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# ARMY VISION 2010: INTEGRATING MEASUREMENT AND SIGNATURE INTELLIGENCE

BY

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USAWC STRATEGY RESEARCH PROJECT

# ARMY VISION 2010: INTEGRATING MEASUREMENT AND SIGNATURE INTELLIGENCE

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## ABSTRACT

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As a critical component of information dominance for Army Vision 2010, will the Army be prepared to capitalize on all the capabilities Measurement and Signature Intelligence (MASINT) can provide? This monograph answers the question by building a case in four key areas. The first section sets the stage with a synopsis of the strategic environment in which the Objective Force could operate. Specifically, the monograph addresses how MASINT affects battlespace dominance. The second section reviews MASINT definitions and the unique capabilities MASINT provides decision-makers from the national to the tactical level. To capitalize on MASINT capabilities by 2010, Army intelligence must develop a coherent transformation plan. The third section concentrates on MASINT training. The monograph identifies how the Army trains today for MASINT and assesses whether or not this training will support our efforts to capitalize on MASINT by the year 2010. The final section analyzes the research while presenting recommendations that answer the question about the Army's ability to capitalize on all MASINT capabilities by the year 2010. Recommendations include centralizing the MASINT training process, re-evaluating MASINT personnel management and developing a tenable advocacy for Army MASINT within the United States MASINT System.

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## ARMY VISION 2010: INTEGRATING MEASUREMENT AND SIGNATURE INTELLIGENCE

"The doctrine of war is to follow the enemy situation in order to decide in battle."
—Sun Tzu

"As part of the all-source collection environment, measurement and signature intelligence (MASINT) contributes both unique and complementary information on a wide variety of intelligence requirements."[1] As the Army transforms toward the Objective Force, the spectrum of likely operations will extend from humanitarian assistance and disaster relief to peacekeeping and peacemaking operations, major theater wars and possibly conflicts involving weapons of mass destruction. The Army warfighter has a requirement for dominant battlefield knowledge and information superiority to prosecute war decisively and negotiate and leverage missions requiring engagement skills.

This monograph answers the question: as a critical component of information dominance for Army Vision 2010, will the Army be prepared to capitalize on all of the capabilities MASINT can provide? To establish a clear basis for concise understanding, the research process focuses on the impacts of training since MASINT requires extensive technically analytic instruction.

The author structured the monograph into four sections. The first section sets the stage with a synopsis of the strategic environment in which the Objective Force could operate. Since the Objective Force "will provide the National Command Authority with an increased range of options for regional engagement, crisis response and sustained land force operations," reviewing visions and strategies from the national level to the Army's Deputy Chief of Staff for Intelligence appears appropriate.[2] Specifically, battlespace dominance plays a significant role in achieving the Army's objectives by the year 2010. MASINT affects battlespace dominance. The second section of the monograph reviews MASINT definitions based upon input from national experts, service experts and leaders for MASINT. MASINT brings special and unique capabilities to decision-makers from the national to the tactical level. To capitalize on MASINT capabilities by 2010, Army intelligence must develop a coherent transformation plan. The third section concentrates on MASINT training. Legitimate concerns exist regarding the Army's treatment of MASINT trained professionals. The monograph continues to identify how the Army trains today for MASINT compared to training methods under development and assesses whether or not this training will support our efforts to capitalize on MASINT. The final section

analyzes the research while presenting recommendations that answer the question about the Army's ability to capitalize on all MASINT capabilities by the year 2010. Recommendations include centralizing the MASINT training process, re-evaluating MASINT personnel management and developing a tenable advocacy for Army MASINT within the United States MASINT System. Developing advanced and capable MASINT analysts gives us the edge we need in maintaining battlespace dominance. The strategic environment sets the stage for understanding the battlespace for the Objective Force.

## SETTING THE STAGE

### STRATEGIC ENVIRONMENT

The Director Central Intelligence identified our national security environment as: "dynamic and uncertain, replete with a host of ominous threats and challenges that have the potential to grow more deadly. To meet the challenges of this increasingly dangerous and complex world, our consumers are demanding more timely, accurate, and actionable information to inform their decisions and to take preventive measures, if necessary."[3] The Intelligence Community continues to pursue better collection methods and interagency cooperation to allow rapid information transference for more timely and accurate assessments.

The Secretary of Defense outlined the strategic context of the threat in the 2001 Quadrennial Defense Review. The United States may not have an ability to predict its enemies in the future, or the location of its conflicts. This capabilities-based model focuses on the technologies and methods an adversary might use, as opposed to focusing on who our adversary is or where conflict may occur. Specifically, our leadership faces diminishing protection previously afforded by our geographic isolation. Increasing challenges emerge from territories of weak and failing states, affecting regional stability. Political and military power will become diffused to non-state actors, indicating a growing need for the United States to develop and sustain regional security agreements.[4]

Terrorism, narcotics trafficking and international organized crime, coupled with rapid technological advancement and proliferation of chemical, biological and nuclear weapons and ballistic missiles, as well as the need for intelligence collection, analysis and dissemination deserve increased support and a new direction. The United States must not only have the

vision to transform quickly in developing effective deterrence, but must ensure leaders have hard, predictive intelligence of enemy capabilities and intent.

## VISIONS AND STRATEGIES

The most recent National Security Strategy identifies intelligence as one of the critical tools for responding to the full spectrum of threats. Our strategy mandates we have the best trained and effective armed forces in the world. Enabling capabilities specifically include intelligence, surveillance and reconnaissance to prevent, deter, disrupt, and if necessary, respond to a myriad of threats which the United States may face.[5]

This national strategy implies avoiding technological surprise and providing predictive intelligence while integrating that same intelligence into an operational role at every level—strategic, operational and tactical. The Honorable Porter Goss, Chairman of the Permanent Select Committee on Intelligence stated, "Moreover, in an era that is leading to the "digitization" of the armed forces, intelligence will be as much a part of operations as firing a weapon."[6] Congress further highlighted intelligence technologies as the dominating requirements among the top eleven priorities for the nation to pursue in Advanced Concept Technology Demonstrations (ACTD).[7]

The Secretary of Defense directed the development of a broad portfolio of military capabilities exploiting the United States' advantages of superior technology and intelligence capabilities for situational awareness.[8,9] General Shelton, Chairman Joint Chiefs of Staff published his Joint Vision 2020 as: "Dedicated individuals and innovative organizations transforming the joint force for the 21st Century to achieve full spectrum dominance: persuasive in peace; decisive in war; preeminent in any form of conflict."[10] The Chairman focused his vision for success through information superiority and sophisticated intelligence, surveillance and reconnaissance.

Admiral Owens, former Vice Chairman Joint Chiefs of Staff artfully predicted the need for advancement in intelligence technologies and processes to produce what he termed dominant battlespace knowledge to offer the option of dismantling the opposing military versus destroying them. Given voluminous information available to decision-makers, he saw a distinct shift in intelligence operations from its current focus of inductive reasoning toward deductive reasoning. For example, inductive reasoning is much like an artistic painter who combines various colors

together to form a painting. Deductive reasoning is like a sculptor removing material until the artist reveals what she wishes to portray.[11] If Admiral Owens is correct, then commanders in the field will have more information available than they can digest. Intelligence analysts would then use a deductive approach to enhance situational awareness. This change in intelligence strategy requires a new vision of where to direct Army transformation.

General Eric K. Shinseki, Army Chief of Staff developed a futuristic vision and strategy to transform the Army into an Objective Force. General Shinseki announced his vision statement two years ago: "Soldiers on Point for the Nation ... Persuasive in Peace, Invincible in War."[12] To achieve his vision, the Objective Force must demonstrate full spectrum dominance through information superiority and battlespace dominance that comes only through successful intelligence operations.[13]

LTG Noonan, Army Deputy Chief of Staff for Intelligence applied the Army vision to intelligence transformation when he developed his vision for Army intelligence: "A transformed Army intelligence team projecting knowledge at the point of decision empowering the Objective Force to ... See First ... Understand First ... Act First ... and Finish Decisively!" He anticipates the Army achieving this vision by gaining knowledge dominance, which uses information superiority and decision dominance as critical enablers for transformation.[14] Every vision for the future Army sees intelligence as the critical enabler for battlespace dominance.

BATTLESPACE DOMINANCE

Leaders from the national to the Army level write about some form of information superiority, information dominance, or battlespace dominance based on information and knowledge.[15] Admiral Owens carefully distinguishes between the terms dominant battlespace knowledge and other terms. Paraphrased, he advocates dominant battlespace knowledge emphasizes the relative character of the concept applied to all the environments—land, sea, air, space and information—to rate the relative importance of a plethora of targets. The Admiral distinguishes knowledge from awareness in that the latter implies only the ability to locate and track items in the battlespace; the former connotes the ability to relate the items.[16]

All of these informational dimensions relate to what has been the case historically, to tell the commander on the battlefield: where the enemy is located; what the enemy is doing; and, what the enemy will do. What our leaders add to the equation is the need to also monitor in real

time; location of friendly forces; identify what friendly forces are doing; and, determine what the friendly forces commander is supposed to do.[17] As the military migrates through this information dimension, it becomes easier to understand why measurement and signature intelligence (MASINT) may emerge as the future of intelligence in support of combat operations.

