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**ARMY TRANSFORMATION AND STRATEGIC MANEUVER:
FUTURE FORCES AND DEPLOYABILITY CONSTRAINTS**

BY

**CHARLES J. DAVIS
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USAWC STRATEGY RESEARCH PROJECT

**Army Transformation and Strategic Maneuver:
Future Forces and Deployability Constraints**

by

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The views expressed in this academic research paper are those of the author and do not necessarily reflect the official policy or position of the U.S. Government, the Department of Defense, or any of its agencies.

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ABSTRACT

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The Army's desire for continued relevance in the 21st century has led to a host of concepts to enhance Army strategic maneuver capability. Current Army forces cannot meet the desired timelines of warfighting CINCs and will become less relevant if future adversaries move quickly to seize their strategic objectives. To introduce the problem, this paper shows how current forces are too large and heavy, requiring unavailable transportation capability to always deploy in a relevant period of time. Recognizing this problem, the Army Chief of Staff has proposed new goals for strategic maneuver of future forces in a transformed Army. Meeting these goals will require improved transportation capabilities and smaller and lighter Army forces that require less sustainment cargo. Despite some expected improvements in transportation capabilities, it is unclear that the future Army forces will be designed to meet strategic maneuver goals. This paper examines future force concepts such as mobile combat teams, middle weight brigades, and future warfare divisions, and applies realistic global deployability constraints to determine possible solutions to meet strategic maneuver goals for a relevant transformed Army.

TABLE OF CONTENTS

ABSTRACT III

PREFACE..... VII

LIST OF ILLUSTRATIONS..... IX

LIST OF TABLES..... XI

ARMY STRATEGIC MANEUVER: FUTURE FORCES AND DEPLOYABILITY CONSTRAINTS..... 1

ENDNOTES31

BIBLIOGRAPHY35

PREFACE

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LIST OF ILLUSTRATIONS

Figure 1. CONUS capabilities to deploy sealifted Army forces.....	8
Figure 2. Airlift Capability.....	10
Figure 3. Future 30-day Strategic Lift Capabilities.....	23

LIST OF TABLES

TABLE 1 DEPLOYABILITY OF ARMY TOE COMBAT UNITS	5
TABLE 2 DEPLOYABILITY DATA FOR LIGHT AND AIRBORNE DIVISIONS.....	16
TABLE 3 MOBILE COMBAT TEAM DEPLOYMENT DESIGN.....	17
TABLE 4 AVERAGE DAILY INFRASTRUCTURE WORKLOADS (STON PER DAY) FOR FUTURE STRATEGIC LIFT SCENARIOS.....	25

ARMY STRATEGIC MANEUVER: FUTURE FORCES AND DEPLOYABILITY CONSTRAINTS

The National Military Strategy requires that the Army provide dominant land combat power over the entire spectrum of operations. The Army Chief of Staff, GEN Eric K. Shinseki, has issued a new Army Vision Statement: "soldiers on the point for the nation transforming the most respected Army in the world into a strategically responsive force that dominates across the full spectrum of operations."¹ GEN Shinseki is leading a transformation of the Army that specifically focuses on improving the deployability and responsiveness of the Army.

Today's National Military Strategy requires the ability to respond to nearly simultaneous major theater wars (MTWs) in both Southwest Asia and Northeast Asia. Significant Army forces are required in both wars for the expected halt and counterattack phases of the campaigns. Scenarios describing these potential wars have been analyzed in both the deliberate planning and programmatic communities.² Deployment of Army forces to support either or both of these wars would be a tremendous challenge for the Defense Transportation System (DTS). These dual-MTW scenarios provide the fundamental requirements that DoD uses for investing in strategic mobility programs to build a robust global defense transportation system. Capabilities of strategic sealift and airlift assets, along with worldwide transportation infrastructure, impose measurable constraints on the speed of Army deployments.

The National Military Strategy also requires effective response to small scale-contingencies and the conduct of military operations other than war. U.S. national authorities may decide to use military power to respond to a potential enemy's regional aggression. This response may include military means well short of those required for the classic MTW, but still require lethal firepower and extremely rapid maneuver. The Army needs to have relevant forces to help achieve national objectives in such limited war scenarios. Today's highly lethal armored and mechanized Army forces are very effective, but may take too long to get to the fight and be extremely hindered by austere infrastructure both entering and maneuvering within the theater. Army airborne and light infantry forces designed for air deployability lack lethality, and actually are much less deployable than sometimes advertised.

General Shinseki's recently announced plan to transform the Army seeks to build a deployable and responsive force that is relevant across the spectrum of operations. He has set new and ambitious global deployability goals for the Army. This paper seeks to pinpoint critical deployment constraints and discuss the implications of those constraints on aspects of the Army transformation such as force design, deployment and warfighting doctrine, and transportation asset requirements to determine possible solutions to meet strategic maneuver goals for a relevant Army. Improved transportation capabilities will contribute to these solutions, but radical force design changes (both lighter and fewer deployable systems) are mandatory to meet Army transformation goals.

ARMY DEPLOYABILITY SINCE DESERT STORM

Operation Desert Shield/Desert Storm was a single MTW requiring the largest deployment of US forces since World War II. Two Corps were deployed from CONUS and Europe to Saudi Arabia in a little over six months (from August 1990 to February 1991). The lengthy time required for this deployment illustrated DoD's need for significantly more organic strategic lift, especially sealift. The Army also had difficulty with rapid unit deployment and shipment of CONUS ammunition stocks due to inadequate rail and container loading infrastructure.³ After the Gulf War, the Joint Staff initiated a Mobility Requirements Study (MRS)⁴ to determine mobility requirements and possible programmatic solutions to predicted shortfalls. The Army's participation in the MRS included the development of the Army Strategic Mobility Vision, a significant statement of clear deployment goals.

These deployment goals were defined for a scenario requiring strategic response "anywhere in the world." The goals included the following: airlift of an Army brigade within four days, airlift of an Army division within 12 days, sealift of two heavy divisions within 30 days, and complete delivery of a fully sustained 5 and 1/3-division corps within 75 days.⁵ An additional goal of delivering a heavy brigade within 15 days also emerged with the Army's pre-positioning afloat strategy. The Army Strategic Mobility Vision evolved first into the Army Strategic Mobility Plan and then into the Army Strategic Mobility Program (ASMP) as resources were applied to meet shortfalls.

The Joint Staff included a scenario that reflected the new Army deployment goals as "Case D" of the Mobility Requirements Study.⁶ The original MRS has been followed by a series of studies during the 1990s, including the Mobility Requirements Study Bottom Up Review (MRS BUR), the MRS Bottom Up Review Update (MRS BURU), and the current MRS - 2005. The scenarios used in these studies have continued to require Army strategic responsiveness similar to the ASMP goals for one or two major theater wars. The recommendations from these studies have helped justify an impressive investment in DoD strategic mobility assets, greatly improving the Army's ability to meet ASMP deployment goals.

The Army has designated 16 CONUS installations as power projection platforms (PPPs) that will serve as the origin for most Army unit deployments. Meeting ASMP goals implies specific transportation requirements at these installations. For example, transportation infrastructure at Forts Stewart, Benning, and Hood must support the deployment of full brigades (one third of a heavy division) in 2-day increments. The Army has programmed significant investments to improving transportation infrastructure such as rail loading and airfield facilities at these 16 installations. Another 12 installations that mobilize and deploy some Army units have been identified as power support platforms (PSPs), along with critical ammunition depots, are programmed for similar transportation infrastructure investments.

The MRS studies have continued to justify the need for investment in the C-17 aircraft to provide vital airlift for units and cargo. A fleet of 135 C-17 aircraft is under production, with 56 aircraft completed by the end of 1999 and the entire fleet programmed by the end of 2005. The C-17 is essentially replacing the retiring fleet of 266 C-141 aircraft and not increasing total airlift throughput capability. The C-17

provides more capability to transport large, "outsize" cargo not eligible for C-141 transport, but the "fewer tails" somewhat reduces the flexibility of the airlift fleet.

The most significant result of the MRS studies is the vast improvement in DoD organic sealift capability. The Navy is procuring 19 large medium speed roll-on/roll-off (RORO) ships, or LMSRs. Eight of the LMSRs will be used by the Military Sealift Command (MSC) Combat Prepositioning Force for the Army's afloat pre-positioning cargo, and the remaining 11 LMSRs will be held in the surge sealift fleet. (A 20th LMSR is programmed to support the Marine Corps pre-positioning fleet.) The Navy is also enhancing the Ready Reserve Force, which includes 8 Fast Sealift Ships (FSS), 31 ROROs and 30 other ships, bringing the total capacity of the 80-ship surge sealift fleet to about 9.6 million square feet by 2002.⁷

Pre-positioning of unit and sustainment cargo is an important component of the Army's mobility strategy. By 2005, the Army will have two heavy brigades and a significant package of combat service support (CSS) equipment and sustainment cargo loaded on eight LMSRs, which will usually be stationed at Diego Garcia in the Indian Ocean. Additional pre-positioned packages (usually heavy brigade sets) are located in Southwest Asia (Kuwait and Qatar), South Region Europe (Camp Darby, Italy), two brigades in Central Region Europe (Germany) and Korea.

Theater reception and transportation within a theater of operations is usually the "narrow end of the funnel" when measuring the ability to deliver Army forces to warfighting commanders. Transportation infrastructure varies around the world and can literally choke the flow of combat power to a crisis situation. Some countries have "world-class" sea and airports (i.e. Saudi Arabia) that can support large surges of ships or aircraft arriving, while others may totally lack modern facilities (i.e. Albania) and can only accept military cargo at very slow rates. Road and rail networks also vary widely, with land transportation in some countries hindered by poorly built or maintained roads and bridges that can not handle the Army's heavy weapon systems and trucks.

The Army's Transportation Center and School focused on solving theater transportation problems in the late 1990s, and helped the Army resource enabling capabilities that will enhance theater reception, staging, onward movement, and integration (RSOI). In particular, the Army has recognized the need for heavy trucks, procuring hundreds of heavy equipment transporters (HETs) to move M1-series tanks and other heavy tracked systems. Newly organized combat HET companies (with 96 HETs each) were formed to support operational maneuver and RSOI requirements. Fielding of the Palletized Loading System (PLS) and HEMTT-series truck and trailer fleets, commercially-adapted fuel trailers and container handling equipment has enabled the Army to increase greatly the theater throughput of massive sustainment requirements.

