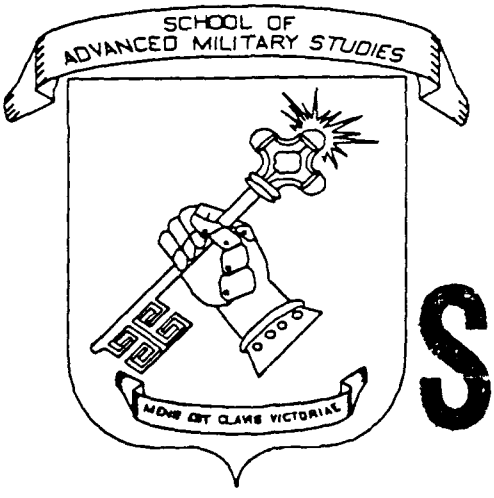
THE ROLE OF ARMY RAILROADING AT THE OPERATIONAL LEVEL OF WAR

A Monograph

by

Major Bradley E. Smith
Transportation Corps



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Little emphasis is being placed upon military railroading today by Defense Department planners. Rail is overshadowed by motor transport and theater air when it comes to supporting large unit operations. In doing that, logisticians may be shortchanging themselves and, worse still, the units they are obligated to support. A new look at Army railroading at the operational level of war is warranted because little has been written about it over the last several decades. Current terminology, doctrine and capabilities are summarized before further analysis is undertaken.

The Army's present railroad doctrine is based upon the assumption that the present day equivalent of the Military Railway Service, which is the Transportation Railway Service, will be small in comparison to our efforts in World War II and the Korean conflict. In fact, our reliance upon host nation rail support is at an all time high.

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It is concluded that this mode of transportation warrants much more attention and consideration than it is currently receiving. Operational commanders have a great deal to gain from increasing the number of U.S. Army rail units. The advantages of rail outweigh any likely difficulties which might result from its use.

To gain a true appreciation of rail, however, further analysis is required. Strengths and weaknesses of different transport modes need to be examined and quantified. Systemic comparisons need to be drawn so our logistical efforts can be better focused and directed. The appropriate place for military rail must be identified and the necessary personnel and equipment obtained. This is an important step which we can take now which will help to meet the pressing demands that are likely to be placed upon our logistical support structure in the future.

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by

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ABSTRACT

THE ROLE OF ARMY RAILROADING AT THE OPERATIONAL LEVEL OF WAR
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Little emphasis is being placed upon military railroading today by Defense Department planners. Rail is overshadowed by motor transport and theater air when it comes to supporting large unit operations. In doing that, logisticians may be shortchanging themselves and, worse still, the units they are obligated to support. A new look at Army railroading at the operational level of war is warranted because little has been written about it over the last several decades. Current terminology, doctrine and capabilities are summarized before further analysis is undertaken.

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I. Introduction

Little emphasis is being placed upon military railroading today by Defense Department planners. Rail is overshadowed by motor transport and theater air when it comes to supporting large unit operations. In permitting that, logisticians may be shortchanging themselves and, worse still, the units they are obligated to support. A new look at Army railroading at the operational level of war is warranted because little thought has been given to it over the last several decades.

Attention to operational art has increased since the 1982 version of Field Manual 100-5: Operations reintroduced the concept into our military literature. The concept is not new -- it was employed particularly well in the War Between the States and World War II. Operational art concerns the employment of military forces in a theater of war to accomplish strategic[1] goals. Theater operations and campaign planning are central to the concept. The mechanics of operational art deal with sequencing tactical[2] engagements and battles to form coherent, long-range plans to defeat the enemy. Logistics plays an important role in operational art because it affects when and where forces can fight, and therefore, whether theater forces can accept or must decline battle.[3]

The five war fighting commanders in chief (CINCs) are theater commanders. They include the commanding officers of

Atlantic Command, Central Command, European Command, Pacific Command and Southern Command. These CINCs operate at the strategic and operational levels of war[4] to accomplish strategic objectives as specified in the Joint Strategic Capabilities Plan, Unified Command Plan and Joint Chiefs of Staff Publication 2: Unified Action Armed Forces. These CINCs employ operational art in their war planning process.[5]

Many of the U.S. Army's past operational achievements are logistical in nature, because our style of warfare emphasizes mass. For the same reason, logistics will continue to be especially instrumental in future wars.[6] As much effort is needed to develop ways to supply combat forces as is needed to develop the new fighting doctrine itself.[7] The importance of transport in large unit operations cannot be overstated. The type and amount of cargo which can be distributed within a theater has a direct impact on the tempo of battle, lines of operation and support of the main effort.[8]

Transportation capabilities are of fundamental concern to operational commanders. General George S. Patton, Jr., pointed out that road and rail networks are of paramount importance in operational planning.[9] The ability to maneuver is fundamental for any army, and the lateral shifting of forces in a theater in a timely fashion (which rail can do so well) is often critical to the success of a campaign. Wise decisions must be made now, taking a long-term and systemic

approach to permit the maximum use of all available sources of transport, to include rail.

The current status of U.S. Army railroading is trivial. At the height of its glory days in World War II, the Military Railway Service (MRS) was active on every continent except Antarctica. It had 43,500 soldiers assigned to railway operating, maintenance of way and shop units. These men were responsible for more than 22,000 miles of main line track in North Africa, Sicily, Italy, Northwest Europe, the United Kingdom, Iran, India, Burma, New Caledonia, Alaska and western Canada.[10] During the Korean War, the MRS controlled in excess of 10,000 pieces of rolling stock, 460 engines and 1,243 miles of track. Between July 1951 and November 1952, Army railroaders more than doubled the short tons (STONs)[11] cleared from South Korean ports.[12] The Military Railway Service truly did live up to its motto, "Ready For My Country".[13]

At present, our deployable rail assets are limited to one railway battalion, which is assigned to the Army Reserve. Under optimal conditions, this battalion can barely keep one heavy division and one separate mechanized brigade resupplied over 90 to 150 miles of track.[14] The Army lost its only rail operational planning capability when the 67th Railway Group was inactivated in 1986.[15] But even before that happened, that group's doctrinal span of control was

approximately 600 miles of main line track,[16] which is not much to offer a theater commander.

The U.S. Army's rail capability has been scaled back more than severely since the end of the Korean conflict. The Nixon Doctrine is the reason for the acceleration in the inactivation of railway units in the 1970s. President Nixon's policy, simply stated, was that the United States would withhold commitment of its combat troops until the host nation(s) could assure that adequate logistical support, such as rail, would be provided to our forces. This opened the door to tremendous slashes in the Army force structure.[17]

Because of America's strategic focus upon Central Europe at that time, a solid case could be made for President Nixon's decision. But today, the Defense Department has been directed to look at other contingencies around the world, particularly in Third World areas. The Army may have to deploy troops into theaters that have an inadequate infrastructure to support our logistical needs. Or, it may be in our national interest to intervene in a place where the native government is hostile and will provide no host nation support. In either case, the theater commander and his logistical staff will face challenges with no easy solutions.

