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Enhancing Performance in Light Infantry Digital Tactical Operations Centers

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U.S. Army Research Institute

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14. ABSTRACT *(Maximum 200 words)*:

At the request of the Commanding General, U.S. Army Infantry Center, this report assesses whether current digitization efforts for the light forces are addressing the specific needs of light forces, as opposed to more simply migrating heavy/mechanized digital solutions to light platforms. Twelve Infantry leaders, selected by the Chief, Dismounted Battlespace Battle Lab, provided information : the most critical digital concerns for light Infantry; differences between light and heavy tactical operations centers (TOCs); battle captain requirements; modifications of light Infantry tactics, techniques, and procedures (TTPs) resulting from digitization; and "soldier as a platform" requirements.

The most frequently mentioned light Infantry TOC concern was the need for user-friendly, information management capabilities that will allow: situational awareness of friendly and enemy units, more accurate and simpler battle tracking, and integrated access to information across battlefield operating systems. Responses also indicate significant efforts must be made to minimize information overload. New training programs, TTPs, and automated tools must be developed to permit full utilization of new digital capabilities. The new digital systems must be lightweight, durable, and maintainable, and contain reliable communication links with adequate bandwidth. Relevant results from the Warrior Focus and Focused Dispatch Advanced Warfighting Experiments are also summarized.

15. SUBJECT TERMS

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FOREWORD

This report presents findings that address future requirements and potential pitfalls in the digitization of light Infantry forces. Selected Infantry leaders provided keen insights into the full range of digitization needs for light Infantry and light Infantry tactical operations centers. Not only do the results address system design issues that should result in enhanced situational awareness through user-friendly information management capabilities, but also articulate the need for new, immersive training techniques. This work was conducted by the Army Research Institute's (ARI) Infantry Forces Research Unit at Fort Benning, GA, at the request of the Commanding General, U.S. Army Infantry Center.

The ARI Infantry Forces Research Unit conducts personnel performance and training research and development in support of current and future Infantry needs. This research was conducted as part of Work Package 2127: Light Infantry Training Environments. Research sponsors for this work are the U.S. Army Infantry Center and School including the Chief, Dismounted Battlespace Battle Lab, the Joint Readiness Training Center, and the Training and Doctrine Command Systems Manager (TSM) - Soldier.

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ENHANCING PERFORMANCE IN LIGHT INFANTRY DIGITAL TACTICAL OPERATIONS CENTERS

EXECUTIVE SUMMARY

Research Requirement:

The Commanding General (CG), U.S. Army Infantry Center (USAIC) and the Chief, Dismounted Battlespace Battle Lab (DBBL) requested that ARI assess whether current digitization efforts for the light forces are addressing the specific needs of light forces, as opposed to more simply migrating heavy/mechanized digital solutions to light platforms. The primary focus of the report is on the digital tactical operations center (TOC).

Procedure:

Twelve Infantry leaders selected by the Chief, DBBL provided information through a questionnaire and follow-up interview on the following issues:

- Most critical digital concerns for light Infantry
- Differences between light and heavy TOCs by battlefield operating system (BOS)
- Battle captain requirements
- Modifications of light Infantry TOC tactics, techniques, and procedure (TTPs) resulting from digitization
- "Soldier as a platform" requirements.

Findings:

The most frequently mentioned light Infantry TOC concern was the need for user-friendly, information management capabilities that will allow: situational awareness of friendly and enemy units, more accurate and simpler battle tracking, and integrated access to information across BOSs. Responses also indicate significant efforts must be made to minimize information overload. New training programs, TTPs, and automated tools must be developed so as to permit full utilization of new digital capabilities. The new digital systems must be lightweight, durable, and maintainable, and contain reliable communication links with adequate bandwidth.

Light and heavy TOC functions were found to be largely the same, but that finer grain analyses are required for light units. Battle captains and battle staff in digital tactical operations centers will require considerably more experience, skills, and training than are provided to current battle captains and battle staffs. New TTPs are needed that specify how digital tools can be used to improve orders processing and ways to communicate over the digital net to facilitate the back-brief process. Also, regarding "soldier as a platform" issues, responses were evenly split between tracking the individual soldier and tracking at platoon level. Relevant results from

the Warrior Focus and Focused Dispatch Advanced Warfighting Experiments are also summarized.

Utilization of Findings:

The results have been provided to the CG, USAIC, the Chief, DBBL, the TSM-Soldier and to other key Infantry leaders as a basis for decisions about the Infantry of the future.

ENHANCING PERFORMANCE IN LIGHT INFANTRY DIGITAL TACTICAL OPERATIONS CENTERS

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Introduction

In Force XXI and the Army After Next (AAN), commanders and their staffs will have access to tremendous amounts of near real-time battlefield information. The intent is obvious. More accurate, complete, and timely information should help improve commanders' planning, preparation, and execution. More information, however, does not necessarily translate into more useful information. To improve planning, preparation, and execution, commanders and staffs need relevant information presented in manageable and understandable formats. There is some risk that proliferation of digital information will result in information overload, information incompatibility, and even a possible drift from the effective use of mission critical information. Digitization holds great potential, but its functions and design should focus on the operational needs of the user.

The recently revised U.S. Army Training and Doctrine Command's (TRADOC) requirements determination process (U.S. Department of the Army, 1996a) is designed to ensure the Army acquires systems that are integrated, capabilities oriented, and experiment-based. Ultimately, school commandants, representing the warfighter's needs, are responsible for defining their respective requirements. While the requirements determination process is to consider emerging technologies, technology should not be driving the requirements. Rather, system requirements should reflect the warfighters' needs be they from the school, the field, or other commands. Nevertheless, new technologies are often enticing and can lead to pressures for including them in new systems. While warfighters are to determine the requirements, technologists often have a less constrained vision as to the potential value of new technological capabilities. In the end, successful systems are those that blend affordable, cutting edge technologies with realistic warfighter needs.

The Battle Labs were formed in 1992 as a means to streamline TRADOC's mission of identifying concepts and requirements for new doctrine, training, leader development, organizations, materiel and soldier systems. The Battle Labs provide a common ground for concept development, requirements generation, technology development and empirical research and validation. The Dismounted Battlespace Battle Lab (DBBL) located at Fort Benning Georgia is responsible for integrating all TRADOC activities that deal with soldiers operating in the dismounted battle space. A major focus of DBBL is the development and application of digital technologies for the dismounted force. In support of this mission, DBBL was recently responsible for the overall planning and execution of the Warrior Focus advanced warfighting experiment (AWE). The objective of the Warrior Focus AWE was to study the effects of digitization and "Own the Night" technologies on lethality, survivability, tempo, supportability, and operability (U.S. Army Infantry School, 1997).

This report addresses a series of questions raised by the Commanding General (CG), U.S. Army Infantry Center (USAIC) and the Chief, DBBL regarding the development of digital

systems for light Infantry; these questions were, in part, an outgrowth of the Warrior Focus AWE. The primary focus is on the digital tactical operations center (TOC). The basic concern is whether digitization for the light forces is addressing the specific needs of light forces, as opposed to more simply migrating heavy/mechanized digital solutions to light platforms. In general, this project asked selected Infantry leaders what they thought were the primary light Infantry digital requirements. The intent of this report is to provide a reality check by Infantry warfighters on the planning and development of digital systems and on the overall effect of such systems on Infantry's future. The information should aid decision-makers like the CG, USAIC in decisions about future Infantry requirements.

Method

Participants

Twelve Infantry leaders selected by the Chief, DBBL participated in this project. The group included the Assistant Commandant, USAIC, former brigade and battalion commanders from the 10th Mountain Div (Light Infantry) who had participated in Warrior Focus, brigade commanders from the 82nd Airborne Div, 101st Airborne (Air Assault) Div, and 3rd Infantry Div (Mech). Also included were officers from the Joint Readiness Training Center Operations Group, the USAIS Combined Arms and Tactics Directorate, the Task Force XXI Support Cell, DBBL, and the Product Manager, Tactical Operations Centers. Interestingly, over half of those interviewed have come out on promotion lists since the data were collected, including one to Major General and three to Brigadier General.