The Total Army Analysis for the 2005 program horizon (TAA-05) has also justified Army units required to support Wartime Executive Agency Requirements (WEAR) from the other services. Under WEAR, the Army must provide land transportation for sustainment of the Air Force and Marines. TAA-05 added significant transportation and other combat service and combat service support (CS/CSS) forces to the Army, but this has also greatly added to the footprint of the Army's deployed force. For example, the

Army's total deployment weight of unit equipment increased by 50 percent (from 2 to 3 million short tons) in the dual-MTW scenarios used for the two most recent MRS studies (MRS BURU to MRS-05). Much of this increase is explained by WEAR and the funding of other CS/CSS units.⁸

DEPLOYABILITY ANALYSIS: MEASURES FOR CURRENT FORCES

Force deployability analysis examines transportation and deployment resources (for example, quantities of transportation assets) and time required to deliver a force to a tactical assembly area for employment by a combat commander. Restated, the key questions are: (1) How much transportation is required? and (2) How long does it take to get somewhere? Power projection includes the strategic- and operational-level transportation of unit equipment, personnel, and sustaining supplies. When measured at the division and other appropriate levels, transportation requirements for Army forces have increased tremendously since the Vietnam era. Despite many initiatives to "lighten the force" and supposedly improve deployability of Army forces, the evidence shows that deployable Army forces continue to grow and get heavier.

Table 1 shows a set of deployability measures for a variety of current Army forces. Army heavy divisions (armor and mechanized infantry) essentially doubled in weight between the Vietnam era (about 50,000 short tons (STON)) and the early 1990s, when they reached about 100,000 STON. The heavy divisions are also voracious consumers of sustainment supplies, especially fuel and ammunition, effectively consuming their own weight of 90,000 to 100,000 STON every 30 days. Except for small ready forces, heavy forces are always deployed by sealift. Strategic airlift of heavy battalions, brigades, or a division is simply not practical, as it would consume a large percentage (or all) of the Army's allocation of the total airlift throughput for many days and weeks. A heavy division can be transported faster using 6 to 12 strategic sealift ships, even if the entire airlift fleet is dedicated to the mission.

The Army's new "conservative heavy" design for the Force XXI heavy division is a step in the right direction to improve deployability. The increased situational awareness provided by the "digitization" of the major combat elements allows heavy maneuver forces to operate effectively over far greater "boxes" of terrain. Therefore, the Army decided to reduce the number of combat weapon systems in a division (Abrams tanks and Bradley fighting vehicles) by eliminating a full company from each armor and mechanized infantry maneuver battalion. Table 1 shows that this change and others in the design of the Force XXI division have resulted in reducing the total weight of the heavy divisions (mechanized or armored) by 7 to 11 percent, but have reduced the sealift requirement by only about 3 percent. Stages of deployment on land (CONUS and intratheater) are also improved with reduced requirements for unique DoD heavy-duty railcars and heavy equipment transporter (HET) trucks. The reduction in sustainment (fuel, ammunition, etc.) and other logistics support (trucks, maintenance units) required to employ the division is more difficult to measure, but will certainly contribute to a reduced deployment footprint.

Unfortunately, another important change to the heavy division has a negative impact on deployability. The self-propelled M109A6 Paladin howitzer and the tracked M992 resupply vehicle will be

TABLE 1
DEPLOYABILITY OF ARMY TOE COMBAT UNITS⁹

Army Unit	Short Tons (K STON)	Square Feet (K sq ft)	Sealift		Airlift
			LMSR*	RRF RORO**	C-17 Missions
<u>Divisions:</u>					
Light Infantry Division	17.8	548	2.1	4.4	549
Infantry (Airborne) Division	24.8	908	3.4	7.2	667
Airborne (Air Assault) Division	34.3	1056	4.0	8.4	1027
Infantry (Mechanized Division	93.6	1460	5.5	11.6	1898
Armored Division	97.3	1447	5.5	11.5	1936
Heavy Force XXI Division	86.8	1411	5.3	11.2	1780
<u>Regiments:</u>					
Armored Cavalry	29.9	411	1.6	3.3	578
Light Armored Cavalry	11.4	300	1.1	2.4	310

* Average capacity = 264,000 square feet

** Average capacity = 125,600 square feet

replaced by the Crusader. The two-vehicle Crusader system is providing an important upgrade in the mobility and lethality of artillery systems for heavy forces. However, the combat-loaded Paladin and M992 each weigh under 30 tons and each Crusader vehicle will weigh 64.5 tons (129 tons for the two-vehicle system).¹⁰ This modernization is replacing 24 Paladin tubes with 18 Crusaders in each of the division's three field artillery battalions. The impact of Crusader on sealift is negligible; but land transport requirements for unique DoD heavy-duty railcars and HET trucks increase significantly, **essentially erasing the land deployability improvements from reducing the number of tanks in the Force XXI division.** Crusader explicitly trades off a gain in tactical mobility for a loss in operational maneuverability and increased HET truck support requirements.

At the other end of the deployability spectrum are the Army's light divisions, including infantry (light), infantry (airborne), and airborne (air assault) divisions. The light infantry division was designed and organized in the mid-1980s, with deployability goals of 500 C-141 missions and no outsize equipment requiring C-5 aircraft. The light division has never met these goals, and in 1997 required 816 C-141 missions, plus another 61 C-17 missions (to move outsize cargo such as UH-60 Blackhawk helicopters).

The weight of the division has increased from about 11,000 to 18,000 STON since 1987.¹¹ The current light division (April 1999 TOE) actually requires 549 C-17 missions.¹² If the Army's entire allocation of airlift and optimal airport infrastructure is available, a light division could possibly be deployed to SWA in about 10 days. A simple example of how the Army has continued to fool itself regarding its deployability is the fact that formal Army War College lecture briefing slides and exercise pamphlets still proclaim the light division can be deployed in 500 C-141 missions.¹³

Elements of the infantry (airborne) division are rapidly deployable by air, but it would require about 2 weeks to deploy the whole division to SWA by air, and only under optimal conditions. Airborne division weight has grown from 16,000 to 25,000 STON since 1983.¹⁴ About one half of the 82d Airborne Division deployed by sea during Operation Desert Shield. The airborne (air assault) division is a mobile and lethal force desired by CINCs, but it is most likely to be deployed by sea. It weighs about 34,300 tons (up from 22,000 STON in 1983)¹⁵ and includes substantial outsize cargo requiring the C-5 or C-17 for airlift.

DEPLOYMENT CAPABILITY AND CONSTRAINTS

The capability of the global Defense Transportation System (DTS) to project military power is built primarily upon infrastructure and transportation assets. Manpower to operate the infrastructure and assets is the third key resource, but is the least constraining, so this discussion focuses on the physical constraints of infrastructure and assets.

Infrastructure includes the fixed physical facilities required for transportation operations, including rail, highway, and sea/airport networks and terminals in CONUS and overseas. Overseas infrastructure includes en route facilities, intermediate or theater staging bases, and ports/networks in the area of operations. Infrastructure usually requires enabling equipment such as cranes, container handlers, K-loaders, and forklifts to maximize the throughput of military power. Secondary infrastructure enablers include electric power, communications, and information systems to provide maximum capability, in-transit visibility, and deployment command and control. The presence of adequate infrastructure varies widely around the world, and Army forces have been especially stymied in overcoming transportation infrastructure obstacles in support of recent operations in Somalia and Albania. Significant infrastructure problems also exist in more modern countries such as South Korea.

Transportation assets include the actual vehicles, ships, and aircraft that move combat power. DoD relies on both: (1) organic assets such as cargo aircraft, RORO ships, and heavy equipment transporter (HET) trucks, and (2) commercial and host nation assets such as passenger aircraft, container ships, locomotives and railcars, and trucks. The size and weight of much of the Army's weapons and equipment do not allow efficient transportability, and limit their strategic movement to very limited assets such as C-17 and C-5 aircraft or to ships. The time and distance equations that rule worldwide deployment with these assets provide stark realities when analyzing the time required to deploy the type of force usually desired by Army commanders.

Overseas deployments will depend almost entirely upon strategic airlift delivery until the date the first sealift ship arrives in theater (SLOC closure). This "early-entry" phase of a deployment is very difficult to plan and manage, as the very limited throughput of the airlift system must deliver a balance of weapons, equipment, personnel, and sustaining supplies for each of the participating Services as prioritized by the warfighting CINC commander. The CINC's wish-list of requirements always greatly exceeds the capability of the airlift system during the early entry phase, and allocation of scarce airlift is one of the toughest planning and crisis management challenges faced by the supported CINC and TRANSCOM. Recent operations (Desert Storm and later) and contingency plans show that the Army can expect to be allocated no more than 40 percent of the airlift (measured in STON delivered) during the early entry phase. According to a senior Army transportation officer, at least one existing MTW plan allows the Army only 14 percent of the airlift in the first ten days of deployment.

The Army Prepositioning Set (APS-3) stationed at Diego Garcia can be transported in about 7 to 10 days to the major SPODs in the Arabian Gulf or South Korea. These ships provide substantial combat power and support units (two heavy brigades by 2005 with 30 days of sustainment), but the sealift faucet can not really pump larger forces into theater until surge sealift vessels arrive from CONUS. This will take about 3 weeks for a deployment to the Arabian Gulf or Korea.

The immense size of current Army organizations and the logistical support required to sustain them have destined our planned MTW deployments to be best measured in months, rather than weeks or days. Current sealift and airlift programs will provide capabilities to deploy Army MTW counterattack forces in 3 to 4 months by the year 2005.

ARMY DEPLOYMENT CAPABILITY QUANTIFIED – CONUS MOVEMENT

Analysis of deployment constraints includes examination of the three primary segments of deployment: CONUS movement, strategic transportation, and theater delivery.

CONUS-based Army forces deploy from their installations, also known as their Power Projection or Power Support Platform. They move by rail or highway to ports of embarkation for strategic transportation by airlift or sealift. Since deployment of convoyed vehicles is relatively unconstrained, rail transportation is the most limited capability for sealifted forces. Most tracked vehicle deployment is planned for rail, and most unit movement (wheeled and tracked vehicles and containers) of greater than 400 miles is planned for rail. Some airlifted forces face possible infrastructure constraints at Army APOEs, which are being addressed by ASMP studies.¹⁶

Figure 1 shows estimates of total CONUS capability of key transportation systems to deploy sealifted Army forces. CONUS seaport of embarkation capability is very robust. Total throughput capability of 29 CONUS ports studied in MTMC's Ports for National Defense (PND) Program is about 910,000 STON per day (excluded from figure 1).¹⁷ MTMC has negotiated port planning orders for the priority use of 33 actual berths. These 33 berths, along with DoD ammunition ports, provide an estimated capability of 177,350 STON (figure 1), or less than 20 percent of the total capability of the PND ports.

This ample infrastructure is unlikely to constrain Army deployment, even though disruption of commercial traffic will be a political issue except in the case of national emergency.

When current ASMP programs are complete, the Army's 16 Power Projection Platforms will have the capability to load a total of about 3600 railcars or 108,000 short tons (STON) per day. Also, the 12 Power Support Platforms will have capability to load 900 additional railcars or 27,000 STON per day.¹⁸

The availability of railcars is the most likely constraint on acceleration of Army deployments within CONUS. MTMC's fleet of 1156 flatcars can deliver an average of about 17,000 STON per day to SPOEs.¹⁹ These cars are pre-positioned at Power Projection Platforms to transport heavy tracked vehicles, and would be the Army's primary source of railcars until commercial railcars become available (usually within 7 days). Over 10,000 commercial rail flatcars are useful for military unit equipment cargo and could deliver about another 50,000 STON per day after the first week of deployment.²⁰

Therefore, Army forces enjoy a robust CONUS infrastructure and can move rapidly to ports of embarkation. Airlifted forces require continued improvement of APOE infrastructure as planned under ASMP, but are generally unconstrained until they seek actual strategic aircraft (addressed in the next section). Additional infrastructure studies and investments (for Army installations) will be required for sealifted forces to meet the Army transformation goal of deploying a full Corps in 30 days.