## MEASUREMENT AND SIGNATURE INTELLIGENCE (MASINT)

MASINT remains a very scientific and technically-based intelligence discipline providing unique knowledge to decision-makers by identifying specific weapons systems and capabilities. MASINT analysis often reveals weapons research years in advance through unique signatures of chemical composition, biological by-products, material content at the molecular level and even unintentional radio frequency emanations. MASINT captures metric data that can be gleaned from directly measuring kinematics of an object, like the flight pattern of a ballistic missile. Furthermore, MASINT captures high-fidelity measurements so each target is uniquely identified much the same as each person has a unique fingerprint or DNA sequence.[18]

### DEFINING MASINT

Based on Congressional records:

> MASINT is technically derived [information] (excluding traditional imagery and signal intelligence) which when collected, processed and analyzed, results in intelligence that detects, tracks, identifies or describes the signatures (distinctive characteristics) of fixed or dynamic target sources. MASINT includes the advanced processing and exploitation of data derived from imagery intelligence (IMINT) and signals intelligence (SIGINT) collection sources. MASINT sensors include, but are not limited to, radar, optical, infrared, acoustic, nuclear, radiation detection, spectroradiometric, and seismic systems as well as gas, liquid, and solid sampling systems.[19]

The Federation of American Scientists specifies lasers and effluent debris collection as additional forms of MASINT.[20]

### MASINT ROLES AND CAPABILITIES

According to John L. Morris, former Director Central MASINT Office (CMO) of the Department of Defense's Defense Intelligence Agency (DIA), MASINT fulfills numerous roles. These roles include information in support of intelligence, operations, proliferation, defense, fratricide, civil planning and the environment. For example, in support of military operations, MASINT signatures may be used in precision guided munitions targeting, intelligence preparation of the battlefield, battle damage assessment, space control, search and rescue, SCUD hunting and even peacekeeping, to name a few. During Desert Storm, CMO analysts

provided MASINT products on Iraqi SCUD missiles to deployed forces within two to eight hours, resulting in narrowing the search area.[21]

As a national asset concerning missile, weapon proliferation, arms control and treaty monitoring, MASINT identifies and tracks nuclear, chemical, biological and advanced conventional weapon systems. MASINT allows target identification from a safe distance based on target features difficult to conceal, such as rocket plumes and biological or molecular composition. The detailed nature of these capabilities remains classified, but processing methods like multispectral thermal imaging provides valuable insights for identifying trace gaseous emissions, such as those produced by nuclear or chemical weapons whether in production, storage or employment. As seen in Figure 1, MASINT process models characterize activities including surface temperatures, water quality, material composition and pollutants.[22,23]

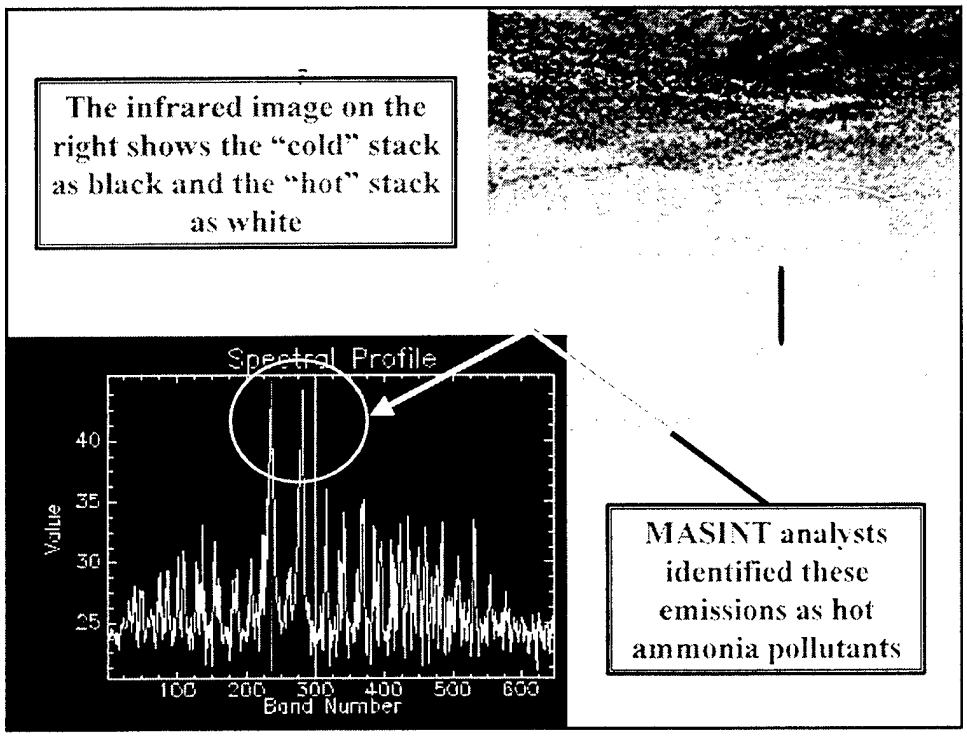


FIGURE 1. EXAMPLE OF MASINT PRODUCTS

John Lindquist, Chief Executive Officer of Electronic Warfare Associates demonstrates that the distinctive acoustic signature of a T-72 tank, as shown in Figure 2, reveals a lucrative target on the battlefield. For decades, the Navy employed acoustic sensors to detect, track and characterize ships and submarines.[24] Today, the Army's Remotely Monitored Battlefield

Surveillance System (REMBASS) serves as an example of unattended MASINT sensors. The Army emplaces these sensors by hand or aircraft, supplying more sophisticated acoustic and seismic information to detect, track and characterize moving vehicles like SCUD mobile missile launchers.[25]

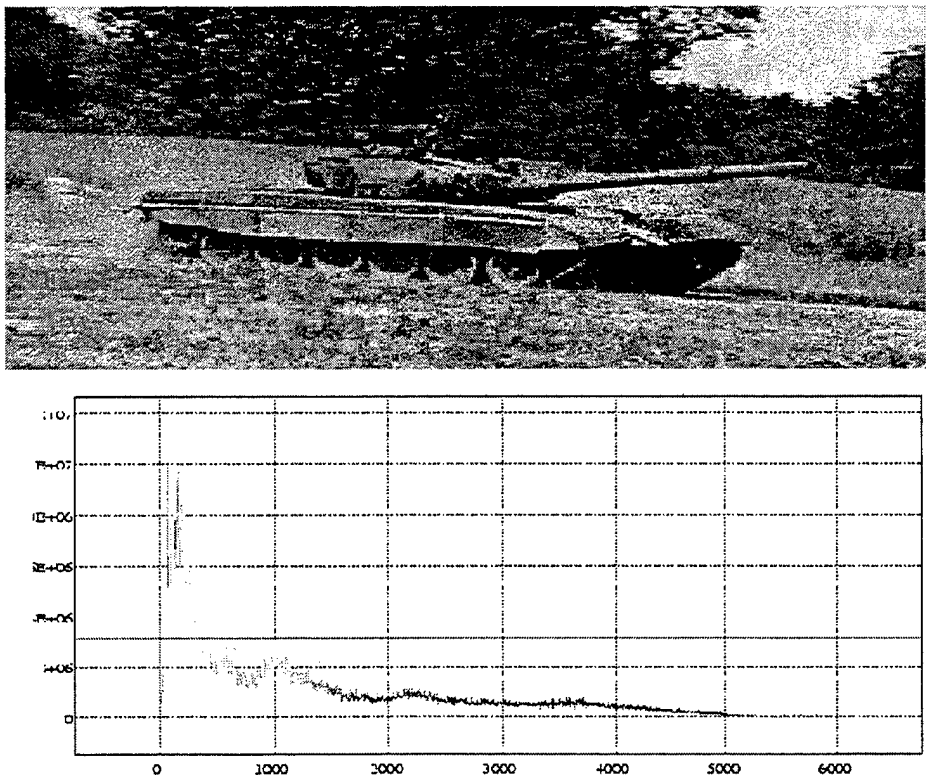


FIGURE 2. UNIQUE ACOUSTIC SIGNATURE EMITTED BY A T-72 TANK

Seismic MASINT collectors were used as early as the 1960's during the Vietnam War. Aircraft and soldiers emplaced remote sensors along the Ho Chi Min Trail to detect the vibrations created by personnel and equipment traversing the trail. The sensors relayed data and information to the IGLOO WHITE Command Center where MASINT analysts converted data into targeting information for use by forward deployed warfighters.[26]

Another example of the type of information MASINT can provide decision-makers lies in Active Radio Interferometer for Explosion Surveillance (ARIES). This technique implements an operational system for monitoring ionospheric pressure waves resulting from surface or atmospheric nuclear or chemical explosives. Explosions produce pressure waves that can be

detected by measuring phase variations between signals generated by ground stations along two different paths to a satellite.[27]

The Department of Defense Intelligence Centers use signatures of threat equipment and capabilities to develop countermeasures and establish a baseline for foreign equipment under development. Industry then uses these signatures during the acquisition process to design and develop superior weapons, intelligence collectors and force protection systems for United States forces.[28]

When discussing imagery, the average person thinks in terms of the visible light portion of the electromagnetic spectrum. Old photographs in the family album represent this imagery model. In a MASINT context, light is defined in the broader sense beyond the visible spectrum to include ultraviolet, visible light, infrared, microwave, radar and radio, as shown in Figure 3. Spectral collection simply records electromagnetic radiation absorbed, reflected or transmitted to another layer of material by the target. Analysts then refine imagery-derived MASINT into multispectral, hyperspectral, ultraspectral, polarimetric and radar analyses.[29,30]

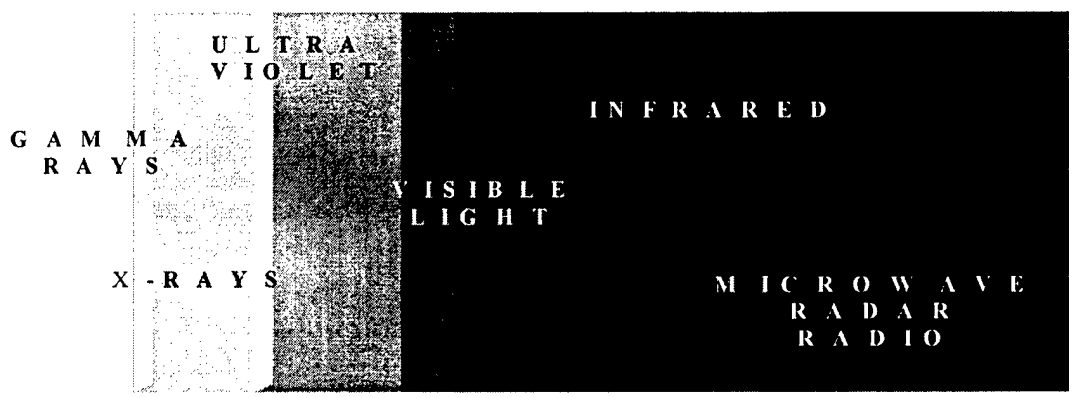


FIGURE 3. THE ELECTROMAGNETIC SPECTRUM

"A spectral image can be thought of as many images combined."[31] Multispectral imagery measures light waves in the infrared regions to discriminate features invisible to the naked eye. Specific land features become obvious to the trained analyst. For example, oil-bearing rock or underground facilities appear different than other mineral-laden structures. Heat generation facilities stand out like a neon light, as do other mechanical heat producers like aircraft and tank engines. Natural substances like vegetation produce their own unique signatures as well.[32]

Healthy vegetation appears green because chlorophyll absorbs blue and red light waves. Stressed vegetation (e.g., vegetation with inadequate water or recently cut brush for camouflage) absorbs less of the blue and red light waves, so vegetation appears different when viewed with multispectral sensors. United States government, other agencies and foreign governments apply this process to determine healthy crop rotations, deforestation around the globe, archeology, urban analysis, and even differentiate between types of flora and fauna.[33] The military uses multispectral imagery to reveal marijuana crops cultivated under forested canopies because marijuana leaves reflect a different color of green than the surrounding vegetation.