Questionnaire

The 12 officers were given a written questionnaire which was later followed up with a telephone interview. The questionnaire with cover letter and instructions is at Appendix A. The questionnaire and interview included questions on the following topics:

- Most critical digital concerns for light Infantry
- Differences between light and heavy TOCs by battlefield operating system (BOS)
- Relative emphasis of BOS by phase of operation
- Battle captain requirements
- Modifications of light Infantry TOC tactics, techniques, and procedure (TTPs) resulting from digitization
- Soldier as a platform requirements

Procedure

The questionnaire, cover letter endorsed by the CG, USAIS, and instructions were mailed to the participants. Follow-up phone calls were made as necessary. Within two weeks after receipt of the completed questionnaire, ARI researchers conducted follow-up interviews either by phone or in person.

The questionnaire and interview responses were transcribed, combined, and then parsed into separate ideas. The separate ideas were then grouped into common themes or concepts. This content analysis procedure clearly was quasi-scientific at best. Some points were repeatedly made while others were mentioned only once or twice. In the results we indicate the relative frequency of each idea. Also, because the questions were not independent, written responses would sometimes say, "See comments on question 1." We used our best judgment in representing the relative frequency of each idea. In a number of cases, individuals presented fairly unique ideas about future Infantry needs and possible solutions; these were included as deemed appropriate.

As a way of characterizing differences between light and heavy units, section two asked the 12 respondents to rank the relative importance of each BOS (plus Aviation) for the three phases of an mission, namely planning, preparation, and execution. The prioritizations were done separately for light and heavy battalion TOC operations. Because some of the selected leaders had only light or heavy experience, we received a total of eight rankings for both light and heavy TOC operations. A simple analysis was conducted on these rankings to identify the top (and bottom) three BOSs for heavy and light by phase of operation. The procedure simply counted the number of times a BOS was prioritized in the top three (or bottom three). Ties were broken by subtracting out the number of times a potential top three BOS was prioritized in the bottom three, and vise versa for determining the bottom three BOSs.

Results

The results presented here are fundamentally the opinions of those Army leaders interviewed. Their experience and expertise varied, as did their experience with emerging digital systems. The results and discussion are a synthesis and paraphrase of their written and verbal comments. In some cases, exact quotes are included. Taken together, this report represents the visions and concerns of a select group of Infantry leaders.

Most Critical Digital Concerns for Light Infantry

The leaders were asked to identify the "five or six issues that should have the highest priority in preparing light Infantry battalions for the Force XXI digital battlefield." Four broad issues were repeatedly addressed: the need for a user-friendly information management systems, the need for appropriate training and TTPs, the need for light-weight, maintainable systems, and the need for reliable communication capabilities to support the new systems. A number of other separate issues were also addressed.

1. Light Infantry TOCs require user-friendly, information management capabilities that will allow:

   - Situational awareness of friendly and enemy units
   - More accurate and simpler battle tracking
   - Improved information dissemination, including the capability of sending orders, graphics, and maps over digitized nets
   - A common, accurate picture of the battlefield
   - Integrated access to information across BOSs.

Improved information management was the most frequently mentioned concern -- not only in response to this question, but throughout the questionnaire. Of foremost importance is that the new information management systems and tools are easy to use. A major goal of digitization is to increase the TOC operational tempo so as to be able to get inside the enemy's decision making cycle. To do so, future systems must reduce TOC workload and allow tasks to be accomplished more quickly and easily. New information management systems should complement the functions of the TOC, not complicate them. This requirement is clearly underscored in "The Digitized Infantry Battalion" student text which notes that good digital systems should reduce workload and generally make life easier (U.S. Department of the Army, 1996b).

Another frequently identified issue was the need for improved situational awareness, through a shared, accurate picture of the battlefield. Enhanced situational awareness should significantly improve both synchronization and force protection. Increasing numbers of sensors and digital message capabilities could make tracking battle information in the TOC more difficult. To handle the increasing amounts of information, improved automated tools will be needed to aid battle tracking.

Several of those interviewed suggested that a common database structure will also be needed with tools that can intelligently integrate information from various sources, e.g., Maneuver Control System/Phoenix, All Source Analysis System (ASAS), Advanced Field Artillery Tactical Data System (AFATDS), etc. The supporting software tools will have to operate at speeds that support commanders and staffs in the military decision making process. These tools might include artificial intelligence/expert systems to help identify additional mission analyses, compare alternative courses of action, and wargame. It was proposed that these tools would have to be linked to the common database with access to information from all BOSs.

Those interviewed recognized that designing an integrated information system and common database is not an easy task, especially if it is to accurately track enemy dispositions. One suggestion for improving information management structure, procedures, and tools was to look at civilian organizations that handle large amounts of information, e.g., the Cable News Network. The Army might examine these companies' procedures and how they train their people to manage information. Several of the leaders thought there may be a need to

significantly redesign the TOC structure and operations to where structure and operations would be organized around information flow requirements, rather than historical staff functions.

A primary TOC information management requirement is to take disparate pieces of information and construct a composite picture of the battlefield. Currently, a commander goes to one area to get information on enemy dispositions from ASAS, to another area to get information on friendly dispositions, etc. It was suggested that in the future cells of people in the TOC will all be working to update or analyze the common picture of the battlefield and then passing the decisions/recommendations down or up depending on the issue. A new system must quickly and accurately integrate information onto a common screen which would allow the commander to visualize the entire battlefield. The system might include templates for artillery and air defense coverage with other optional templates as desired. Electronic maps and graphical representations of the common picture of the battlefield could then be sent out for others to see, not just by those few in the TOC.

The need to minimize information overload was also frequently mentioned. Several suggested that information overload could at least partially be avoided by designing a system with open access to common databases by all echelons. In such a system, the information user would pull the information he or she needed. By contrast, if information is pushed down from higher echelons, TOCs are more likely to become overloaded with information not really needed. One example addressed the commander's critical information requirements (CCIR). Currently a commander might identify three CCIRs which would be sent up the chain of command; a response would later come down the chain in the form of intelligence summaries. With access to a common database, brigade could directly query to get the requested CCIR information. This would require battalion and/or brigade to have trained personnel that could efficiently access information in the databases. Any redistribution of functions would also require a re-look at organizational structure.

The basic requirement to have fully integrated software and databases that link BOSs was mentioned by most of those interviewed. Common, integrated access to information across BOSs and systems would be the foundation for good information management. This recommendation is consistent with current doctrine. For example, FM 100-6 "Information Operations," (U.S. Department of Army, 1996c) states that effective management of information and assets allows information to flow horizontally and vertically across BOSs to enable effective planning, preparation, decision making, and execution. By contrast, a number of current systems require their own software, communications packages, and specific support. In the future, all systems should be able to interface with each other. This requirement should extend to systems that feed the TOC, for example, receiving systems that interface with existing systems. If, for example, a Land Warrior system is to be able to send pictures from soldiers on patrol to the TOC, the TOC should not have to have a special 'base station' to receive those pictures. Land Warrior should be required to send the information in a format that is readily understood by the standardized TOC system.

The National Research Council (1997) has recently conducted a study examining the tactical information needs of the individual soldier as related to the proposed Land Warrior

system. Many of the study's findings amplify the results reported here. They recommended, for example, that the Land Warrior display design should minimize the cognitive load that it places on the user by providing integrated information and enhance situational awareness by providing salient cues to the most important information. The system should allow for easy sharing of information between team members and between the field and headquarters. The report also concludes that "research should be undertaken about the relationship among design attributes, human attributes, and successful performance for the Land Warrior system. Significant increases or changes in soldier skills and abilities may be required as a consequence of these technologies. Effective personnel selection and training for the system will depend on understanding these relationships."

