's 21st century threats, changes in doctrine, and ALB-2000's definition that air defense, " . . . is all efforts directed at destroying, disrupting, or degrading the effectiveness of enemy air breathing systems, tactical missile systems, and satellites."⁵³

The AAMDC is a C2 headquarters with operational control of all Echelon Above Corps Army AMD forces. It possesses the expertise and systems (AMDCPS) to develop robust anti-tactical ballistic missile (ATBM) defenses; and the means to receive timely TBM launch warning data (JTAGS). It ensures all ground air defense systems are integrated into joint defensive counter-air and active air defense operations. Its Theater Army Air Defense Element works in the theater's deep operations coordination cell (DOCC) to ensure ATBM attack operations are coordinated and to nominate TBM targets for targeting by the air forces (see Appendix 3).⁵⁴

The AAMDC provides the headquarters where ALB-2000's synergy of air defense is coordinated and applied to defeat the 21st century's air and missile threat.

ADA IN 1998--AN AIRLAND BATTLE 2000 FORCE?

Thus far, this paper has defined ALB-2000; its operational concepts and requirements for ADA; and provided a brief description of ADA's efforts to meet those requirements. It will now assesses whether ADA has met ALB-2000's objective requirements. It will compare system characteristics to those specified by ALB-2000 and, where appropriate, compare current and projected systems to legacy systems. System assessments are separated into four distinct categories: FAAD Systems, AMD Systems, Combat Multipliers, and Future Initiatives.

FORWARD AREA AIR DEFENSE SYSTEMS

Today's FAAD systems clearly meet ALB-2000's design characteristics. They are simple, durable, and reliable. They are not manpower intensive as Table 1 illustrates, nor do they require highly qualified personnel to operate or maintain.⁵⁵

Table 1 -- SHORAD to FAADS Crew Manning Comparison⁵⁶

SHORAD to FAAD Weapon System	Crew Manning	Personnel Savings
Chaparral : Avenger	5 : 2	3
Vulcan : BSFV-E*	4 : 4	0
FAAR : Sentinel Radar	3 : 2	1
*BSFV-E (Bradley Stinger Fighting Vehicle-Enhanced was fielded to fill the void created by the LOS-F's cancellation.		

FAADS' modularity enables upgrades without major redesign and its commonality with other systems reduces maintenance costs

(BSFV-E has 80% commonality with the Infantry's Bradley-IFV; Sentinel has 65% commonality with the AN/TPQ-36 Firefinder Radar⁵⁷; FAAD C2 employs Army Common Hardware and Software). BIT, BITE, and imbedded trainers are fielded or soon to be fielded for all systems.

System mobility is commensurate with its area of operations.⁵⁸ Table 2 illustrates FAADS significant achievements towards meeting ALB-2000's air transportability requirements.

Table 2 -- FAADS Transportability ⁵⁹						
FAADS SYSTEM	AIR FRAMES					
	UH-60*	CH-47*	C-130	C-141	C-17	C-5A
STINGER	YES	YES	YES	YES	YES	YES
AVENGER	YES	YES	YES	YES	YES	YES
BSFV-E	NO	NO	NO	NO	YES	YES
FAAD C2	YES	YES	YES	YES	YES	YES
SENTINEL	YES	YES	YES	YES	YES	YES
*external sling load						

The systems derive survivability from low profiles, rapid displacement times, mobility, positioning on the battlefield, and being indistinguishable from other combat systems. All weapon target acquisition systems are totally passive. The Sentinel is a phased array radar which makes detection and lock-on by an anti-radiation missile extremely difficult.⁶⁰

FAAD weapons possess great lethality. The Avenger's and BSFV-E's 'slew-to-cue' capability greatly decreases system reaction times and allows for engagements of UAVs, RPVs, and CMs. The systems do counter most forward area threats (see Table 3).

Table 3 -- Threats Countered by FAADS⁶¹

FAAD SYSTEMS	THREAT AIR VEHICLES						
	FORWARD AREA					REAR AREA	
	RW	FW	UAV-RPV	CM	PGM	TBM	SAT
STINGER	YES	YES	YES	YES	NO	NO	NO
AVENGER	YES	YES	YES	YES	NO	NO	NO
BSFV-E	YES	YES	YES	YES	NO	NO	NO
SENTINEL	YES	YES	YES	YES	YES	NO	NO

The Avenger and BSFV-E have shoot-on-the-move capability; employ fire and forget missiles, with complementary gun systems; and can conduct near-simultaneous engagements without missile control limitations. Limited supplies of ready-to-fire and on-board ammunition stores are the only significant weapon system limitations (see Table 4).

Table 4 -- FAADS Ammunition⁶²

FAAD SYSTEM	READY-TO-FIRE		ON-BOARD STORES	
	MISSILES - GUN*		MISSILES - GUN*	
STINGER	2		4	
AVENGER	8	225	0	1000
BSFV-E	4	300/400	6	600/2800
* Avenger 50 caliber machine gun.				
BSFV-E 25mm chain gun/7.62mm machine gun.				

FAADS greatest achievement is its effectiveness. The FAADS C2I system meets all of ALB-2000's operational requirements.⁶³ Sentinel radars generate a netted, local air picture which FAAD C2 correlates with that received from adjacent FAAD or AMD battalions and joint services. The correlated air picture is shipped via an area broadcast communications network to command posts and fire units where it is displayed on a Simplified

Handheld Terminal Unit (SHTU). When an Avenger or BSFV-E operator selects a target from his SHTU, his weapon automatically slews to the target's anticipated location in the sky. The fielding of 'slew-to-cue' completes the 'sensor to shooter' link ALB-2000 forecasted.⁶⁴

FAAD C2 also provides enhanced situational awareness and staff effectiveness at the battalion operations centers through the Enhanced Positioning and Location Radio System (EPLRS), the Tactical Mission Planner, and the Tactical Staff Planner.⁶⁵

FAADS failed to meet ALB-2000's requirement to field an on-board target detection system for each weapon platform. This capability would greatly enhance weapon effectiveness when operating in an autonomous mode without the support of FAADS C2I.

AIR AND MISSILE DEFENSE SYSTEMS

Current and future AMD systems clearly reflect all ALB-2000's requirements. These systems will continue to be developed to enhance strategic deployability, force projection, mobility, lethality, and interoperability. They are the most capable air defense systems in the world.

A key aspect of all ALB-2000 systems is a reduction of manpower requirements through automation, system simplification, technology, or robotics. Table 5 depicts AMD system's decreases in manpower. With robotics, palletized loading systems, and

integrated diagnostic systems, further manpower savings will be realized.

Table 5 -- HIMAD to AMD Battalion Manpower Comparison⁶⁶

LEGACY SYSTEM : AMD SYSTEM	PERSONNEL REQUIRED	SAVINGS
NIKE HERCULES : PATRIOT	1030 : 765	265
NIKE HERCULES : THAAD	1030 : 700	330
HAWK : MEADS	878 : 412	466

Modularity and commonality of components are embedded in all system designs. All three systems employ BIT, BITE, and a component failure concept that degrades operating capability without total loss of combat capability.

Mobility for all systems is commensurate with its operating area and supported force (see Table 6).