Imagine extracting hundreds and thousands more levels of information from imagery than is possible with multispectral processing--that's the power of hyperspectral, ultraspectral and polarimetric capabilities. The refinement processes of hyperspectral, ultraspectral and polarimetric properties allow military operators to detect, classify, discriminate, characterize, identify, quantify and predict target information, as seen in Figure 3.[34,35] Complex MASINT analytic processes compare and contrast digital images taken over time—within seconds or minutes--to assess targets. For example, recall that spectral sensors measure target surfaces in the way they reflect light and emit energy. MASINT renders most modern concealment and camouflage methods obsolete. Based on a MASINT signature, commanders can distinguish a specific country's equipment on the battlefield from the others for discreet targeting. Even better, commanders could conceivably preclude fratricide by using MASINT to track friendly forces in the battlespace. In addition, radar systems can remotely measure the shape of an object like a tank, missile or warhead to help commanders determine specific models or types.[36]

Another form of MASINT comes from radar. Different from previously described forms of imagery, radar imagery is active. Radars produce their own form of electromagnetic energy. They have specific characteristics making them ideal for MASINT. Radars operate day or night, not needing the sun to reflect energy off an object. Radar operates in all forms of weather; though 80 percent of the earth is cloud covered at any one time, clouds do not obscure radar views of the target. The frequency at which radar operates penetrates numerous materials or surfaces which would normally hide equipment or facilities. For example, most wooden sheds become transparent to radar. Radar must acquire images from angles to the target instead of imaging from directly overhead (called nadir). This means radars can look into buildings, sheds

and tunnels. Radar provides phased history data—information stored over time like a digital movie camera. Most importantly, radar can be merged with other forms of data within the MASINT realm to produce usable and understandable products.[37]

Commanders require advanced processing techniques like phased history data, coherent change detection and multi-color multi-view analysis to build products that tell a clear, straightforward story. Phased history data provides three-dimensional radar images for battlefield manipulation.[38] Coherent change detection consists of overlaying two radar images to produce a picture of what changed between the two radar return images. These change images provide extremely useful intelligence by revealing information like traffic patterns, type of traffic and even terrain maps of critical areas where tunnels may be in use, like Afghanistan.[39] Another form of comparative analysis lies in multi-color multi-view imaging.

Multi-color multi-view imagery may be combined with Army laser radar technologies to very accurately track and discriminate ballistic missile defense targets with three-dimensional imaging processes. This level of MASINT fusion rapidly provides high resolution uniform imagery. Sophisticated change detection analysis is synonymous with indications and warning by monitoring and developing trends.[40]

More importantly, the Department of Defense identified MASINT as a critical player in providing signature data to brilliant weapons systems and munitions to detect and positively identify targets while in flight. Specifically, weapons capabilities like the Ballistic Anti-Tank (BAT) and Non-Cooperative Target Recognition (NCTR) systems would have the ability to exchange networked MASINT data between submunitions and redefine targets while en route to the original target, as Admiral Owens suggests. MASINT would answer the questions of what target signature data has changed and help establish which friendly targeting system this signature change will affect. In these cases, reprogramming targeting methods include seismic, infrared, ultraviolet, and millimeter wave radar MASINT.[41] As shown though numerous examples, MASINT provides significant potential to greatly enhance information dominance while expanding the view of the commander's battlespace. The next section describes how the Intelligence Community views MASINT in the context of transformation and future war.

## IMPORTANCE OF MASINT RECOGNIZED

Incorporating MASINT into Army transformation will not be easy. It requires forethought, intelligent preparation, and quality personnel who are dedicated and educated. MASINT must be incorporated into the Army transition process. This need has been recognized at the highest echelons.

President Clinton recognized the significance of MASINT transition as it pertains to the Intelligence Community and the nation. Through several Presidential Decision Directives, he effectively shaped a coherent and unified plan of action using MASINT to counter the proliferation of nuclear, biological and chemical weapons capabilities.[42,43]

Congressional leaders readily recognize the need for transformation and the role for MASINT. In their published Overview of the Intelligence Community, Congress identified MASINT as one of the four primary intelligence disciplines, with a need to tailor products to meet the needs of individual users.[44]

Defense Secretary Rumsfeld stresses the need for intelligence transformation in his recently released Quadrennial Defense Review. Not only does he program for information operations, space and intelligence as enablers, but foresees these assets as core capabilities of future forces. In particular, he highlights MASINT's multi-disciplinary nature as critical to maintaining United States military advantages. The Secretary of Defense specified six operational goals for transformation. Although five of the six goals require intelligence support, the sixth goal hones in on intelligence and implies significant MASINT participation: "Deny enemies sanctuary by providing persistent surveillance, tracking, and rapid engagement."[45]

Earlier this year, the Honorable Arthur L. Money, Assistant Secretary of Defense for Command, Control, Communications and Intelligence briefed a subcommittee of the Senate Armed Services Committee concerning MASINT. He cited MASINT as one of the Department of Defense's primary goals for increased intelligence capability at the tactical level.[46] His statement of emphasis followed the implementation of a six-year incremental budgetary increase for MASINT resources to support military operations and transformation.[47]

The Honorable Jacques S. Gansler, Under Secretary of Defense for Acquisition and Technology identified the priorities for achieving total battlespace dominance in transforming the

military. Among his priorities he highlighted the need to achieve an integrated and interoperable command, control, communications, computer, intelligence, surveillance and reconnaissance (C4ISR) infrastructure encompassing strategic and tactical needs because enhanced situation awareness and information assurance are the critical elements of an effective fighting force in the 21st century. Specifically, he believes the C4ISR system should "provide in-flight re-targeting updates to weapons launched from remote platforms."[48]

The Joint Requirements Oversight Council (JROC) also identified the need for intelligence, surveillance and reconnaissance (ISR) and non-ISR sensors (i.e., brilliant weapons, unmanned aerial vehicles, etc.) to rapidly and independently rely upon baseline target signatures for success in future warfare. Based on the Central Intelligence Agency Annual Report for the Intelligence Community in May 1999, MASINT has the potential to locate, track, identify and describe "the unique characteristics of fixed and moving targets."[49] However, to capitalize on the potential provided by MASINT requires implementation of an emerging architecture.

MASINT TRANSFORMATION PROCESS

Congress specified that the Defense Intelligence Agency's Central MASINT Office has responsibility for directing and implementing national and Department of Defense policies and procedures for MASINT, including transformation.[50,51] CMO retains centralized management for transformation to ensure responsive MASINT support from national level decision-makers to the soldier in the foxhole. They plan to do this through the development of a United States MASINT System (USMS) similar to the United States Signals Intelligence System (USSS) and the United States Imagery and Geospatial Service (USIGS).[52]

Mr. John Morris, former Director CMO articulated the transformation process to develop the USMS along specific thrusts. His MASINT thrusts focused on: developing advanced sensors on multiple platforms; streamlined collection operations; centralized processing and exploitation with coherent signature libraries; advanced research and development in timeliness of data; data standards and interoperability between services; iconic reporting capabilities in seconds to commanders and allies; improved user training and centralized policy direction and oversight.[53] The next section addresses how the Army plans to exploit MASINT.

**Army Intelligence Transformation Campaign Plan**

LTG Noonan recently published the Army Intelligence Transformation Campaign Plan emphasizing the overarching principle that dominant knowledge "provides the commander with decision and action advantages essential for mission success across the spectrum of conflict. The transformed Army will depend on Army intelligence to provide the "KNOWLEDGE EDGE."[54] He later identified dominant battlespace knowledge—knowledge Army intelligence elements provide the commander—as the single greatest enabler of the Objective Force.[55]

In the Objective Force era, Army intelligence consists of five core competencies: full dimensional protection of physical and cyber domains, unique collection to cover intelligence gaps, integration of intelligence and non-intelligence sensors, analysis to transform data into knowledge, and presenting knowledge in a format that imparts immediate understanding. Army battlespace dominance provides decision superiority through knowledge projection at the point of decision.[56] Army intelligence must retain a careful balance between sustaining the Legacy Force while investing in technology and training to develop the Objective Force by 2010.

Mr. Keith Masback, the senior intelligence executive developing the Army's Intelligence Master Plan, presented a briefing concerning Army intelligence transformation to the Army War College in 2001. He stressed that Army intelligence extends well beyond the Army into the national intelligence arena, especially as we transform to the Objective Force. The speaker highlighted the six long range planning objectives for Army intelligence transformation then tied the objectives to the Army's procedural tenets of doctrine, training, leadership, organization, material and soldiers. He later focused on the concept that transforming MASINT provides a key element for success to those commanders forward at the point of decision.[57]

Members of the Army Staff prepared a draft Army Transformation MASINT Update Briefing for key intelligence leaders within the national arena. The briefing outlines steps necessary to effect MASINT transformation by the year 2010 in support of the Objective Force. Of critical importance is the justification for an increase in funding, leveraging reserve component forces and creating centers of excellence of MASINT operations (referenced as Knowledge Reach Centers in the published Army Intelligence Transformation Campaign Plan). These Centers would process complicated MASINT algorithms at the national level and push intelligence forward through Regional MASINT Centers to the forces at the point of action.[58]

The Army intelligence transformation actions reflect conclusions drawn by the Permanent Select Committee on Intelligence concerning the future of MASINT. By partnering with CMO, the Army can establish comprehensive "reach" centers for deployed forces and provide near-real time MASINT to develop dominant battlespace knowledge.[59]

Army MASINT transformation provides Commanders in Chief and Land Component Commanders a dedicated MASINT capability, while also responding to national, joint and Army priority intelligence requirements. The future architecture also ensures the Army remains a key contributor to the Intelligence Community while providing decisive Army MASINT presence within the Army and the USMS.

**Army MASINT Transformation Thrusts**

As articulated in the Army Intelligence Transformation Campaign Plan, the "successful and relevant transformation of MASINT to support Objective Force Operations is predicated on a network centric concept in which "swarming sensors" will proliferate on the battlefield."[60] Advanced algorithms should mitigate the sheer volume of data produced by the prolific forms of MASINT sensors. The output for commanders would appear in iconic format or text-based versus reams of raw data. Concepts, tenets and emerging capabilities are embedded in Legacy, interim and Objective Forces as Army intelligence transforms MASINT by 2008 along five major thrusts tied to those illustrated earlier by the Director CMO.

