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JOINT DOCTRINE SAYS THAT "to exercise control at the strategic, operational and tactical levels of war, commanders must also exercise control over logistics."[1] Control cannot be exercised without timely and comprehensive information, a picture of the battlefield logistically speaking, including not only what is already on the battlefield but what is flowing into it as well.

The commander's requirement is for information, not just data. Data becomes information—with which to create a picture of the logistics of the forces on the battlefield, to predict the sustainability of those forces, and to evaluate alternative courses of action as they are affected by logistics—when it has been processed by software built around models that transform input data (tons of ordnance or barrels of fuel, for example) into measures of sustainability (days of supply, for example). Further, such information must be generated not for just the current moment but for the future as well. This implies a need for models that can predict sustainability. Better logistics planning factors incorporated in models of the use and replenishment of commodities, better "visibility" (that is, ability to keep track) of the stocks of material on the battlefield and flowing into it, and an ability to predict sustainability will make it possible to achieve appropriate levels of sustainability with minimal stocks of materials.

In 1990, lacking such capabilities, General Norman Schwarzkopf sought to assure himself of appropriate levels of sustainability for the Persian Gulf War by

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requiring in-theater thirty to sixty days of supply of most sustainment materials.[2] This brute-force approach was necessitated by the absence of sustainment planning models and of adequate knowledge about material flowing into the Gulf theater. Huge stockpiles that take months to accumulate and represent a huge "footprint" and great vulnerability can be avoided, and logistics can be made more focused, if a combatant logistics command and control system is developed.[3]

The theme of this article is that logistics is a central part of the operational and tactical levels of warfare and must be included in the command and control system of the joint force commander. Logistics has generally not been afforded this recognition. It has been seen as an administrative aspect of military operations rather than an operational and tactical component of combat. Running out of fuel or ordnance while in combat, however, is painfully operational.

Logistics: 1960s to the Gulf War

While logistics is the subject of much attention during times of actual conflict, it is not an inherently glamorous subject; it is not close to the hearts of most warriors, and it usually receives little attention during interwar periods. An example of the result of such neglect was the experience of the 173d Airborne Brigade during the first months of U.S. involvement in Vietnam. Ammunition had been supplied in "push" packages. Unfortunately, these packages had been developed and tailored on the basis of Second World War and Korean War experience. When the 173d arrived to protect the Tan Son Nhut airport, near Saigon, it found that it used ammunition faster than the rates for which the packages had been designed. To make matters worse, some of the ammunition supplied was for weapon systems that had been retired from the Army inventory. Over 255 tons of ammunition had to be flown from Okinawa in an emergency effort to ensure Tan Son Nhut's security. The operation took every transport aircraft available in the theater for a period of seven days.[4]

New logistics planning factors were created during the Vietnam conflict, at the behest of Commander, Military Assistance Command Vietnam. Due to the coarseness of available data, the planning factors were derived by dividing the tons of "stuff" shipped into theater by the theater troop strength; thus, all the new planning factors were in units of pounds per man per day. Rations and M-16 rounds are perhaps sensibly quoted in these terms, but other commodities are not: specifying naval ship propulsion fuel usage in pounds per man per day is not terribly useful.[5] Navy logistics planners began the Gulf War in 1990 expecting to supply each aircraft carrier with 188 tons of ammunition per day, based on the Vietnam logistics planning factors. In Vietnam, carrier aircraft had dropped a great many "dumb" bombs. In early 1991, when the air campaign began in the Gulf, precision guided munitions partially substituted for the brute force of tons of dumb bombs, and actual carrier ammunition usage was less than half the planning factor.[6]

While precision guided munitions and other high-technology projects were being initiated in the 1970s, logistics was largely ignored. Non–high tech improvements to strategic sealift were bought in the early 1980s in the form of the fast sealift ships, the crane ships, and the two hospital ships. The maritime prepositioning program was also initiated in this period.[7] With the exception of these programs, logistics did not share in the technology of the 1980s. It was not accounted for in command and control systems. Software support programs for operational and tactical logistics were not developed, nor did logistics claim any part of the communications bandwidth becoming available. The logistics software support programs that were written pertained to inventory and maintenance accounting, which was administrative in nature rather than operational or tactical.