Table 6 -- AMD System Mobility Characteristics⁶⁷

AMD SYSTEM	CROSS COUNTRY	IMPROVED ROADS	HIGHWAY
PATRIOT	YES	YES	YES
MEADS	YES	YES	YES
THAAD	LIMITED	YES	YES

Air transportability is greatly improved, with MEADS and THAAD meeting ALB-2000's requirement for strategic mobility (see Table 7).

Table 7 -- AMD System Transportability⁶⁸

AMD SYSTEM	AIR FRAME					
	CH-47	CH-53	C-130	C-141	C-17	C-5A
PATRIOT	NO	NO	NO	NO	YES	YES
MEADS	YES*	YES*	YES	YES	YES	YES
THAAD	NO	NO	NO	YES	YES	YES

*external sling load.

The systems derive survivability from netted sensor architectures; told-in, external sensor data (which allows operations in a passive mode); and agile, phased array radars.⁶⁹ All AMD systems have or will have the capability to remote launchers and control launchers from other fire units. MEADS will disperse various fire unit components (radar, engagement control, launchers;) across the battlefield to reduce vulnerability to detection and targeting systems.⁷⁰

Maximum lethality is essential in air and missile defense operations. The engagement window is exceptionally short, therefore precise timing and rapid reaction are key requirements. All AMD systems do or will have the capability for computer controlled engagement modes of operation. The operator is merely present to eliminate the potential for fratricide under this mode.

Threat air vehicles carrying nuclear, chemical, or biological warheads make total warhead destruction a critical requirement. Patriot's PAC-3 and THAAD's kinetic energy missiles ensure warhead destruction.

AMD systems are more threat specific than FAADS systems because ballistic missile threats possess unique characteristics that drive system capabilities. Table 8 compares ALB-2000's threats to AMD capabilities.

Table 8 -- Threats Countered by AMD Systems ⁷¹							
AMD SYSTEMS	RW	FW	RPV-UAV	CM	PGM	TBM	SAT
PATRIOT	YES	YES	YES	YES	YES	YES	NO
MEADS	YES	YES	YES	YES	YES	YES	NO
THAAD	NO	NO	NO	YES	YES	YES	NO

All AMD systems can conduct simultaneous engagements.⁷²

These are not forward area weapons systems, therefore none of them require a shoot-on-the-move capability. Their long range fires support forward maneuver forces from rear areas.

Table-9 shows AMD systems have significant amounts of ready-to-fire ammunition.

Table 9 -- AMD System Ammunition ⁷³		
AMD SYSTEM	READY-TO-FIRE MISSILES	AVAILABLE STORES
PATRIOT	32/128*	4/16**
MEADS	Not Yet Determined	Not Yet Determined
THAAD	72	72
* PAC-3 missiles are smaller, allowing 16 missiles to be uploaded on a launcher vs. 4, PAC-2 missiles. Units will upload some launchers with PAC-2 and others with PAC-3 allowing a mix.		
** Assumes reload vehicle is uploaded.		

AMD systems derive effectiveness from interoperability with adjacent Army, joint, and allied AMD systems. All AMD systems do or will: exploit national intelligence through JTAGS and AMDCPS; employ Joint Tactical Information Distribution System (JTIDS) for joint connectivity; link into combined air defense systems; and employ AMDCPS' automation capabilities for tactical planning,

situational awareness, operational control, fire distribution control, and staff support.⁷⁴

THE COMBAT MULTIPLIERS

JTAGS, the AMDCPS, and the AAMDC are combat multipliers, fully embracing the spirit and intent of ALB-2000's operational concept. Their automation, technology, and robust communication architectures exploit national, regional, joint, and combined intelligence to optimize warfighting capabilities. They represent a doctrinal shift from the stove pipe operations of the 1970s to the synergistic joint and combined arena of the 1990s and 21st century. They are rapidly deployable; employ standard Army equipment; and have a common goal of leveraging available knowledge, expertise, and information, to ensure maximum combat power is delivered at the critical time.

AIR DEFENSE ARTILLERY'S FUTURE INITIATIVES

ALB-2000's mission for ADA is not completely satisfied by today's systems or those under development. The Aerostat, Counter Air Directed Energy Weapons System (CADEWS), and Tactical High Energy Laser (THEL) are initiatives being explored to meet ALB-2000's unanswered challenges.

The Aerostat is an unmanned, long-endurance airborne search and fire control sensor, supported by a tethered helium blimp.

It will detect targets masked by terrain (RW, CM, UAVs) and support over-the-horizon engagements by AMD weapon systems.⁷⁵

CADEWS is a strategically deployable and tactically mobile, directed energy weapon, capable of aerial vehicle platform kills at 6-8 kilometers and soft, sensor/warhead kills at greater ranges. CADEWS will operate with a " . . . deep magazine and rapid retargeting capability to counter missile volley attacks. It will have a high kill efficiency -- one shot per engagement."⁷⁶

THEL employs laser technology for acquisition and close-in engagement of short to medium range targets (rockets and low signature maneuvering targets). THEL's cost per engagement is expected to be only a few thousand dollars. A prototype system should be available in March 1998 (see Appendix 4).⁷⁷

CONCEPTUAL DIFFERENCES

The ADA branch has made substantial gains towards achieving ALB-2000's doctrinal and materiel requirements. The ALB-2000 concept paper defined ten conceptual differences between air defense operations in the 1980s and the 21st century. An assessment of these differences follows.

#1 - In 1980 air defense operations were " . . . multilevel and responsive to a layered and complicated chain of command"⁷⁸. Airland Battle 2000 saw air defense as being, " . . . bilevel

which is not layered . . . responsible only to the Airland Force Commander and the Close Combat Force Commander"⁷⁹

The 1980's concepts speak of distinct engagement zones and limitations on authority to conduct engagements. Additionally, in 1980, all high and medium altitude systems were owned by the Army but their positioning and fires were controlled by the Air Force.

Today's Patriot battalions are assigned at Echelons Above Corps and Corps level and are responsive to the needs of the Joint Force Land Component Commander and the Corps Commander. Fires against fixed wing aircraft are still controlled by the Air Force but fires against other targets are not. Present and future systems are not layered but are integrated, providing seamless air defense to maneuver forces and critical assets.

#2 - Air defense operations were oriented on area or belt defenses in the 1980s. ALB-2000 wanted the orientation to be on the threat and critical assets.⁸⁰

Air defense in 1998 is threat and asset oriented. Intelligence preparation of the battlefield ensures threat capabilities are accurately assessed and a robust, offensive and defensive counter air-missile plan is developed. The AAMDC's participation in TBM attack operations validates this conceptual shift.