The Army's current railroad doctrine is based upon the assumption that the present day equivalent of the MRS, which is the Transportation Railway Service (TRS),[18] will be small in comparison to our efforts in World War II and the Korean

conflict.[19] For that reason, our reliance upon host nation rail support is at an all time high. Foreign nationals will have to be asked to perform missions that soldiers have traditionally done in past wars. Two staff organizations will assist the operational commander with the intensive management of civilian and military rail assets -- the Joint Transportation Board (JTB) and the Theater Army Movement Control Agency (TAMCA).

JTBs are established by unified, joint or combined commanders as a means of massing transport capability of two or more military services or allied nations. The board recommends allocation of transport assets to the commander, based on his tactical/operational plans. JTBs permit the use of scarce resources in the most efficient way possible.[20]

TAMCAs provide the means for a theater commander to implement movement management and traffic control functions within his area of responsibility. But the agency's most important function in a joint and combined situation is to integrate U.S. Army assets and needs with those of our allies and sister services.[21] In the case of railroads, the United States will be a "have not" participant in the war, trying to compete with the "haves" in using their resources.

Doctrinal discrepancies exist between what is expected of the TRS and what it can realistically provide.[22] For example, the combat arms are counting on having a rail option for intertheater and intratheater moves.[23] They will be

relying on the Army Transportation Corps to make it happen, regardless of the intentions or capabilities of any foreign nation.

And some of the Army's logistical manuals are based upon the assumption that the Army has a comprehensive rail capability. One field manual explains that it is a "real probability" that military railway units will have to be called into Third World areas for "nation building" programs, because the host nation cannot provide the necessary levels of support.[24] It would have to be a pretty small nation for our meager present resources to make a difference.

A reevaluation of Army railroading at the operational level of war is warranted before any realignment of doctrine and force structure is initiated. This paper is an attempt to make a contribution toward that end. The first step in that approach is to explore the inherent advantages of rail from the standpoint of a theater commander. Second, railroad challenges confronting the operational commander and his staff are outlined. Final analyses will conclude the paper.

II. Advantages of Rail at the Operational Level of War

Railroads have inherent qualities that are useful to an operational commander. Trains can haul large amounts of cargo in an economical manner. This results in a cost efficient means of transportation where costs are measured in terms of

personnel and fuel consumption. Conservation efforts are necessary in war because resources are expected to be in short supply. Logisticians will have to manage supplies and transport on hand to support the execution of campaign plans. Shortages are going to occur. It is a matter of keeping them to a minimum.[25]

Another complicating consideration is combined operations. The United States may find itself in a position of having to supply allies who, in many cases, may be woefully unprepared to sustain a large scale war effort. Logistics is supposed to be a national responsibility, but there are no guarantees that allied nations, to include our own, will be sufficiently prepared. We ourselves need to give serious consideration to getting the most productive use of our money. Railroads, because of their great capacity and economy, do exactly that. The Army Transportation Corps, as the "Spearhead of Logistics", can only hold up its end in these efforts by maximizing the use of railroads.

Capacity

Rail offers the greatest tonnage capacity for theater transportation. Simple comparisons can be made to illustrate this point (Appendix A). More complex comparisons were made by the Rand Corporation in 1970. In a detailed study, they applied "redeployment/resupply" ratios to road and rail

movements. A mechanized infantry division was the focal point, but the conclusions can be applied to larger size forces and different types of organizations.[24] In this respect, the findings are particularly noteworthy for theater commanders who are concerned with moving divisions and corps throughout their respective areas.

An explanation of the "redeployment/resupply" ratios is necessary before the final results can make sense. Numerators will vary, based upon the mode of transportation selected for analysis and comparison purposes. The numerator will reflect the maximum daily capacity, in short tons (STONs), of a given type of conveyance used over a particular <u>way</u> of transportation (i.e., gravel road<u>ways</u>, paved high<u>ways</u> or rail<u>ways</u>). One example might be the total STONs that a steady stream of five ton trucks could haul within a 24 hour period over a given stretch of gravel road. (This assumes an unlimited supply of vehicles, drivers, fuel and load/offload capabilities. No traffic congestion or other delays are taken into account.)

The more amenable the <u>way</u> is to movement and the greater the carrying capacity of the conveyance selected, the more STONs will be delivered at the destination. The denominator on the other hand, represents the amount of supplies in STONs, that the mechanized infantry division needs for one day. The larger the carriage capacity of the particular transportation mode, the smaller will be proportionate amount of road or rail

space needed to accomplish the daily resupply for that one division. It is a simple and straightforward means of measuring capacity and efficiency based on the carrying capacity of the conveyance selected and the way of transport. The larger the ratio, the greater is its potential as a source of mass transportation for the theater commander.[27]

The conclusions of the Rand study are not surprising. "Redeployment/resupply" ratios for five ton trucks on gravel roads and paved highways are 6:1 and 7.6:1, respectively. Eight ton trucks on gravel and hardstand produce ratios of 12:1 and 15:1, respectively. But these results are puny compared to railway efficiency of 145:1.[28] Logisticians need to remind themselves of the basics when planning for ways to exploit all available means of moving large units and supplying them in overseas theaters.

Rail is the ideal mode of transportation for large tonnages. Men with railroad experience in peace and war are firm proponents of this point of view. One such man was Colonel J. Monroe Johnson, Chief of the Office of Defense Transportation in World War II and later, Commissioner of the Interstate Commerce Commission. He wrote,

> There is only one mass transportation -- the railroads. You cannot go to war without them, for war is mass transportation.[29]

Another aspect of capacity, other than carriage capability, is potential for expansion. Provided either a country has or we can supply a sufficient base of railroad rolling stock and maintenance of way assets, rail networks in theaters of operation can be expanded rapidly to meet military requirements. One illustration of this is the growth of our nation's infrastructure during World War II. American railroad companies handled 87 percent of the increase in ton-miles generated by the War Department, or six and one-half times the amount of the other modes combined. They more than doubled their ton-miles hauled in 1943 compared to 1933.[30] Even though this is an application of rail at the strategic level, the point about its potential for expansion is still valid at the operational level.[31]

Rail capacities for lines all over the world can be calculated in advance of any U.S. commitment of combat forces. The Defense Intelligence Agency has published unclassified methodologies and some statistical results that are available to the general public.[32] Theater commanders know what needs to be moved for any given scenario and they can find out, if they have not already done so, what railroad facilities are available overseas to support them. The challenge that remains is to minimize any transportation shortfalls.