2. Infantry must develop new training programs and TTPs to:

- Permit full utilization of new digital systems and tools
- Develop leaders who understand and can take full advantage of digital capabilities

The development of the new digital systems will have significant implications for Army training. Soldiers in line units will have to be trained to operate and provide user-level maintenance on the new digital systems. In the TOC, commanders and their staff will have to be trained to use the new systems and to manage the increasing amounts of information. In addition, digital units must still be able to function when the digital systems are down. In a digital environment, non-digital skills, e.g., using a compass, map, and grease pencil, essentially become degraded mode skills, which still must be trained. To complicate matters, for many years to come some units will be digitally equipped while other units will not. Institutional and unit training plans are going to have to be modified considerably to accommodate the new digital skill requirements as well as the non-digital requirements; these issues will have to be addressed in the context of decreasing training budgets. Relatedly, ARI is currently conducting a study to examine the impact of having to simultaneously train digital skills and back-up training of non-digital skills (Salter, Black and Lickteig, 1997).

Training battle captains in the digital TOC was one of the more frequently mentioned issues; battle captain training and digital TTPs will be discussed in greater detail later in the report. In general, the battle captain and staff will need to be trained to take full advantage of the entire suite of digital tools that will be developed. For example, there may well be a skill requirement for battle captains and staffs to be adept at querying databases. Decisions will have to made as to where in the officer development program those skills will be trained. Several of the leaders interviewed suggested the digital battle captain skills might be trained in the Officer Advanced Course. It was further suggested that battle captain refresher training be included at the Command and General Staff College and in the Pre-Command Course. New TTPs will also be required for digital battle staff operations. The battle captain and staff must be taught, for example, to determine which information is most important and which is less important, for efficiency and to avoid information overload.

In general, it was suggested there needs to be more frequent staff training exercises, both for conventional and future digital units, to include greater development, distribution, and use of training support packages for conducting staff training exercises. It was further suggested that units might maintain training support databases whereby a commander could query for an order or enemy situation from higher headquarters. Progress is being made in this area. The Force XXI Training Program is currently developing a series of training packages that can be used to help train staff members (U.S. Army Research Institute, 1995).

Another training issue involves the selection and training of enlisted soldiers in line units. It used to be relatively easy to train soldiers to become radio-telephone operators (RTOs). Digital units will not be able to afford to have hunt-and-peck RTOs if they are expected to make full use of their digital capabilities. It was suggested that units need someone with keyboard skills equivalent to that of a court typist who could enter text and data as the commander speaks. Keyboard/typing skills may become critical skills for success in combat. These proficiency requirements are very different from current 11B/Infantry skill requirements. One problem is that the more specialized soldiers in the Infantry become, the more difficult it is to replace them when there are casualties. It was suggested that there needs to be a hard look as to what is trained in One Station Unit Training. In general, it was suggested that both officers and enlisted personnel will need to be computer literate.

It was also suggested that Infantry, be it heavy or light, should consider implementing continuing education requirements. Infantry could set up continuing education gates for its officers similar to continuing education requirements in other professions. Through the use of improved distance learning technologies, it would not be necessary for Infantry officers to return to the schoolhouse for the training and certification. As an example, there could be a requirement or "gate" for an Infantry captain, regardless of his assignment, to retrain to standard a specific set of tasks in a distance learning environment. This might include computer-based instruction, or even structured training exercises using constructive or virtual simulations. With the aid of training management software, Infantry branch could easily verify that the training had been completed.

One last training issue identified addressed the need to increase the experience of officers and NCOs, even though their actual time in units is decreasing. Realistic military decision-making experience is critical for officers and NCOs as one of their principal requirements in the digital battlefield is to make sound judgments and decisively direct actions. One leader suggested there needed to be a significant revamping of the basic and advanced courses toward total immersion training. He suggested that when a lieutenant comes into Infantry that he be immersed in virtual training simulation battle scenarios early on in the basic course. The training should require the young officer to repeatedly fight virtual battles, even before he is allowed to go to the field. The advanced course might be similarly reconstructed, but with more constructive simulation exercises and fewer virtual exercises. The fundamental component of the advanced course would likewise be computer-enhanced, repetition training.

3. The new digital systems must be lightweight, durable, and maintainable.

A frequently mentioned concern both for the digitized TOCs and new digital soldier systems was that they must be lightweight, simple, and durable. The ultimate value of digitization in light units is very much a function of weight and maintainability. Light battalions have light structures in terms of maintenance capabilities, i.e., few vehicles, little mechanical equipment. There was some concern that the technical, maintenance, and sustaining issues that Land Warrior and digitization will bring to the light battalion may inundate the relatively simple, light organization with complex problems that will require substantial increases to its logistical tail. While some organizations, e.g., air assault, have greater lift capability than other light units, weight and maintenance requirements were identified as concerns for them as well. It was suggested that the real issue is that we need to need to develop separate systems for light Infantry. "To think that we can develop one system for both the heavy and light and just take it out of the track and issue it to the soldier is asking for more problems. Let's recognize that the requirements are different and form different paths for development."

The dismounted soldier must already carry an substantial amount of weight just for essentials, e.g., water, ammunition, individual equipment, weapons, and food. There was concern that the added weight of any additional digital equipment and its support system would slow mobility and ultimately reduce effectiveness. Future equipment must be extremely light. It was also recommended that no new attachments be added to the soldier's current equipment. As one leader said, "The Infantry soldier's equipment has become a plethora of 'Christmas ornaments' because everything is an attachment and hangs on the soldier -- protective mask, ammunition, binoculars, compass, GPS, gloves, MREs, MILES equipment for training, flashlight if required, strobe light, combat lifesavers bag, 2-quart canteen for extended missions, M60 machine-gun spare barrel bag, etc. Another family of equipment to hang on the soldier is not needed. Integrate the camera into the kevlar, the computer into the LBE, the GPS in the buttstock of the weapon, PAQ-4s into the weapon stock, etc."

There was also considerable concern about batteries. To the greatest extent possible, all of the new systems must have low power requirements. While battery technology is improving, batteries are likely to be a problem for some time. As for maintenance, the systems should not be so complex that ordinary soldiers cannot maintain or operate them. It is very unlikely that units will always be able to rely on contractor support during wartime. It was further suggested that the Army should avoid having to send too many soldiers to specialized schools to be able to operate and maintain the new digitized equipment. Infantry soldiers will have to be trained how to operate the new equipment and to do basic maintenance and troubleshooting. Lastly, there was also some concern about the amount of time required to set up the digital TOCs.

4. There must be reliable communication links with adequate bandwidth.

The success of digitization hinges on the fielding of reliable digital networks that function in the field, not just in the laboratory. This includes the requirement to develop reliable digital links among the variety of sensors that will complete the maneuver to fire delivery platform circle. These will likely include a variety of sensors from unmanned aerial vehicles (UAVs),

rotary and fixed wing aircraft, and future systems like the enhanced fiber optic guided missile system (EFOG-M). It was suggested that the total network might be a combination of different types of networks to include fiber optics and radio.

Network bandwidth requirements will be great in order to handle all of the digital transmissions. In addition to sensors, network transmissions will be required down to the level of the individual land warrior, e.g., for position location, status reporting. The utility of the future systems will be greatly diminished if there are persistent information backlogs and disconnects because of inadequate bandwidth. As one leader noted, one intent of digitization is, "to make the commander more situationally aware and to increase force protection; both of these point toward accentuated command and control. Currently, the weak link in command and control is typically limited communications, not only in terms of voice, but in terms of systems communicating with each other." It was suggested that the communications infrastructure supporting future systems must be the best possible -- one that will not degrade as a function of weather and terrain.