The Gulf War

Thus, logistics did not receive much attention in the efforts of the Department of Defense to develop and apply technology in the years after the Vietnam conflict. Nonetheless, logistics was one of the successes of the Gulf War. Still, there were a number of logistics problems, and they have implications for the logistics picture needed by the joint force commander.

When Iraq invaded Kuwait on 2 August 1990, the U.S. joint force commander in the theater was the Commander in Chief, U.S. Central Command (CINCCENT). General Norman Schwarzkopf was at his headquarters at MacDill Air Force Base in Florida. Iraqi forces took less than twenty-four hours to secure their hold on the independent state of Kuwait, and it was unclear whether they would be content with their capture of Kuwait or press on into northeast Saudi Arabia. On the evening of 4 August, Central Command (CENTCOM) planners met to rough out requirements if U.S. forces were to be committed. Early on 5 August, Secretary of Defense Richard Cheney, General Schwarzkopf, and Lieutenant General John J. Yeosock, the commander of Army Forces Central Command (ARCENT), flew to Riyadh for top-level meetings with King Fahd. On 6 August, President George Bush announced that U.S. forces would be committed to the defense of Saudi Arabia; XVIII Airborne Corps was already mobilizing. On 8 August, the first troops of the 82d Airborne Division were arriving at the airport in Dhahran, Saudi Arabia. Also on 8 August the USS *Eisenhower* battle group was on station in the Red Sea, and the USS *Independence* battle group was on station in the Gulf of Oman.[8]

In early August 1990, the United States had no forces, bases, supplies, or infrastructure in Saudi Arabia. Forces, their equipment, and their sustainment stocks of fuel, ordnance, spare parts, and a million other things would have to be deployed into the theater, and bases established for them. The current CENTCOM operation plan was OPLAN 1002-88, which involved Iran. In October 1989 the Joint Chiefs of Staff (JCS) had directed that a major revision of this plan be prepared, with Iraq as the opponent. In April 1990 the outline for

USCINCCENT OPLAN 1002-90 had been published; the plan would be completed in April 1991, after DESERT STORM ended.[9]

An OPLAN represents the full development of the concept of operations of the commander in chief (CINC) of a unified command. It specifies the forces and support needed to execute the plan and the transportation schedule required to move those resources. In developing a plan, the CINC and service-component staffs develop a detailed flow of resources into the theater to support the approved OPLAN concept. After forces are selected, time-phased support requirements are determined, and transportation feasibility is established, the detailed planning information is generated and stored as a "time-phased force and deployment data" (TPFDD) file. Clearly, in August 1990 CINCCENT had neither an approved OPLAN nor a TPFDD for the operations he was about to undertake. Worse yet, there had been no warning time; Central Command was playing catch-up from the start.

Because it was not known whether Iraq would invade Saudi Arabia, Schwarzkopf's initial concern had to be to put defensive forces into northeastern Saudi Arabia as rapidly as possible. Thus, combat units were deployed ahead of logistics support and sustainment cargo.[10] Absent an approved OPLAN and TPFDD, the first tasking received by the Military Airlift Command consisted of an unprioritized list of units to be deployed as soon as possible. The situation was chaotic until CINCCENT established movement priorities. Thus began the implementation of the principle that the warfighter must have command of, and exercise control over, his logistics. Joint logistics doctrine states:

> To exercise control at the strategic, operational and tactical levels of war, commanders must also exercise control over logistics. For a given area and for a given mission, a single command authority should be responsible for logistics, especially in the joint operational environment. The logistics support system must be in harmony with the structure and employment of the combat forces it supports. This unity of effort is best attained under a single command authority. . . . Commanders must be able to call forward in a timely manner those assets needed to initiate and sustain war.[11]

Operation DESERT SHIELD, which began as the defense of Saudi Arabia, was ultimately to result in the liberation of Kuwait and involve more than five hundred thousand U.S. personnel, from all the services, plus coalition forces. CENTCOM's ability to set transportation priorities and gauge its capacity to defend Saudi Arabia and ultimately to free Kuwait depended upon having a picture of what forces, unit equipment, and sustainment material had arrived, what bases had been established, and what intratheater transportation assets were available to move forces and material from their ports of entry to their intended locations. In terms of personnel, the Army was the dominant service, but the picture needed to include the Air Force, the Navy, the Marines, and coalition forces. The feasibility and timing of DESERT STORM ultimately depended on knowing that the forces were ready, in the right places, and that their sustainment stocks were adequate for the task about to be undertaken. Some of the required information was tactical, some of it was readiness related, and much of it was logistical.