Economy

In comparison to other modes of transportation, the use of rail will result in large scale savings in personnel and fuel.[33] This is reflected by the fact that only a three man crew (conductor, engineer and brakeman-switchman) are needed for a train which can haul thousands of short tons of cargo.[34] Such manpower savings are significant.[35]

Motor transport uses 20 times the men and four times the fuel as does rail to move the same amount of tonnage a given distance.[36] Trucks are personnel intensive per short ton delivered. In the commercial trucking industry, manpower costs are approximately 80 percent of the total operating budget.[37] Even though salaries are of little concern to theater commanders from the standpoint of war fighting, they are significant in peacetime in order to get the most productive use from every dollar. Air transportation is even less efficient. Planes use 30 times the fuel and 12 times the manpower than does rail.[38] Only inland waterways and pipelines are more fuel efficient than railroads.[39]

Shortages of fossil fuels in a theater are likely today because of the great consumption rates of modern equipment.[40] Railroads can help theater commanders conserve their fuel resources. In World War II, surprisingly enough, there was less use of internal combustion, diesel railroad engines overseas than in World War I. Because of petroleum

shortages in the European theater in World War II, both sides turned to coal-burning, steam engines. Russia, for instance, relied almost entirely upon steam. This preserved diesel fuel for tactical combat operations.[41] Influenced by available host nation support assets and the depressed state of worldwide maritime shipping,[42] the same could happen today.

What's more, the economic aspect of rail could be an advantage in securing more realistic minimum force levels for theaters if included in CINC estimates. Congressional committees are concerned about the Army's tooth to tail ratios. The Defense Department has been criticized in past years because critics believe the logistical component is too large. That is one reason why there is some merit to increasing the size of the military's railroad force. Far fewer people, and in the long run dollars, are needed to produce the same result. Railroads are likely to be given favorable consideration by the national legislature. The results of cost-benefit analyses of greater use of rail would be a recognition of its capacity and economy. The war fighting CINCs should initiate such analyses because they are the ones who submit minimum risk force estimates to the Joint Chiefs of Staff. Those estimates are intended to reflect the smallest forces needed, to include combat service support units,[43] to meet current threats around the world.

The United States is not the first country to have internal disputes over purse strings. The interwar period

provided an opportunity for Germany to expand her rail system. Her primary goal was to facilitate the rapid movement of military forces in future wars. Rail was less expensive than trucks as measured in ton-miles. The German military believed railroads could play a role in even the Blitzkrieg doctrine, which relied on fast paced battle and rapidly changing fronts. Breakthroughs left enemy rail intact which was later exploited by Germans for their own logistical efforts.[44] And it worked. Similar rationales are applicable today in our struggle to spend wisely. Money spent on U.S. Army rail crews, engines and rolling stock is money well spent in terms of doing the most logistically -- at minimal cost -- even for tactical[45] as well as operational commanders.

One final budgetary concern deals with low intensity conflict[46] and a theater commander's nation building responsibilities as specified in current Army doctrine.[47] When a theater CINC is faced with protracted war, nation building is one way to help win the hearts and minds of the indigenous population, which, despite its having become a hackneyed phrase, is fundamentally important if an insurgency is ever to be managed. Money spent to improve rail networks overseas may benefit both U.S. forces and the local economy. Friedrich List, a German writer whose arguments for military rail date back to the 1820s, focused on this symbiotic relationship. He reasoned that armies have always been a

necessary drain on national treasuries, but the expansion of rail networks would not only benefit military operations, but would also enhance civilian business as well. This line of reasoning applies equally well today in dealing with insurgency operations or helping a country reestablish its economic and military power during a conventional war.[48]

Section Summary

Two strengths inherent to railroading -- capacity and economy -- have great impact at the operational level of war. Theater commanders should exploit these potential advantages to the maximum extent possible in framing their minimum risk force estimates and in the planning and execution of campaigns. But they cannot count, exclusively, on indigenous resources. The real value lies in organic army rail units. Because rail can provide these advantages, the use of trains should at least be considered for any large unit move. Capacity and economy can also offset, and in some cases, solve some of the challenges that arise from rail operations. These potential stumbling blocks are discussed below.

III. Challenges of Rail at the Operational Level of War

Theater commanders will face a myriad of challenges in any future war. One of the less easily solved problems will be

the movement of men and materiel. Even though rail offers a partial solution to transportation shortfalls, its use can introduce some new challenges of its own. At the operational level, these challenges are of a systemic nature, therefore, much of the response will have to be initiated at high levels within the chain of command.

The first challenge any logistical staff will confront is general skepticism in the employment of operational rail. (Some of the greatest critics, surprisingly enough, are logisticians themselves.) These attitudes date back to the first use of railroads in the mid-Nineteenth Century. Similar viewpoints persist today, and are not restricted to our own army. The British historian, Hew Strachan, wrote about this phenomenon and offered the following explanations.

First, there are the different ways in which civilians and soldiers contribute to wars. The greatest distinctions among these contributions are most readily apparent at the tactical level of war. Failure to appreciate the civil-military team effort, however, can eventually lead to breakdowns in a national unity of effort. Some members of the combat arms see logistics as irrelevant to their business of war and tend to get "annoyed by intendants and commissaries who do not appreciate the exigencies of campaigning".[49] Such viewpoints are likely to be exacerbated by the use of host nation support. Civilian railroaders appear to have little in common with the military and probably do not understand the

finer points of conducting war, but this does not diminish their value. The U.S. Army may be forced to rely upon host nation support, if for no other reason that insufficient military rail assets exist.[50]

Second, Strachan wrote that the expansion of railroads in Europe and the United States was prompted only in part by military needs. (These efforts were private business ventures for the most part.) Track construction therefore did not include many of the transverse links that would have military value for operational sustainment and maneuver purposes. Rail lines also were single-tracked for the most part, except where heavy commercial traffic warranted double lines. Simultaneous forward and back hauls, which would better support military operations, were therefore not always possible.[51] So, critics of military rail argue, with some truth, that track networks are not designed for use in a theater of war. What they fail to address, however, are modifications to track, such as by-passes and "shoo-flies",[52] that historically have been successful in improving the efficiency for military use.

Third, there are challenges inherent to railroading and sources of friction, other than just attitudal ones, that develop between railroaders and other branches of service. They include differences over the allocation of resources, breakdowns in command and control, differences in rail gauge, use of railcars as storage facilities, and misuse of rail

production and maintenance facilities. These are challenges that must be resolved at the highest echelons of command.

Allocation of Resources to Subordinate Commands

Major subordinate commands will compete for limited resources, especially in war. Theater commanders and their staffs will be deluged with support requests and, no doubt, excellent reasons will exist to justify needs. It will be a demanding task to sort through this information. The Transportation Railway Service will also need its share of men and materiel, but the distinction of the TRS is that, once the rail network is operational, the entire theater will read rewards in terms of the massive amount of men and materiel which can be moved in a scale impossible by any other means.

According to the Director General of the Military Railway Service in World War II, Major General Carl R. Gray, Jr., rehabilitation of the railroads is a continuing challenge throughout any conflict.[83] Assistance from the Army Corps of Engineers in forward areas and host nation support in the rear will be needed to maintain rolling stock and roadbeds. There are few railroad assets presently in the Army's inventory to do the job.[84]

Combat forces will be competing for these same engineer resources to perform countermobility, mobility and survivability missions. There will not be enough to go

around, so difficult choices will have to be made. Engineer assets will have to be committed in theater to repair highways, roadways or railways that deteriorate from heavy use or are destroyed by bombs. Our resources should applied where the returns will be greatest, and that means rail. No easy solution exists, but the shortfalls in, and conflicts over, engineering resources can be reduced, in part, by beefing up our military railroad capabilities now.