5. The following are critical light Infantry digital concerns that were mentioned only once or twice.

a. Revised procedures for clearance of fires - Digitization should permit better situational awareness as to the location and direction of friendly and enemy forces. New clearance of fires procedures based on the use of digital information should increase lethality as well as force protection. The effect of quicker clearance of fires will likely lead to a dramatic increase in combat performance of light units.

b. Full integration of Global Positioning Satellite (GPS) data - TTPs need to be developed to integrate GPS location information for calling medical evacuation, fire support, resupply, etc. It was suggested that GPS might also be integrated into communications gear so that leaders will know where their transmitters are located.

c. Refine Military Operations in Urban Terrain (MOUT) TTPs - MOUT TTPs can be revised to leverage future digital capabilities, e.g., identifying locations in buildings, sewers, streets, etc., to better prevent fratricide, calling for medical evacuation, resupply, and adjusting fires.

d. Use of night vision equipment - Despite claims about "owning the night," night performance can be significantly improved with new image intensification and thermal technologies, as well as with proper of use with aiming point devices.

e. Split base operations - Enhanced digital networks will permit workable split base operations. This could include light mobile battlefield TOCs, with planners in a safe rear area, even CONUS. High bandwidth satellite links can be used to ensure necessary communication requirements are met.

f. Using/synergizing the unmanned sensors, e.g. unmanned aerial vehicles, satellite imagery - Digital TTPs need to be developed to make better use of near-real time sensor information.

g. Identification Friend/Foe procedures for air/ground - Improved procedures are needed.

h. Improved ability to disseminate CCIRs to lowest level and back - New digital TTPs are needed to help capture and disseminate CCIR information.

Critical Differences between Light and Heavy TOC Operations

The Infantry leaders were asked to describe the differences between light and heavy TOC operations for each BOS. Again, the text represents an amalgamation of comments from the written questionnaires and the interviews.

General Comments

(1) Light and heavy TOC functions are largely the same.

Overwhelmingly, the comments indicated that the basic responsibility and operations in the light and heavy TOCs are largely identical. The critical differences are in the TOC platforms, not in the BOS functions themselves. The primary question becomes how to create equipment that will allow the same functions to be performed in both the heavy and light environment. Heavy units have inherently more capable vehicles than do light units which are limited to High Mobility Multifunction Wheeled Vehicle (HMMWV)-carried TOCs. TOC size and weight is considerably more critical for light TOCs.

(2) Finer grain analyses are required for light units.

As will be mentioned repeatedly in the separate BOS sections, analyses for light operations, e.g., intel, terrain, must be in greater detail than for heavy/mech operations. By contrast, the analyses for heavy/mech operations address a larger battlespace, but with less detail.

(3) The BOS/staff structure may need to change for both heavy and light units.

Several of those interviewed said that the new information management requirements may require a relook at the BOS and staff structure for Force XXI and the AAN. The BOSs may need to be realigned as a function of their information management requirements. One suggestion was to consider combining fire support and air defense into one BOS, possibly even to include some portions of aviation and missile defense. Another noted that in the short run the implementation of digital TOC technology may require more staff to handle the increasing amounts of information. But once the digital information management systems are well-understood, it is likely that the number of people required in the TOC will be fewer than today.

Relatedly, it was suggested that a better, more mature training system will further lead to fewer staff positions.

Intelligence

(1) Light units require more focused intelligence and finer detailed analyses.

As a whole, light Infantry requires more detailed intelligence and refinement than heavy units which translates into greater amounts of intelligence information being processed. Terrain analysis is especially important for light units so as to identify possible friendly and enemy infiltration routes. While both heavy and light battalions conduct terrain analysis, light Infantry, because of their limited mobility, tends to conduct more detailed terrain analysis in the intelligence preparation of the battlefield (IPB) process. For example, the light Infantry battalion intelligence officer (S2) will look for very fine detail in terrain features for infiltration routes whereas the heavy battalion S2 will tend to focus on wide mobility attack corridors. Light Infantry units conduct a microscopic analysis of a single map sheet whereas heavy/mech units take a more generalized look across several map sheets. Also in low intensity combat (LIC) and stability operations, there is a greater need for light units to identify precise locations for caches, Air Defense Artillery (ADA) positions, mortar, and command and control sites.

(2) Light units rely more on human intelligence (HUMINT) and pattern analysis.

By contrast, heavy forces focus more on pronounced intelligence indicators such as enemy order of battle and predictable enemy courses of action (COAs). The most noteworthy difference occurs during MOUT and LIC operations. Light forces focus more on HUMINT and pattern analysis in LIC because it is more difficult to: (1) discriminate the enemy from non-combative elements, (2) conduct tactical COA analyses or even predict when and where the enemy will strike, and (3) predict high payoff targets. In addition, counter-insurgency operations require significant intelligence gathering from the non-combative/civil population.

(3) Light Infantry are more likely to be deployed in an "immature" area of operation (AO).

In the immature AO, there is often little infrastructure to support operations, for example, following rapid force projection and/or forced entry. Since scenario and deployment options are more varied, to include stability operations, intelligence requirements are correspondingly more varied. As a result, it was suggested that light Infantry may require direct downlinks from satellites as theater-level assets (or division/corps assets) may not be in place. It was suggested that light Infantry may require a direct broadcast downlink. By contrast, heavy/mech forces are more likely to arrive later than light Infantry when airfields and ports are secured and after air superiority has been achieved. Intelligence feeds can be expected from in-theater sources; therefore, ASAS may be sufficient for heavy/mech forces with no direct feeds required.

(4) Lack of mobility makes intelligence gathering by light Infantry more difficult.

Intelligence gathering is normally more difficult to obtain for light Infantry soldiers due to limited visibility in restrictive terrain. In some cases, soldiers must venture, literally, on top of obstacles or enemy positions to detect them. In more open terrain, such as a desert environment, obstacles and enemy positions can often be detected from great distances. Also while the AO of light forces is relatively compact, that is not always the case. During Desert Storm, a dismounted brigade from the 101st Airborne (Air Assault) Division had an AO covering over 100 square kilometers which significantly taxed their intelligence gathering capability.

Maneuver

(1) Light Infantry requires more precise situational awareness.

Light Infantry units have more moving parts and it is sometimes critical that they know where all elements are located. Mission success frequently hinges on accurate situational awareness. Infiltrations or ambushes, for example, based on precise intelligence can allow small dismounted forces to achieve decisive results. Also it takes longer to mass light units. Increased situational awareness will assist leaders in working out time distance factors, therefore aiding synchronization. For indirect fire purposes, light units may be required to know the location of their sister and subordinate light units down to the nearest meter. Light Infantry units have less individual force protection available than heavy/mech units. As a result, indirect fire can easily neutralize a light force, whereas in similar situations it might have little effect on an heavy force.

While situational awareness most often refers to the location of friendly and enemy forces, awareness of the location of non-combatants is also often critical. This certainly was true in Desert Storm where there were sometimes thousands of non-combatants in a unit's AO. It is even more important in LIC/stability operations.

(2) Light units rely more on stealth and surprise.

Heavy forces, by contrast, focus more on fire and movement to control the enemy, i.e., to exploit their inherent shock and speed. Light forces are generally better equipped to fight in close terrain, poor weather, MOUT, and operations other than war environments, and a primarily wheeled or dismounted threat. Success often depends on stealth and surprise rather than fire and movement. As to the supporting TOC requirements, light forces must track more detailed information in a smaller battlespace, while heavy forces must track less detail over a greater battlespace.

(3) Light forces require more effort to find the enemy.

During counter-insurgency operations, for example, light forces typically engage in pro-active searches to "find" the enemy and to maintain the offensive (as opposed to a reactive defense). Taking the initiative and maintaining the offensive are essential factors for a

successful counter-insurgency operation. Heavy forces put less emphasis on searching/finding the enemy in medium and high intensity combat. It was suggested that one contrast how light forces conduct a search and attack to how heavy forces conduct a meeting engagement. It was estimated that light forces have from 70-95% of their ground combat power searching for the enemy, while, by comparison, heavy forces typically lead with about 33% of their combat force. Again this notion supports the light force requirement for collecting and efficiently managing detailed information for better situational awareness and enhanced combat efficiency.

Fire Support

It was generally agreed that TOC operations were largely the same for light and heavy units. The differences were in time and space and asset availability.