#3 - Air defense was a 'stove pipe operation' in the 1980s, " . . . tenuously guided with an Air Force lead."⁸¹ ALB-2000

called for the integration of tri-service air defense assets under a single commander to practice offensive and defensive air defense at the operational level.⁸²

Joint doctrine's Joint Force Air Component Commander does this through the Area Air Defense Commander and with the support of the AAMDC. This concept was validated during Operations Desert Shield/Storm when the 11th Air Defense Artillery Brigade Headquarters was expanded to perform the AAMDC's mission.⁸³

#4 - Centralized control was the primary mode of operation for HIMAD systems in the 1980s and autonomous mode was a fallback mode. ALB-2000 stated decentralized control would be the normal mode of operation with centralized control utilized in offensive air defense operations.⁸⁴

Patriot and future AMD systems still fight the defensive counterair battle against air breathing threats in a centralized mode. The ATBM mission, with its extremely short reaction times, is executed under the decentralized mode of operation. Patriot is the only fielded ATBM system and there is little likelihood of fratricide in an ATBM engagement. With the advent of THAAD and other ATBM systems (USN has a program under development) the need for centralized control and fire direction may be necessary. Centralized control and fire direction will ensure the most capable weapon executes the engagement, simultaneous engagements are avoided, and ammunition conservation is maximized.

#5 - C2 systems of the 1980s were rigid and vulnerable. The air battle was fought from fixed sites and dependent on inflexible communication architectures. ALB-2000 forecasted netted sensors, information systems, and C2 networks capable of supporting highly fluid operations.

Today's AMD and FAADS C2 systems are extremely flexible. They are supported by netted sensors and area user communication networks which allow them to 'plug-in' to a network to receive and integrate various forms of intelligence and external data. They are not fixed to any one site and are highly mobile.

#6 - Fire units of the 1980s were dependent upon organic sensors for early warning and target acquisition. Higher echelons contributed little to the active defense. ALB-2000 predicted all echelons of command would contribute to an intelligence data base to provide fire units early warning and intelligence.⁸⁵

ADA has made tremendous strides in achieving ALB-2000's vision. FAAD C2I, AMDCPS, JTAGS, and the AAMDC, with area user communication systems and satellite communications support; collect, fuse, and distribute all sources of intelligence. Final acquisition of a target by a fire unit's organic sensor is still necessary for engagement but ALB-2000's vision of external warning and cueing to fire units has been achieved.

#7 - Inability to conduct multiple engagements, multiple missile control constraints, limited numbers of ready-to-fire

missiles, and long reload times made the air defense systems of the 1980s vulnerable to high volume air attacks. ALB-2000 required air defense systems to be highly agile, logisitically inexpensive, and armed with highly lethal munitions.⁸⁶

Today's systems can execute multiple, simultaneous engagements. Fire and forget missiles or improved software has negated the multiple missile control problem. Uploaded, ready-to-fire ammunition capacities of today's systems have increased over previous systems. Reload times are significantly shorter than those of legacy systems and will decrease when palletized loading systems and robotic systems are fielded. Remote launch capability and battlefield dispersion enhances a commander's flexibility to counter the threat and survive. Munition lethality has increased but so has cost, and this is spurring the development of directed energy weapons such as CADEWS and THEL.⁸⁷

#8 - Weapons systems of the 1980s were dependent upon active radars for target acquisition. ALB-2000 saw a transition to "multimode sensing, quiet/passive technologies, and remote cueing being the normal mode [of operations]."⁸⁸

Today's FAAD weapons employ external data for early warning and passive technologies for target acquisition. AMD systems exploit active and passive external data for early warning but target acquisition for engagement is still via system radars. All current radars are phased array, with reduced susceptibility

to jamming and targeting, and efforts to develop passive or multimode technologies are continuing.

#9 - In the 1980s C2 was highly dependent upon boundaries, corridors, and rigid weapon control rules. ALB-2000 wanted, " . . . all systems referenced to a common grid and netted so C2 would be fluid, changeable, and responsive to situations."⁸⁹

FAAD C2I and all AMD systems employ the ALB-2000 concept. Airspace control measures and weapons control guidance are automated and downloaded through communication networks to dispersed fire units. Plotting control measures on overlays with grease pencils is passe.

#10 - Legacy ADA units were manpower intensive, and movements and operations were logistically burdensome. ALB-2000 dictated systems be, " . . . agile, non-manpower intensive . . . [and] capable of independent, sustained operations."⁹⁰

Today's systems are agile, less manpower intensive, and are more capable of independent, sustained operations. Manning requirements for all present and projected air defense systems have decreased. Increased mobility, with rapid emplacement and displacement times, have improved unit responsiveness and agility. Imbedded diagnostic software and built-in-test equipment have greatly reduced the maintenance and logistics burden of present day systems.

CONCLUSIONS

ALB-2000 was a futurist's vision of the Army in the 21st century. The Air Defense Artillery branch, and the Army, have made significant strides in achieving ALB-2000's goals. It was a revolutionary idea, accomplished through an evolutionary process.

The Army Science Board (ASB) reviewed the concept in 1983 and stated, " . . . the changes in operations [must] be evolutionary . . . to [ensure successful] introduction without loss of continuity or ability to fight."⁹¹

The ASB also stated it would take:

- eight to ten years for the doctrine to be firmly emplaced in Army operations.⁹²

- current and near term weapon systems will have to grow, through product improvements, to meet ALB-2000 requirements.⁹³

- it will take an additional eight to fifteen years before systems possessing ALB-2000 characteristics will be fielded.⁹⁴

Timelining the ASB's predictions, with a start date of 1983, and you'll find:

- in 1991, the Army demonstrated Airland Battle doctrine in the Persian Gulf War.

- Patriot, a legacy system, continues to grow through planned product improvements to meet ALB-2000 requirements.

- the MEADS requirement document embodies ALB-2000's operational requirements and should be fielded in 2010.

- future initiatives place us on the verge of breaking a new threshold in weapon and sensor technology which ALB-2000 predicted would be mature by 2010.

Was there an element of science fiction in Airland Battle 2000 and is it present in the Army After Next? Yes, because concept studies must be free to consider what is plausible and not be constrained by what is possible or probable or affordable.

Future studies must focus well into the future and set what often appear to be outlandish expectations. Through these expectations, combat and material developers, in concert with industry, focus their efforts. We must conceptualize about what might be and qualify our opinions of futuristic studies as Mr. Robert Stein, a member of industry, recently did when he stated,

. . . in terms of technological advances, thirty years is a very long, unimaginable time . . . in terms of geopolitics, thirty years creates significant evolution in the world's political landscape . . . in terms of deploying real [military] systems, thirty years is a relatively short time!⁹⁵

Are concept studies a valid approach to shaping and guiding the future of our Armed Forces or are they government sanctioned science fiction? I believe they are a valid process for developing operational concepts; setting goals; and focusing industry and military developers on a vision; but they often do read like science fiction to the uninformed.

Total word count is 5,920.

APPENDIX 1-AIRLAND BATTLE 2000'S TRENDS FOR THE FUTURE⁹⁶

Airland Battle 2000's authors identified the following sixteen trends that would change the geopolitical environment and present new challenges to the Army in the 21st century:

- Increasing third world population.
- Growing worldwide urbanization.
- Decreases in U.S. and Soviet Union military age population.
- More diverse lifestyles.
- The Earth's capacity to sustain its populations declines.
- Energy dependency grows.
- Strategic material dependency increases..
- Greater world and political interdependency.
- Increased foreign investment in technology.
- Dwindling U.S. [heavy industry] production base.
- U.S. becoming more of an information based society.
- U.S. to Soviet investment imbalance [favoring the Soviets].
- Soviet's ability to project power increases.
- Proliferation of conventional arms.
- Proliferation of nuclear technology.
- More issues and less consensus.