Decisions will have to made about the assignment of personnel to rail units. The situation may dictate that men with little or no railroad background be thrown into a related specialty and learn on their own. Train operations will not be efficient, but at least the cars will be moving. General George S. Patton, Jr. using men with minimal experience had Third Army run trains from Normandy into his rear near Nancy, France when it appeared that his petroleum supplies were drying up in October 1944. The role of host nation support was to assist in the training of his men and provide the necessary rolling stock. Patton's idea worked for a short time.[33] Because the U.S. Army has only one train operating company, and that is on Reserve status,[34] we may be forced to repeat history.

Defending the rail lines of communication may consume considerable resources. In World War II, Major General Bull had 14 Military Police battalions attached to him in Europe, strictly for railroad security purposes. Most of these

soldiers were there to stop foreign nationals from stealing.[57] In addition, there will be physical security requirements to protect trains from air strikes and ground assault.[58] These add up to considerable, but necessary, investments in personnel. But they will be more than compensated for by the assets saved by reducing the need for truck transport and by the facility with which the combat assets can be massed at the critical point.

Command and Control

Successful rail operations depend upon centralized planning and decentralized execution. Theater commanders need to delegate sufficient authority to their senior rail officers if they are to carry out their responsibilities. This authority will have to be great because, historically, railroaders have always faced considerable interference in running their lines. Combat commanders have a history of assuming control of railways and rolling stock in their respective areas of operation, without consideration for the demands of the overall plan of distribution and supply.[59]

Major subordinate commanders, whose units are recipients of supplies, want responsive support -- and the job of logisticians is to provide exactly that. These senior leaders believe, and sometimes rightly so, that their personal involvement will result in faster service for their particular

organizations. While this sometimes produces isolated cases of success, it virtually guarantees failure of the overall plan. (Train schedules are interrelated, and disruptions in one area have repercussions throughout the entire system.) The theater commander's priorities must have overriding consideration if the campaign plan is to be successful. Superintendents of railroads need sufficient authority to carry out theater missions as assigned by the CINC.

Failure to delegate authority properly and hold subordinates responsible for their actions will guarantee problems in the execution of any operation. There have been instances of gross mismanagement in the past, when soldiers have been given the same treatment as bulk cargo. In December 1870, during the Franco-Prussian War, the French attempted to use the railroads to exploit Prussian weakness. Helmuth K. von Moltke the Elder was overextended and vulnerable to counterattack, particularly in Eastern France. Without thinking through all the logistical details, French leaders, Gambetta and Bourbaki, hurriedly threw a plan together to take advantage of the situation. Two of Bourbaki's corps were supposed to be shifted by rail from the Loire to the Saone River over a two day period. Trains arrived at the embarkation sites three days late. It took days to load the men and equipment. Soldiers were packed into cattle cars for over a week in freezing weather without fires for warmth. Trains broke down and food ran out. Some of the men died. It

was a bad situation that was allowed to get progressively worse because of a nebulous chain of command. No one specific person or office was responsible for the operation.[60]

Nor were the French quick to learn from their errors. The following month, it took nine days to move a French battalion 230 miles from Bourges to Baume. On the first day, the troops had repeatedly to entrain and detrain and subsequently were delayed for several more days enroute. They ran out of food because they had brought only two days rations with them.[61] No single authority took it upon itself to straighten out the mess -- it was always someone else's problem. Similar events could happen today, extreme and absurd as they might sound, unless we develop a strong command and control structure oriented to transport needs.

So, in addition to illustrating the need for sufficient authority to carry out responsibilities, the French experience also points out the need for a clear and properly executed chain of command for railroad efforts. These requirements are closely related to a principle that financially sound private railroads follow in peacetime -- that of a "supreme coordinating authority",[62] dedicated to centralized planning and decentralized execution. During the American War Between the States, Daniel McCallum, who in peacetime worked as the General Superintendent of the Erie Railroad, was essentially given carte blanche by Secretary of War Stanton. McCallum was commissioned as a colonel and was appointed Military Director

and Superintendent of the Railroads of the United States. He was also given the authority to take possession of any and all rail equipment within the theater of operations. He could "do and perform all acts and things that may be necessary and proper to be done for the safe and speedy transport aforementioned".[43] His powers were tremendous, but no more than needed to get the job done.

Century Magazine in March 1887 printed an article entitled, "Recollections Of Secretary Stanton". An order issued by Stanton was published.

> No officer, whatever may be his rank, will interfere with the running of the cars, as directed by the Superintendent of the road. Anyone who so interferes will be dismissed from the service for disobedience of orders.[44]

General Samuel D. Sturgis, a Union division commander, was one of the first to challenge this order. It was immediately prior to the Second Battle of Bull Run and Sturgis demanded immediate transportation to the front for his troops. When informed he would have to wait his turn, the general seized portions of the track near Alexandria, Virginia for a day and stopped four troop trains destined for Manassas. He backed down when shown a telegram from General Henry W. Halleck, General in Chief of the Armies, authorizing the railroad colonel to place the division commander under arrest.[45]

Friction between various operational interests has always been present, and not just in our army. Sir Percy Girouard, Director of British Military Railroads during the South African War, complained that field commanders would "seize and work the portion of the line nearest to them",[46] thereby throwing the entire logistics system into confusion. Theater commanders will have to do whatever is necessary to enforce cohesion.

Major General Gray argues that military railroads should be under a separate major subordinate command that reports directly to the theater commander. His rationale is that railroads are of such critical importance to the war effort, that the railway service commander needs direct access. His communications should not be slowed or modified by intermediate authorities. Railroading is a highly technical industry, and the Director General should be allowed to operate without interference[47] (from commanders subordinate to the theater commander).

Differences in Rail Gauges

Disruptions to rail operations can occur from differences in rail gauges. (Gauge is the distance between the two rails.) Four separate gauges existed throughout Europe prior to World War II. This posed challenges for military planners who tried to integrate the various lines into one system.[48]

Cargo had to transloaded to and from trucks, which then hauled the cargo between the railroads of different gauges.

Today, standard gauge of four feet, eight and one-half inches has been adopted by all European countries except Finland, Ireland, Spain, Portugal and Russia. The Warsaw Pact countries, South Korea, North Korea and Communist China have also built, using standard gauge track.[69] A complete list of countries with standard gauge is provided at Appendix B.

The Soviet Union (except for Latvia and Lithuania) uses a different gauge than the rest of Europe for military reasons. They consider it an additional buffer against invasion.[70] But the Soviets have also taken steps to facilitate logistical support if they were to attack across their borders. Warsaw Pact rolling stock is unique in that decks, underframes and couplers can be removed as complete units from their supporting wheel and axle assemblies.[71] Cranes hoist the laden railcars off their wheel and axle assemblies and transfer them to new ones waiting on an adjacent track of different gauge. This allows the Soviets to speedily modify railcars, even as part of their normal peacetime rail activity, to avoid transloading cargo to another mode of transportation.[72] Western Europe and the United States have nothing similar.