(1) Clearing fires

Light forces are often challenged to "clear fires" during decentralized operations on a non-linear, abstract battlefield. Heavy forces typically operate on a more structured battlefield, and in comparison, normally have clearance of fire challenges only when in close combat. Again, light units need finer situational awareness so as to know where all of their moving parts are located and to be able to clear fires rapidly. Fire suppliers need to have awareness of all units so they can fire rapidly and effectively. Light Infantry also relies more on final protective fires than do heavier forces.

(2) Asset availability

Currently, heavy battalions have a wider variety of indirect fire munitions available than do the light battalions. This is because the heavy division's standard direct support indirect fire system is the 155 mm self-propelled howitzer as compared to the 105 mm towed howitzer for light units. In addition, the heavy battalion's indirect fire support has nearly 10-15 km greater range than light unit fire support, depending on munition type. Maneuver elements consider direct support artillery for every operation. By contrast, light units typically lack heavy direct support artillery, being more dependent on attack aviation and close air support. As a result it is more difficult for light units to achieve decisive mass with fires.

Air Defense

Heavy and light battalions have essentially the same number of assets available from supporting ADA battalions. However, because the light Infantry units operate much closer together, a Stinger team can generally cover a company sized element plus. The same Stinger/Avenger team in a mechanized unit can, however, only provide partial coverage for the same element size because of the dispersion during operations. In light units, lack of mobility of Stinger teams makes it more critical to know where the location of the teams are at all times, for numerous reasons to include resupply, security, and change of mission.

In addition, it was noted that light units rely more on passive ADA protection because of more limited ability to defend with active ADA measures. In light units there is less dispersion and they are generally in less open terrain. Early warning is also more redundant in the heavy TOC due to the availability of more communication links and the greater range afforded by mounted radios. In mechanized units, nearly every combat vehicle provides some ground-to-air air defense countermeasures.

Mobility and Survivability

(1) Vulnerability of light units requires better intelligence of obstacles.

Precise intelligence and good information management would allow light units to make better route selections to avoid natural and man made obstacles. In addition, lack of fire power and security in light Infantry sappers, relative to mechanized engineers, makes it critical to have a database with recent updates on obstacles and mobility route status.

(2) Fewer engineer assets are available to light units.

An engineer platoon typically supports a light task force (TF) with the TF Engineer being a lieutenant. By contrast, an engineer company typically supports a heavy/mech task force with the TF Engineer being a captain. This translates not only to differences in equipment issues, but also to differences in engineer command and control. The mechanized engineer company that supports a maneuver battalion has 102 personnel including two sapper platoons and an assault and obstacle platoon. The light engineer platoon supporting a light maneuver battalion has only 27-29 soldiers. The light engineer platoon is equipped much like an Infantry platoon, but with greater demolition capability. Typically, the platoon receives an engineer equipment slice from the engineer company which is dependent upon maneuver support requirements.

The light TF Engineer is only present in the Infantry TOC for planning and coordination requirements, as he must simultaneously lead the platoon. Therefore, many times there is no engineer presence in the TOC. Because of this, the operations officer (S3) must identify someone in the TOC to assist in tracking engineer status. The mechanized TF engineer is a more permanent feature within the TOC because of the additional manpower provided by the company headquarters section. Often four full time engineer soldiers operate in the mechanized Infantry battalion TOC. The heavy TOC relies on the engineer unit to provide full time coordination, requirements, expertise, and battle tracking of the task force's engineer assets.

Logistics (As part of the Combat Service Support)

(1) Delivery requirements are more precise for light units.

Maintaining classes of supply are critical for both heavy and light. But for light Infantry organizations, resupply must be delivered exactly when and where planned. Lack of mobility

and carrier capability make it inefficient for light units to move classes of supply once they are delivered on ground.

(2) Heavy and light units have different focus and assets available

Generally, the light community focuses on ammunition and water, whereas heavy forces place more emphasis on ammunition, fuel, and repair parts. A primary difference is the dependence on transportation assets in the light community. Light battalions have less than 50 vehicles (HMMWVs and trucks) in the entire battalion which are only available at the battalion level; none are in the companies. By contrast there are over a hundred vehicles in the heavy/mech battalion, with nearly 20 available to the companies. As a result, light battalions cannot conduct casualty evacuation operations as effectively.

Most combat service support (CSS) tracking is done apart from the battalion TOC at the combat trains command post. CSS tracking is more complex within the heavy units because of the extensive quantities and types of fuel, repair parts, and ammunition. Digitization must focus on ways to more quickly and accurately identify requirements, status, location, and urgency of logistic requirements.

Battle Command

(1) Level of detail for light operations requires transmission of greater amounts of graphics and text.

A number of those interviewed emphasized the need to be able to send text and graphics over the digitized net. This is especially important for light units, in that conducting a commander's huddle is more difficult because of mobility limitations. As a result, light unit commanders' huddles are more dangerous and time consuming than for mech units. TTPs need to be developed to permit brief-backs from different locations using digital text and graphic transmission tools. As one leader noted, a "John Madden-like" light pen would be very useful, one that would allow dynamic graphics to be transmitted in real time.

(2) Size, weight, and power are more of a concern for light units.

Light and heavy battalions should possess the ability to disseminate and receive information down to platoon level. It was suggested that the primary difference between light and heavy involves packaging. Light forces require a system that can be carried by individual soldiers, whereas heavy forces can mount systems inside armored carriers. Both require the ability to pass intelligence, operations, and CSS information vertically and horizontally. In addition, light TOCs must be more compact, lighter, and require smaller, quieter power sources than heavy TOCs, in part because light units depend more on passive measures to reduce signature. Light TOCs stress stealth, noise and light discipline for survivability much more than their mechanized Infantry and Armor counterparts.

(3) Increasing numbers of radio nets, number of digital transmissions, and frequency management are a concern.

Currently, messages passed digitally cannot be on the same frequency as voice messages. For example, the battalion commander's voice net can not use the same frequency as the frequency used by each soldier's GPS. Increased digitization, including the integration of GPS, will increase the number of frequencies required. Digitization also raises issues about space within the TOC and concerns about weight for the soldiers who must carry radios. Frequency management also becomes an issue, especially since only a limited number of frequencies are available. It was suggested that digitization will require at least one additional net/frequency at each level of command. Current operations require one antenna per radio net. This impacts space requirements, because additional radios are required to be carried by the sender and receiver of information. The signature of the TOC might also increase due to the vast amount of digital radio traffic and the increased number of antennas. Just as significant, current digital transmissions have a reduced range of roughly a third to a half as compared to voice transmissions. Also, as mentioned, there are real concerns about bandwidth limitations. Unless these issues are sufficiently resolved, digital command and control may become more difficult rather than easier.

Prioritization of BOSs by Phase of Operation

To further characterize the differences between light and heavy TOC operations, the Infantry leaders were asked to prioritize the relative importance or amount of emphasis placed on each BOS (plus Aviation) during the three phases of an operation. Table 1 shows the top three ranked BOSs for heavy and light while Table 2 shows the bottom three ranked BOSs for heavy and light. The BOSs are rank ordered within the tables, i.e., intelligence was highest ranked for both heavy and light during planning, while air defense was the lowest ranked.

As can be seen, the top three and bottom three BOSs for heavy and light are virtually identical. These results further substantiate the results contrasting heavy and light TOC operations. TOC operations and emphasis vary little between heavy and light units. As discussed earlier, the key differences between heavy and light TOCs are not in the functions, but with the equipment on which the operations are executed.