APPENDIX 2-SUMMARY OF PATRIOT ADVANCED CAPABILITIES

In 1988 PAC-1 provided Patriot a self-defense capability to defeat short range ballistic missiles (SRBMs). This was accomplished through radar software modifications that enabled high angle detection, tracking, and engagement of the SRBMs.

PAC-2 capabilities were fielded in August of 1990, in response to the Persian Gulf War. PAC-2 enabled Patriot to provide area anti-tactical ballistic missile (ATBM) defense to friendly units and assets.⁹⁷ These modification were mainly software changes to the radar⁹⁸ and changes to the missile's fuse. A second phase of PAC-2, known as the Quick Response Program (QRP), was applied after the Persian Gulf War. QRP: enhanced radar performance through software changes, allowing the system to discriminate between missile debris and the missile warhead; allowed launchers to be remoted from the battery's radar, permitting split operations and an extension of the system's protected area; and applied the Global Positioning System (GPS) to enhance system emplacement times, accuracies, and land navigation.⁹⁹

In a parallel program, Raytheon (Patriot's primary developer and manufacturer) developed the GEM missile (Guidance Enhanced Missile). The GEM increased the missile fuse's reaction time by an order of magnitude and increased the size of the warhead's fragments thereby enhancing its lethality.¹⁰⁰

In 1995, PAC-3 fielding began. This improvement is a series of major upgrades to the Patriot's radar, computers, launchers, and the introduction of a new missile. PAC-3 fully demonstrates the system's modular design as the upgrade simply removes outdated components, replaces them with modern components, and allows enhanced capabilities without redesign.

PAC-3 upgrades increase the Patriot's: ATBM battlespace by twofold; firepower by fourfold; and lethality with a kinetic energy kill capability. PAC-3 also improves Patriot's capabilities to defeat low observable cruise missiles and aircraft, and enhances joint force interoperability by application of JTIDS.¹⁰¹

APPENDIX 3-AIR AND MISSILE DEFENSE COMMAND

Joint doctrine makes the Joint Force Air Component Commander (JFACC) responsible for coordinating all aspects of aerial combat against aircraft. He is also responsible for attack operations against TBM launch sites, facilities, and equipment beyond the Joint Force Land Component Commander's (JFLCC) area of operations.¹⁰²

The Area Air Defense Commander (AADC) is responsible for all theater air defense operations, to include the conduct of anti-tactical ballistic missile (ATBM) active defense operations and disseminating TBM attack alerts and information. The AADC may be, and often is, the JFACC.¹⁰³ The AADC possesses neither the means nor expertise to accomplish either of these functions.

The Army Air and Missile Defense Command (AAMDC) is a command and control headquarters with operational control of all Echelon Above Corps Army air defense forces (Patriot; THAAD; MEADS;). It possesses: the expertise, systems (AMDCPS) and skills to develop coherent and robust ATBM defenses; and the means to receive timely TBM launch warning data (JTAGS).¹⁰⁴ Its commanding officer, normally a general officer, is the Joint Land Force Component Commander's Theater Army Air Defense Coordinator (TAADC). The TAADC is charged to ensure all ground air defense systems are fully integrated into the joint defensive counter-air and active air defense operations.¹⁰⁵

The AAMDC's G-2 and G-3 (intelligence and operations) cells form the Theater Army Air Defense Element (TAADE) to execute 'offensive ATBM operations'. Working with the theater's deep operations coordination cell (DOCC) they identify and recommend targeting priorities and requirements to attack and defeat TBM launch sites or equipment within the JFLCC's area of operations (AO) and nominate those outside the AO for targeting by the JFACC's forces.¹⁰⁶

Army air defense doctrine states the AAMDC's commander should serve as the Deputy Area Air Defense Commander.¹⁰⁷ This concept joins the 'missioned headquarters with the mission capable headquarters'. The AAMDC provides the JFACC/AADC the required expertise and information to execute their missions; ensures coordination and effective employment of all air and ATBM capable weapons; and synchronizes attack operations against enemy TBM assets.

The AAMDC provides the air and missile defense headquarters where Airland Battle 2000's synergy of air defense effort (Army, joint, and combined) can be coordinated and applied to defeat the 21st century's air and missile threat.

APPENDIX 4-FUTURE INITIATIVES

AEROSTAT

The Aerostat program was established in 1996 to develop a surveillance and fire control platform for current and future AMD systems. It is an unmanned, airborne search and fire control sensor that is supported by a tethered helium blimp. It can detect targets normally masked by terrain (RW, CM, UAVs, etc.) and support over-the-horizon engagements by AMD weapon systems. The Aerostat is relatively inexpensive to procure; has long endurance (30 days on station; 24 hours a day operations;) and provides 360°, wide area, long range detection and tracking down to the lowest threat operating altitudes. Other potential missions for the Aerostat include fire support, battlefield classification, discrimination, and identification, boost phase intercept of missiles, communication relays, and battlefield situational awareness.¹⁰⁸

The Aerostat is currently undergoing testing at Fort Bliss, Texas. If the program continues as planned a deployable prototype system will be fielded in 2002.¹⁰⁹

COUNTER AIR DIRECTED ENERGY WEAPON SYSTEM (CADEWS)

The following CADEWS system description reads as though it were in fact a direct quote from the air defense section of the Airland Battle 2000 concept brief.

The CADEWS "provides new warfighting capabilities using directed energy technologies (i.e.: lasers,

high-power microwave) in a strategically deployable, tactically mobile, surface-to-air weapon system. CADEWS will use an integrated suite of directed energy systems to provide protection of forces in the forward area and defense of scarce, high value assets. It will be capable of 'hard kills' of platforms, to a range of six to eight kilometers, and 'soft kills' of sensors of an expanded threat target set that includes TBMs, CMs, UAVs, rockets, mortars, artillery rounds, helicopters, and fixed wing aircraft. CADEWS will operate with a 'deep magazine and rapid retargeting capability to counter missile volley attacks. It will have a high kill efficiency -- one shot per engagement."¹¹⁰

CADEWS is an unfunded program but if funding were available it would undergo advanced technology demonstration and advanced concept technology demonstration during the period 2002 through 2005. The earliest projected dates for fielding are 2015, plus or minus 10 years (assuming FY 99 funding). CADEWS is an Airland Battle 2000 system that will provide " . . . an offensive information warfare capability to negate an adversary's eyes (e.g., UAV)."¹¹¹

TACTICAL HIGH ENERGY LASER (THEL)

The THEL Advanced Concept Technology Demonstration (ACTD) was initiated in July 1996. It is a joint program initiative between the U.S. and the Government of Israel. THEL employs proven: "laser beam generation technologies . . . beam pointing technologies, and existing sensors and communication networks . . . to provide an innovative solution . . . for the acquisition and close-in engagement problems associated with short-to-medium range threats."¹¹² It will provide a 'low cost per kill' (a few

thousand dollars per kill) defense against short range rockets and low signature, maneuvering threats. The program is intended to deliver a prototype system with initial operating capabilities to counter short-range rockets by March 1998.¹¹³