Differences in rail gauge elsewhere around the world are not as severe as they once were. Efforts to standardize have been successful in North America. Mexico, Cuba, Canada and

the United States have adopted one standard for their main lines.[73] Such a uniform system has its advantages, especially if we became involved in combat on the American continents.

Still, railroads in some parts of the world have not achieved the same degree of uniformity and lack interchangeability in rolling stock.[74] That could be a problem for us if we ever need to operate in those areas, using our equipment. One possible solution would be the purchase of some rolling stock and locomotives with removable wheel and axle assemblies. More than one can play the Russian game. This alternative is most effective and least costly in terms of labor and time delays.

A second alternative is to set up transfer points to manhandle cargo between the different lines. The Turkish Army was plagued with numerous transfer points during the World War I Palestine Campaigns. These points drew off valuable motor and animal transport which was needed elsewhere in the theater. The British Navy capitalized upon this by disrupting enemy operations on the one main line that did have a uniform gauge. Naval gun fire from British warships in the Mediterranean forced Turkish rail operations further inland to lines with incompatible gauges, which resulted in delays from transloading operations necessitated by different gauges.[75]

The difficulties and inefficiencies of operating transfer points are addressed in after action reports of Allied rail

operations in French North Africa during World War II. Most of the transfer points in Algeria and Tunisia were the result of poorly planned lines, intertwined with standard and narrow gauges that had been built before America entered the war. Major challenges at these locations included: obtaining an ample supply of railcars, vehicles to shuttle cargo between the lines and the manpower to do the work. Acquiring the men was perhaps the hardest task because of the numbers required.[76]

A third alternative in solving problems generated by gauge differences is to build new track. In the long run, new construction can be an effective solution, but it requires significant capital outlays initially. The French in World War I built new lines to relieve intramodal congestion caused by gauge differences within France. During the Spring of 1917, a main line was extended 60 kilometers to Dugny. Another line was completed to Souilly, which was directly behind the trenches near Verdun. The new track was standard gauge and avoided interface complications the light rail (three foot and three and three-eighths inch gauge) had caused elsewhere. The new track also took better advantage of terrain masking to hide trains from German forward observers.[77]

When Germany invaded Russia in 1941, Hitler's armies repaired and converted hundreds of miles of Russian five foot gauge track to German standards.[78] Before Operation

Barbarossa began, the German High Command had prepared plans to undertake this massive engineering task, so the work was carried out smoothly and with relatively few unplanned delays. But at least two historians -- Martin Van Creveld and Ron Ziel -- argue that even greater preparations in this area would have solved many of Germany's later logistical problems and perhaps would have altered the course of the war in favor of the Nazis.[7]

Use of Railcars as Storage Containers

The use of railcars as mobile storage containers is a self-inflicted wound. It does not take much bleeding off of rolling stock to reduce a railroad's carrying capacity significantly. Prompt unloading of cars by consignees is of paramount importance if the railroad is to continue operating effectively. Sometimes, because of poor logistical planning, that does not get done. For example, personnel or materials handling equipment (MHE) may not have been coordinated in advance. Trains may be scheduled in such a way that cargo is delivered to railheads faster than the goods can be distributed to the user. Since, many times, there is so little space at railheads to store cargo, materiel sits on cars until the congestion can be cleared. And the cars are, effectively, lost to the transport system. Such was the case in September 1870, when the Prussian 2nd Army backlogged 2,322

railcars with 16,830 STONs of provisions on five spur lines. Meanwhile, their troops were going hungry.[80]

The misuse of railcars became acutely serious for the Allies in France and Belgium in 1944. In one instance, 2,240 loaded cars were backlogged at one railhead.[81] By the end of April 1944, the allies had sent 12,000 more cars into Germany than had been returned.[82] The only way to avoid such misuses of railcars is the effective exercise of command and control. Not only must senior leaders stress the importance of returning railcars to the transportation system, but they must also ensure sufficient MHE and/or stevedores exist to manhandle cargo.

Misuse of Rail Production and Maintenance Facilities

Using rail production and maintenance facilities for purposes other than that for which they were originally designed can have serious long-term consequences. England used her rail plants to produce tanks during World War II, and her engines and rolling stock suffered accordingly. The Germans, on the other hand, made proper use of their railroad assets. They reserved their rail production and maintenance facilities for their intended purposes and were able to keep their rolling stock operational until the end of the war.[83] To avoid the error of misusing rail and engine production facilities requires setting proper logistical priorities and

recognizing the contributions railroads can make. We need to set those priorities now.

Host Nation Support

Even if we enhance our present military railroad establishment, theater commanders will still have to rely on assistance from the host nation to run the railroads. But it is unlikely that our chain of command will rely entirely upon local nationals for all management. TRS supervision will be necessary to ensure U.S. Army interests are protected.[34] Naturally, differences in priorities are going to exist between civilian and military agencies. Conflicting orders, uncoordinated instructions and confusion will ultimately ensue if there is no clearly dominant authority -- and that will have to be the theater CINC, who is represented by the TRS.[35]

The Luzon military railroad in World War II provides an excellent example of how the military and civil authorities interface and how the three phases of railroad operations, as specified in our doctrine, are put into practice.[36] On January 14, 1945, the 790th Railway Operating Company came ashore and began Phase I level operations -- which is strictly a military operation. Japanese destruction of track, engines and rolling stock was severe, so the rehabilitation effort was expected to be intense. In February and March, engines and

rolling stock began arriving from the United States. More rail units were called in to assist. Working conditions were not good. Steaming jungle, disease, poisonous snakes and roaming bands of Japanese soldiers slowed progress. Military short tons hauled were 12,047 for February and 43,645 for March. Ton-miles continued to increase until July 1945, when replenishment demands peaked due to a stabilizing combat situation.[87]

Because of increased stability in the area, limited civilian passenger and freight traffic was accepted beginning May 16, 1945. With complete cessation of hostilities on Luzon in August, a railway operating battalion and three companies were ordered off the island in preparation for the invasion of Japan. With the consequent reduction of Army railroading capabilities, it became immediately necessary to start Phase II operations -- joint military and civilian railroad activity. The 6,674 Filipinos hired by the end of August made up for the loss of American rail personnel. It was a step toward accomplishing our long-term goal of turning the railroads over to indigenous business companies with minimal military supervision. That would constitute Phase III operations, which occurred in January 1946.[88]

The phases of railroad operations are not always that clear cut and simple. For example, General Douglas MacArthur had access to ample military rail units in the Southwest Pacific theater and, so, he did not have to be concerned with

Phases II and III. That is a luxury which does not exist at present. Depending on the theater and tonnage requirements involved, we may have to go immediately to Phase II operations. Army railroad assets may be spread so thin that supervision of the civilians may be inadequate. These are but a few of the consequences of our maintenance of such a small military rail force."

Section Summary

The challenges confronting a theater commander are numerous and complex. Railroad related problems may not capture his immediate attention, but even a competent staff cannot keep the transport requirements -- which are potentially the most serious of the logistical matters -- under control unless proper resources are provided in advance. Staff officers are going to have to work now at obtaining the needed railroad units so rail can be used to its fullest potential when it is needed.