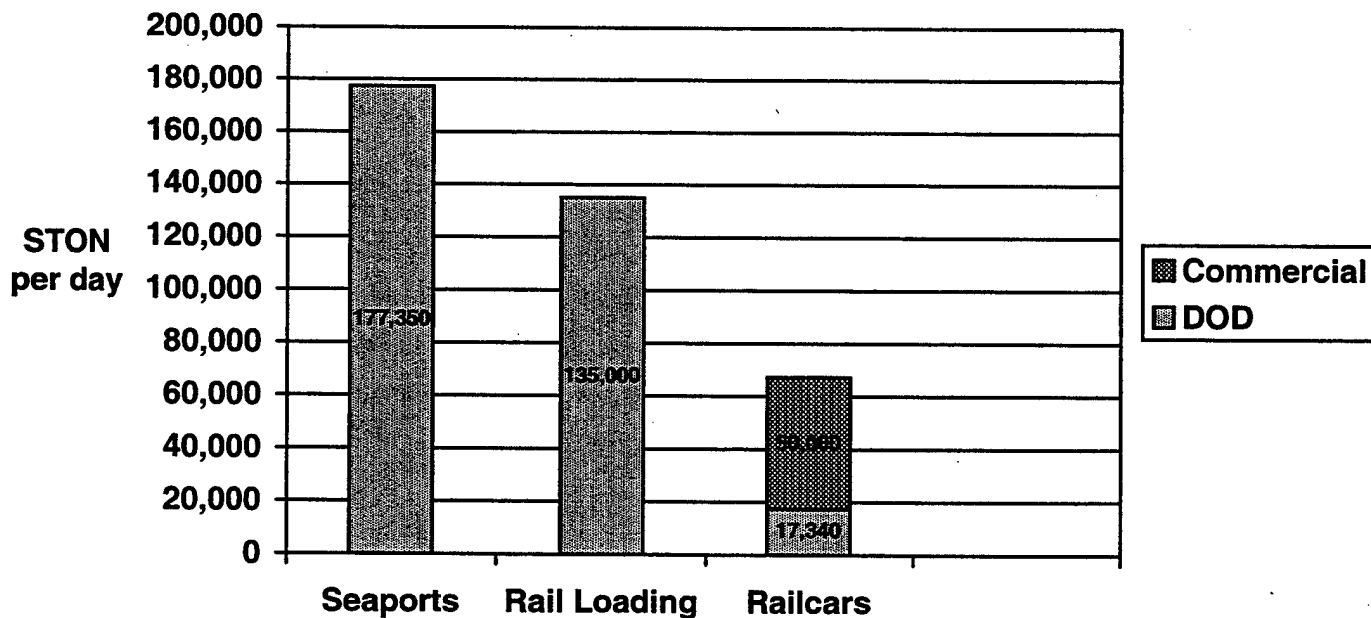


Figure 1. CONUS capabilities to deploy sealifted Army forces.

Airports of embarkation (APOEs) should not present unsolvable constraints to airlifted forces, as adequate infrastructure exists at major APOEs to project more cargo than the strategic airlift fleet can handle. For example, almost all major CONUS APOEs have a working "maximum on ground (MOG)" of three to nine aircraft. Air Mobility Command analysis shows that each "slot" of working MOG could throughput 364 STON per day when servicing the programmed airlift fleet (C-5, C-17, and CRAF aircraft).²¹ Each of these APOEs would have a 24-hour throughput ranging from 1092 to 3276 STON per day.²² Between 5 to 10 airports of this size could support continuous strategic mobility operations of the entire AMC and CRAF fleets. One MRS-05 scenario spreads the airlift workload over dozens of APOEs, with the most active 25 of them handling a total workload of about 700,000 STON over the length of the dual-MTW scenario. Those 25 APOEs have programmed infrastructure that could support loading about 62,000 STON per day.

The Army does have specific APOEs that lack sufficient MOG or processing facilities to meet current programmed airlift requirements. These requirements will certainly become more compressed to meet Army transformation goals. Installations with future early entry forces will require very robust MOG, aircraft fueling and cargo processing facilities at their APOEs.

ARMY DEPLOYMENT CAPABILITY QUANTIFIED – STRATEGIC TRANSPORTATION

Sealift is currently the primary mode for strategic transportation of Army forces and sustainment. Roll-on/roll-off (RORO) ships are the ideal assets for sealift of Army unit equipment, as vehicles are simply driven on and off these ships and tied down directly to decks resembling parking garages. Container ships, primarily owned by commercial industry, are most useful for delivery of sustainment cargo. Older breakbulk and other special heavy-lift ships provide supplementary capability, but are far less efficient than RORO and container ships. DoD's surge sealift fleet will have a 9.6 million square foot RORO capacity by 2002 with completion of the Large Medium Speed RORO (LMSR) fleet and enhancements to other ships in the Ready Reserve Force (RRF). Another 4.6 million square feet of sealift capacity resides in the 24 RORO ships programmed for the Army and Marine Corps pre-positioning fleets.

The Army's programmed force from TAA-05 provides the force list for the current MRS-05 study. Dual-MTW scenarios in the MRS-05 study require deployment of about 48 million square feet (or 3 million STON) of Army unit equipment.²³ If 90 percent of this force (about 43 million square feet) is transported by sealift, the programmed sealift fleet, including the pre-positioning ships, could deliver this force in about 160 to 180 days.²⁴ According to ongoing MRS-05 analysis, using U.S. flag containerships participating in the Voluntary Intermodal Sealift Agreement (VISA) to supplement the RORO fleet for transporting Army unit equipment could save up to six weeks in closing the dual-MTW force. TRANSCOM exercises have shown that containerships can effectively deploy Army unit equipment, but cargo transfer rates (loading and unloading) are much slower for unit equipment than RORO ships and require modern port infrastructure (container gantry cranes).

Over recent years, planning models predict a total airlift throughput of 47.6 million ton-miles per day with the fully mobilized organic AMC fleet supplemented by CRAF Stage III from the commercial airline industry.²⁵ This capability could deliver about 5,000 STON per day to overseas locations such as SWA and NEA. Figure 2 shows how AMC organic aircraft and the various stages of CRAF contribute to the total airlift throughput. CRAF contributes 43 percent of the total throughput, with Stages I, II, and III, contributing 12, 16, and 15 percent, respectively. Analysis of recent MTW scenarios (from CINC plans and programmatic studies) shows that Army forces would be allocated no more than 40 percent of the total airlift throughput, or an average of about 2,000 STON per day.

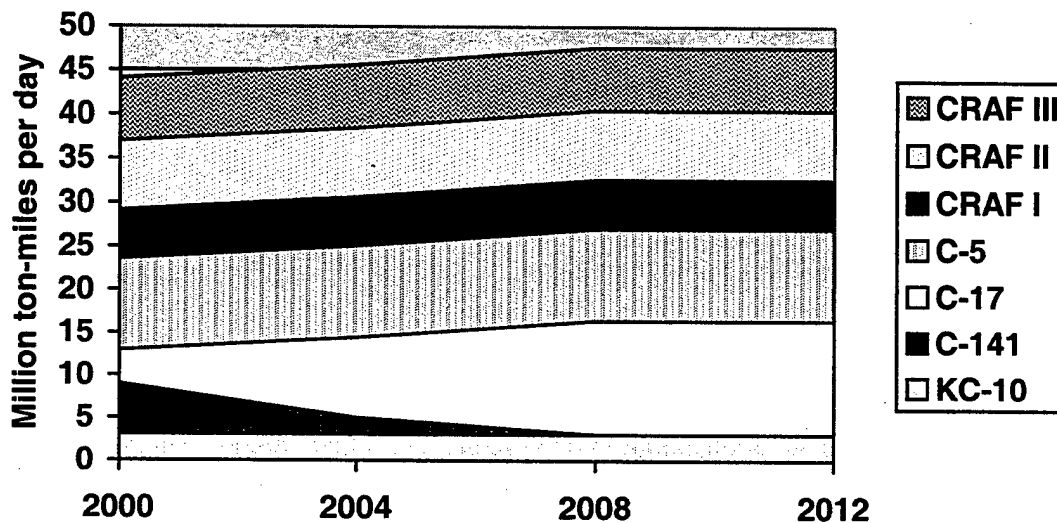


Figure 2. Airlift Capability

However, our airlift system has never produced a sustained throughput of 5,000 STON per day for an overseas deployment. The Desert Storm deployment operated under CRAF Stage II and averaged 2,400 STON per day, with about 2,000 STON per day for the first four months, and peaked with delivery of about 3,500 STON per day in January 1991.²⁶ The high tempo of deployment operations in recent years has led to severe readiness problems with the C-5 fleet. Air Mobility Command analysts now claim that the current airlift fleet (at CRAF Stage III) could only generate about 3,800 STON per day in overseas throughput (implies 1520 STON per day for the Army share). They predict that reaching throughput capability of 5,000 STON per day by the year 2014 would require \$25 billion investment in additional C-17s, C-5 modernization, and infrastructure above existing programs.²⁷ An additional \$20+ billion in another 100 C-17 aircraft and even more infrastructure would perhaps yield throughput of 6,200 STON per day.²⁸

Investment to reach throughput of 6,200 STON per day is highly unlikely due to DoD resource competition and constraints. AMC advises that the Army structure a force that can operate around the globe with early maximum strategic air delivery rates of about 5,000 tons per day to serve the entire Joint

force. The number of "tails" (aircraft), the budget, and the infrastructure will not allow any more.²⁹ Given the past performance of the airlift system and the uncertainty of future infrastructure capability and security, 5,000 STON per day (2,000 STON per day for the Army share) is still a very optimistic assumption for 2014 and beyond.

Dual-MTW scenarios in the MRS-05 study require deployment of about 3 million STON of Army unit equipment. If 10 percent of Army unit equipment (300,000 STON) is transported by airlift, the programmed airlift fleet could deliver this force in about 200 days (assuming 1520 STON per day for the Army).

Strategic airlift throughput will be far less than 5,000 STON per day during conduct of limited wars, such as the recent Kosovo campaign. CRAF was not activated for the Kosovo campaign. CRAF Stage III and partial mobilization will be used only in times of severe national emergency (such as a dual-MTW) where our vital national interests are at stake. The early stages of limited wars are likely to have only some contracted commercial aircraft support (Stage I or no CRAF), only a Presidential Reserve Call-up (PRC), and competition for other priority use of the organic AMC fleet. The 2,400 STON per day achieved during Desert Storm (using CRAF Stage II) is a very optimistic airlift goal for limited wars that still might require rapid deployment of Army forces. The Army share (40 percent) of this "limited war" throughput would be 960 STON per day.