APPENDIX 5-ABBREVIATIONS

AADC	Area Air Defense Commander
AAN	Army After Next
ACTD	Advanced Concept Technical Demonstration
AD	Air Defense
ADA	Air Defense Artillery
ADSI	Air Defense System Integrator
ALB-2000	Airland Battle 2000
ALF	Air Land Force
AMD	Air and Missile Defense
AAMDC	Army Air and Missile Defense Command
AMDCPS	Air and Missile Defense Command Post Systems
AMDWS	Air and Missile Defense Workstation
AO	Area of Operations
ASB	Army Science Board
ATBM	Anti-Tactical Ballistic Missile
BIT	Built-In Test
BITE	Built-In Test Equipment
BSFV-E	Bradley Stinger Fighting Vehicle-Enhanced
CADEWS	Counter Air Directed Energy Weapon System
CAI	Combined Arms Initiative
CCF	Close Combat Force
CHS	Common Hardware-Software
CINC	Commander In Chief
CM	Cruise Missile

C2	Command and Control
C2I	Command, Control, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
DOCC	Deep Operations Coordination Cell
FAADS	Forward Area Air Defense Systems
FAAR	Forward Air Alerting Radar
FUE	First Unit Equipped
FLOT	Forward Line Of Troops
FW	Fixed Wing (aircraft)
FY	Fiscal Year
GBS	Ground Based Sensor
GPS	Global Positioning System
GEM	Guidance Enhanced Missile
HIMAD	High to Medium Altitude Air Defense
IFV	Infantry Fighting Vehicle
IOC	Initial Operating Capabilities
JFACC	Joint Force Air Component Commander
JFLCC	Joint Force Land Component Commander
JTAGS	Joint Tactical Air Ground Station
JTIDS	Joint Tactical Information Distribution System
LOS-F	Line-of Sight Forward
LOS-R	Line-of-Sight Rear
mm	millimeter
MEADS	Medium Extended Air Defense System

NATO	North Atlantic Treaty Organization
NLOS	Non Line-Of-Sight
OPCON	Operational Control
PAC	Patriot Advanced Capabilities
PGM	Precision Guided Munition
Q/P	Quiet/Passive
QRP	Quick Response Program
RPV	Remotely Piloted Vehicle
RW	Rotary Winged (aircraft)
SAM	Surface to Air Missile
SAT	Satellite
SBIRS	Space Based Infrared System
SRBM	Short Range Ballistic Missile
SHORAD	Short Range Air Defense
SHTU	SHORAD Handheld Terminal Unit
TAADC	Theater Army Air Defense Coordinator
TAADE	Theater Army Air Defense Element
TBM	Tactical Ballistic Missile
THAAD	Theater High Altitude Air Defense
TOC	Tactical Operations Center
U.S.	United States
USAF	United States Air Force
UAV	Unmanned Aerial Vehicle
USN	United States Navy

ENDNOTES

¹ Jules Verne, Twenty Thousand Leagues Under The Sea, (translated by Walter J. Miller and Frederick P. Walter, Annapolis, MD: Naval Institute Press), xix. Verne's initial work on this book began in 1865 and was first published as a magazine serial between October 1869 and June 1870. The first complete book was published in 1870.

² Department of the Army, The Annual Report on the Army After Next Project to the Chief of Staff of the Army -- Knowledge and Speed, (Washington, D.C.: Headquarters, U.S. Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans (DAMO-SSP), July 1997), 1.

³ MG Robert H. Scales, Jr., "The Army After Next Project, Knowledge & Speed," lecture, Carlisle Barracks, PA, U.S. Army War College, 13 November 1997, cited with permission of MG Scales, 1.

⁴ George Cahlink, "Excerpts on the 1997 Annual Report on the Army After Next," Inside The Army, 25 August 1997, 15

⁵ Ibid.

⁶ Department of the Army, Airland Battle 2000, (Fort Monroe, VA: Headquarters, U.S. Army Training and Doctrine Command, 10 August 1982), 1.

⁷ Department of the Army, Assistant Secretary of the Army for Research, Development, and Acquisition, Army Science Board (ASB) 1983 Summer Study on the Future Development Goal, report prepared by W.B. LeBerge and A.R. Eaton (Washington, D.C., November 1983), 25.

⁸ LTG James H. Merryman, "'70s R&D Efforts Are Bearing Fruit," Army Magazine 32 (October 1982): 108.

⁹ Ibid., 109.

¹⁰ COL Wayne A. Downing, "Firepower-Attrition-Maneuver, U.S. Army Operations Doctrine: A Challenge for the 1980s and Beyond," Military Review 61 (January 1981): 64.

¹¹ Tony Velocci, "Battle Doctrine for the 21st Century," National Defense, 67 (November 1982): 11-14.

¹² Department of the Army, Airland Battle 2000, 3.

¹³ Ibid. 5

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ Ibid.

¹⁸ Ibid., 7.

¹⁹ Department of the Army, Air Defense Artillery Mission Area Analysis - Level-II - Vol.-1 (S) (Fort Bliss, TX: U.S. Army Air Defense Artillery School, Directorate of Combat Developments (ATSA-CD), 28 Feb 1983), 2.

²⁰ Department of the Army, Airland Battle 2000, D-1.

²¹ Ibid.

²² In 1981, ADA systems had extremely limited capabilities to counter CMs, PGMs, and TBMs. All ADA systems were designed to counter fixed and rotary wing aircraft. The Patriot system, which was about to enter production, would be fielded with a self-defense capability to defeat TBMs and PGMs (anti-radiation missiles). In theory all of the systems could defeat a CM if it could be detected and acquired. These functions were significant challenges for AD systems of that time because of the CMs' low speeds and altitudes.

²³ Department of the Army, Airland Battle 2000, D-1.

²⁴ Ibid., D-5.

²⁵ Ibid., D-7.

²⁶ Ibid.

²⁷ Ibid., D-9.

²⁸ Ibid., D-8.

²⁹ Ibid., D-11.

³⁰ Ibid.

³¹ Ibid.

³² Ibid.

³³ Ibid., D-12-13.

³⁴ Ibid., D-14.

³⁵ Ibid.

³⁶ Eric C. Ludvigsen, "The Get Well Point - Still Over The Horizon," Army Magazine 31 (October 1981): 391-393. Roland suffered a "budgetary roll-coaster ride" throughout its development and early production as the difficulties inherent in translating European design drawings and specifications into U.S. engineering and production practice surfaced. The European design was not as mature as originally believed and the system was canceled in October 1981 on the grounds of affordability.

Millard Barger, "DIVAD Postmortem Reveals Multiple Suspects Involved In Its Death," Armed Forces Journal International 16 (November 1985): 58. SGT York was canceled in August 1985 because of low availability rates (operational readiness of the system) and it could not effectively counter a significant change in the Soviet attack helicopter capabilities (enabling stand-off engagement with anti-tank guided missiles beyond 5 kilometers). Any improvements in the system to attempt to counter the threat were considered marginal and not worth the additional expense.