IV. Conclusion

The applications of military railroads at the operational level of war are numerous. This mode of transportation warrants much more attention and consideration than it is currently receiving. Operational commanders have a great deal

to gain from increasing the number of U.S. Army rail units. The advantages of rail outweigh any likely challenges which might result from its use.

Railroads are unequaled in their ability to haul massive numbers of men, pieces of equipment and volume of supplies within a theater of operations. Their great capacity would be particularly valuable in high intensity conflicts which consume large amounts of petroleum and ammunition. At the low intensity end of the spectrum, rail can make substantial contributions to our foreign policy in the form of nation building projects. Such projects can contribute to the prevention or resolution of insurgencies and revolutions.

The rail option is efficient in its use of fuel and manpower, compared to other modes of transportation. During wartime, getting the most from our limited resources could make the difference between victory and defeat. In peacetime, efforts to increase the U.S. Army's wartime operating efficiencies are welcomed by our senior military leaders and elected officials. Increased use of railroads would effect that increased efficiency.

Any skepticism in using rail will have to be overcome by demonstrated performance. Unbiased analysis of the potential contributions of rail will not be enough to convince everyone of its value. When military railroaders have the support of senior military officers, sufficient to allocate necessary

men, tools and equipment, rail's value in future conflicts will be apparent enough.

But it will not be free. Engineer resources will need to be allocated to keep the track, engines and rolling stock working throughout the theater. Since, in any case, the engineers will be required to maintain rights of way -- be they rail, water or road -- efforts should be made where the returns will be greatest. This means rail with its great capacity.

Command and control challenges will have to be resolved. Sufficient authority should be delegated to railroad organizations to ensure the theater CINC's overall plan of distribution and supply can be successfully executed. With that authority should come a corresponding level of responsibility. Poor performance and instances of gross neglect, as have occurred in the past, should not be tolerated. A clearly designated chain of command will help prevent such incidents from happening again.

Differences in rail gauge exist in parts of the world where the U.S. Army may be called upon to fight. A long-term solution to this problem could be a construction program to regauge track, but this is not feasible in a short war scenario. Regauging is not absolutely necessary. Steps can be taken, such as rerouting trains or purchasing rolling stock and locomotives with removable wheel and axle assemblies, to minimize disruptions to rail operations. As a last resort,

transloading operations between different transport modes can be undertaken.

Self-inflicted wounds have occurred throughout the history of modern warfare and military rail has not been exempted. The use of railcars as storage containers is one example and this can be stopped only with command emphasis. The misuse of rail production and maintenance facilities in an overseas theater is another example. It is a complicated issue due to the probable involvement by foreign political leaders. U.S. military considerations may not be given top priority in allocating another nation's industrial infrastructure, and this could have negative effects upon the conduct of our campaigns unless we have our own, organic, rail units and all it takes to support them.

Challenges can arise while implementing host nation support agreements. Problems may occur in resolving conflicts between our Army's doctrinal phases of rail operation such as assigning movement priorities, when national interests are competing, and even deciding upon the maximum danger to which civilian workers will be exposed. Solutions to these issues will have to be worked out on a case by case basis at the time.

The evolution of technology continues, but no new forms of intratheater transportation have been developed which compare favorably with railroads at the operational level of war. Strengths and weaknesses of different transport modes need to

be examined and quantified by theater. Systemic comparisons need to be drawn so our logistical efforts can be better focused and directed. The appropriate place for military rail must be identified and the necessary personnel and equipment obtained. It is an important step which we can take now which will help to meet the pressing demands that are likely to be placed upon our logistical support structure in the future.

ENDNOTES

ENDNOTES

[1]Strategy provides the ways, means and ends of achieving national goals. War is an extension of the political process by other means. Armed force is only one of numerous options available to elected officials in pursuit of national goals. Economic and diplomatic efforts are usually exhausted before force is resorted to. Carl Von Clausewitz, On War (1984): pp. 87, 88; Department of the Army, Field Manual 100-5: Operations (1986): pp. 1, 9, 28, 29.

[2]The tactical level of war is the one with which soldiers are most familiar. Tactics usually concern activities at corps level and below. That is where engagements and battles are won and lost. (Field Manual 100-5 defines engagements as "small conflicts between opposing maneuver forces" and battles as "a series of related engagements".) Tactics focus on the immediate or short-term defeat of enemy forces. Department of the Army, op. cit., p. 10.

[3]Ibid., pp. 10, 59, 60, 65.

[4]The three levels of war -- strategic, operational and tactical -- are not distinct and tend to overlap. Situational criteria have a bearing on what level units and organizations are operating. A transporter's job becomes more complex as he focuses his efforts at the operational level as distinct from the tactical. It is inherently difficult, from any standpoint, logistically, to support sequential operations and large unit movements. Logisticians must think big and be prepared to move massive amounts of supplies. Transport options for each mode of transportation, including rail, continue to increase as one moves toward strategic planning, but so do the transport requirements. Army railroading assets are so limited. However, it is likely they will be spread thin at any level to which they are applied. Bradley E. Smith, "The Role of Army Railroading at the Tactical Level of War" (1988): pp. 29 - 33.

[5]Personal Interview with Major Alexander J. Rose, Instructor/Author, Department of Joint and Combined Operations, Command and General Staff College, Fort Leavenworth, Kansas, January 12, 1989.

[6]Edward N. Luttwak, "The Operational Level of War", International Security (Winter 1980 - 1981): pp. 62, 63.

[7]Operational art ought to be of great concern to professional officers, because this is where new ground is most likely to be broken. Senior military leaders are

assigned strategic missions by their political masters, and -- rightly or wrongly -- due consideration is not always given to the soldier's point of view. Tactics are centered upon specific techniques and often are chosen as the result of an opinion of the senior officer present. But operational art is different. This level of war is wide open for creative thinking and solutions on how to link the strategic and tactical spheres. New theory and approaches such as Blitzkrieg and AirLand Battle are examples of contributions to modern war fighting. Luttwak, op. cit., pp. 62, 63.

[8]Department of the Army, op. cit., p. 10.

[9]Peter S. Kindsvatter, "An Appreciation for Moving the Heavy Corps: The First Step in Learning the Art of Operational Maneuver" (1986): p. 26.

[10]Department of the Army, The Transportation Corps Railway Fleet (1960): pp. 524, 525. Prior to World War II, the condition of the Military Railway Service (MRS) was significantly different than in 1945. Brigadier General J.J. Kingman, Assistant Chief of Engineers, concluded in 1938 that the "MRS had fallen to less than nothing". This is the position we are finding ourselves in today. Carl R. Gray, Jr., "The Military Railway Service -- Part I", Army Transportation Journal (May - June 1948): p. 38.

[11]A short ton is a unit of weight equivalent to 2,000 pounds. Random House College Dictionary (1980): p. 1383.

[12]Department of the Army, The Transportation Corps Railway Fleet (1960): p. 533.

[13]Kevin C. Ruffner, "Yankee Boomers in Action", TRANSLOG (March 1980): p. 5.