The Army's first thrust focuses on migrating MASINT to an operational capability. This requires MASINT contribute value-added knowledge to the Common Relevant Operating Picture (CROP). To accomplish this thrust, the Army must reorganize and reinvest in MASINT by clearly defining the benefits of MASINT and the requirements, investing in tactical sensors, producing highly qualified MASINT analysts and assigning qualified personnel to national MASINT facilities to inject Army requirements into the USMS.[61]

Second, augmenting national MASINT sites allows the Army to leverage tasking, collection, processing, exploitation and dissemination from the national and theater level. The second thrust concentrates on Regional Knowledge Reach Centers at echelons above corps to provide support to the commander at the point of decision. Congressional leaders see a distinct need to consolidate intelligence assets and capabilities at critical virtual locations to support

Department of Defense transformation. These investments also indicate the Army's contribution to the emerging USMS orchestrated by CMO.[62]

The third thrust looks at investing in MASINT sensors and systems for the tactical commander at corps and below. The Army accomplishes this thrust through the procedural requirements of the Planning Programming Budgeting System (PPBS). It also means developing tactics, techniques and procedures for operationalizing MASINT.

The fourth thrust, disseminating tailored text-based or iconic MASINT products to the unit of action, is scheduled for completion by 2003. The Army also intends to begin development of timely, relevant, regionalized, MASINT signature libraries. This thrust allows brilliant munitions to network while in-flight and adjust to newly identified targets automatically.[63]

The fifth and final thrust focuses on training investment through the development of formal, institutionalized training for soldiers. The result of training is the achievement of an additional skill identifier to track and assign MASINT-trained personnel to MASINT-related assignments. This is a point of concern.

## MASINT TRAINING

### MASINT AS A DISCIPLINE

Given these significant thrusts, it is imperative to understand the significance of training for MASINT. The first third of this monograph provided insight into the complex MASINT environment. MASINT is like rocket science—literally and figuratively. It requires highly trained personnel dedicated to MASINT analysis. The Army does not do a good job growing MASINT specialists and leaders.

The Army Training and Doctrine Command (TRADOC) defers to the United States Army Intelligence Center as the proponent for intelligence training and military occupational skill (MOS) development, including additional skill identifiers (ASI). The Directorate for Combat Developments at the Army Intelligence Center identified the fact that there is no MOS for MASINT. Neither is there an additional skill identifier for MASINT.[64] However, the Army Personnel Command (PERSCOM) approved a Project Development Identifier (PDI) for a limited number of soldiers in existing intelligence MOSs who complete rudimentary MASINT training. A

PDI allows PERSCOM to manually track and assign soldiers to MASINT positions, but these jobs do not guarantee career progression in this very complex field. The Army promotes soldiers by MOS or branch, not ASI or PDI.[65,66]

The Office of the Chief of Military Intelligence at the Army Intelligence Center agreed to submit a request for an additional skill identifier for MASINT approved by PERSCOM, instead of TRADOC, in June 2002. TRADOC approves additional skill identifiers only for training and sponsorship within TRADOC. The Army Intelligence Center at Fort Huachuca may be the proponent for Army intelligence, but the Intelligence and Security Command (INSCOM) has operational responsibility for MASINT in the Army.[67] The result is the Commander Intelligence and Security Command (INSCOM) expends approximately $680,000 of operational funds to train approximately 47 students per year in MASINT skills.

It also means INSCOM conducts training directly for major subordinate commands. This clearly violates the fifth thrust identified by the Army Deputy Chief of Staff for Intelligence to develop a formal and institutionalized training program for MASINT. Currently, the Army has 54 authorized positions in various active and reserve units dedicated to MASINT.[68] Given the fact imagery intelligence positions in the Army—exceeding 800—represent a fraction of signals intelligence positions, the meager number of MASINT positions appears woefully inadequate. This is especially apparent given the power of MASINT as described earlier in this paper. So how will the Army prepare to capitalize on MASINT capabilities by 2010?

## ARMY PLAN FOR DEVELOPING MASINT SOLDIERS

Fortunately, Army intelligence leadership planted the seeds for transformation success years ago. The intelligence community realized no one echelon can be responsible for MASINT analysis. Intelligence operations are inextricably linked from the national to the tactical level. The next step lies in developing intelligence personnel who can see and understand the battlespace as a crucial operational multiplier. Although the Army needs people skilled in some specific disciplines, the real need lies in the Army's ability to reach back to a point where collaborative analysis remains centralized.[69] Under the Army's current plan, this implies intelligence generalists may serve as the Army's MASINT experts. This is not good.

Sergeant Major Antonio C. Moreno, Office of the Chief of Military Intelligence believes soldiers of the Objective Force must embrace new technology, new training models and other

sophisticated platforms for intelligence operations. These soldiers will acquire and develop skills to perform a multitude of tasks. Specifically, information operations soldiers should have the ability to transition easily or apply other skills in relation to MASINT. MASINT skills and technology remain force multipliers, but Sergeant Major Moreno sees no specific plan for a separate MASINT MOS. MASINT becomes a learned on-the-job skill set to enhance other intelligence disciplines.[70] However, based on previous comments about the technical complexity of MASINT analysis, this approach may not fulfill our needs.

Sergeant Major Moreno proposes a modification of the current training philosophy based on more soldier and team training. His model suggests intelligence soldiers receive training on traditional intelligence skills secured with a full understanding of complex sensing and processing technologies, moving away from the old paper map to digital production techniques. Students would then participate in live and simulated exercises to sustain their digital warfighting intelligence skills.[71]

Commissioned Warrant Officer Five Rex A. Williams, senior warrant officer in the Office of the Chief of Military Intelligence, stated, "Automation does not make a poor analyst good, but it will make an excellent analyst better."[72] With this philosophy, the future warrant officer skill set encompasses communications, tactical and technological skills in addition to strong ethical values. Emphasis on assignment-specific training, climbing a capabilities-based career pyramid replaces the traditional one-size-fits-all training strategy in use today. According to CW5 Williams, the Army should integrate intelligence support of MASINT into training, then rotate warrant officers less frequently so they retain a continuity of operations.[73]

## SENIOR LEADER CONCERNS

The two approaches to MASINT training and growth described above will not meet either the commanders' or Intelligence Community's needs. If these practices continue, MASINT capabilities could become just another learned duty spread among several basic intelligence disciplines and ultimately decay inside the Army's intelligence toolbox. This is exactly what our national leaders fear. Enemies hide their activities in underground structures, concealing activity from traditional intelligence sources, but not from MASINT. Based on the new and emerging capabilities of MASINT, our nation's leaders expect MASINT to supplant traditional technical sources like imagery.[74,75] When it comes to training and competency retention, the

formal Army training bureaucracy does not appear to share the concerns of the United States MASINT System or that of our national leaders.

Members of the Permanent Select Committee on Intelligence articulated concern for trained MASINT personnel. They perceive a need for MASINT experts to analyze MASINT versus using traditional signals or imagery analysts to perform MASINT functions as an extra duty. A valid consideration exists that traditional analysts with an additional skill identifier for MASINT will "get lost" in the traditional intelligence systems charters. This was the original reason for creating MASINT as its own discipline.[76] The Honorable Porter Goss singled out the need for developing analytic depth and breadth with MASINT requiring advanced processing and analytic tools.[77] What is the Army's response to the MASINT training challenge?

## ARMY'S MASINT TRAINING PROGRAM

### MASINT and TRADOC

MASINT remains difficult to learn and retain, but since there is no Army MOS for MASINT, no TRADOC requirement exists to teach MASINT.[78] The Army Intelligence Transformation Campaign Plan does not call for a MASINT MOS. As a result, the Army training bureaucracy has no plans to develop formal training for MASINT to support the Objective Force.

However, training does occur in sporadic forms at multiple echelons for several intelligence MOSs. For example, the Army Intelligence Center and School provides a 1-hour overview of MASINT, with plans to teach up to 40 hours of spectral MASINT. Ground Surveillance Radar Operators receive entry level training in REMBASS at the Army Intelligence Center.

In July 2001, the Army's Intelligence Center developed a Spectral Training Transition Plan with CMO. This plan provides some level of MASINT spectral orientation training from the senior level to every intelligence soldier and officer trained at Fort Huachuca. In addition, a 40-hour course introduces analysts to MASINT processing.[79] Unfortunately, it is the operational intelligence commander who carries the burden for training MASINT in the Army.

**Operational Reality For Training MASINT**

Since INSCOM has operational responsibility for MASINT in the Army, INSCOM works closely with CMO to teach several MASINT courses in the classroom, on the web and through distance learning.[80] In conjunction with CMO, INSCOM develops courses for basic and intermediate training on acoustic, infrared, seismic, laser and spectral MASINT operations, to name a few. As part of the transformation process, they will co-develop two ten-week courses as the Army's MASINT sponsor. As the sponsor, INSCOM will manage any approved MASINT additional skill identifier, which continues to reinforce training along segregated intelligence discipline stovepipes .[81]

To meet emerging intelligence mission needs, intelligence unit commanders in the field often assume responsibility for training MASINT analysis and techniques associated with separate intelligence disciplines. For example, human intelligence personnel may obtain training on biometrics, signals intelligence soldiers receive training in radio frequency discernment, or imagery intelligence analysts learn about coherent change detection or phased history analysis.[82] These commanders expend operational funds to hire contract training teams because a formal system for Army MASINT training does not exist.