³⁷ COL John H. Little, U.S. Army, and MAJ Michael A. Vane, U.S. Army, "Forward Area Air Defense - ADA Laydown Results", Air Defense Artillery (Spring 1986): 12-14. The ADA School conducted the ADA Laydown and the Army's Training and Doctrine Command conducted the Forward Area Air Defense Study Group. The combined efforts of these studies resulted in the development of the FAADS concept.

³⁸ Ibid., 14.

³⁹ Ibid.

⁴⁰ Ibid., 15-16.

⁴¹ Ibid.

⁴² Ibid.

⁴³ "Army Weaponry and Equipment," Army Magazine, 37 (October 1987): 400-401.

⁴⁴ Ibid., 401. The Avenger was a total success story, meeting requirements and timelines. FAAD C2I, a far more significant challenge for software engineers and material developers, has just been fielded with a ground based sensor (GBS; known as the Sentinel). FAAD C2I's masked target sensor (intended to see targets beyond the FLOT and masked from LOS-F and NLOS systems) was not fielded. The CAI were met by developing an air defense sight for the Bradley IFV, arming helicopters for air-to-air combat, incorporating aerial engagements into gunnery and conduct of fire training.

Stephen K. Conver, "Army Weaponry and Equipment," Army Magazine, 41 (October 1991): 286. The Canadian ADATS (Air Defense - Anti-Tank System) won the development contract for LOS-F but failed to reach production due to system integration, reliability, and cost overrun problems. The NLOS system was developed as a weapon platform but never fielded because of cost overruns and the tech base's inability to deliver an acceptable masked target sensor, and a reliable, pre-NLOS missile launch, target acquisition/identification device.

"Army Weaponry and Equipment," Army Magazine, 42 (October 1992): 254. NLOS was transferred to the Artillery School and then to the Infantry School as a potential long range anti-armor weapon system for light and special divisions. To date, no proponent has been able to field an economical and reliable pre-NLOS launch detection/acquisition/identification device. The Aerostat, discussed later in this paper, may be the solution required to support fielding of NLOS.

⁴⁵ Conver, 282 to 283. The first Patriot battalion achieved full operational capability in 1985, after being in development for twenty years.

⁴⁶ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-12.

⁴⁷ Martin Streetly, Jane's Radar and Electronic Warfare Systems, Alexandria, VA: Jane's Information Group, Inc., 1996: 302. THAAD will be capable of conducting endo and exoatmospheric engagements (at altitudes 20 to 150 times greater than Patriot's) and ranges up to 200 to 400 kilometers. It will be cued by space and ground-based sensors, and capable of acquiring ballistic missiles at ranges in excess of 500 kilometers.

⁴⁸ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-13.

⁴⁹ "The Army Modernization Plan - Army Weaponry, equipment, and New Technologies," Army Magazine, 47 (October 97): 237.

⁵⁰ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-9. Air breathing threats are defined as RW, FW, UAV, RPV, and CM aerial vehicles.

⁵¹ Ibid. 5-14 thru 5-19. The AMDPCS' standardized TOCs ensure interoperability and compatibility. AMDWS integrates FAAD C2, Patriot, THAAD, and MEADS force operation software products (defense planning, staff functions) to provide common AMD workstations for all echelons. It also provides the common planning module to be incorporated into the joint air/missile defense planning system. The AMD brigade fire control and monitoring capability integrates AMDWS with the Air Defense System Integrator (ADSI) and JTIDS for linkage to joint and multinational forces

⁵² Ibid. 5-14 thru 5-15. An Army-Navy jointly manned system, JTAGS provides an in-theater capability to receive, process, and disseminate, near-real time space-based sensor information for TBM defensive operations. There are five JTAGS systems in the field today.

⁵³ Department of the Army, Airland Battle 2000, D-1.

⁵⁴ Department of the Army, U.S. Army Theater Missile Defense Operations (Final Draft), FM 100-12 (Fort Bliss, TX: Commandant, USAADASCH, ATTN: ATSA-TAC-D, undated), Chapter-3, pg 5.

⁵⁵ LTC Michael Six, "Sentinel Radar - Eyes of the Digital Battlefield," information briefing, Fort Bliss, TX, TSM-SHORAD, 11 November 1997, cited with permission of LTC Six. Two men can emplace the Sentinel and the system is automatic once emplaced

⁵⁶ Ibid.

CPT Brian Bosworth, <bosworthb@emh10.bliss.army.mil>, "Request For Information," electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>, 10 January 1998.

⁵⁷ LTC Michael Six, "Sentinel Radar - Eyes of the Digital Battlefield."

⁵⁸ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-3 thru 5-18

⁵⁹ Ibid.

⁶⁰ LTC Michael Six, "Sentinel Radar - Eyes of the Digital Battlefield."

⁶¹ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-3 thru 5-7; 5-17.

⁶² CPT Brian Bosworth, <bosworthb@emh10.bliss.army.mil>, "Request For Information-2 & -3," electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>, 16 January 1998 and 27 January 1998, respectively.

⁶³ FAADS C2I consists of six, netted Sentinel radars, a C2 system that employs Army Common Hardware and Software (CHS), and an area communications architecture.

⁶⁴ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-15 thru 5-17. The Sentinel has an instrumented range of 40 kilometers. Various communication systems are used to exchange the air picture between joint and adjacent units. The Joint Tactical Information Distribution System (JTIDS Class 2M radio terminal) provides communication links to Navy and Air Force. Multi-Subscriber Equipment radios provide connectivity to adjacent FAAD battalions and Army TMD units. Enhanced Positioning and Location Radio Systems (EPLRS) or Single Channel Ground - Air Radio Systems (SINCGARS) provide connectivity from FAADS battalions to subordinate units and fire units.

⁶⁵ Ibid., 5-15 thru 5-16.

⁶⁶ CPT Howard B. Bromberg, "Patriot", Air Defense Artillery, (Winter 1985), 31.

Peter Olson, <olsonp@emh10.bliss.army.mil>, "Request For Information-MEADS." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 15 January 1998.

⁶⁷ MAJ Nicholas S. Liberatore, TSM-TMD, Fort Bliss, TX. PHONECON with author, 5 January 1998.

Department of the Army, Operational Requirements Document for Medium Extend Air Defense System (Draft), (Fort Bliss, TX: USAADASCH, ATTN: ATSA-CD, 10 December 1997), 18.

⁶⁸ MAJ Nicholas S. Liberatore, TSM-TMD, Fort Bliss, TX.
PHONECON with author, 5 January 1998.

Department of the Army, Operational Requirements Document for Medium Extend Air Defense System (Draft), (Fort Bliss, TX: USAADASCH, ATTN: ATSA-CD, 10 December 1997), 17 & 19.

⁶⁹ MAJ Nicholas S. Liberatore, TSM-TMD, Fort Bliss, TX.
PHONECON with author, 5 January 1998.

Department of the Army, Operational Requirements Document for Medium Extend Air Defense System (Draft), 5.

⁷⁰ MAJ Nicholas S. Liberatore, TSM-TMD, Fort Bliss, TX.
PHONECON with author, 5 January 1998.