Table 1. Top Three Ranked BOSs by Phase of Operation

Planning		Preparation		Execution	
Light	Heavy	Light	Heavy	Light	Heavy
Intelligence	Intelligence	Intelligence	Intelligence	Maneuver	Maneuver
Maneuver	Maneuver	Fire Support	Maneuver	Fire Support	Intelligence
Fire Support	Fire Support	Maneuver	Logistics	Intelligence	Fire Support

Table 2. Bottom Three Ranked BOSs by Phase of Operation

Planning		Preparation		Execution	
Light	Heavy	Light	Heavy	Light	Heavy
Mobility/Surv	Battle Cmd	Mobility/Surv	Battle Cmd	Mobility/Surv	Mobility/Surv
Battle Cmd	Aviation	Battle Cmd	Aviation	Logistics	Logistics
Air Defense	Air Defense	Aviation	Air Defense	Air Defense	Air Defense

It must be added that there were several comments questioning the general rank ordering of BOSs by mission phase. For example, some noted that the rankings would change as a function of mission, enemy, troops, terrain and time (METT-T). For example in defensive operations, logistics, to include preparing barrier material, push packages, and supplying ammunition caches, will play a much larger role than in offensive operations. Also, air defense would not play a role in a triple canopy jungle. Aviation also has many different functions. For light Infantry, aviation tends to be thought of as a lift asset. In the heavy communities, it is considered more of an attack asset. Despite these caveats, the results converge with those in the earlier sections to suggest little functional difference between heavy and light TOC operations.

Battle Captain Issues

In both digital and conventional TOCs, the battle captain, with the aid of the battle NCOs, is the center of TOC information management. His job is to synchronize the battlefield by tracking the battle, anticipating enemy actions, and reacting to those actions through the other BOS representatives. While all battalions and brigades have officers serving the role of battle captain, there is no official battle captain slot on a unit's table of organization and equipment (TO&E). There is likewise no formal training for the battle captain. This in itself is a problem. The Infantry leaders were asked two related questions about possible changing roles of battle captains in digital TOCs. The first addressed the experiences and skills needed by the digital battle captain and the second addressed any special tools that should be designed to assist the battle captain in doing his job.

Battle Captain Requirements

The responses overwhelmingly indicated that future, if not current, battle captains need more experience than they have today. One third of the leaders interviewed said battle captain should have company command experience while another quarter indicated they should have battalion or brigade staff experience. Similarly, one quarter said battle captains should have graduated from the advanced course while another quarter said they should have graduated from the Combined Arms and Services Staff School (CAS3). Two of the leaders interviewed recommended that the battle captain should have a rank of major.

The other comments addressed skills that battle captain should possess. Foremost was the need for the battle captain to be able to analyze and/or visualize the commander's intent. It was

suggested that the battle captain must be able to recognize discrepancies between plans, the current situation, and resource availability. To do so, the battle captain must have both computer skills and analytical skills so as to be able to turn disparate data into meaningful information -- information that he can understand as well as to pass on to others. Several suggested that the battle captain must understand brigade operations, even if serving at battalion level.

One person commented, "The real issue is how do we get battle captain more experience in handling a broader range of assets in a broader variety of situations. He must be able to handle a much broader range of assets and a much larger variety of situations faster than the guy we got now." He went on to suggest that realistic, simulation-based, immersion training was probably the answer. Other training recommendations for the battle captain included the Joint Readiness Training Center (JRTC) Leader Training Program, a new course on digital systems to include information on sensor capabilities, and a joint firepower course.

TOCs frequently have two teams of battle captains/NCOs who serve 12 hour shifts. One team normally is more experienced than the other. This discrepancy in skills will become even more of a problem in the digital TOC as the digital sensors and computers download large quantities of information around the clock. One observation about Warrior Focus was that the TOC had to "struggle to handle the deluge of information...and the information was never-ending - 24 hours a day." Several of the leaders mentioned the need for two highly experienced, well-trained teams of battle captains/NCOs. Such a requirement poses a tough personnel staffing problem.

Another frequently mentioned point was that the light Infantry battle captain will need to be computer literate. He must be able to use the TOC software tools and fully understand their capabilities and limitations. He will also need to be able to fix software and general system problems. He must also have a basic understanding of the connectivity between the systems, especially for when the systems go down or have difficulty communicating with each other. In addition he must know how to manipulate and transfer text and graphics data. Rapid dissemination of information will be crucial. When and where the battle captain will be trained to develop these skills needs to be addressed.

Battle Captain Tools

It was generally agreed that the single most beneficial tool would be one that provides real-time, three dimensional, situational awareness of friendly and enemy locations. A constant awareness of battlefield locations will enhance battle command, permit more effective maneuvering of units in response to fluid situations, reduce casualties, minimize fratricide, and limit collateral damage. The comments indicated the need for a set of complementary tools that could be used to provide an integrated view of the battlefield. This might include an expert system with intelligent tools that would aid the battle captain in identifying and evaluating alternatives. One suggestion was for an expert system that would allow the battle captain to use something like a net browser to scan an integrated digital network. The battle captain could, for example, consider resupply alternatives based on intelligence, weather, and air asset data. He

could accept or reject proposed alternatives or direct alternative searches of the integrated databases.

Other recommended battle captain tools include:

(1) A common profile screen with the capability to turn on and off overlay data from multiple staff systems.

The common profile screen was frequently mentioned and is the platform for most of the other recommendations.

(2) Tools that aid tracking of combat power.

These tools might include real time intelligent information fusing capabilities that would help eliminate multiple plottings of the same track. It was suggested that this is a current limitation with ASAS. These tools would also help the S2 in the analytical process.

(3) Tools that assist data transmission, reporting, and dissemination of orders and information.

One of the most cited potentials of the digital battlefield and TOC is the opportunity for parallel planning. Tools will be needed to facilitate the routing, sharing of timely information, and to minimize information overload.

(4) Databases showing the current status of critical battlefield indicators.

The battle captain should be able to pull up information on personnel, equipment/weapons, ammunition, and fuel status of each friendly unit; he could use that information as the basis for tactical recommendations to the commander during mission execution. Each unit could regularly update this information and forward it to battalion/brigade, where it would be stored in a database for analysis as required. This information would also allow the logistics officer (S4) to more efficiently resupply units without having to wait for lengthy verbal or written reports from each unit -- a process which is especially difficult during mission execution.

(5) Templates showing artillery coverage.

The battle captain should be able to graphically see the artillery unit's coverage areas. He could then ensure that indirect fires were available to provide coverage throughout the mission execution. This, along with the ability to talk to the fire support element (FSE) via intercom, would enhance the effectiveness of indirect fires as a combat multiplier. By seeing friendly and enemy locations on the battlefield, he could cue the FSE to potential targets.

(6) Templates showing ADA coverage.

The battle captain should be able to see air defense unit's coverage areas. This, coupled with visually observing enemy air on his screen, would allow him to cue air defense units and maneuver units of impending threats. During the planning phase it would also allow the commander to visually observe his unit's air defense coverage plan.

(7) Templates that reflect the status of aviation assets.

The battle captain should be able to see aviation units on the screen and the status of each unit. As attack helicopters fly support missions, the battle captain could alert friendly units of incoming friendlies. Also, with improved situational awareness, he should be better at utilizing the unit's aviation assets by recommending their use at the most critical points on the battlefield.

(8) Internal TOC communication capabilities.

A wireless intercom/communication system that would allow the battle captain to access anyone and any radio in the TOC would be beneficial, especially during mission execution. A wireless intercom would also facilitate faster emplacement/displacement operations.

Modifications of Light Infantry TOC TTPs

Nearly all said that new TTPs must be developed that specify how to manage the flow of information in the TOC. Other TTPs are needed that specify how to turn the digital TOC data into information that can be used to influence the battle. This would include TTPs that would help the commander get an integrated picture of the battlefield. TTPs must be developed to permit very short TOC response times for fighting on the move and in 24 hour operations. The foundation of winning the information war is getting inside of the enemy's decision cycle. Enhanced near real-time situational awareness and improved battlefield identification will permit more rapid exploitation of enemy weaknesses. TTPs for rapid response movement and logistics support will be critical to take full advantage of these new digital battlefield capabilities.

The new TTPs should specify how the digital tools can be used to improve orders processing. For example when planning an infiltration, new TTPs might specify how to query the system to get the best infiltration routes. Similar TTPs currently do not exist. The TTPs would specify how to interact with the new systems to get the recommended routes and then, as an option, wargame the various routes to predict likely outcomes.