INSCOM develops and recommends appropriate changes to concepts, and systems relating to Army MASINT. However, CMO provides the backbone of MASINT training for the services, which INSCOM serves as a willing recipient. Mr. Austin Grisham and Ms. Karen Bassinger, CMO's Directorate for Training outlined the experiential teaching processes CMO and the Intelligence Community use to train MASINT across the four stages of learning.[83,84]

**Learning Process**

Psychologists contend learning is an active, constructive process that is contextual where knowledge is acquired in relationship to other knowledge, and information becomes meaningful when it is presented in a usable framework.[85] Doctors Harrison and Branson, popular modern psychologists, went so far as to categorize five styles of thinking in their recognized book, The Art of Thinking. Several variations exist for the number and types of stages students transition as part of learning, but despite variations on a theme, students at the adult level generally learn through four distinct stages.[86,87,88]

**MASINT Training Applied To The Four Stages Of Learning**

During the first stage of learning, analysts attend a MASINT Fundamentals course taught by CMO or INSCOM representatives. This course briefly outlines and describes the capabilities and limitations of each MASINT sub-discipline. Analysts must pass examinations consisting of true-false and multiple choice questions. These students then participate in a reinforcing practical exercise associated with the material presented. The Army's course for understanding MASINT fundamentals focuses on the physics of MASINT as well as the sensors themselves.[89] During the first stage of adult learning, students display what Dr. William Perry calls dualism.[90] Dualism simply means students conclude with yes-or-no, right-or-wrong answers, much like Dr. M. David Merrill's Descriptive Component Display Theory. Questions for dualism would include: "On a topographic map, what is the symbol for a church?"[91] The students' knowledge comes from what the instructor or expert provides. Students at this level remain uneasy when higher authorities disagree with the student's answer. MASINT analysts at this stage seldom draw independent conclusions needed as MASINT analysts, but this is the level where the basic understanding of MASINT principles must occur.

As MASINT analysts graduate to the second stage, analysts take CMO-led courses that focus on specific MASINT sub-disciplines and individual segments. Analysts are introduced to multiple inputs with no clear answers. Analysts must operate at the subjective knowledge level to provide educated opinions as responses to situational activities. As students revise their thinking and migrate to the second stage, they compare analyses and realize no one has the one right answer to complicated questions. Intelligence analysts face these situations routinely. This college level subjective knowledge represents educated opinion.[92] MASINT analysts in this stage draw broad conclusions about enemy intentions based on single source inputs. The Joint Military Intelligence College offers a graduate level elective on MASINT focusing mostly on stages one and two, but requires a research project to engage students at the third stage.[93,94]

By the time analysts reach the third stage, what the Intelligence Community may refer to as the journeyman level, standardized centralized training no longer occurs. Hands-on experience and constant exposure to MASINT analysis raises the standard. Students may attend academic institutions like Georgia Technology Institute or California Poly-technical Institute. INSCOM developed a training needs statement shifting MASINT training from the science and technology arena to processing and analysis.[95] Training continues to focus on systems, but delves deeper into complex employment issues. The third stage of learning

begins when leaders repeatedly ask for evidence to support the student's (intelligence analyst) analytic judgments. Every analyst who has briefed a senior leader understands this stage perfectly well. Analysts at this level assess knowledge as contextual and situational. They learn to distinguish the difference between weak and strong evidence. Ambiguity becomes a part of their routine thought processes in developing alternative points of view. This is the level where MASINT analysts must function to effectively provide meaningful intelligence for dominant battlespace knowledge necessary for the Objective Force. Learning about programmatic architectures usually occurs in the fourth and final stage.[96]

Most senior leaders within the MASINT arena operate at the fourth stage where individuals develop their own issues and stands. This transition occurs when CMO conducts seminars with academic institutions and individual participative sessions with senior leaders. For example, Admiral Jacoby, J2 Joint Chiefs of Staff regularly receives training and briefings on MASINT capabilities, employment, policy and funding issues so he can make coherent recommendations to our national leadership concerning MASINT transformation. Once students or analysts produce their own analyses and develop a stand on issues, they emerge as stage four adults with a commitment to relativism. This constructed knowledge integrates learning from others with personal experience and self-reflection.[97] Understanding the four stages of learning allows us to review how the Army should train MASINT analysts if Army intelligence plans to capitalize on MASINT capabilities available to the Objective Force.

TRADOC clearly recognizes the need to capitalize on the learning process as a whole. Key leaders within TRADOC identified the need to educate soldiers in a dynamic, technology-based environment. Much to their credit, TRADOC has taken the lead in innovative learning techniques that are applicable to MASINT training for the Objective Force. To rapidly support Army transformation, TRADOC recently developed the Adaptive Thinking Process for learning as part of Army experiments with digital training methodologies at Fort Leavenworth. The Adaptive Thinking Model allows for modification of the instructional strategy based on inputs from the student.[98] This process could enhance CMO's experiential teaching methodologies while dissolving the traditional stovepipe approach Army intelligence analysis training employs today.[99]

## ANALYSIS AND RECOMMENDATIONS

Based on current Army intelligence campaign planning and training bureaucracy, the Army will not be postured to take advantage of all the capabilities existent with MASINT. MASINT has the potential to provide us with dominant battlespace awareness, but MASINT remains a highly technical discipline. Three significant measures would allow the Army to capitalize on all of the capabilities MASINT can provide by the year 2010. First, the Army needs to recognize MASINT as an overarching discipline. By relegating MASINT to an ASI or PDI, intelligence analysts in the military will always have another "primary" job. Second, it is necessary to fully engage the Army training bureaucracy to collaborate with the United States MASINT System. Right now, our efforts remain uncoordinated. Third, but most importantly, the Army should create senior executive positions on the Army Staff to represent MASINT and Imagery Intelligence. Success comes only if the Army has the right muscle to flex within the USMS.

### PERSONNEL MANAGEMENT

National level leaders--who control the budget--and the Intelligence Community obviously recognize MASINT as a separate discipline. The Secretary of Defense recognizes MASINT as a separate discipline. The Chairman of the Joint Chiefs of Staff recognizes MASINT as a separate discipline. Still, the Army views MASINT as an additional duty. Timeliness of value-added knowledge in the battlespace drives relativity of the intelligence discipline. That may be the case today for MASINT, but not tomorrow as technology improves according to Moore's Law. Based upon current capabilities, it will not be long before MASINT-derived knowledge arrives near real time to the decision-maker at the point of action.

To capitalize on the capabilities MASINT can provide, the Army should seek a more proactive and predictive approach in preparing for MASINT capabilities available by 2010. The Army should treat MASINT as an overarching discipline. Instead of segregating intelligence and adding MASINT as an additional duty to each discipline, the Army should create a MASINT discipline assigning MASINT soldiers into imagery, signals or human intelligence positions. This personnel process proposed change focuses on integration rather than the current method of de-confliction.

The conundrum lies in the highly technical requirements of MASINT blending with the flexible requirements of all source intelligence analysis. It takes about a year to train proficiency

in MASINT across the entire electromagnetic spectrum to the second stage of learning.[100] However, in spite of the technical training requirements, this expertise may not be utilized with MASINT as an extra duty.

TRAINING

A Congressional Staff Study discussed the need to improve formal initial and continuing education for MASINT because MASINT exploitation requires scientific, mathematical and engineering skills. Currently, these analysts cannot be created from Army service schools nor maintain expertise under normal service employment practices because the Army does not formally train MASINT. Specifically, the study recommends three significant points of order. CMO should establish a training capability, structure and architecture for MASINT like the National Security Agency has for signals intelligence. This is inconsistent with how TRADOC views Army training but seems appropriate based on the joint nature of MASINT exploitation and the complexity of the MASINT field. Second, the service War Colleges need to include formal blocks of instruction on MASINT to educate our senior leaders. Third, CMO must serve as the clearing house for developing training materials and creating "for credit" courses.[101]

It seems prudent for the Army to recognize the Central MASINT Office as the responsible agent for the United States MASINT System. Since CMO has policy, direction and training responsibility for the USMS, they should be given the means to develop an architecture to execute their responsibilities. Quality and timely MASINT analysis requires joint and sophisticated technical training. Some ad hoc technical MASINT training is being conducted, but needs consolidating. This could be done outside service channels under the CMO. For example, the National Imagery and Mapping Agency's Defense Mapping School (DMS) provides all formal training in terrain analysis for the services, including the Army. The Army should collaborate with CMO to establish robust MASINT training operations similar to the DMS.

Currently, the Army training bureaucracy does not adequately train MASINT personnel for a transformed Army—nor is there a coherent plan to do so by the year 2010. The Army Intelligence Center trains signals, human and imagery intelligence in depth, but only provides a cursory overview of MASINT capabilities. As stated above, USMS should train the intelligence analysts in the complex and technical aspects of MASINT analysis. TRADOC, however, does have a role in the MASINT training process. TRADOC should focus on educating the rest of the

Army force in the non-technical aspects of MASINT and how to apply MASINT capabilities in general.

CMO meets with INSCOM regularly to produce an aggressive training program directly supporting the commander in the field. However, a Major Command like INSCOM should not be responsible for formal and institutionalized training of the Army's piece of the United States MASINT System.

EXECUTIVE LEADERSHIP

Most importantly, the Army should strongly consider creating senior executives to represent the Army in the United States MASINT System. Current Army senior executives just do not have the time and expertise to dedicate toward the complex and highly technical MASINT field. The Army already has a plethora of well-established senior executives representing the Army in the United States SIGINT System and Defense Human Intelligence Service. By expanding the Army's senior executive pool to incorporate MASINT, it would send the right signal to Congress and the Intelligence Community, who first made the recommendation.[102] Senior executives provide incredible leverage in the national community by articulating the Army's requirements to the legislature and key leaders within the Executive budgeting process—a critical piece of transforming Army intelligence.

According to the Central MASINT Office, the Army's MASINT budget has been relatively sparse and stable for the past five years. Despite a Congressional programmed increase of $200M for MASINT, the Army's MASINT budget for the next five years remains relatively flat. The Army's lack of commitment to MASINT in the past led to the flat-lined budgets that reach into the future. The good news is that the Army has recently shown increased interest in working with CMO. However, the number of Army MASINT positions—54—remains inadequate to justify a significant increase in the MASINT budget. The problem will continue to exist without dedicated Army MASINT senior leadership and direction.

**CONCLUSION**

The Objective Force of 2010 expects to dominate across the full spectrum of likely operations. The Army warfighter has a requirement for dominant battlefield knowledge to prosecute war decisively. MASINT contributes both unique and complementary information on a wide variety of intelligence requirements as part of the all-source collection environment to support the warfighter. In this extremely complex and technical world, MASINT training as

currently structured, and MASINT as an additional duty, will not support our requirement for information dominance or information superiority. General Henry H. Shelton, Chairman of the Joint Chiefs of Staff penned an article about transformation in the Fall of 2001. He wrote, "We must also push the development of new doctrine and flexible organizations to fully realize the benefits of 21st-century technological advances."[103] As a critical component of information dominance for Army Vision 2010, the Army will be prepared to capitalize on all the capabilities MASINT can provide, only if our force changes its approach to MASINT.