Logistics in the Gulf War

There being no OPLAN or time-phased force deployment data, crisis action planning of necessity went on alongside the deliberate planning process. CENTCOM rushed defensive forces into Saudi Arabia, beginning with Army airborne forces and Marines. These were followed by heavy forces, whose arrival times were dictated by the availability of strategic sealift from the United States and later Europe. Naval forces surged into the theater from nearby deployment areas. Air Force tactical aircraft were flown from U.S. bases directly into Saudi Arabia, while their equipment and personnel were airlifted. Bases had to be created for the forces. Though existing Saudi air bases would be utilized by the Air Force, in some cases they were simply runways, with little or no infrastructure. Fuel systems, ordnance magazines, maintenance facilities, and housing for personnel all had to be created. These efforts were handicapped by the need to assign movement of combat forces a higher priority than combat service support. Fortunately, host-nation support was rich in such resources as air and sea ports to receive the inflow, tents to house personnel, and trucks, buses, and drivers to move personnel, equipment, and supplies.[12]

The early arrival of Marine Corps troops and Air Force squadrons was facilitated by the existence of prepositioned unit equipment and susrainment stocks on ships at Diego Garcia and, for the Air Force, of ammunition storage sites in Southwest Asia. A buildup for the defense of Saudi Arabia (known as Phase I) lasted until approximately 1 November, and Phase II (the liberation of Kuwait) brought the VII Corps from Germany to Saudi Arabia. In all, more than five hundred thousand personnel and 9.7 million tons of material were transported into the theater to support the Gulf War. Lieutenant General William G. Pagonis, the Army's senior logistician, likened it to transporting the entire population of Alaska, along with their personal belongings and vehicles, to the other side of the world, on short notice.[13]

CENTCOM logistics contingency plans were based on the doctrine that each service would train, equip, and sustain its own forces in the CENTCOM area of responsibility.[14] Each service was responsible for its own logistics, except that common-user support (such as water and food) would be provided by the component having the greatest presence. In this case, the Army provided food and water to in-theater forces of the Army and Air Force, and to the Marines ashore; the Navy sustained naval forces and Marines afloat. The Army also provided intratheater ground transportation for the Air Force and the Marines, who also had their own ground transportation. Air transport was provided by the Air Force for the three services. Ships were off-loaded by the Army Transportation Corps, Navy beachmaster units, and the Marine Corps landing support battalion. Intertheater airlift was run by the Air Force's Military Airlift Command (since renamed the Air Mobility Command), and strategic sealift was run by the Navy's Military Sealift Command. The logistics experiences of the four services are summarized below.

The Army Logistics Picture. The Army logistics picture can be inferred from a sample of the logistics situation reports (LOGSITREPs) of the 22d Support Command (SUPCOM), commanded by Major General (later Lieutenant General) Pagonis. General Pagonis, sent to Saudi Arabia at the request of Lieutenant General Yeosock to lead host-nation-support negotiations, arrived there on 8 August. Over time, Pagonis became the chief logistician of the Gulf War. The daily LOGSITREPs of his 22d SUPCOM were sent to General Schwarzkopf (CINCCENT), to ARCENT, to the Pentagon, and to Army logistics agencies. Officially, General Pagonis worked for ARCENT, but there is little doubt that he considered himself to be working for CINCCENT.[15] Thus the 22d SUPCOM LOGSITREPs largely represented the joint commander's logistics picture throughout Desert Shield and Desert Storm. However, the fact that the 22d SUPCOM was a component of ARCENT meant that its reports were essentially about Army logistics and the common support provided to the Air Force and Marines ashore. They contained virtually nothing on the logistics of naval forces; for Air Force and Marine Corps units, they provided data only on rations, water, and petroleum products.