ARMY DEPLOYMENT CAPABILITY QUANTIFIED – THEATER RECEPTION AND ONWARD MOVEMENT

Infrastructure at theater seaports may constrain the strategic delivery of Army forces, as experienced in Somalia and Albania. Many seaports in the world do not have the required water depth (35 feet) to service our LMSRs and other large RORO and container ships. Deployment of Task Force Hawk elements in the recent Kosovo campaign, by surface transportation through the seaport Durres, Albania, was severely limited by a harbor draft of only 26 feet, allowing only Mediterranean ferries, coasters and Army watercraft.

The gradual delivery of Army forces in the MRS-05 scenarios imposes a daily average throughput requirement of about 20,000 STON per day to theater SPODs just to handle Army unit equipment. Even those ports with adequate water depth would require about eight RORO berths to achieve a continuous capability of 20,000 STON per day. Some countries simply do not have the required seaport infrastructure to handle MTW deployments at the pace required by MRS-05. (Cambodia, Colombia, Croatia, Cuba, Djibouti, Ecuador, Eritrea, Libya, Qatar, and Slovenia are all good examples.³⁰) The accelerated deployment pace envisioned for the transformed Army will likely disqualify many other countries if the Army's weight and footprint remain the same.

Theater infrastructure is also vital to supporting airlift operations. Global airlift operations require robust airports of debarkation (APODs), enabling reception equipment, and recovery bases for aircraft refueling, maintenance, and crew shifts. The C-17 can deliver cargo to thousands of runways around the

world, but substantial working MOG capability is required to receive cargo in support of even limited wars. The APOD for Task Force Hawk (Tirana, Albania) was woefully inadequate (MOG = 1) for deployment of a medium-weight Army task force in the recent Kosovo campaign.

The delivery of 5,000 STON per day in support of a MTW will require a set of theater APODs with a total working MOG of at least 14. This would require one "world-class" APOD (MOG = 8 or more) supplemented by at least two other modern APODs (MOG = 3 or more), or a set of four or more modern APODs. Reception of military personnel on passenger aircraft will require additional APOD infrastructure beyond the cargo MOG requirement. All of these APODs would also likely be supported by another set of theater recovery bases. If deploying Army forces are to arrive via airlift at a pace of 2,000 STON per day, they would need to be received at a single world-class APOD or at least two modern APODs. Even if the Army is consuming 960 STON per day to support a limited war operation, it would need a modern APOD for effective continuous airlift operations.

Because so many locations in the world have limited POD infrastructure, the use of theater intermediate staging bases (ISBs) may be the only effective way to maintain smooth operation of the strategic airlift (and possibly sealift) system. ISBs provide a safe haven for the reception of cargo into a theater, and serve as a transloading point between strategic and operational-level transportation. The ISBs would receive strategic deliveries by C-17, C-5 and CRAF aircraft or surface transportation. The most urgently needed forces and sustainment would be deployed forward from ISBs to operating locations with fixed wing (C-17 and C-130) and rotary wing aircraft. The use of ISBs is probably the only way that GEN Shinseki's accelerated Army timelines can be achieved for deploying to a majority of the world's land mass.

Another problem with poor infrastructure is the inability to transport or maneuver the Army's traditional heavy forces by land. Army 60- to 70-ton systems such as the M1-series tanks and Crusader can be transported effectively only in countries with rail systems (that include the required heavy-duty railcars), very modern highway systems, or in areas with few or no bridges (such as desert terrain). In addition to the POD problems at Durres and Tirana, Albania, heavy Army systems could not have maneuvered effectively toward Kosovo without several months of significant repair and upgrade of Albania's roads and bridges.

Surface infrastructure problems are not limited to backward countries such as Albania. Onward movement of heavy systems in South Korea from ports to tactical assembly areas requires rail transportation because host nation bridges cannot support our loaded heavy equipment transporters (HETs). Even if Crusader were to achieve its target weight of 55 tons, it would exceed the permitted capacity of 85 percent of the over 4,000 bridges in South Korea when loaded on the Army's "old HET" (M747). The current rail system in South Korea could deliver about one tank battalion every two days from Pusan to Seoul. US armored forces would face extreme difficulty, perhaps paralysis, if a campaign ever dictated maneuvering in a country such as North Korea.

Even when a host nation possesses adequate infrastructure for heavy armor maneuver (such as Saudi Arabia), Army forces must bring huge fleets of organic trucks (or contract with the host nation) to transport tracked vehicles and supply its gargantuan appetite for fuel and ammunition.

IMPLICATIONS FOR ARMY TRANSFORMATION

The Challenge

The Army's new vision has clear deployability goals: "We will develop the capability to put combat force anywhere in the world 96 hours after liftoff – in brigade combat teams for both stability and support operations and for warfighting. We will build that capability into a momentum that generates a warfighting division on the ground in 120 hours and five divisions in 30 days."³¹ Significant transformation is required for the Army's objective force to meet these goals. The Army must champion the need to reduce its own transportation requirements and simultaneously improve transportation capability.

Early efforts in the Army transformation plan have focused on the design of the "middle-weight" interim brigade combat team (BCT) and procurement of a family of interim armored vehicles (IAV). GEN Shinseki intends to field two interim brigades at Fort Lewis in 2001 that would provide rapid early-entry combat power for small-scale contingencies (such as limited war) and participate in MTWs as a subordinate maneuver component. The IAV systems would serve as the primary weapons platform for the BCT including variants such as infantry vehicles, howitzer, and mobile gun system. IAV systems require C-130 transportability and will have top weights of 16 to 19 tons.

Despite the current attention on designing and fielding interim BCTs, the most compelling questions in achieving the chief's vision may be associated with the deployment of a division anywhere in the world in 5 days. This force must be delivered by airlift. If the first BCT takes 4 days to deploy, then it is difficult to conceive of an airlift system that could **deliver the rest of the division in only one more day.**

The Army must closely examine all aspects of the deployment process and clearly state its requirements for improved infrastructure, strategic and operational lift assets, and enabling forces and equipment. The Army has formed a Power Projection Task Force as a means to identify and address the deployment enhancement initiatives needed to meet the deployment vision. The Army Science Board (ASB) 1999 Summer Study³² identified a cogent set of critical problems to solve to improve strategic maneuver.

Improvements in strategic deployment capabilities must be accompanied by a radically different approach to future force design. Army combat units must have lighter and many fewer deployable systems. If the transformed Army keeps the traditional organization of divisions, brigades and battalions, it will have to slash the size of maneuver units to meet deployment goals. GEN Shinseki has already focused on reducing the deployed Army's logistical footprint, stating "that our support tail demands 90 percent of our lift requirement."³³ Cutting the footprint of logistical units will be important to meeting

deployment goals; however, the following discussion shows that future warfare divisions and brigade combat teams must be drastically smaller than today's forces.

Future Warfare

The Army's two primary efforts in preparing for the future battlefield in recent years have been the Force XXI "digitization" experiments and the Army After Next project. The Force XXI effort is exploiting information technology, leveraging improved ISR capabilities with a "tactical internet" to improve the situational awareness and decision-making ability of commanders and soldiers. Live exercises at the National Training Center and Fort Hood have verified these capabilities. The 4th Infantry Division (Mechanized) is the first unit resourced for the "conservative heavy" design, with other divisions to transition to the Force XXI design and capability during the next decade. The Force XXI heavy division will contain upgraded legacy weapons and will deploy similarly as today's division, by sealift with significant rail and HET support for land transportation and operational maneuver. Light divisions are also to be digitized, but possible designs have not been made public.

The Army After Next project examined the future battlespace and concepts for desired Army capabilities during the more distant future (2020 and beyond). One of the key AAN concepts is the ability for Army forces to respond and deploy to contested territory before a potential aggressive adversary has the opportunity to entrench and "set the defense." AAN examined the potential use of advanced strategic and theater lift concepts (high-speed sealift, lighter than air aircraft, and joint transport rotorcraft) to rapidly deploy future battle forces.

The Strategic Studies Institute at the Army War College has developed some very interesting theories on future warfare and how a responsive Army can defeat regional aggressors, especially in the more likely limited war scenarios. MG Robert H. Scales, Jr., Commandant of the Army War College, offers some maneuver concepts of particular relevance to achieving GEN Shinseki's vision in "Army Issue Paper No. 3, America's Army in Transition: Preparing for War in the Precision Age." Using examples from Korea, Vietnam, and Kosovo, MG Scales argues that despite the improvements in precision munitions, adaptable enemies can and have defended and survived a US strategy that relies on firepower alone. An enemy that disperses "and goes to ground in order to avoid destruction by fire makes his force increasingly vulnerable to defeat by maneuver."³⁴ Due to our distance from overseas conflicts and our deliberate political process, an aggressive enemy can and has gained initial objectives before we can intervene.

MG Scales illustrates possible use of maneuver in future regional limited wars as follows. An enemy invades territory, disperses, and sets the defense to absorb firepower from precision strike weapons. An intervening US force "would paralyze him with precision fires just long enough to allow an early arriving ground force to simultaneously occupy multiple points throughout the enemy's area of operations and saturate the enemy's most vital areas with small, discrete, autonomous and highly lethal, mobile combat elements."³⁵ The enemy then has two choices, to defend and concede the initiative, or

mass, attack, and be destroyed. Once we have entered the enemy's area of operations, we can dominate the ground through our technology for situational awareness and use of short-range precision weapons.³⁶

Division Deployment in Five Days

Sizing the Division. MG Scales' future warfare theories provide a sound framework for the responsive and deployable Army envisioned by GEN Shinseki. A division that can deploy worldwide in 5 days as a set of dispersed mobile combat units would be a highly effective instrument of national power in the conduct of limited war. This division would have to deploy via strategic airlift. Even though C-17 aircraft are capable of direct delivery to forward austere airfields, some of the division would be transloaded to C-130 aircraft at an ISB. Meeting the 5-day goal is an incredible challenge, and deployment constraints must influence the design of the future force.

Most of the world is not readily served by the world-class APOD (MOG = 8 or greater) required to receive the Army's full share of our strategic airlift capability. Even if two or three modern APODs (MOG = 3 or greater) are available, the division is more likely to face its warfighting mission in an area of more austere infrastructure. MG Scales' vision of future warfare is most likely to be enacted by rapid delivery of the division into four or more forward airfields with a MOG of 1 or 2 at best. Initial forces may have to actually conduct airborne assault operations and capture airfield(s) for reception of the remainder of the division.

The bulk of the division would strategically deploy by C-17, C-5, and commercial aircraft to one or more ISBs with world-class capability. The ISB must receive a steady flow of strategic arrivals, averaging up to 2,000 STON per day. Once the first aircraft arrives, each 24-hour period would be marked by the arrival and offload of the equivalent of up to 44 C-17 missions (average aircraft payload of 45 tons). Even more frantic would be the pace of loading C-130 and other aircraft for delivery to forward airfields. Up to 167 C-130 missions (average payload of 12 tons) would be loaded and depart every 24 hours. A C-130 workload of this magnitude is unfathomable to today's airlift planners. The number of C-130 aircraft and crews to support this large of an operation simply does not exist in any current Air Force plans.