Imagery has always had the advantage over other intelligence disciplines since a picture is worth a thousand words. However, future national security concerns will not necessarily be susceptible to surveillance by electro-optical imagery. As Doctor Mark Lowenthal, Adjunct Professor of International Relations and Public Affairs at Columbia University suggests, MASINT will eventually gain the resources it needs because MASINT is extremely useful for acquiring intelligence on hard targets where imagery proves almost futile. In the long term, he believes imagery will lose ground to MASINT.[104] However, MASINT will not flourish in the Army if we do not have an advocate to develop a membership in the United States MASINT System.

WORD COUNT = 8260

## ENDNOTES

[1] John L. Morris, "MASINT," American Intelligence Journal 17, no. 1&2 (1996): 24-25.

[2] Army Intelligence Transformation Campaign Plan (Washington, D.C., August 2001), 10.

[3] Central Intelligence Agency, Director of Central Intelligence Annual Report for the United States Intelligence Community (Washington, D.C.: U.S. Central Intelligence Agency, May 1999).

[4] Secretary of Defense, Quadrennial Defense Review (Washington, D.C. Department of Defense, 30 September 2001), 1-10.

[5] William J. Clinton, A National Security Strategy for a Global Age (Washington, D.C.: The White House, December 2000), 1, 16-33.

[6] Porter J. Goss, "Intelligence Authorization Act Report," American Intelligence Journal 17, no. 3&4 (1997): 7-13.

[7] "Eleven Technologies Selected for Advanced Demonstration," National Defense 83 (March 1999): 4-5 [database on-line]; available from UMI ProQuest, Bell & Howell; accessed 1 October 2001.

[8] "Quadrennial Defense Review," (Washington, D.C., 30 September 2001), 15, 26.

[9] Annual Report of the Secretary of Defense to the President and the Congress: Information Superiority and Space (Washington, D.C., 9 January 2001).

[10] Henry H. Shelton, Joint Vision 2020 (Washington, D.C.: U.S. Government Printing Office, June 2000), 1.

[11] William A. Owens, "Intelligence in the 21st Century," American Intelligence Journal 19, no. 1&2 (Spring 1999): 15-21.

[12] Eric K. Shinseki, The Army Vision, (Washington, D.C., October 1999), 1.

[13] Ibid., 2-8.

[14] Army Intelligence Transformation Campaign Plan, 17.

[15] Department of the Army, Field Manual 3.0 Operations, (Washington, D.C.: U.S. Department of the Army, 14 June 2001), 4-20, 22, 11-2.

[16] Owens, 15.

[17] Michael C. Ingram, Defining the Relevant Common Picture, TRADOC Analysis Center (19 August 1994).

[18] Zachary Lum, "The Measure of MASINT," Journal of Electronic Defense (August 1998): 43-48 [database on-line]; available from UMI ProQuest, Bell & Howell; accessed 1 October 2001.

[19] Congress, House, Permanent Select Committee on Intelligence, IC21: The Intelligence Community in the 21st Century, 104th Cong., 1996. Section VII.

[20] "Measurement and Signature Intelligence," 17 June 1998; available from http://www.fas.org/irp/program/masint.html; Internet; accessed 23 November 2001.

[21] Morris, 24-27.

[22] "Multispectral Thermal Imager," 21 October 2000; available from http://www.fas.org/spp/military/program/masint/mti.html; Internet; accessed 23 November 2001.

[23] Jeffrey L. Hylden, "Remote Sensing of Chemical Plumes (17)," April 2001; available from http://www.technet.pnl.gov/sensors/macro/projects/es4remchem.html; Internet; accessed 26 November 2001.

[24] John L. Morris, "The Nature and Applications of Measurement and Signature Intelligence," American Intelligence Journal 19, no. 3&4 (Winter 1999-2000): 81-84.

[25] Vonny Rohloff, "Ground Sensors Help Protect Troops," May 1997; available from http://www.dtic.mil/armylink/news/May1997/a19970521rembassx.html; Internet; accessed 30 November 2001.

[26] "The conflict in Southeast Asia (SEA)," June 1996; available from http://www.wpafb.af.mil/museum/history/vietnam/sea1968.htm; Internet; accessed 27 November 2001.

[27] "Active Radio Interferometer for Explosion Surveillance (AIRES)," available from http://www.fas.org/spp/military/program/masint/aires.html; Internet; accessed 2 October 2001.

[28] John W. Ives, "National Ground Intelligence Center," briefing slides, Washington, D.C., June 2001.

[29] W.F. Belokon, et al., Multispectral Imagery Reference Guide (Fairfax, VA: 1996), 2-1.

[30] John W. Ives, author attended the Hyperspectram Multispectral Imaging Seminar; 1999.

[31] "Abacus: Hyperspectral Image Processing," available at http://www.saic.com/abacus/; Internet; accessed 28 November 2001.

[32] Belokon, et al., 2-8.

[33] Belokon, et al., 2-5,6.

[34] Ives, Hyperspectram Seminar.

[35] Belokon, et al., 6-1.

[36] John L. Morris, "The Nature and Applications of Measurement and Signature Intelligence," 81-84.

[37] Belokon, et al., 8-2,3.

[38] AF2025 v1c3-1 | 2025 In-Time Information Integration System I3S | (Intro), available from http://www.au.af.mil/au/2025/volume1/cap03/v1c3-5.htm; Internet; accessed 3 September 2001.

[39] Morris, "The Nature and Applications of Measurement and Signature Intelligence," 81-84.

[40] "RDT&E Budget Item Justification Sheet for Project Number/Title: 1161 Advanced Sensor Technology," March 1996; available from http://www.fas.org/spp/starwars/budget/peds_97/60317c9.htm; Internet; accessed 23 November 2001.

[41] Don Atkins and George Crawford, "Reprogramming Brilliant Weapons: A New Role for MASINT," American Intelligence Journal 17, no. 3&4 (1997): 45-46.

[42] "Counterproliferation Program Review Committee CPRC Annual Report to Congress 1997," available from http://www.fas.org/spp/starwars/program/cprc97/cprc9704.htm; Internet; accessed 27 November 2001.

[43] "Counterproliferation Initiative Presidential Decision Directive PDD/NSC 18 December 1993," available from http://www.fas.org/irp/offdocs/pdd18.htm; Internet; accessed 27 November 2001.

[44] "An Overview of the Intelligence Community," available from http://www.gpo.gov/intelligence/int/int023.htm; Internet; accessed 27 October 2001.

[45] "Quadrennial Defense Review," 40-47.

[46] Congress, Senate, Senate Armed Services Committee Subcommittee on Emerging Threats and Capabilities Information Warfare and Critical Infrastructure Protection, Statement by the Honorable Arthur L. Money Senior Civilian Official Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence and DoD Chief Information Officer, 106th Cong., 16 March 1999.

[47] Annual Report of the Secretary of Defense to the President of the United States: Chapter 8 Information Superiority, (Washington, D.C.: 9 January 2001).

[48] Jacques S. Gansler, "Defense Science and Technology: Looking to the Future," 6 April 1998; available from http://www.acq.osd.mil/ousda/speech/darpa40.html; Internet; accessed 11 November 2001.

[49] Central Intelligence Agency, Director of Central Intelligence Annual Report for the United States Intelligence Community.

[50] "An Overview of the Intelligence Community."

[51] IC21, 4.

[52] Morris, "MASINT," 25.

[53] Ibid., 27.

[54] Army Intelligence Transformation Campaign Plan, 18.

[55] Ibid., 20.

[56] Ibid., 20-21.

[57] Keith J. Masback, "Army Intelligence Transformation Vision," briefing slides and personal commentary, Carlisle Barracks, U.S. Army War College, 18 October 2001.

[58] Keith J. Masback, "Briefing Army MASINT Transformation Update," briefing slides and personal commentary, Washington, D.C. 16 October 2001.

[59] IC21, 5-6.

[60] Army Intelligence Transformation Campaign Plan, D-14.

[61] Ibid., D-14-17.

[62] John W. Ives, "Position Paper on Establishing Signature Reach Centers," (Carlisle, PA: 4 November 2001).

[63] Atkins and Crawford, 45-46.

[64] David Bales david.bales@hua.army.mil, "Strategic Research Paper Support," electronic mail message to John W. Ives johnives@pa.net, 19 October 2001.

[65] Jon J. Hinkofer jjhinko@vulcan.belvoir.army.mil, "Descriptions of Classes and MSC MASINT Training," electronic mail message to John W. Ives johnives@pa.net, 27 November 2001.

[66] Department of the Army, Military Occupational Classification and Structure, DA Pamphlet 611-21 (Washington, D.C.: U.S. Department of the Army, 31 March 1999), 1,2.

[67] "Mission—Army Intelligence and Security Command—INSCOM," available from http://www.fas.org/irp/agency/inscom/mission.htm; Internet; accessed 25 November 2001.

[68] Hinkofer, email.

[69] Michael W. Powell, "MI Systems Transformation," Military Intelligence Professional Bulletin 26 (October-December 2000): 19-22.

[70] Antonio C. Moreno, "The MI Soldier of the 21st Century," Military Intelligence Professional Bulletin 26 (October-December 2000): 53-54.

[71] Ibid., 53-54.

[72] Rex A. Williams, "The Military Intelligence Warrant Officer of the 21st Century," Military Intelligence Professional Bulletin 26 (October-December 2000): 55-57.

[73] Ibid., 55-57.

[74] James R. Asker, "Eye Spy," Aviation Week and Space Technology (29 March 1999), 29.

[75] Mark M. Lowenthal, "Imagery's National Status Faces Questionable Future," Signal 53 (May 1999): 53-56 [database on-line]; available from UMI ProQuest, Bell & Howell; accessed 1 October 2001.

[76] IC21, 8.

[77] Goss, 7-13.

[78] Bales, email.

[79] "CMO/SITAC Spectral Education Branch (SEB) U.S. Army Intelligence School, Fort Huachuca, Arizona Transition Plan," 10 July 2001.

[80] "Mission—Army Intelligence and Security Command—INSCOM."

[81] Hinkofer, email.

[82] Bales, email.

[83] Austin E. Grisham Afgriae@dia.osis.gov, "Need Your Knowledge," electronic mail message to John W. Ives johnives@pa.net, 9 November 2001.

[84] Karen Bassinger, Central MASINT Organization Training Officer, telephone interview by author, 26 November 2001.

[85] Barbara Gross Davis, Tools for Teaching (San Francisco: Jossey-Bass, 1993), 177.

[86] Allen F. Harrison and Robert M. Branson, The Art of Thinking (New York: Berkely, 1982).