Other new TTPs should specify ways to communicate over the digital net to facilitate the back-brief process. It was suggested that procedures be developed that will allow subordinate leaders to communicate that they understand the commander's intent. The commander will still need to get on the ground and talk face to face, but digital back-brief TTPs could greatly accelerate this process. Related to that are TTPs that specify how TOCs are to disseminate

information to subordinate units. Also, digital TTPs are needed that specify how critical information should be flagged.

It was stated by several of the leaders that TTPs for new systems should be developed before they are fielded. Units must be properly trained on the new systems, such as future Land Warrior and TOC systems, and, more importantly, be taught how to apply those systems. Instead of just teaching them how to operate the system, provide TTPs on how the system can be applied in each type of mission and situation. It was suggested that unit's level of readiness is instantaneously decreased when they are handed a new system without the TTPs. New TTPs and related training must address impacts on the CSS structure and resupply requirements. As was stated, "Putting a system into unit hands without the appropriate all-inclusive training is a very dangerous practice, especially in rapid deployment units."

"Soldier as a Platform" Issues

The primary question asked at what level or echelon should detailed information be tracked at battalion. Land Warrior technologies will be capable of transmitting a variety of information about the status of each individual soldier. Is it, however, prudent to track the information down to the individual, fire team, or squad level? The responses were evenly split between tracking at the individual and tracking at platoon level with a couple of responses indicating squad level. Taken together, the comments seemed to indicate that battalion should routinely track at platoon level but with the capability of going down to the squad or individual. The principal reasons given for tracking at platoon level was to avoid information overload and micro-management. In addition, the platoon is the lowest level battalion realistically affects, e.g., battalion does not resupply squads. Also, it was stated that battle captains are already burdened during mission execution. If there were a constant flood of status information from 36 or more squads, information overload would likely occur. Of course, well designed automated battle tracking tools could minimize battalion TOC processing requirements.

Others suggested that information should be collected at the individual/team/squad level and automatically rolled up to platoon level. It was suggested that position, and the status of personnel, weapons, ammunition, equipment, and fuel should be tracked at all times by battalion. There should be the capability to display all of this information as needed. Again, this supports the basic requirement for situational awareness described throughout this report. The capability to determine the location of individual squads and soldiers will be necessary for delivering precision munitions and indirect fires on targets of opportunity and will enable fires to be processed and cleared more quickly. Soldiers and leaders should also be able to quickly determine the nearest medic and field ambulance locations.

One leader suggested a more revolutionary approach -- that soldier and small unit status information might better be tracked at the brigade field trains or at the brigade rear TOC rather than at battalion. He argued such an approach would facilitate resupply and air support. This would in effect skip an echelon. The battalion TOC would query for that information when needed.

Related Findings

Warrior Focus AWE

The Infantry leader's comments were largely consistent with the lessons learned from several other analyses of soldier and unit performance in digital environments. For example, the draft Dismounted Battlespace Battle Lab Warrior Focus AWE report (U.S. Army Infantry School, 1997) highlights several areas thought to be key for developing a digital force. The areas include:

- Digitized C2 initiatives can result in more effective battlefield integration. The integration will occur only if the future digital architecture is designed around a common core software which has functionality for intelligence, fire support, aviation, air defense, engineers, and logistics within one centralized database.

- Disseminating planning information and operations orders digitally provides a dynamic capability for parallel planning which can save significant amounts of time.

- Digital C2 initiatives must include several key components: (1) multi-functional common software integrated into a common database, (2) dynamic and redundant non-line of sight communications capability, (3) user-friendly, quick warming tools, and (4) digital products accessible to lower echelons for staff analysis.

- Brigade sized elements received more information than they could display or analyze. Information filters would have helped dramatically, such that each level only receives in real-time the information that they ask for or need.

- Current TTPs need refinement for future use.

- Units need to develop tactical standard operating procedures (SOPs) to determine how TOC information will be routed. The SOPs will need to be adjusted based upon network architecture of the technology being inserted. Units should exercise the SOPs in garrison before conducting digital training in the field.

Focused Dispatch AWE

As reflected in the comments above, the battle labs' focus primarily is on hardware and software system development. The results of our interviews indicate that while hardware and software design are critical to the success of the digital TOC, other factors are important as well, to include new training and TTPs. ARI's Armored Forces Research Unit at Fort Knox, KY conducted an analysis in support of the Mounted Battlespace Battle Lab's 1995 Focused Dispatch AWE. The Focused Dispatch AWE examined the impact of the integration of digital systems on a battalion task force organization, doctrine, and warfighting capabilities. The focus

of the ARI effort (Elliot, Sanders, and Quinkert, 1996) was to: (1) document the battalion task force digital training in preparation for the AWE, (2) derive training lessons learned, and (3) examine the implications for future Force XXI training methods and strategies.

The following information is from the "Summary of Implications for Future Training," from the Elliot, Sanders, and Quinkert (1996) report. Refer to the report for discussions about each point. This section, which is largely taken directly from their report, is included here because of its quality and relevance to the questions at hand.

Training Strategy

- Train individuals, teams, and unit first to proficiency in combat fundamentals - then to digital proficiency using a variety of simulations.
- Develop progressively structured training strategies with clear proficiency criteria (gates) for use in individual, team, and unit training for both digitally and conventionally equipped forces.
- Integrate ARI-sponsored "Simulation-based multi-echelon training for Armor units" (SIMUTA)-based digital training support packages/programs into Force XXI unit training. (Refer to Campbell, Campbell, Sanders, Flynn and Myers, 1995 for a description of the conventional SIMUTA training support packages and to Winsch, Garth, Ainslie and Castleberry, 1996 for digital packages).
- Adapt ongoing ARI-sponsored training research technology programs for Force XXI command and staff training, e.g. ARI (1995), Andre' and Salter (1996).

Training Management

- Involve proponent schools training developers in future Force XXI experimentation, especially for front-end functional task analyses for digitized forces.
- Use a notional digital mission essential task list (METL) as a starting point and then modify it as appropriate.
- Use the latest Standard Army Training System (SATS) technology for Force XXI unit training management. (Available of the world wide web at: www-dcst.monroe.army.mil/wfxxi/op-anx-c.htm).

Training Methods

- Ensure that computer-based training is adaptive and structured with sequential, progressively advanced lessons.
- Ensure tutorial software: (1) is interactive, (2) is adaptable to different levels of user expertise, (3) has on-line help and feedback, (4) includes diagnostic and remediation capabilities, (5) has proficiency gates for advancement, and (6) contains record keeping functions to track user progress.
- Endure digital emulation system software has networking capability for group training applications.
- Develop train-the-trainer packages to include practical exercises for working with groups using networked emulations of the digital equipment.

- Employ chain-of-command motivational strategies with any self-paced training to insure progression of individuals toward unit training goal.
- Field digital equipment emulation and tutorial software along with the digital equipment to provide initial training for individuals and sustainment training.

Prerequisite Skills and Knowledge

- Teach basic computer literacy skills in initial enlisted personnel leadership courses.
- Train basic digital systems, their use, and how they are used for specific jobs in the institution.
- Institute appropriate levels of training of digital systems architecture and system functionality in leadership courses.
- Establish a digital systems course geared toward soldiers who are identified to report to digitized units, for example, similar to the Tank Commander's Certification Course.
- Conduct initial training (or new equipment training) as soon as a unit receives new digital equipment.
- Use off-the-shelf commercial touch typing tutorial software in units to train, sustain, and enhance keyboarding skills.
- Develop information management exercises (IMEXs) and a system to conduct the exercises for schools and units (see Winsch, et. al., 1994).
- Develop intuitive computer interfaces (e.g., Windows) for digital systems to reduce initial and sustainment training needs.
- Develop color coded digital architecture job aids to help soldiers remember connections and radio nets.