[14]Smith, op. cit., p. 31.

[15]United States Army Transportation School, Transportation Master Plan -- Coordination Draft (1987): p. 9-2.

[16]Lewis I. Jeffries, "The Importance of Military Railways in Future Conflicts" (1975): p. 9.

[17]C.J. Schwendiger, "Is This the End of the Line for TRS? Can the Nation Afford It?", Defense Transportation Journal (December 1976): p. 15.

[18]"The Transportation Railway Service (TRS) is the overall organization of railway units assigned or attached to a major transportation organization in the theater army,

usually a transportation command. The transportation command could include groups (brigades if required), battalions, companies and transportation teams." Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 1-6.

[19]Ibid., p. 1-1.

[20]Department of the Army, Field Manual 55-10: Movement Control in a Theater of Operations (1986): pp. 2-1, 2-2.

[21]Department of the Army, Field Manual 100-10: Combat Service Support (1988): pp. 9-10, 9-11.

[22]United States Army Transportation School, loc. cit.

[23]Department of the Army, Field Manual 71-100: Division Operations -- Preliminary Draft (1987): p. 3-22.

[24]Department of the Army, Field Manual 100-10: Combat Service Support (1988): p. 9-13.

[25]Smith, op. cit., pp. 19 - 22.

[26]J.W. Higgins, Military Movements and Supply Lines as Comparative Interdiction Targets (1970): p. V.

[27]Ibid., p. 11.

[28]Ibid., pp. 11, 12.

[29]Association of American Railroads, United States Department of Transportation and United States Interstate Commerce Commission, Guidelines for the Railroad Industry in a National Emergency (1974): p. 2.

[30]Lewis I. Jeffries, "U.S. Railroads -- A Military Asset" (1985): p. 8; James A. Van Fleet, Rail Transport and the Winning of Wars (1956): p. 59.

[31]Since the end of World War II, the growth of containerization and intermodalism in the civilian transportation industry has made possible the more efficient movement of large amounts of cargo. Some of these techniques have military application. Trailers on flatcars (TOFCs) and containers on flatcars (COFCs) facilitate the interface between highway and rail assets of a theater commander. Containers can be double stacked on flatcars to increase the amount and type of goods a flatcar can haul. This has an added benefit of speeding the clearance of rail yards in a hostile environment. Truck trailers can also be fitted with "hi-railer" road wheels which permit chassis and bogies to be

pulled over the tracks by rail locomotives. Telephone Interview with Mr. Anthony T. Newfell, Railroad Equipment Specialist, Transportation Systems Center, United States Department of Transportation, Cambridge, Massachusetts, January 12, 1989.

[32]Defense Intelligence Agency, Railroad Capacity Methodology (Unclassified) (1983): pp. vii - 15.

[33]Jeffries, op. cit., p. 2.

[34]Telephone Interview with Major Robert W. McGuire, Jr., Executive Officer, 1205th Railway Services Unit, Middletown, Connecticut, October 31, 1988.

[35]Dennis E. Showalter, Railroads and Rifles: Soldiers, Technology and the Unification of Germany (1975): p. 21.

[36]Van Fleet, op. cit., p. 60.

[37]P.M. Kalla-Bishop, Future Railways: An Adventure in Engineering (1972): p. 3.

[38]Van Fleet, op. cit., p. 62.

[39]Jeffries, op. cit., p. 3; United States Army Transportation School, op. cit., p. 6-7.

[40]Smith, op. cit., pp. 19 - 22.

[41]Denis Bishop and W.J.K. Davies, Railways and War Since 1917 (1974): p. 107.

[42]Bradley E. Smith, "The United States International Maritime Industry: Challenges to Sustaining the Force" (1988): pp. 15 - 18, 46 - 50.

[43]United States Army War College, Army Command and Management: Theory and Practice (1988): pp. 10-14, 10-15.

[44]Bishop and Davies, op. cit., p. 2.

[45]Bradley E. Smith, "The Role of Army Railroading at the Tactical Level of War" (1988): pp. 8 - 22.

[46]Low intensity conflict is defined as "a limited politico-military struggle to achieve political, social, economic or psychological objectives. It is often protracted and ranges from diplomatic, economic and psychosocial pressures through terrorism and insurgency. Low intensity conflict is generally confined to a geographic area and is often characterized by constraints on the weaponry, tactics

and the level of violence. Also called LIC." Department of Defense, Joint Chiefs of Staff Publication 1: Dictionary of Military and Associated Terms (1987): pp. 214, 215.

[47]Department of the Army, Field Manual 100-10: Combat Service Support (1988): p. 9-13.

[48]Showalter, op. cit., pp. 20 - 22.

[49]Hew Strachan, European Armies and the Conduct of War (1985): p. 122.

[50]Smith, op. cit., pp. 8 - 11, 29 - 33, 35 - 40.

[51]Strachan, loc. cit.

[52]Smith, op. cit., pp. 8 - 19.

[53]Carl R. Gray, Jr., "The Military Railway Service -- Part II", Army Transportation Journal (July - August 1948): p. 44.

[54]Smith, op. cit., pp. 29 - 33.

[55]Christopher R. Gabel, "The Lorraine Campaign: An Overview, September - December 1944" (1985): p. 22.

[56]Smith, op. cit., p. 30.

[57]Gray, loc. cit.

[58]Smith, op. cit., pp. 15, 16.

[59]Strachan, loc. cit.

[60]Michael Howard, The Franco-Prussian War: The German Invasion of France, 1870 - 1871 (1981): pp. 412 - 416.

[61]Strachan, loc. cit.

[62]Howard, op. cit., pp. 26, 70, 414; Strachan, loc. cit.

[63]Carl R. Gray, Jr., "The Military Railway Service -- Part I", Army Transportation Journal (May - June 1948): p. 19.

[64]Ibid.

[65]Bruce Catton, Mr. Lincoln's Army (1951): pp. 6 - [illegible].

[66]Strachan, loc. cit.

[67]Carl R. Gray, Jr., "The Military Railway Service -- Part II", Army Transportation Journal (July - August 1948): p. 44.

[68]Denis Bishop and W.J.K. Davies, Railways and War Since 1917 (1974): p. 89.

[69]Department of the Army, Field Manual 55-15: Transportation Reference Data (1963): pp. 136, 137; James A. Van Fleet, Rail Transport and the Winning of Wars (1956): p. 50.

[70]Strachan, loc. cit.

[71]"The four main components of a freight car are the deck, underframe, truck and coupler. The deck is the surface that the load rests on. The deck or floor is usually steel or wood. The underframe is that structure under the deck that supports the weight of the load. The truck is that assembly which contains a car's wheels, axles, journals, suspension system and brake system. The coupler is a device which connects or couples a car with another car." Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 8-14.

[72]Personal Interview with Colonel Lewis I. Jeffries, Director of Academic Operations, Command and General Staff College, Fort Leavenworth, Kansas, July 8, 1988.

[73]Van Fleet, loc. cit.

[74]Ibid.

[75]Archibald P. Wavell, The Palestine Campaigns (1929): pp. 12, 16.