[87] Davis, 178-182.

[88] Edward E. Scannell and John W. Newstrom, More Games Trainers Play: Experiential Learning Exercises (New York: McGraw-Hill, 1983), xv.

[89] Jon J. Hinkofer, Intelligence and Security Command MASINT Training Officer, telephone interview by author, 26 November 2001.

[90] William G. Perry, Forms of Intellectual and Ethical Development in the College Years (New York: Holt, Reinhart and Winston, 1970).

[91] M. David Merrill, Instructional Design Theory (Englewood Cliffs, NJ: Educational Technology Publishing, 1994), 111-113.

[92] M.F. Belenky et al.; Women's Ways of Knowing: The Development of Self, Body, and Mind (New York: Basic Books, 1986). 184-86.

[93] Grisham, email.

[94] Mark Jensen, Professor for MASINT at the Joint Military Intelligence College, telephone interview by author, 29 November 2001.

[95] Hinkofer, email.

[96] Jensen, phonecon.

[97] Davis, 178-182.

[98] Merrill, 254.

[99] Training and Doctrine Command, Assessment Report: Training Initiative—Army Transformation (Fort Monroe, VA: December 2000), Chap 3.

[100] Jensen, phonecon.

[101] IC21, VII-10-13.

[102] IC21, VII-15, 16-18.

[103] Henry H. Shelton, "Professional Education: The Key to Transformation," Parameters 31 (Autumn 2001): 15-16.

[104] Lowenthal, 53-56.

## BIBLIOGRAPHY


"Abacus: Hyperspectral Image Processing." Available at http://www.saic.com/abacus/. Internet. Accessed 28 November 2001.

"Active Radio Interferometer for Explosion Surveillance (AIRES)." Available from http://www.fas.org/spp/military/program/masint/aires.html. Internet. Accessed 2 October 2001.

Aggarwal, Anil. Web-based Learning and Teaching Technologies: Opportunities and Challenges. Hershey, PA: Idea Group Publishers, 2000.

"Analyst Tools Quantify Sensor Returns." Measurement and Signature Intelligence Software Development Facility, 17 April 1998. Available from http://wv.ewa.com/prog_masintsdtf.html. Internet. Accessed on 3 October 2001.

Anderson, R.C. and Biddle, W.B. "On Asking People Questions About What They Are Reading." Psychology of Learning and Motivation 9 (1975): 89-132.

"An Overview of the Intelligence Community." Available from http://www.gpo.gov/intelligence/int/int023.htm. Internet. Accessed 27 October 2001.

Army Intelligence Transformation Campaign Plan. Washington, D.C. August 2001.

Army Intelligence Transformation Campaign Plan: Corrected. CD ROM. Washington, D.C.: September 2001.

Army Transformation: Training for Full Spectrum Dominance. CD ROM. Fort Monroe, VA: September 2001.

Army Vision Information. CD ROM. Washington, D.C.: July 2001.

Army Worldwide Intel Conference. CD ROM. Fort Huachuca, AZ: 25-29 September 2000.

Asker, James R. "Eye Spy." Aviation Week and Space Technology, 29 March 1999, 29.

Asker, James R. "Streamlining MASINT." Aviation Week and Space Technology, 7 September 1998, 55.

Atkins, Don and George Crawford. "Reprogramming Brilliant Weapons: A New Role for MASINT." American Intelligence Journal 17, no. 3&4 (1997): 45-46.

Bales, David david.bales@hua.army.mil. "Strategic Research Paper Support." Electronic mail message to John W. Ives johnives@pa.net. 19 October 2001.

Bassinger, Karen, Central MASINT Office Training Officer. Telephone interview by author, 26 November 2001.

Belenky, M.F., B.M. Clinchy, N.R. Goldberg and J.M. Tarule. Women's Ways of Knowing: The Development of Self, Body, and Mind. New York: Basic Books, 1986.

Belokon, William F., Mark A. Emmons, Warren H Fowler, III, Brice A. Gilson, Guillermo Hernandez, Alfred J. Johnson, Michael D. Kaiser, John W. McMillan, Michael A Noderer, Earl J. Tullos and Kenneth E. White. Multispectral Imagery Reference Guide. Fairfax, VA, 1996.

Berge, Zane L. Sustaining Distance Training: Integrating Learning Technologies into the Fabric of the Enterprise. San Francisco, CA: Jossey-Bass, 2001.

Bishop, James H. "On the Job Training of New Hires." School of Industrial and Labor Relations: 143.

Bornman, Louis G. Recommendations for the 21st Century Classroom: Derived from Observations of the 1994 Battle Command Elective and Advanced Warfighting Experiments. Fort Leavenworth, KS: TRADOC Analysis Center, 1994.

Bornman, Louis G. The impact of Digital Mapping on the Battle Command: Derived from Observations of the 1994 Battle Command Elective and Advanced Warfighting Experiments. Fort Leavenworth, KS: TRADOC Analysis Center, 1994.

Brethower, D.M. and Katherine A. Smalley. "Performance-based Instruction—Part 5: Evaluating Performance-based Instruction." Performance and Instruction 31 (August 1992): 33-40.

Case, Robert. "Theories of Learning and Theories of Development." Educational Psychologist 28 (1993): 219-33.

Central Intelligence Agency. Director of Central Intelligence Annual Report for the United States Intelligence Community. Washington, D.C.: U.S. Central Intelligence Agency, May 1999.

Clinton, William J. A National Security Strategy for a Global Age. Washington, D.C.: The White House, December 2000.

"CMO/SITAC Spectral Education Branch (SEB) U.S. Army Intelligence School, Fort Huachuca, Arizona Transition Plan." 10 July 2001.

"Counterproliferation Initiative Presidential Decision Directive PDD/NSC 18 December 1993." Available from http://www.fas.org/irp/offdocs/pdd18.htm. Internet. Accessed 27 November 2001.

"Counterproliferation Program Review Committee CPRC Annual Report to Congress 1997." Available from http://www.fas.org/spp/starwars/program/cprc97/cprc9704.htm. Internet. Accessed 27 November 2001.

Cranton, Patricia. Transformative Learning in Action: Insights from Practice. San Francisco, CA: Jossey-Bass, 1997.

Davenport, Jad. "Ball Aerospace Awarded MASINT Air Force Contract with $260 Million Ceiling." Ball 2001 News Releases. 5 April 2001. Available from http://www.ball.com/aerospace/media/nr04_05_01.html. Internet. Accessed 6 October 2001.

Davis, Barbara Gross. Tools for Teaching. San Francisco, CA: Jossey-Bass, 1993.

Department of Command, Leadership, and Management United States Army War College, Strategic Leadership Primer. Carlisle, PA: United States Army War College, 1998.

Driscoll, Margaret. Web-based Training: Using Technology to Design Adult Learning Experiences. San Francisco, CA: Jossey-Bass, 1998.

"Eleven Technologies Selected for Advanced Demonstrations." National Defense 83 (March 1999): 4-5. Database on-line. Available form ProQuest, Bell & Howell. Accessed 1 October 2001.

Erwin, T. Dary. Assessing Student Learning and Development: A Guide to the Principles, Goals, and Methods of Determining College Outcome. San Francisco, CA: Jossey-Bass, 1991.

"Evaluation Report on Measurement and Signature Intelligence." 30 June 1997. Available from http://www.fas.org/irp/program/masint_evaluation_rep.htm. Internet. Accessed on 30 September 2001.

Feldman, D.H. Beyond Cognitive Universals in Cognitive Development. Norwood, NJ: Ablex, 1980.

Gansler, Jacques S. "Defense Science and Technology: Looking to the Future." 6 April 1998. Available from http://www.acq.osd.mil/ousda/speech/darpa40.html. Internet. Accessed 11 November 2001.

Gates, Bill. Business at the Speed of Thought. New York, NY: Warner, 1999.

Goss, Porter J. "Intelligence Authorization Act Report." American Intelligence Journal 17, no. 3&4 (1997): 7-13.

Grisham, Austin E. Afgriae@dia.osis.gov. "Need Your Knowledge." Electronic mail message to John W. Ives johnives@pa.net. 9 November 2001.

Guskey, T.R. "The importance of Focusing on Student Outcomes." North Central Association Quarterly 66 (1992): 507-12.

Harrison, Allen F. and Robert M. Branson. The Art of Thinking. New York: Berkley, 1982.

Herman, Michael. "Where Hath Our Intelligence Been? The Revolution in Military Affairs." Royal United Services Institute Journal 143 (December 1998): 62-68. Database on-line. Available from UMI ProQuest, Bell & Howell. Accessed 1 October 2001.

Hinkofer, Jon J. jjhinko@vulcan.belvoir.army.mil. "Description of Classes and MSC MASINT Training." Electronic mail message to John W. Ives johnives@pa.net. 27 November 2001.

Hinkofer, Jon J., Intelligence and Security Command MASINT Training Officer. Telephone interview by author, 26 November 2001.

Hutchings, Pat and Allen Wutzdorff. Knowing and Doing: Learning Through Experience. San Francisco, CA: Jossey-Bass, 1988.

Hylden, Jeffery L. "Remote Sensing of Chemical Plumes (17)." April 2001. Available from http://www.technet.pnl.gov/sensors/macro/projects/es4remchem.html. Internet accessed 26 November 2001.

"Hyperspectram Multispectral Imaging Seminar." Available from http://www.techexcpo.com/WWW/opto-knowledge/HIS-MSI-course.htm. Internet. Accessed on 3 October 2001.

"Image Exploitation." 2001. Available from http://www.gd-is.com/sections/products/defense/fusion5.html. Internet. Accessed 30 September 2001.

Ingram, Michael C. Defining the Relevant Common Picture. Fort Leavenworth, KS: TRADOC Analysis Center, 1994.

"In-Time Information Integration System (I3S)." 2025 In-Time Information Integration System I3S. DATE. Available from http://www.au.af.mil/au/2025/volume1/chap03/v1c3-3.htm. Internet. Accessed on 3 September 2001.

ISR TTP for the Warfighter (Battalion and Brigade). CD ROM. Fort Huachuca, AZ: 1 February 2001.

Ives, John W. "National Ground Intelligence Center." Briefing slides. Washington, D.C., June 2001.

Ives, John W. "Position Paper on Establishing Signature Reach Centers." Carlisle, PA: U.S. Army War College, 4 November 2001.

Jensen, Mark, Professor for MASINT at the Joint Military Intelligence College. Telephone interview by author, 29 November 2001.