Department of the Army, Operational Requirements Document for Medium Extend Air Defense System (Draft), (Fort Bliss, TX: USAADASCH, ATTN: ATSA-CD, 10 December 1997), 5. Patriot can remote launchers up to 10 kilometers. THAAD will remote launchers up to 50 KMs from the radar. Distances are range limited by communication architecture and radar limitations..

⁷¹ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-8 thru 5-13.

Lawrence E. Ladourceru, <ladoucerurl@emh10.bliss.army.mil>, "Request For Information-THAAD." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 20 January

⁷² Ludvigsen, "The Get Well Point - Still Over The Horizon," Army Magazine 31 (October 1981), 336. Patriot can simultaneously control 8 missiles in-flight.

⁷³ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-8 thru 5-13.

Lawrence E. Ladourceru, <ladoucerurl@emh10.bliss.army.mil>, "Request For Information-THAAD." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 20 January.

Peter Olson, <olsonp@emh10.bliss.army.mil>, "Request For Information-MEADS." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 15 January 1998.

⁷⁴ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan(Final Draft), 5-8 thru 5-15, 5-18.

Exploitation of other allied integrated air pictures is a required capability for MEADS.

⁷⁵ Ibid., 4-10 & 5-19 thru 5-20.

⁷⁶ Ibid., 5-7 thru 5-8.

⁷⁷ Ibid. 4-11 thru 4-12.

⁷⁸ Department of the Army, Airland Battle 2000. D-16.

⁷⁹ Ibid.

⁸⁰ Ibid.

⁸¹ Ibid.

⁸² Ibid.

⁸³ Department of the Army, U.S. Army Air and Missile Defense Command Operations (Final Draft), FM 44-94, Chapter-1, pg.2.

⁸⁴ Ibid.

⁸⁵ Ibid.

⁸⁶ Ibid., D-17.

⁸⁷ Patriot missiles cost \$1.5 million.

⁸⁸ Ibid., D-16.

⁸⁹ Ibid.

⁹⁰ Ibid.

⁹¹ Department of the Army, Assistant Secretary of the Army for Research, Development, and Acquisition, Army Science Board (ASB) 1983 Summer Study on the Future Development Goal, 11.

⁹² Ibid., 27.

⁹³ Ibid., 25.

⁹⁴ Ibid., 27.

⁹⁵ Robert M. Stein, "Army After Next (AAN) - Air Defense Considerations." Briefing to attendees at U.S. Army Air Defense School's Industry Day. Fort Bliss, TX, U.S. Army Air Defense Artillery School, 13 June 1997, cited with permission of Mr. Stein.

⁹⁶ Department of the Army, Airland Battle 2000, 3.

⁹⁷ Conver, 282. Patriot's missile warhead is a high explosive, fragmentation warhead. PAC-2 increased the fuse's sensitivity thereby increasing the speed of detonation. Although a direct missile to warhead hit is desired, Patriot's initial capabilities were expected to destroy attacking missiles by proximity detonations and fragmentation.

⁹⁸ Ibid. A total of 35 separate software changes were made to Patriot during Operations Desert Shield and Storm in response to changes in the threat and to improve system effectiveness.

⁹⁹ Martin Streetly, Jane's Radar & Electronic Warfare Systems, (Alexandria, VA: Jane's Information Group Inc., 1996), 306. During the Gulf War Iraqi TBMs broke apart after passing apogee. The Patriot radar tracked all pieces of the missile (warhead, boosters, fuel cells) and declared each an engagable target. The system software could not determine what was the warhead and what was debris. PAC-2 provides this capability and will not present debris for engagement.

¹⁰⁰ Streetly, Jane's Radar & Electronic Warfare Systems, 306.

¹⁰¹ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 5-10 thru 5-11.

¹⁰² Joint Chiefs of Staff, Doctrine for Joint Theater Missile Defense. JCS Pub 3-01.5. (Fort Monroe, VA: Joint Warfighting Center, ATTN: Doctrine Division, 22 February 1996), II-6.

¹⁰³ Joint Chiefs of Staff, Doctrine for Joint Theater Missile Defense, JCS Publication 3-01.5, II-5 thru II-6.

¹⁰⁴ Department of the Army, U.S. Army Theater Missile Defense Operations (Final Draft), FM 100-12 (Fort Bliss, TX: Commandant, USAADASCH, ATTN: ATSA-TAC-D), undated, Chapter-3, pg. 5.

¹⁰⁵ Ibid.

¹⁰⁶ Department of the Army, U.S. Army Air and Missile Defense Command Operations (Final Draft), FM 44-94 (Fort Bliss, TX:

Commandant, USAADASCH, ATTN: ATSA-TAC-D), undated, Chapter-3, pg 4.

¹⁰⁷ Department of the Army, U.S. Army Theater Missile Defense Operations (Final Draft), FM 100-12, Chapter-3, pg 5.

¹⁰⁸ Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft), 4-10 & 5-19 thru 5-20.

¹⁰⁹ Ibid.

¹¹⁰ Ibid., 5-7 thru 5-8.

¹¹¹ Ibid., 5-8.

¹¹² Ibid., 4-11 thru 4-12.

¹¹³ Ibid.

BIBLIOGRAPHY

- "Airland Battle 2000: Air Defense." Air Defense Artillery, Winter 1983, 36-38.
- "Army Weaponry and Equipment" Army Magazine 37 (October 1987): 350-472.
- "Army Weaponry and Equipment" Army Magazine 42 (October 1992): 231-303.
- "Army Weaponry and Equipment" Army Magazine 44 (October 1994): 233-319.
- "The Army Modernization Plan - Army Weaponry, Equipment, and New Technologies" Army Magazine 46 (October 1996): 237-314.
- Barger, Millard. "DIVAD Postmortem Reveals Multiple Suspects Involved in Its Death". Armed Forces Journal International 117 (October 1985): 58-59.
- Bosworth, CPT Brian <bosworthb@emh10.bliss.army.mil>, "Request For Information." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 10 January 1998.
- Bosworth, CPT Brian <bosworthb@emh10.bliss.army.mil>, "Request For Information-2." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>, 16 January 1998.
- Bosworth, CPT Brian <bosworthb@emh10.bliss.army.mil>, "Request For Information-3." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>, 27 January 1998.
- Bromberg, CPT Howard B.. "Patriot - The Support", Air Defense Artillery, Winter 1985, 21-41.
- Cahlink, George. "Excerpts from the 1997 Annual Report on the Army After Next." Inside The Army (25 August 1997), 11-17.
- Conver, Stephen K. "Army Weaponry and Equipment - Procurement Dilemma (Modernization a Continuous Process)" Army Magazine 41 (October 1991): 214-327.
- DePuy, GEN(Ret) William E. "FM 100-5 Revisited." Army Magazine 30 (November 1980): 12-17.
- Doerfel, LTC John S. "The Operational Art of the Airland Battle." Military Review 62 (May 1982): 3-10.

Downing, COL Wayne A. "Firepower-Attrition- Maneuver, U.S. Army Operations Doctrine: A Challenge for the 1980s and Beyond." "Military Review 61(January 1981): 64-72.