The ISB(s) could have an average of both 8 strategic aircraft and 8 C-130 aircraft working on the ground. A single ISB would need a MOG of 16 to accomplish this mission. Airports with that large a cargo capacity are extremely rare (such as Pope Air Force Base), so using two ISBs may be necessary for such a high-volume operation. The Army will need to work with TRANSCOM and the other geographic CINCs to identify possible ISBs and determine infrastructure requirements for possible future investments. Direct strategic delivery to forward airfields by C-17 aircraft would reduce the pressure on the ISBs and the finite C-130 fleet. Each C-17 mission delivered forward eliminates the need for about four C-130 missions. Some C-17 aircraft might be assigned solely to intratheater missions, as they are far more efficient than C-130s. The Army needs to work with the Air Force to analyze requirements for deploying the future warfare division with C-130 and C-17 aircraft under a variety of scenarios.

Throughput of the strategic airlift system, ISBs, and C-130 fleet has severe implications on the design of the division to be deployed in 5 days. GEN Shinseki's vision "starts the clock" when the first airlift mission departs an APOE. If deploying from CONUS to "the other side of the world," travel time for strategic airlift missions will be up to 18 hours, assuming that aerial refueling is available. The initial loads must be transloaded into C-130 aircraft, which would probably make their first deliveries at forward airfields no earlier than 24 hours after the 5-day clock starts. If the end-to-end airlift system can deliver 2,000 STON per day to forward airfields each day after the first 24 hours (a feasible goal by 2015), then no more than 8,000 STON could be delivered to worldwide locations in 5 days.

Designing the Future Warfare Division. What would be the design of a future warfare division that weighs no more than 8,000 STON (including its initial combat load and sustainment)? This constraint radically changes the paradigm of current division designs and requires bold and provocative ideas, especially if a 16- to 19-ton IAV serves as the primary weapon platform.

Table 2 shows the design and important air deployability data for the current (1999 TOE) light and airborne infantry divisions. Each division design includes three infantry brigades, an artillery brigade, aviation brigade, DISCOM, and combat support battalions (signal, MI, air defense, engineer). The light division weighs almost 18,000 STON and has over 4,000 pieces of cargo and about 11,500 personnel that could be delivered in 549 C-17 missions. The average C-17 load is 7 or 8 pieces of cargo totaling 32.4 STON (4.2 STON per piece). The three infantry brigades combined account for only 18 percent of the weight and 20 percent of the C-17 missions. The combined artillery and aviation brigades account for 30 percent of the weight and C-17 missions. The DISCOM, CS units and division HHC account for the remaining 52 percent of the weight and 50 percent of the C-17 missions.

The airborne division weighs almost 25,000 STON and has about 5,500 pieces of cargo and about 13,600 personnel that could be delivered in 667 C-17 missions. The average C-17 load is 8 or 9 pieces of cargo totaling 37.3 STON (4.5 STON per piece). The three infantry brigades combined account for 20 percent of the weight and 22 percent of the C-17 missions. The combined artillery and aviation brigades account for 22 percent of the weight and 24 percent of the C-17 missions. The DISCOM is very heavy, weighing over 9,000 STON (37 percent of the division), requiring almost 600 20-foot containers and consuming 28 percent of the C-17 missions. CS units and the division HHC account for the remaining 21 percent of the weight and 26 percent of the C-17 missions.

Designing a future warfare division under 8,000 STON will likely include many of the same building blocks of current divisions. It will still need infantry teams, to include airborne assault elements to capture and secure airfields, a primary infantry vehicle, and perhaps a mobile gun system. Artillery, aviation, signal, air defense, engineer, and other support elements will likely remain within a "warfighting division." The key to building an 8,000 STON division will be to reduce drastically the number of deployable systems or "pieces" required for warfighting deployment. If the same general construct of brigades and battalions is retained, they will all have significantly fewer systems and perhaps soldiers.

Consider a division that can be task organized for early entry deployment into nine mobile combat teams (MCTs) formed around the usual nine infantry battalions. Each team would weigh less than 900 STON, have less than 225 pieces of deployable cargo, and be delivered in less than 30 C-17 or 85 C-130 missions. Once it reaches an ISB, it would be delivered into a forward airfield by C-17 and C-130 aircraft in 36 to 72 hours (depending on forward airfield MOG). The primary platform would be a IAV variant that is designed within the limits of C-130 transportability.

**TABLE 2
DEPLOYABILITY DATA FOR LIGHT AND AIRBORNE DIVISIONS**

Element	Infantry (Light) Division			Infantry (Airborne) Division		
	Pieces*	STON	C-17 Missions	Pieces*	STON	C-17 Missions
Infantry Brigade (1)	307	944	36	386	1650	48
Infantry Brigade (2)	307	944	36	386	1650	48
Infantry Brigade (3)	307	944	36	386	1650	48
Artillery Brigade	552	2252	72	625	2439	76
Aviation Brigade	582	3196	91	593	3037	86
DISCOM	863	4903	118	1684	9098	188
Signal Battalion	517	1625	59	454	1331	51
Military Intell Battalion	281	955	34	287	993	34
Air Defense Battalion	217	821	27	277	1119	35
Engineer Battalion	165	736	23	191	976	26
MP Company/Band	47	198	7	70	250	8
Chemical Company				53	367	9
Division HHC	77	295	10	86	317	10
Total	4222	17,813	549	5478	24,875	667

* A count of all self-propelled and towed vehicles, aircraft and containers.

Table 3 shows a possible distribution of deployable pieces among elements of a mobile combat team. This mobile combat team would include 20 IAVs and be deployable with about 83 C-130 missions. If the 20 IAVs weigh 19 tons each,³⁷ then the remaining 200 deployable pieces must average only 2.5 tons each to keep the MCT weight under 900 STON.

If the future warfare division were built to support nine MCTs as described, then as a warfighting division, it would include 180 IAVs, weigh about 8,000 STON, have under 2,000 deployable pieces, and be transported in under 250 C-17 and 750 C-130 missions. This division is less than half the size of a current light infantry division and one-third the size of an airborne division. This concept may seem shocking and unacceptable to traditional warfighting force developers. However, a strong case can be made for smaller warfighting task forces that can still control a sufficient area of operations. Digitization experiments have shown that "a properly internetworked maneuver brigade provided with an immediately available suite of aerial sensors could expand its area of control by a factor of four or more."³⁸ We must

**TABLE 3
MOBILE COMBAT TEAM DEPLOYMENT DESIGN**

Mobile Combat Team Element	IAVs	Deployable Pieces	C-130 Missions
Infantry Battalion	10	15	12
Artillery	6	30	14
Aviation		40	13
CS Units	4	65	22
DISCOM		70	22
Total	20	220	83

leverage our dominance in information technology to design warfighting forces that can be deployed within real-world transportation constraints to meet GEN Shinseki's goals.

Applying the operational maneuver warfare proposed by MG Scales with the future warfare division is a bold doctrine requiring a very complex deployment scheme. It must be supported by world-class infrastructure at ISBs, and would require many C-17 and C-130 aircraft flying through hostile territory. A key point is that the MCTs will most likely be maneuvering into austere forward airfields that can probably only absorb the reception of one or two MCTs during the 5-day deployment window for the division. C-17 and C-130 MOG capability and rapid aircraft turn-around time are critical elements for airfield reception. To deploy the entire division of nine MCTs would require spreading them over 4 to 9 airfields, with each destination requiring support from precision fires as C-17s and C-130s arrive and depart. However, if GEN Shinseki truly desires capability to deploy a warfighting division "anywhere in

the world" within 5 days, it must weigh under 8,000 STON and deploy by spreading over multiple locations centered on forward airfields.

Another word of caution regarding airlift capability is in order. The assumption that Army can expect 2,000 STON per day of airlift throughput is very optimistic, and probably not valid until 2014. The Army should expect no more than 1520 STON per day with our current capability, and that assumes the political decision to activate hundreds of commercial aircraft under CRAF Stage III. If the Army deployed using 40 percent of the average airlift that AMC achieved under CRAF Stage II in Operation Desert Storm (2,400 STON per day, or 960 STON per day for the Army), the future warfare division would take about 10 days to deploy.

Brigade Combat Team Deployment in 96 hours

Two important efforts that will drive the deployability of the BCT are developing the organizational design (TOE) of the BCT and a family of interim armored vehicles (IAV). The Army is working hard to develop and field two interim BCTs by the end of 2001. The interim "middle-weight" BCTs will be more deployable than brigades from heavy divisions, but will be heavier than a light infantry brigade. Based on a sample set of alternative BCT designs under analysis by the Army, the interim BCTs will not meet the goal of worldwide deployability in 96 hours.

One early BCT alternative considered by TRADOC was similar to a mechanized infantry brigade, with two mechanized infantry battalions, and single tank, 155mm self-propelled artillery, heavy engineer, and support battalions. This "mechanized heavy" BCT would weigh almost 22,000 STON³⁹ and require two weeks to deploy by air to a world-class APOD or ISB. Many of its systems (47 LINS) lack C-130 transportability and would not be deployable to forward airfields unless dozens of C-17s were committed to theater airlift.

A senior TRADOC officer briefed the Army War College in late 1999, and showed a graph with the following data points on possible interim BCT designs:

- Light Infantry Division Brigade - 2.6 days to deploy
- Medium Weight Brigade SSC Initial - 5.9 days to deploy
- Medium Weight Brigade MTW Sustainment - 8.2 days to deploy
- Assumes Army gets 2,000 STON/day airlift

The data implies that the medium brigades weigh 11,800 and 16,400 STON, respectively. Since it would take about 24 hours for the airlift flow to begin reaching forward airfields, the estimated days to deploy should be increased to 7 and 9 days, respectively.

Finally, a December 1999 analysis by MTMC's Transportation Engineering Agency and the Logistics Management Institute used the JFAST and ELIST transportation models to predict closure of an initial middle-weight division and a follow-on Force XXI heavy division for a Balkan scenario.⁴⁰ The analysis predicts a brigade forward deployed in Germany arriving at Pristina, Kosovo, with over 8,000 tons in 9 days, with a CONUS brigade closing about 11,000 STON through an ISB in Greece to Kosovo in

13 days. This analysis did not achieve throughput of 2,000 STON per day, due to more conservative assumptions regarding airlift capability and required time for units to marshal at ISBs before onward movement.

The Army may be able to design an Interim BCT that could deploy worldwide in 96 hours. If the 96-hour deployment was a stand-alone goal, then the BCT could weigh as much as 6,000 STON and meet that goal by 2014. However, GEN Shinseki's vision clearly implies that the initial deploying BCT will usually be part of a division that must arrive within 5 days. Therefore, the design of the future warfare division should include three BCTs (unless the Army is prepared to change the paradigm requiring three maneuver brigades to complete a division) that each make up roughly one third of the division. If each BCT included three mobile combat teams described earlier, they would weigh less than 2,700 tons, have about 60 IAVs, 660 deployable pieces, and deploy using about 84 C-17 and/or 250 C-130 missions.