Joint Publication 2.0, Joint Doctrine for Intelligence Support to Operations. Washington, D.C.: Joint Chiefs of Staff, 1996.

Keith, John F. Training Applications of Artificial Intelligence. Strategy Research Project. Carlisle Barracks: U.S. Army War College, 23 March 1987.

Kotter, John P. Leading Change. Boston, MA: Harvard Business School Press, 1996.

Lowenthal, Mark M. "Imagery's National Status Faces Questionable Future." Signal 53 (May 1999): 53-56. Database on-line. Available from UMI ProQuest, Bell & Howell. Accessed 1 October 2001.

Lum, Zachary. "The Measure of MASINT." Journal of Electronic Defense, 21 (August 1998): 43-48. Database on-line. Available from UMI ProQuest, Bell & Howell. Accessed 1 October 2001.

Magee, Roderick R. II, ed. Strategic Leadership Primer. Carlisle Barracks, PA: U.S. Army War College, 1998.

Mager, Robert Frank. Preparing Instructional Objectives. Belmont, CA: Pitman Learning, 1975.

Masback, Keith J. "Army Intelligence Transformation Vision." Briefing slides and personal commentary. Carlisle Barracks, PA: U.S. Army War College, 18 October 2001.

Masback, Keith J. "Briefing Army MASINT Transformation Update." Briefing slides and personal commentary. Washington, D.C., 16 October 2001.

"MASINT." Available from http://bss.sfsu.edu/fischer/IR%20360/Lectures/Lecture%204/sld020.htm. Internet. Accessed on 30 September 2001.

McDonald, Robert A. A Selective Bibliography on Imagery Reconnaissance and Related Matters. Washington, D.C.: Defense Intelligence College, January 1993.

"Measurement and Signature Intelligence." 17 June 1998. Available from http://www.fas.org/irp/program/masint.html. Internet. Accessed 23 November 2001.

"Measurement and Signature Technology: MASINT—The View From Industry." MAST March 2000. Available from http://www.mastassociation.org. Internet. Accessed 30 September 2001.

Merrill, M. David. Instructional Design Theory. Englewood Cliffs, NJ: Educational Technology Publishing, 1994.

Mezirow, Jack. Transformative Dimensions of Adult Learning. San Francisco, CA: Jossey-Bass, 1991.

"Mission—Army Intelligence and Security Command—INSCOM." Available from http://www.fas.org/irp/agency/inscom/mission.htm. Internet. Accesssed 25 November 2001.

Moreno, Antonio C. "The MI Soldier of the 21st Century." Military Intelligence Professional Bulletin 26 (October-December 2000): 53-54.

Morris, John L. "MASINT." American Intelligence Journal 17, no. 1&2 (1996): 24-25.

Morris, John L. "The Nature and Applications of Measurement and Signature Intelligence." American Intelligence Journal 19, no. 3&4 (Winter 1999-2000): 81-84.

"Multispectral Thermal Imager." 21 October 2000. Available from http://www.fas.org/spp/military/program/masint/mti.html. Internet. Accessed 23 November 2001.

Munn, Christopher J. The Evolution of OPMS XXI: The Need to Specialize Military Intelligence Officers. Strategy Research Project. Carlisle Barracks: U.S. Army War College, 10 April 2001.

"ODCSINT Vision and Mission." 23 April 2001. Available from http://www.dami.army.pentagon.mil/vision-mission.asp. Internet. Accessed 13 August 2001.

Olson, Sherry L. "Enhancing MASINT Sensor Effectiveness." 3 March 2000. Available from http://www.mitre.org/technology/tech00/briefings/tailored_situational/olson1_presentation . Internet. Accessed 30 September 2001.

O'Neill, Edward C. Impact of the Emerging Technologies of Distance Learning and Simulations on the Army National Guard. Strategy Research Project. Carlisle Barracks: U.S. Army War College, 18 May 1998.

Owens, William A. "Intelligence in the 21st Century." American Intelligence Journal 19, no. 1&2 (Spring 1999): 15-21.

Perry, William G. Forms of Intellectual and Ethical Development in the College Years. New York: Holt, Reinhardt and Winston, 1970.

Powell, Michael W. "MI Systems Transformation." Military Intelligence Professional Bulletin 26 (October-December 2000): 19-22.

"RDT&E Budget Item Justification for Project Number/Title: 1161 Advanced Sensor Technology." March 1996. Available from http://www.fas.org/spp/starwars/budget/peds_97/60317c9htm. Internet. Accessed 23 November 2001.

Reimer, Dennis J. Army Vision 2010. Washington, D.C.: United States Department of the Army, 1996.

"Report from the National Commission for the Review of the National Reconnaissance Office." Database on-line. Available from U.S. Army Command and General Staff College. Accessed 30 September 2001.

Reynolds, James H. and Robert Glaser. "Effects of Repetition and Spaced Review Upon Retention of a Complex Learning Task," Current Research on Instruction. Englewood Cliffs, NJ: Prentice-Hall, 1969.

Rog, Debra J. and Deborah M. Fournier. Progress and Future Directions in Evaluation: Perspectives on Theory, Practice and Methods. San Francisco, CA: Jossey-Bass, 1997.

Rohloff, Vonny. "Ground Sensors Help Protect Troops." May 1997. Available from http://www.dtic.mil/armylink/news/May1997/a19970521rembass.htm. Internet. Accessed 30 November 2001.

Rovegno, John S. "Kosovo Lessons Learned." Military Intelligence Professional Bulletin (January-September 2001). Database on-line. Available from UMI ProQuest, Bell & Howell. Accessed 1 October 2001.

Sassenrath, Julius M. and Charles M Garverick. "Effects of Differential Feedback from Examinations on Retention and Transfer," Current Research on Instruction. Englewood Cliffs, NJ: Prentice-Hall, 1969.

Scannell, Edward E. and John W. Newstrom. More Games Trainers Play: Experiential Learning Exercises. New York: McGraw Hill, 1983.

Senge, Peter M. The Fifth Discipline . New York, NY: Doubleday, 1990.

Shalikashvili, John M. Joint Vision 2010. Washington, D.C.: Joint Chiefs of Staff, 1996.

Shelton, Henry H. Joint Vision 2020. Washington, D.C.: Government Printing Office, 2000.

Shelton, Henry H. "Professional Education: The Key to Transformation." Parameters 31 (Autumn 2001): 15-16.

Shinseki, Eric K. Army Vision 2010. Washington, D.C.: Government Printing Office, October 1999.

Smart, Thomas D. "Aerial Common Sensor: The Eyes and Ears of the 21st Century Warfighter." Military Intelligence, October-December 1998, 37-41.

"Spies in the Sky: Satellites." Documentary. Public television. The Learning Channel. 30 November 2001.

"Support to the National Intelligence Community." 5 July 2000. Available from http://www.ewa.com/iit/masint.html. Internet. Accessed on 6 October 2001.

Theall, Michael. Motivation From Within: Approaches for Encouraging Faculty and Students to Excel. San Francisco, CA: Jossey-Bass, 1999.

"The Conflict in Southeast Asia." June 1996. Available from http://www.wpafb.af.mil/museum/history/vietnam/sea1968.htm. Internet. Accessed 30 November 2001.

"TRADOC." 23 May 2001. Available from http://www.tradoc.army.mil/mission.htm. Internet. Accessed 14 October 2001.

Training and Doctrine Command. Assessment Report: Training Initiative—Army Transformation. Fort Monroe, VA: December 2000.

Travers, R.M.W., R.K. Van Wagenen, D.H. Haygood and Mary McCormick. "Learning as a Consequence of the Learner's Task Involvement Under Different Conditions of Feedback," Current Research on Instruction. Englewood Cliffs, NJ: Prentice-Hall, 1969.

Ulmer, Walter F., Jr. Inside View: A Leader's Observations on Leadership. Greensboro, NC: Center for Creative Leadership, 1997.

U.S. Congress. House of Representatives. Permanent Select Committee on Intelligence. IC21: The Intelligence Community in the 21st Century. 104th Cong., 5 June 1996.

U.S. Congress. Senate. Senate Armed Services Committee Subcommittee on Emerging Threats and Capabilities Information Warfare and Critical Infrastructure Protection. Statement by the Honorable Arthur L. Money Senior Civilian Official Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence and DoD Chief Information Officer. 106th Cong., 16 March 1999.

U.S. Department of the Army. Field Manual 3.0: Operations. Washington, D.C.: Department of the Army, 14 June 2001.

U.S. Department of the Army. Field Manual 34-1: Fundamentals of Intelligence and Electronic Warfare Operations. Fort Huachuca, AZ: U.S. Army Intelligence Center and Fort Huachuca, 27 September 1994.

U.S. Department of the Army. Field Manual 34-43: Reconnaissance Overview. Fort Huachuca, AZ: U.S. Army Intelligence Center and Fort Huachuca, 7 June 1996.

U.S. Department of the Army. Military Occupational Classification and Structure, DA Pamphlet 611-21. Washington, D.C.: U.S. Department of the Army, 31 March 1999.

U.S. Department of the Army. Tactical Intelligence Readiness Training Program, Army Regulation 350-3. Washington, D.C.: U.S. Department of the Army, 30 August 1995.

U.S. Department of the Army. TRADOC Pamphlet 525-91, Theater Missile Defense (TMD) Integrating Concept. Fort Monroe, VA: Training and Doctrine Command, 7 February 2000.

U.S. Department of Defense. Annual Report of the Secretary of Defense to the President and the Congress. Washington, D.C.: U.S. Department of Defense, 9 January 2001.

U.S. Department of Defense. Secretary of Defense. Quadrennial Defense Review. Washington, D.C.: 30 September 2001.

U.S. Department of Defense. U.S. Department of Defense Directive 3100.10: Military Space Policy. Washington, D.C.: 9 July 1999.

U.S. Department of Defense. DoD General Intelligence Training, Department of Defense Directive 3305.2. Washington, D.C.: U.S. Department of Defense, 20 July 1984.

Walsh, Walter V. MI Officer Training in the Future: How Can We Make It Better. Strategy Research Project. Carlisle Barracks: U.S. Army War College, 1993.

Williams, Rex A. "The Military Intelligence Warrant Officer of the 21st Century." Military Intelligence Professional Bulletin 26 (October-December 2000): 55-57.

"What is MASINT?" Air Force Intelligence Office. April 1999. Available from http://www.afio.com/sections/wins/1999/notes0499.html. Internet. Accessed on 4 September 2001.