Dunlap, Charles J., Jr.. "21st Century Land Warfare: Four Dangerous Myths." Parameters 27 (Autumn 1997), 27-37.

Dupuy, COL(Ret) T.N. "Perceptions of the Next War ." Armed Forces Journal International 117 (May 1980): 49-50.

Dupuy, COL(Ret) T.N. "The Nondebate over How Army Should Fight." Army Magazine 32 (June 1982): 34-38.

Fields, COL James C., R&D Investments Towards the 21st Century, Study Project Report for U.S. Army War College, Carlisle Barracks, PA, 28 March 1983.

Flynn, LTC Thomas, "Into the Twenty First Century, Beginning the Journey -- ADA After Next". Briefing to industry. Fort Bliss, TX, U.S. Army Air Defense Artillery School, 16 September 1997, cited with permission of LTC Flynn.

Green, Gerald. "Approaching 2000 -- Technology and Defense." National Defense, December 1985, 17-24.

Ladourceru, Lawrence E. <ladoucerurl@emh10.bliss.army.mil>, "Request For Information-THAAD." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 20 January 1998

Little, COL John L. & MAJ Michael A. Vane. "Forward Area Air Defense (ADA Laydown Results)", Air Defense Artillery, Spring 1986, 12-15.

Little, LTC John H., Future Trends in Air Defense Artillery (S), Research Report for U.S. Air Force Air War University, Maxwell Air Force Base, AL, March 1983.

Lopez, Ramon. "The Airland Battle 2000 Controversy - Who Is Being Short-Sighted?" International Defense Review 16 (November 1983): 1551-1556.

Ludvigsen, Eric C. "Light Forces Reshaping Modernization Programs" Army Magazine 34 October 1984): 318-504.

Ludvigsen, Eric C. "Modernization: Readiness for Airland Battle 2000." Army Magazine 33 (October 1983): 282-440.

Ludvigsen, Eric C. "The Get Well Point - Still Over Horizon." Army Magazine 31 (October 1981): 290-360.

- MacGregor, Douglas A. Breaking the Phalanx. Westport, CN: Praeger, 1997.
- Martin, Harry V. "Airland Battle 2000 Is Being Implemented With a High Technology Light Division." Military Electronics/Countermeasures, January 1983, 28-36.
- McLarty, LTC William T. "Technology Implications: The Need for Change." Military Review 63 (January 1983): 47-57.
- Merrill, MAJ Ralph F., "A Silver Bullet - Conquering The Threat," Air Defense Artillery, November-December 1995, 28.
- Merryman, LTG James H. "'70s R&D Efforts Are Bearing Fruit." Army Magazine 32 (October 1982): 106-114.
- Metz, Stephen P.. "Which Army After Next? The Strategic Implications of Alternative Futures." Parameters 27 (Autumn 1997), 15-26.
- Olson, Peter <olsonp@emh10.bliss.army.mil>, "Request For Information-MEADS." Electronic mail message to LTC Francis G. Mahon <mahonf@carlisle-emh2.army.mil>. 15 January 1998.
- Oseth, MAJ John M. "FM 100-5 Revisited: A Need for Better Foundation Concepts?" Military Review 60 (March 1980): 13-19.
- Russell, David M. "Airland Battle 2000 Takes the Offensive Using High Technology." Defense Electronics, June 1982, 60-62.
- Scales, MG Robert H., Jr.. "The Army After Next Project, Knowledge & Speed." Lecture. Carlisle Barracks, PA, U.S. Army War College, 13 November 1997, cited with permission of MG Scales.
- Schultz, James B. "Airland Battle 2000: The Force Multiplier." Defense Electronics, December 1983, 48-67.
- Six, LTC Michael. "Sentinel Radar - Eyes of the Digital Battlefield," Information briefing. Fort Bliss, TX, TSM-SHORAD, 11 November 1997, cited with permission of LTC Six.
- Stein, Robert M., "Army After Next (AAN) - Air Defense Considerations." Briefing to attendees at U.S. Army Air Defense School's Industry Day. Fort Bliss, TX, U.S. Army Air Defense Artillery School, 13 June 1997, cited with permission of Mr. Stein.
- Streetly, Martin Jane's Radar & Electronic Warfare Systems. Alexandria, VA: Jane's Information Group Inc. 1996.

- U.S. Department of the Army, Air & Missile Defense Master Plan (Fiscal Year 97). Fort Bliss, TX: Headquarters, U.S. Army Air Defense Artillery School, 30 September 1996.
- U.S. Department of the Army, Airland Battle 2000, Fort Monroe, VA: Headquarters, U.S. Army Training and Doctrine Command, 1982.
- U.S. Department of the Army, Assistant Secretary of the Army for Research, Development, and Acquisition. "Army Science Board (ASB) 1983 Summer Study on the Future Development Goal." prepared by W.B. LeBerge and A.R. Eaton. Washington, D.C., November 1983.
- U.S. Department of the Army, Fiscal Year 98 Air & Missile Defense Master Plan (Final Draft). Fort Bliss, TX: Headquarters, U.S. Army Air Defense Artillery School, 5 September 1997.
- U.S. Department of the Army, The Annual Report on The Army After Next Project to the Chief of Staff of the Army -- Knowledge & Speed. Washington, D.C.: Headquarters, U.S. Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans (DAMO-SSP), July 1997.
- U.S. Department of the Army, The U.S. Army Air Defense Artillery Functional Area Assessment Briefing. Fort Bliss, TX: Headquarters, U.S. Army Air Defense Artillery School, 5 March 1996.
- U.S. Department of the Army, U.S. Army Air and Missile Defense Command Operations (Final Draft). FM 44-94. Fort Bliss, TX: Commandant, USAADASCH, ATTN: ATSA-TAC-D, undated.
- U.S. Department of the Army. Battlefield Development Plan '82 (BDP 82) (S). Fort Monroe, VA: Headquarters U.S. Army Training and Doctrine Command, Feb 1983.
- U.S. Department of the Army. The Alternative Futures Approach to Long Range Planning. prepared by James L. Morrison for Headquarters, U.S. Department of the Army, Office of the Deputy Chief of Staff for Operations and Plans (DAMO-SSP). Washington, D.C., April 1990.
- U.S. Department of the Army. U.S. Army Theater Missile Defense Operations (Final Draft). FM 100-12. Fort Bliss, TX: Commandant, USAADASCH, ATTN: ATSA-TAC-D, undated.
- U.S. Joint Chiefs of Staff, Doctrine for Joint Theater Missile Defense. JCS Pub 3-01.5. Fort Monroe, VA: Joint Warfighting Center, ATTN: Doctrine Division, 22 February 1996.

Van Riper, Russell W. and Robert H. Scales, Jr.. "Preparing for War in the 21st Century." Parameters 27 (Autumn 1997), 4-14.

Velocci, Tony "Battle Doctrine for the 21st Century." National Defense 67 (November 1982): 11-14.

Verne, Jules Twenty Thousand Leagues Under The Sea. Translated by Walter J. Miller and Frederick P. Walter, Annapolis, MD: Naval Institute Press.

Wagner, Robert E. "Active Defense and All That." Military Review 60 (August 1980): 4-13.