BCTs from the future warfare division would be much smaller than any of the examples cited above as possible interim BCTs (weights range from 8,000 to 22,000 STON). Even though the Army is determined to field "middle-weight" BCTs as soon as possible, it must consider how to design warfighting BCTs that weigh less than 2,700 STON.

Five-Division Corps Deployment in 30 Days

Sizing Today's Corps. Deploying a fully supported 5-division corps in 30 days will greatly stress the multimodal end-to-end defense transportation system. The Army will need to extract every bit of capability available from TRANSCOM's organic sealift fleet and improve its deployability over CONUS and theater land transportation networks. Future strategic lift concepts, such as high-speed sealift and lighter than air aircraft, may provide supplemental capability to maximize deliveries in the first 30 days of deployment. The Army must reduce its Corps transportation requirements to match reasonable expectations of future transportation capabilities.

What are deployment requirements for a 5-division warfighting corps? Three echelons of forces, including division, corps, and echelon above corps (EAC) are relevant. Three Force XXI heavy and two light (AASLT and LID) divisions (3H/2L) would weigh about 313,000 STON, while four heavy divisions and one light (AASLT) division (4H/1L) would weigh 382,000 STON. A Corps usually includes multiple heavy artillery, engineer, and aviation brigades, along with other combat support brigades, battalions, corps support groups, and other Combat service support units. A warfighting Corps will also require support from some elements of a theater support command (echelon above Corps) to conduct RSOI to tactical assembly areas and sustain any operations.

The size of the supporting Corps and EAC units are often described by a tooth-to-tail ratio, which can vary widely depending upon host nation logistics support and infrastructure. One of the MRS studies in the 1990s settled on a tooth (weight of combat divisions) to tail (weight of support units) ratio of one to 2.7 in an accepted moderate risk scenario. Using that assumption would require support units with weights of 845,000 STON for the 3H/2L Corps (total weight 1.16 million STON) or 1.03 million STON for

the 4H/1L Corps (total weight 1.41 million STON). Recall that the current MRS-05 includes a total Army unit equipment weight of about 3.0 million STON for one of the typical dual-MTW scenarios. The first theater requires about 1.9 million STON, with 1.1 million STON scheduled for the first 75 days (current Army timeline for deployment of a Corps).⁴¹ Therefore, the weight of a current 5-division Army Corps is most likely in the range of 1.1 million to 1.4 million STON.

Corps Deployment Constraints. What are the deployment constraints that would restrict the worldwide deployment of a 5-division Corps in 30 days and are any of them severe enough to limit the Corps force design? The remainder of this discussion examines the capability of strategic lift assets (sealift and airlift), host nation infrastructure, Army trucks, and CONUS railcars and infrastructure to determine how much Army cargo might be accelerated into the 30-day deployment window. Improvements in these capabilities and their relative costs help identify affordable solutions to meeting the 30-day goal and point to force design imperatives.

Surge sealift capability provides the most important transportation constraint in a 30-day deployment. Existing sealift ships can make only one delivery to remote overseas theaters in 30 days. Since the surge sealift fleet can not depart CONUS and arrive into destinations such as the Arabian Gulf until at least day 20, overseas SPODs and RSOI infrastructure must then absorb a huge workload during days 20 to 30. Lengthy sealift travel times also will compress CONUS land movement and seaport loading for the 5-division Corps into the first 12 deployment days.

The programmed surge sealift fleet of 9.6 million square feet (spread over 80 ships) can deliver about 600,000 STON of unit equipment cargo in its first complete delivery cycle. However, about 2.0 million square feet of this capacity is found on 34 ships that are highly unlikely to deliver their first load to remote theaters within the first 30 days. Of these 34 ships, 30 are non-RORO ships (breakbulk, LASH, SEABEE, and TAC-S) that are generally slow and take substantially longer to load and unload than RORO ships. Four RORO ships are kept in a low readiness status. Therefore, the programmed fleet of 46 high-readiness RORO ships could possibly deliver about 475,000 STON of Army unit equipment by day 30.

According to MRS-05 databases, the programmed Army pre-positioning fleet will store 245,000 STON of Army unit equipment,⁴² including two heavy brigades and substantial CS/CSS units. These ships can also deliver their cargo before day 30 (most likely between days 10 and 20). Therefore, the currently programmed sealift fleet could deliver no more than 720,000 STON of Army unit equipment by day 30. Airlift could deliver about 45,000 STON of Army cargo by day 30 (will increase to 60,000 STON by 2014 with improvements to the C-5). Therefore, the currently programmed strategic transportation system could theoretically deliver about 765,000 STON of Army cargo in 30 days (780,000 STON by 2014).

Adding to strategic transportation deliveries in the first 30 days would require buying more LMSRs (current cost is between \$315 million to \$350 million) for pre-positioning or surge sealift. Each LMSR delivers an average of 18,000 STON per load.

High-speed sealift (HSS) and global aircraft are two concepts with promise for improving strategic deliveries before day 30. Most RORO ships advance at about 24 knots, except for the eight fast sealift ships (28 knots). HSS ships will be most effective if they can make more than one delivery in the first 30 days. HSS must achieve average speeds of 45 or 75 knots to make two or three deliveries, respectively, to worldwide seaports. Current technology trends show that HSS ships will be much smaller than existing ROROs to achieve desired speeds. Assuming a capacity of 2,000 STON (or 32,000 square feet), a fleet of 25 HSS-45 (45 knot average speed of advance) with a 90 percent readiness rate could deliver the weight of a Force XXI heavy division worldwide in 30 days. With a capacity of 500 STON (or 8,000 square feet), a fleet of 65 HSS-75 (75 knot average speed of advance) with a 90 percent readiness rate could deliver a Force XXI heavy division worldwide in 30 days.

Some high-speed watercraft are currently employed for commercial ferry services, using catamaran and hydrofoil designs. The Maine National Guard provided some Army trucks for a demonstration voyage between Maine and Nova Scotia during 1998.⁴³ The commercial viability of low-capacity HSS remains unclear. The primary trend in cargo ships is building larger giant containerhips to realize economies of scale for movement of cargo not requiring the speed provided by air transportation. High-capacity HSS require development of high-risk technology and will certainly be very expensive.

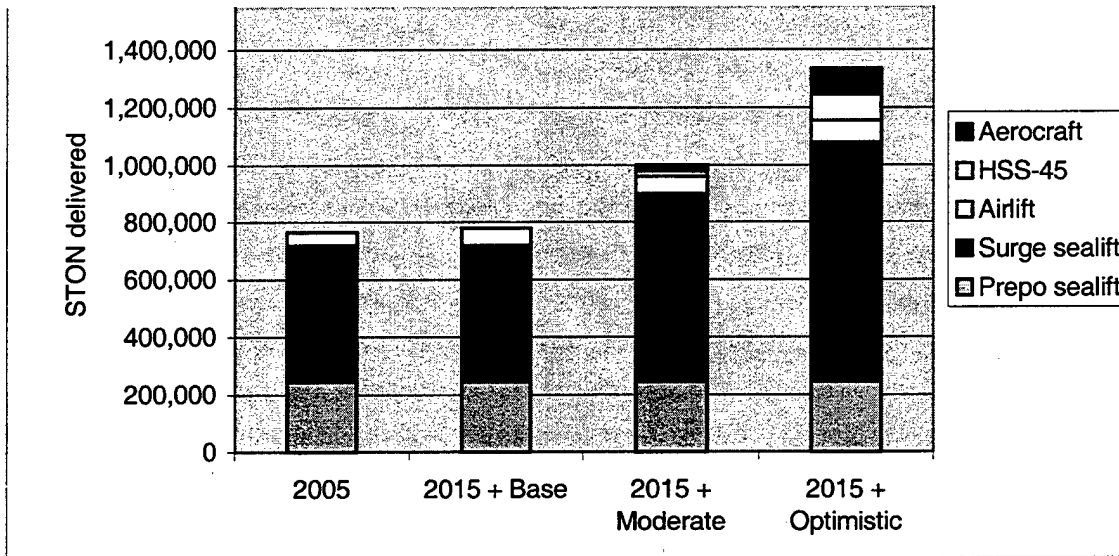
The global aircraft concept is under research by a leading aircraft manufacturer. The concept envisions huge "lighter-than-air" craft (blimps) that could transport loads of 500 tons at a speed of 120 knots. Aircraft proponents believe the air freight business will develop a worldwide network of carriers using hundreds of these craft. Each aircraft could deliver 2500 STON every 30 days (assumes a 6-day cycle time). A fleet of 40 aircraft with a 90 percent readiness rate could deliver the weight of a Force XXI heavy division worldwide in 30 days.

Despite the commercial research, no prototype aircraft has been built or tested. Early designs of the aircraft use a system of racks for transporting special air freight containers, and would not be compatible with most Army unit equipment. Even if national defense features are designed into the aircraft, it may still be unable to transport most of the Army's heavy legacy systems. The commercial viability of the global aircraft remains unclear, and would require unique ground support infrastructure. The air freight industry continues to expand rapidly, primarily through orders of wide-body cargo aircraft and building ground terminal infrastructure.

Even if both the HSS and global aircraft are commercially successful in the next 15 years, DoD might have to spend significant resources to have enough of these craft available to support the first 30 days of Army deployment. If commercially successful, the cargo carriers will be unlikely to make such high-value assets immediately available for DoD deployments.

Figure 3 shows a series of scenarios summarizing potential 30-day strategic lift capabilities for Army unit equipment in 2005 (765,000 STON) and beyond 2015 (base of 780,000 STON). Two scenarios show potential capabilities if DoD makes significant additional investments in strategic lift assets by 2015. The “2015 + moderate” scenario adds capabilities from ten LMSRs, five HSS-45, and ten global aircraft, for a total 30-day capability of about 1,000,000 STON. The “2015 + optimistic” scenario adds capabilities from 100 C-17s, 20 LMSRs, 25 HSS-45 and 40 global aircraft, for a total 30-day capability of about 1,350,000 STON. The capability range between the moderate and optimistic scenarios approximates the weight range of a current Army warfighting Corps.

Figure 3. Future 30-day Strategic Lift Capabilities



	2005	2015 + Base	2015 + Moderate*	2015 + Optimistic**
Prepo sealift	245,000	245,000	245,000	245,000
Surge sealift	475,000	475,000	655,000	835,000
Airlift	45,000	60,000	60,000	75,000
HSS-45			18,000	90,000
Aircraft			22,500	90,000
Total	765,000	780,000	1,000,500	1,350,000

* Adds ten LMSRs, five HSS-45, and ten global aircraft.

** Adds 100 C-17s, 20 LMSRs, 25 HSS-45 and 40 global aircraft

Regardless of the future strategic lift scenario, compressing the delivery of a 5-division Army Corps into 30 days will be a tremendous challenge to air and seaports of debarkation, intermediate staging bases, other RSOI infrastructure, port operators, host nation support and enabling units. This accelerated deployment would also require the CONUS infrastructure to transport and load all this equipment in the first two weeks.