Digital Learning Center

- Establish a digital learning center at battalion level to ensure sustainment of highly perishable digital skills.
- Provide workstations that use accurate digital system emulations; provide the capability to interface the workstations with real radios.
- Provide a Janus software capability to serve as a driver for leader and staff training.
- Develop and field structured training support packages with proficiency gates and train-the-trainer materials.

Simulation Training

- Develop structured training support packages for both digital and conventional units.
- Provide tools for the observer/controllers to monitor and capture digital traffic and information exchanges.
- Investigate various simulation combinations for simulating larger scale training exercises with fewer resources.

Training Literature

- Involve proponent training developers in the Force XXI process to develop approved training materials and guidance.

Training Assessment

- Identify, track, and/or stabilize digitally trained and experienced subject matter experts (SMEs) for observer/controllers (O/C) teams to ensure a capability to conduct Force XXI assessments in the near and mid term future.
- Investigate methods for rapidly training and developing digital O/Cs.

Training Support

- Conduct coordination efforts early to obtain needed quantities of digital equipment for supporting training, especially for scarce C2 equipment like ASAS.
- Secure high end workstations with appropriate technical support personnel for the digital learning center.
- Consider adding automation officers with support personnel at the battalion level to support digital and network operations.

Elliot, Sanders, and Quinkert (1996) go on to say that the single most important lesson learned in the Focused Dispatch AWE was that the Army should build on previous lessons learned. The Army should avoid repeating the same mistakes and/or having to rediscover what was learned before.

Conclusions

Requirements for light Infantry digital systems should focus on the full range of warfighter needs, not just on fielding high-speed communication technologies. The value of future digital TOC systems is primarily a function of how well the commander can use the TOC information to affect the battle, not on number of messages processed or the speed of digital transmission. Foremost is the need for a user-friendly information management system that will provide situational awareness of friendly and enemy units. The system should include tools to allow simpler, more accurate battle tracking with methods for quick dissemination of appropriate text and graphics. Information overload is a likely problem; it can be reduced with well-designed automated tools and integrated databases. Digital systems fundamentally are tools to assist the light Infantry commander, staff, and unit in completing their battlefield mission. System weight, battery requirements, and need for high-tech logistical support must not hinder the basic capabilities of light units. The tail must not wag the dog.

If the digital systems are to be successful, new training and TTPs must be developed early on to support the fielding. Commanders and their staffs must not only understand the capabilities and functions of their digital systems, but must also have an ingrained understanding of their tactical potential. Training support packages are needed that will train both the basics and to provide repetitive training on the full range of information management tasks. Proponent schools need to get an early jump on the development of TTPs, training, and training support materials; they must also continue to train and sustain non-digital skills. TTPs are needed that clearly specify how to manage the flow of the digital information, e.g., that detail mission-specific strategies for querying integrated databases. Digitization is going to impact training at

all levels. Battle captains and other staff members may, for example, need advanced analysis skills that are currently not trained in the officer and NCO development programs. Proponents should also examine the impact of digitization on staff structure and functions.

Digitization holds great promise for enhancing the performance of light Infantry TOCs and the performance of units. With the emerging technologies, commanders and their staffs will have near-real time information on the location and status on their own and adjacent units, as well as on the location and status of the enemy. There is, however, some risk that the flood of digital information will contribute to a *new fog of war.* Commanders and their staff could become so overwhelmed by the magnitude of detailed information that they are less aware of the situation than they would have been without the information. By contrast, if digital information systems are well-designed to include appropriate automated tools, training, and TTPs, commanders and their staffs may well have better information on the location and movement of enemy forces than do the enemy force commanders. Such information would permit commanders to deliver crippling, synchronized attacks to the enemy's most vulnerable points. In the end, winning the information management war will mean decisive victory with fewer casualties.

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Appendix A.

Questionnaire with Cover Letter and Instructions

DEPARTMENT OF THE ARMY
U.S. ARMY RESEARCH INSTITUTE INFANTRY FORCES RESEARCH UNIT
POST OFFICE BOX 52086
FORT BENNING, GEORGIA 31995-2086

REPLY TO
ATTENTION OF

PERI-IJ

29 May 1996

10 JUN 1996

MEMORANDUM THRU Commander, U.S. Army Infantry Center and Fort Benning, Fort Benning, GA 31905

FOR SEE DISTRIBUTION

SUBJECT: Interview on Light Infantry Command and Control (C2) Issues

1. MG Hendrix has requested ARI interview key personnel regarding Light Infantry C2 and digital tactical operations center (TOC) issues. Your input can help ensure that Light Infantry needs are adequately represented in the design and implementation of Force XXI digital C2 systems.

2. Force XXI C2 system designs have largely been driven by the requirements of the heavy force. To ensure that the special needs of light battalions are met, our interview will primarily identify significant operational differences between light and heavy TOCs. To the extent possible, the results will be used to support the Task Force XXI Advanced Warfighting Experiment.

3. Enclosed is a questionnaire addressing five related topics; these will be discussed during the interview.

a. Differences between light and heavy TOCs
b. Prioritization of battlefield operation systems by phase of operation
c. Digital modifications to Light Infantry TOC tactics, techniques, and procedures
d. Battle captain requirements
e. Soldier as a platform requirements

4. Request that you complete the questionnaire, keep a copy of your responses, and return the questionnaire in the enclosed envelope by 28 Jun 96. We will then call your office to schedule the interview; in most cases the interview will be conducted over the phone.

5. We appreciate your help. POC for this action is LTC Lee Washington, commercial (706) 545-5589, DSN 835-5589.

Scott E Graham

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SCOTT E. GRAHAM
Chief

Light Infantry Command and Control Questionnaire

Name: _____ Rank: ____ Position: _____

1. Critical differences between light and heavy TOC operations:

Consider a future digital battalion TOC in which the Army Common Operating Environment (ACOE) and planned components are in place and reasonably stable. Identify the key differences between a Light Infantry battalion and a Armor/Mech battalion for each of the BOS plus Aviation.

a. Intelligence

b. Maneuver

c. Fire Support

d. Air Defense

e. Mobility and Survivability

f. Logistics (CSS)

g. Battle Command (C2)

h. Aviation

2. Prioritization of BOS by Phase of Operation

Another way of characterizing the differences between Light Infantry and Armor/Heavy units is the relative importance or amount of emphasis placed on each BOS and Aviation during phases of a typical operation.

a. Light Infantry - Based on your knowledge of Light Infantry battalion TOC operations, rank order the relative importance or amount of emphasis placed on each BOS and Aviation during mission planning, preparation, and execution. Use a ranking only once within the phase of operation.

	Phase of Operation		
	Planning	Preparation	Execution
Intelligence	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Maneuver	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Fire Support	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Air Defense	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Mobility & Survivability	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Logistics	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Battle Command	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Aviation	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8

b. Armor/Mech - Based on your knowledge of Armor/Mech battalion TOC operations, rank order the relative importance or amount of emphasis placed on each BOS and Aviation during mission planning, preparation, and execution. Use a ranking only once within the phase of operation.

	Phase of Operation		
	Planning	Preparation	Execution
Intelligence	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Maneuver	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Fire Support	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Air Defense	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Mobility & Survivability	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Logistics	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Battle Command	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Aviation	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8

Comments:

3. TTP Revisions

As Land Warrior with its planned technology insertions and digital C2 systems are fielded, which Light Infantry TOC TTPs do you think will need the most revision?

4. Battle Captain Requirements

a. What attributes, i.e., skills, level of experience, education, do you think future Light Infantry battle captains should possess?

b. What special capabilities or digitized tools do you think digital battle captains require?

5. Soldier as a Platform Requirements

Digital technologies permit the tracking of increasing amounts of information, e.g., position location, ammo levels, medical status, weapons availability. What information do you think needs to be tracked at the battalion TOC for the individual soldier and/or should be aggregated at team, squad, platoon levels?

6. Most Critical Digital Concerns for Light Infantry

What five or six issues should have the highest priority in preparing Light Infantry battalions for the Force XXI digital battlefield?