[76]William P. Addison, "Rail Movements: Office of the Chief of Transportation -- French North Africa, November 1942 to December 1945" (1946): pp. 64, 65.

[77]Bishop and Davies, op. cit., pp. 93, 94; Department of the Army, Field Manual 55-15: Transportation Reference Data (1963): p. 136.

[78]Bishop and Davies, op. cit., p. 2.

[79]Ron Ziel, Steel Rails to Victory: A Photographic History of Railway Operations During World War II (1970): p. 49. Martin Van Creveld has written, "Among the factors that prevented the Germans from entering Moscow, general mud (which practically stopped all wheeled vehicles) is usually considered the most important....During October, supplies of

fuel were almost nonexistent....Had politico-military-economic considerations allowed Germany to attempt the conquest of Russia in a slow and methodical manner, more reliance could have been placed on the railways". Martin Van Creveld, Logistics From Wallenstein to Patton (1984): pp. 176, 177.

[50]Strachan, loc. cit.

[51]Van Fleet, op. cit., pp. 17, 20, 28.

[52]James A. Huston, Army Historical Series: The Sinews of War -- Army Logistics, 1775 - 1953 (1966): pp. 535, 536. Another example of misusing railcars occurred in Iran during World War II. "Failure of the Russians to unload cars of Lend-Lease supplies forwarded to them over the Iranian railroad system from the Persian Gulf caused substantial reduction in traffic capacity of the line. Once the situation got so desperate that all cars were on the north end of the line under load. Therefore, an embargo was established from 8 August to 13 August 1943, during which period no freight was put aboard cars nor moved out of the southern ports until the situation was improved. To illustrate the effect of the congestion, it was taking tank cars 30 days to move from the Persian Gulf to the Caspian Sea and return, which was twice the necessary time. While such conditions lasted, the carrying capacity of the tank-car fleet was halved, of course by the Russian failure to unload." Van Fleet, op. cit., p. 20.

[53]Bishop and Davies, op. cit., p. 3.

[54]Smith, op. cit., pp. 33, 34.

[55]Department of the Army, The Transportation Corps Railway Fleet (1960): p. 510.

[56]Department of the Army, Field Manual 55-20: Army Rail Transport Units and Operations (1986): p. 1-2: Smith, loc. cit.

[57]S. Kip Farrington, Jr., Railroading From the Rear End (1946): pp. 370 - 372.

[58]Farrington, op. cit., pp. 372 - 375.

[59]Smith, loc. cit.

APPENDIXES

Appendix A

Tonnage Capacities of Intratheater Transportion Assets

Payload capacities for motor and air transport were extracted from Department of the Army Field Manual 101-10-1/2: Staff Officers' Field Manual -- Organizational, Technical and Logistical Data Planning Factors (Volume 2) (1987): pp. 3-5, 3-6, 3-11, 3-12, 3-19, 3-21. Payload capacities for rail transport were extracted from Department of the Army Field Manual 55-20: Army Rail Transport Operations (1969): pp. C-2, C-3 and a Telephone Interview with Mr. Thomas M. Hatchard, Director, Safety and Operating Rules, Association of American Railroads, Washington, D.C., April 14, 1989. Sample capacities for different types of trucks, helicopters, Air Force transports and railcars are provided. Listings are not intended to be complete for all items in the Army and Air Force inventories.

	Payload Capacity (pounds)
Motor Transport	
Truck, utility, tactical, 3/4 ton (CUCV M1009)	1,200
Truck, util, cgo, troop carr, 5/4 ton (HMMWV M998)	2,500
Truck, cargo, tactical, 5/4 ton (CUCV M1008)	2,900
Truck, cargo, LWB, tactical, 5 ton (M939)	10,000
Truck, tractor, tactical, 5 ton (M931)	75,690
Truck, tractor, line haul (M915)	105,000
Truck, tractor, line haul, 20 ton (M916)	126,000
Semitrailer, low bed, 15 ton (M172)	30,000
Semitrailer, flatbed, break bulk container (M872)	68,000
Semitrailer, truck transporter, 50 ton (M15A2)	100,000
Semitrailer, low bed, 60 ton (M747)	120,000
Air Transport	
Helicopter, CH-6A	650
Helicopter, OH-58C	837
Helicopter, UH-60	3,360
Helicopter, AH-64	4,090
Helicopter, CH-54A	11,650
Helicopter, CH-54B	16,256
Helicopter, CH-47C	18,200
Helicopter, CH-47D	20,206
Air Force Transport, C-130E/H	35,500
Air Force Transport, C-141B	90,200

Appendix A, continued

Rail Transport

Type of Car	Capacity (pounds)
Box, 40 ton, foreign service	80,000
Gondola, 40 ton, low side, foreign service	80,000
Box, 50 ton, domestic service	100,000
Tank, 10000 gallon, domestic service	100,000
Tank, 16000 gallon, European service	138,600
Flat, 70 ton, depressed center, foreign service	140,000
Flat, 70 ton, domestic service	140,000
Flat, 80 ton, foreign service	160,000
Flat, SSym, European service	180,000
Flat, FFlm, European service	190,000
Flat, 100 ton, domestic service	200,000
Flat, 140 ton, domestic service	280,000
Flat, 150 ton, domestic service	300,000
Flat, 200 ton, domestic service	400,000
Flat, 250 ton, depressed center, domestic service	500,000
Flat, 250 ton, span bolster, domestic service	500,000
Flat, 250 ton, well hole, domestic service	500,000
Flat, 290 ton, steel loading deck, domestic service	580,000
Flat, 300 ton, span bolster, domestic service	600,000
Flat, 350 ton, span bolster, domestic service	700,000

Appendix B

Countries With Standard Gauge Track

The information provided below was provided in Department of the Army Field Manual 5-35: Engineers' Reference and Logistical Data (1960): pp. 100 - 106 and Department of the Army Field Manual 55-15: Transportation Reference Data (1963): pp. 133 - 138. The countries listed below have standard gauge track. Some of them have more than one gauge and are confronted with the ensuing transload challenges.

Africa:
- Algeria
- Egypt
- Mali
- Mauritania
- Morocco
- Niger
- Senegal
- Tunisia
- Upper Volta

Asia:
- Afghanistan
- China
- Indonesia
- Iran
- Iraq
- Israel
- Japan
- Korea
- Lebanon
- Saudi Arabia
- Syria

North America:
- Canada
- Continental U.S.
- Mexico
- Alaska

South America:
- Argentina
- Chile
- Guyana
- Paraguay
- Peru
- Uruguay
- Venezuela

Central America and West Indies:
- Cuba
- Jamaica
- Trinidad

Europe:
- Albania
- Austria
- Belgium
- Bulgaria
- Czechoslovakia
- Denmark
- France
- Germany
- Greece
- Hungary
- Italy
- Latvia
- Lithuania
- Luxembourg
- Netherlands
- Norway
- Poland
- Rumania
- Sweden
- Switzerland
- Turkey
- United Kingdom
- Yugoslavia

Pacific Ocean:
- Australia
- Hawaii

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