Theater APOD/SPOD capabilities and RSOI enablers to maximize throughput are essential to "widening the narrow end of the funnel" for strategic delivery of cargo. Recall that the pace of deployment currently prescheduled for MRS-05 requires average SPOD throughput of 20,000 STON per day. The same scenario requires average APOD throughput (for Army cargo alone) of about 1,000 STON per day. If a theater's SPODs were limited to 20,000 STON per day and APODs could receive 1,000 STON per day, then the theater APOD/SPOD infrastructure could receive only 470,000 STON of cargo by day 30. Airlift would deliver 30,000 STON, the pre-positioned LMSRs would deliver 240,000 STON by day 20, and surge sealift would deliver another 200,000 STON during days 21 to 30. This total weight is significantly less than the potential capabilities of the strategic lift assets shown in figure 3.

As stated earlier in this paper, many countries in the world lack infrastructure to receive Army cargo at this reduced pace, which delivers a Corps in 75 days. Worldwide commerce and trade will continue to expand, and developing nations will develop more infrastructure; however, limited port facilities will not allow rapid deployment of an Army Corps in many countries.

Table 4 shows the required daily throughput of APODs (or ISBs) and SPODs to support the potential future strategic lift capability scenarios described in figure 3. Just compressing all the programmed RORO surge sealift ships to arrive by day 30 requires average SPOD throughput of at least 47,500 STON per day for days 21 to 30. The 2015 + moderate and optimistic scenarios require average SPOD throughput of at least 66,400 and 88,000 STON per day, respectively. Introduction of the global aircraft (and additional C-17s) increases APOD throughput requirements to 2900 and 6100 STON per day for the moderate and optimistic scenarios, respectively. Many more countries and regions of the world would be unable to support these vastly accelerated deployment velocities. In addition to countries mentioned earlier, other countries incapable of handling these increased SPOD throughput requirements include Iraq, Kuwait, Nigeria, Oman, Panama, Peru, and Tunisia.⁴⁴

After reception at SPODs, the staging and onward movement of Army maneuver units to tactical assembly areas is a tremendous logistical challenge that will be exacerbated by a 30-day Corps deployment. Current deployment schedules require hundreds of Army and host nation HETs and other flatbed trucks to transport the Army's many tracked weapon systems. A 30-day Corps deployment will require substantially more trucks to support RSOI, unless the warfighting commander will be content for the deployment to result in a huge "mountain of steel" in staging areas just outside SPODs that will trickle forward to TAAs over the next 30 to 45 days. One very positive element of the Army's vision for long-range transformation is the possibility of an all-wheeled force. Transformation to an all-wheeled force

TABLE 4
AVERAGE DAILY INFRASTRUCTURE WORKLOADS (STON PER DAY)
FOR FUTURE STRATEGIC LIFT SCENARIOS

	Deployment Days			
	1 to 5	6 to 10	11 to 20	21 to 30
2005 Base				
APOD/ISB	1500	1500	1500	1500
SPOD	0	0	24,500	47,500
2015 + Base				
APOD/ISB	2000	2000	2000	2000
SPOD	0	0	24,500	47,500
2015 + Moderate				
APOD/ISB	2000	2900	2900	2900
SPOD	0	0	25,400	66,400
2015 + Optimistic				
APOD/ISB	2500	6100	6100	6100
SPOD	0	0	29,000	88,000

would greatly relieve this tremendous problem that the Army suffers with every large-scale deployment. Requirements for scarce Army or host nation HETs would disappear. These advantages would be even more important for operational maneuver, such as the movement of VII and XVIII Corps during the four weeks preceding the Desert Storm ground war.

The CONUS transportation infrastructure would also be severely stressed to meet a 30-day Corps deployment. All of the surge sealift RORO ships would require SPOE loading in a 10-day window (probably days 3 to 12 of deployment) to complete SPOD unloading in a 10-day window (days 21 to 30) overseas. During peacetime, the surge RORO ships are stationed in "layberths" at CONUS ports spread among the East, Gulf, and West Coasts. Ships stationed on the opposite coast of the direction of strategic deployment (i.e. West Coast ships that need to travel to Europe, Africa, or Southwest Asia) will have to be loaded by day 6 to complete unloading at SPODs by day 30. Similar to SPODs, average daily SPOE throughputs would range from 47,500 to 88,000 STON per day depending on the future strategic lift scenario. The CONUS workload would be spread over many seaports, consuming between 30 to 60 percent of the seaport berths with MTMC port planning orders, but would impose tremendous management and manpower challenges on MTMC port operators.

The most likely constraints to CONUS transportation are installation rail loading infrastructure, availability of railcars, and coordination. Even though total rail loading capability (at 28 Army unit installations) is projected to be 135,000 STON per day (figure 1), some installations will require additional

infrastructure upgrades to support a 30-day Corps deployment. DoD may have to invest in hundreds or thousands of more railcars to pre-position at Army installations, as the existing fleet can deliver only 17,000 STON per day for the first seven deployment days. Even if infrastructure and railcars are adequate, coordination of such an incredibly complex CONUS-wide deployment operation will be an immense challenge. Prior planning and exercises among FORSCOM, MTMC/TRANSCOM, Department of Transportation, State highway officials, and the transportation industry will be vital to have any chance of success.

An all-wheeled force would have tremendous advantages over today's force in meeting deployment goals. CONUS movement would be far less dependent on rail transportation, which would be used only as one option for units traveling more than 400 miles to SPOEs. Lighter wheeled systems would usually convoy to SPOEs, or could be transported by highway without permits on common flatbed trucks. Elimination of these difficult transportation problems faced by tracked vehicles is one of the most fruitful steps to make our Army more deployable.

Force Design Imperatives. What is the impact of all these transportation concerns on the design of Army forces at the Corps level? Transportation problems are eased if the weight and footprint of Army forces diminish. A good first step for the Army would be to explore designs for a warfighting Corps reduced in size from the range of 1.1 million to 1.4 million STON down to less than 780,000 STON (the programmed strategic lift capacity). If the Force XXI division design remains constant, a five division Corps weighing 780,000 STON would have a tooth to tail ratio in the range of one to one up to one to 1.5. Even that Corps can only deploy to countries with ample port infrastructure (at least 50,000 STON per day).

Reductions in the tooth-to-tail ratio can be achieved by reducing consumption of sustainment supplies (especially fuel and ammunition), developing more efficient logistics supply systems, and reducing the deployment footprint of logistics units through split-based operations. These are not simple solutions, and will require continued development of precision munitions, fuel-efficient vehicles, logistics doctrine and information systems, among others. The Army needs to develop deployment doctrine and C2 systems that could successfully support deploying a Corps of that size from fort to foxhole in 30 days. Larger Corps designs should be considered only if additional strategic lift improvement is deemed affordable and if the Army is willing to eliminate even more countries whose infrastructure can not support even higher velocity deployments.

A senior Army officer briefed the Army War College on some aspects of Army transformation in early 2000. He described a plan where the Army would continue keep some legacy forces and systems through the first decade of this century (i.e. most of the current divisions, Force XXI heavy division with M1A2 SEP, Apache Longbow), while also fielding interim middle-weight brigades with an interim weapon system. By 2009, the Army hopes to begin fielding "objective-design" brigades with an objective C-130

transportable weapon system that will emerge from robust R&D efforts. One of his more fascinating statements was the statement that eventually all Army divisions should have the same design.

Will the transformed objective Army really have a common division design? The 8,000-STON future warfare division proposed earlier in this paper could possibly deploy in five days and compose a 5-division Corps that could easily deploy in 30 days. However, that division is unlikely to have sufficient lethality and survivability to defeat all possible ground war threats in the 2009 to 2020 timeframe. It is difficult to conceive of an Army consisting only of 8,000-STON divisions in the next 20 years. The Army Science Board 1999 Summer Study recommends a long-term strategy to develop future ensembles of paired systems in the 9- to 12-ton range.⁴⁵ Homogenous Army divisions with these systems can be viewed as the ultimate objective force, but it must be assumed that GEN Shinseki's intent is to meet transformation deployment goals before 20 years have passed.

The Army needs to design an evolutionary Corps that gradually phases out legacy organizations and systems. The interim brigade combat teams and current light and airborne divisions would eventually be replaced as new light systems are developed and fielded into 8,000-STON future warfare divisions described earlier in this paper. It is unlikely that Force XXI heavy forces and legacy systems can be eliminated before 2020, and the evolutionary Corps will retain some of these forces and systems.

The Army should consider another attempt at reducing the size of the Force XXI division. The current design reduced the mechanized division's M1 Abrams and M2/M3 Bradley systems by 25 percent (and total tracked vehicles by 17 percent), but only reduced its footprint by three percent (and weight by seven percent). Wheeled vehicles were reduced by only two percent, as the Force XXI division still retains over 6,000 self-propelled and towed vehicles. Achieving a proper balance between combat and supporting systems and units is a difficult issue, but it appears that opportunities remain for reduction of wheeled systems. A more radical idea would be to consider further cutting of combat systems (and their supporting systems) from the division. Finally, the 64.5-ton Crusader has no place in the evolution of a more deployable Force XXI division. It should either be canceled or redesigned not to exceed 40 tons, allowing transport on more common flatbed trucks and railcars.

SUMMARY AND CONCLUSIONS

The transformation of the Army seeks to build a deployable and responsive force that is relevant across the spectrum of operations. The Army's new vision has clear deployability goals to deploy a brigade combat team in 96 hours, a warfighting division in 120 hours and five divisions in 30 days. Improved transportation capabilities and radical force design changes are mandatory to meet Army transformation goals.

Improved sealift, airlift, CONUS infrastructure, RSOI capabilities and more pre-positioned unit equipment and sustainment stocks will help the Army realize most of the goals of the Army Strategic Mobility Program by 2002. However, with minor exceptions, Army forces and systems grew tremendously in weight and footprint over the last 30 years.

Current sealift and airlift programs will provide capabilities to deploy Army MTW counterattack forces in 3 to 4 months by the year 2002. DoD's surge sealift fleet will have a 9.6 million square foot RORO capacity by 2002 with completion of the LMSR fleet and RRF enhancements. High operations tempo has led to severe readiness problems with the C-5 fleet. AMC now believes the current airlift fleet (at CRAF Stage III) could only generate about 3,800 STON per day. (Army 40 percent share = 1520 STON) AMC advises that the Army assume maximum strategic air delivery rates of about 5,000 tons per day (Army share = 2,000 STON) for the Joint force after C-5 modernization is complete in 2014. The 2,400 STON per day achieved during Desert Storm (using CRAF Stage II) is a very optimistic goal for limited wars that require rapid deployment of Army forces. (Army share = 960 STON)

Army deployment can be stymied by transportation infrastructure obstacles in underdeveloped and modern countries. Limited POD infrastructure requires the use of theater ISBs for smooth operation of the strategic airlift (and possibly sealift) system. Highway infrastructure is often unable to support transport or maneuver of the Army's traditional heavy forces by land in underdeveloped and modern countries.

The most compelling Army transformation problem may be to airlift a division worldwide in 5 days. No more than 8,000 STON of Army unit equipment can be delivered to worldwide locations in 5 days, which sets an important constraint on the design of the future warfare division.

A future warfare division under 8,000 STON could include nine mobile combat teams formed around infantry battalions, where each team would weigh less than 900 STON, and be delivered in less than 30 C-17 or 85 C-130 missions. The future warfare division could include 180 IAVs, have under 2,000 deployable pieces, and be transported in under 250 C-17 and 750 C-130 missions.

Smaller warfighting task forces can control a sufficient area of operations. Digitization experiments show that internetted maneuver brigades with aerial sensors can control a greatly expanded area. We must use information technology to design warfighting forces that can be deployed to meet GEN Shinseki's goals. Applying operational maneuver with the future warfare division is a bold doctrine requiring a very complex deployment scheme. Mobile combat teams would maneuver into multiple locations centered on forward airfields, with each destination requiring support from precision fires as C-17s and C-130s arrive and depart.

The Army should expect to deploy no more than 6,000 STON in five days with current airlift capability, and that assumes the political decision to activate hundreds of commercial aircraft under CRAF Stage III. The future warfare division would take about 10 days to deploy with the throughput achieved under CRAF Stage II in Operation Desert Storm. The Army needs to work with the Air Force to analyze requirements for theater delivery of the future warfare division with C-130 and C-17 aircraft under a variety of scenarios

The Army is designing an Interim BCT to deploy worldwide in 96 hours. The BCT could weigh as much as 6,000 STON and meet that goal by 2014. However, the initial deploying BCT may be part of a division that must arrive with 5 days. If each BCT included three mobile combat teams, they would weigh

less than 2,700 tons, have about 60 IAVs, 660 deployable pieces, and deploy using about 84 C-17 and/or 250 C-130 missions.

To deploy a 5-division corps in 30 days, the Army must optimize use of TRANSCOM's organic sealift fleet and CONUS and theater land transport networks. The Army must reduce Corps transport requirements (currently 1.1 million to 1.4 million STON) to match future transport capabilities.

The currently programmed strategic transportation system could theoretically deliver about 765,000 STON of Army cargo in 30 days (780,000 STON by 2014). Additional investment in LMSRs and C-17s, or future technology concepts such as high speed sealift and global aircraft could provide supplemental capability by 2015.

A 30-day Corps deployment requires many more trucks to support RSOI, unless the CINC can accept deployments that trickle from SPOD staging areas to TAAs over the next 30 to 45 days. An all-wheeled force would help relieve this problem as requirements for HETs would disappear.

The Army must invest in infrastructure upgrades and more railcars to pre-position at Army installations to support a 30-day Corps deployment. An all-wheeled force would make CONUS movement far less dependent on rail transportation.

The Army should reduce Corps size from the range of 1.1 million to 1.4 million STON down to less than 780,000 STON. Larger Corps designs require additional strategic lift improvement and eliminate countries whose infrastructure can not support higher velocity deployments.

The Army should design an evolutionary Corps, phasing out legacy organizations and systems. Interim brigade combat teams and current light and airborne divisions would eventually be replaced as new light systems are fielded into 8,000-STON future warfare divisions. The evolutionary Corps will retain some Force XXI heavy forces and systems until the Army's ultimate future combat systems can be fielded. The Army should consider another attempt at reducing the size of the Force XXI division. Strong opportunities remain for reduction of wheeled systems, and further cutting of combat systems is possible. The 64.5-ton Crusader should either be canceled or redesigned not to exceed 40 tons.

THE FINAL WORD

The Army has tried before to lighten the force to improve deployability. It has set goals such as deploying 10 divisions to Europe in 10 days during the Cold War era, and the earlier mentioned goal of 500 C-141 missions for the light infantry division. However, the Army's recent history shows that these goals are superseded for other priorities or the Army tells itself that it can meet the goals when in fact "the emperor has no clothes." The DoD transportation community has maintained a can-do attitude, and in fact can eventually deploy the Army to many places in the world if given enough time.

The Army's new goals for deployability are very ambitious and history indicates we should be startled if the Army truly achieves them. The Army must not place the burden on achieving the goals solely on improving transportation capabilities to frankly unattainable levels. Reports such as the Army Science Board 1999 Summer Study place great promise on the ability to utilize growing commercial

transportation capabilities and more efficient use of transportation infrastructure. However, that study, along with this one, also emphasizes the need to greatly reduce the Army's weight and footprint.

Transportation capabilities will improve over the next twenty years; but only marginal improvement is most likely due to DoD budget limitations. The great promise of commercial airlift and use of containerships is a reality; however, they simply can not provide much capability to meet the Army's 5-day and 30-day goals. Future deployments will continue well beyond 30 days, and those assets will be very productive for sustaining operations.

If the Army is truly serious about the new deployment goals, it must consider the force design imperatives uncovered in this paper. The force design community has almost always chosen to build the most combat effective force and believe overstated transportation assumptions. Then the Army is surprised when divisions take months to deploy or a Task Force Hawk is stuck in the mud of Durres and Tirana. We probably cannot design a force to meet the 5-day and 30-day goals truly "anywhere in the world." However, we should not fool ourselves by designing a force that meets these goals only if we are going to Canada or Western Europe. (word count = 13,709)

ENDNOTES

- ¹ GEN Eric K. Shinseki, USA, "The Army Vision," as submitted for publication in Retired Officer, January 2000.
- ² Defense Planning Guidance provides the basis for dual-MTW scenarios, which are analyzed by CINCs in deliberate planning, and the Joint Staff, OSD, and Services for programmatic efforts such as Mobility Requirements Studies, Total Army Analysis, etc.
- ³ James K. Matthews and Cora J. Holt, So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Shield / Desert Storm, (Office of the Chairman of the Joint Chiefs of Staff and USTRANSCOM, 1992).
- ⁴ Department of Defense, Mobility Requirements Study, 1992.
- ⁵ Mark J. O'Konski, "Army Strategic Mobility Vision," briefing slides, Assistant Director for Transportation, Office of the Deputy Chief of Staff for Logistics, HQDA, 1991.
- ⁶ Department of Defense.
- ⁷ Michael Silvia, "Surge Fleet Capacity," spreadsheet, TCJ5-AS, USTRANSCOM, 24 February 2000.
- ⁸ DAMO-FD, HQDA DCSOPS, "MRS-05 General Officer Steering Committee," briefing slides, 1999.
- ⁹ Deployability data is based on TRADOC's April 1999 TOE database and was calculated using MTMCTEA's Transportability Requirements Generator (TARGET) model.
- ¹⁰ Robert Kerr, kerr@tea-emh1.army.mil, "Paladin and M992 weight--and Crusader," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 17 February 2000.
- ¹¹ GEN Ronald R. Fogleman, CINC USTRANSCOM, 1994 Congressional Testimony. Input to GEN Fogleman's testimony was provided by MTMCTEA publications and project files and based on TARGET model analysis.
- ¹² Kelly Musick, MusickK@tea-emh1.army.mil "2nd reply," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 1 March 2000. Message includes MTMCTEA analysis of TRADOC TOE with TARGET model.
- ¹³ Department of Military Strategy, Planning and Operations, US Army War College, briefing slides and exercise pamphlets, AY 2000.
- ¹⁴ Fogleman.
- ¹⁵ Ibid.
- ¹⁶ Steve Godwin, MTMCTEA, MTTE-INF Information Paper dated April 1998.
- ¹⁷ MTMCTEA Reference 97-700-2, Logistics Handbook for Strategic Mobility Planning, August 1997. Total throughput was obtained by summing capabilities of the 29 ports described in pages D-1 through D-8.

¹⁸ Steve Godwin, MTMCTEA, MTTE-DPE Information papers dated July 1998 and January 2000. STON per railcar was analyzed from additional data found in the MTMCTEA Reference 97-700-5, Deployment Planning Guide, July 1997

¹⁹ 822 of these railcars can transport M-1 series vehicles. Assumes a 4-day cycle time between PPPs and SPOEs and an average load of 60 STON/railcar.

²⁰ Assumes a 6-day cycle time between PPPs and SPOEs and an average load of 30 STON/railcar.

²¹ LTC Jim Donovan, "APOE data," spreadsheet, AMC-XPY, Air Mobility Command, 1999.

²² Ibid.

²³ Phil Raiford, RaifordP@tea-emh1.army.mil, "MRS-05 Army footprint," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 30 November 1999.

²⁴ This estimate assumes that ships can cycle between CONUS and overseas SPODs in about 40 to 50 days. The estimate also assumes that the surge sealift fleet is supplemented by additional ships after discharging Army and Marine Corps prepositioned cargo.

²⁵ Bryant Jordan, "Overloaded: Can the Airlift Fleet Handle Two Wars At Once? By All Forecasts, No." Air Force Times, August 30, 1999.

²⁶ Matthews and Holt.

²⁷ GEN Tony Robertson, CINC USTRANSCOM and Commander, Air Mobility Command, Congressional testimony, 28 October 2000.

²⁸ Michael K. Williams, "Strategic Deployability In 2020 - Lessons Learned," briefing slides, MTMC Transportation Engineering Agency, 5 October 1999. This briefing to the OSD-Net Assessment Strategic Deployability Workshop included direct input from David Merrill, Air Mobility Command, AMC-XPY.

²⁹ David Merrill, Dave.Merrill@scott.af.mil, "Airlift Stuff," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 2 March 2000.

³⁰ C. Wayne Crews, "MTMCTEA World Ports database," spreadsheet, MTTE-DP, MTMC Transportation Engineering Agency, February 2000.

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³² Army Science Board, FY1999 Summer Study, Enabling Rapid and Decisive Strategic Maneuver for the Army Beyond 2010, August 1999.

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³⁴ MG Robert H. Scales, Jr., America's Army in Transition: Preparing for War in the Precision Age, Army Issue Paper No. 3, US Army War College, November 1999, p 22.

³⁵ Ibid, p 24.

³⁶ Ibid, p 25.

³⁷ Department of the Army, Operational Requirements Document for a Family of Medium Armored Vehicles, ACAT I Milestone I Decision, January 2000.

³⁸ Scales, p 25

³⁹ Vanessa Sweat, SweatV@tea-emh1.army.mil, "C-130 outsized equipment for 5 Oct brigade," electronic mail message to message to Charles J. Davis charles.davis@carlisle.army.mil, 2 March 2000. The input data was provided by TRADOC Analysis Center - Lee in October 1999 and analyzed by Vanessa Sweat, MTMC Transportation Engineering Agency.

⁴⁰ David Canella and Lawrence Glicoes, "Interim Brigade Deployment Analysis," briefing slides, MTMC Transportation Engineering Agency and Logistics Management Institute, December 1999.

⁴¹ Phil Raiford, RaifordP@tea-emh1.army.mil, "MRS-05 Army footprint," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 17 March 2000.

⁴² Phil Raiford, RaifordP@tea-emh1.army.mil, "MRS-05 Army footprint," electronic mail message to Charles J. Davis charles.davis@carlisle.army.mil, 7 March 2000.

⁴³ Owen Spivey, "High-Speed Sealift: Deployment Support for the Future," Army Logician, January-February 1999, 124-126.

⁴⁴ Crews.

⁴⁵ Army Science Board.

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