An inability to keep track of inbound shipments is evident in most of the LOGSITREPs. This was especially prevalent at the beginning of operations, but it persisted throughout the conflict. Without in-transit visibility, logisticians could only track, not predict, the logistics situation. Asset visibility was also a problem: of the more than forty thousand containers deployed to the theater, well over half had to be opened at least once to determine contents, ownership, and destination.[16]

In general the LOGSITREPs were organized in terms of commodity classes, as in the table (next page). Commodity classes I, III, V, and VII (items like aircraft, tanks, and artillery) received the most attention in the LOGSITREPs, with water, fuel, and ammunition generally considered to be logistics "drivers," or controlling factors. The quantities of end-items was of interest, and their operational status got more detailed attention as Desert Storm approached. The Army's responsibility for the subsistence of Air Force and Marine Corps personnel ashore and for the in-theater distribution of Air Force fuel and ordnance and Marine Corps fuel made trucks and buses items of great interest as well. People and mail are not commodities, but both had to be received and distributed within theater and thus were reported in the LOGSITREPs.

The situation reports also displayed sea and air port-of-debarkation information, in terms of the number of flights or number of ships arriving on a given

Commodity Classes

Class I	Subsistence items
Class II	Clothing, individual equipment
Class III	Petroleum, oils, lubricants (POL)
Class IV	Construction materials
Class V	Ammunition
Class VI	Personal demand items
Class VII	Major end-items
Class VIII	Medical supplies
Class IX	Repair parts
Class X	Material for nonmilitary programs

day, and to date. Cargo was reported as passengers, aircraft, vehicles, pallets, or containers—and in raw numbers, not associated with the units to which the passengers, equipment, or commodities were destined. There was no indication of how the receipt of cargo related to the "plan"; hence, performance could not be evaluated. In any case, of course, there *was* no plan against which to evaluate the deployment surge. This turned out not to be crucial, since Iraq did not move across the border into Saudi Arabia and thus gave the coalition all the time it needed to build up its forces. The timing of DESERT STORM was dictated instead by the policy decision that there would be no troop rotation, by concern about how long the Kingdom of Saudi Arabia would allow foreign forces in the country, by UN Security Council Resolution 678, and by how long it would take to move the necessary forces and their sustainment materials into position.[17]

For two of the three logistics drivers—water and POL—the LOGSITREPs reported present status in terms of capacity, quantities on hand, and sometimes days of supply and a five-day forecast.[18] Water and POL status was given for ARCENT and for the Marine Corps and Air Force components of Central Command (MARCENT and CENTAF, respectively), though not all the reports had information other than for ARCENT. The notion of trying to project ahead was in the spirit of providing really useful information, but none of those numbers ever changed—the expected quantities for each of the days in the five-day forecast were the same as the current day's numbers. No forecasting capability actually existed. The third logistics driver, ammunition, was usually noted in terms of the number of short tons or truckloads received or distributed within the theater. The operational commanders would have wanted to know how much of each specific ordnance type they had. This level of detail may have been available; the LOGSITREP of 26 February reported the quantity of major ammunition types delivered, the quantity required, and the percent of the requirement on hand. However, this data was theaterwide, not broken down for corps or divisions.

End-item and equipment status was generally given in terms of the number authorized, number on hand, number "mission capable," and the operational readiness rate. During the fall of 1990 the majority of not-mission-capable systems were awaiting delivery of repair parts. By December there had been a shift; the majority now awaited maintenance availability rather than parts.[19] Only Army end-items appeared in the LOGSITREPs. As the ground war approached there was massive movement of personnel, equipment, and sustainment stocks, which was reflected in declining mission-capable rates of the forces' and host nation's trucks and buses.

Air Force Logistics. The *Gulf War Air Power Survey*, Volume III, *Logistics and Support*, evaluates logistics performance from the Air Force perspective. Its general conclusions are that the Cold War resource base, which made virtually anything possible in the Gulf War, is being reduced and that having five and a half months for preparation should not be assumed in the future.[20] More specifically, it notes that the joint commander's decision to deploy "tooth before tail" created interesting logistics challenges, given that forces were deploying to an area devoid of U.S. military bases or infrastructure and that there was no OPLAN or time-phased force and deployment data. The *Survey* concludes that logistics initially operated without confirmation of priorities and with insufficient knowledge of details. CENTCOM and U.S. Transportation Command had to build TPFDD data and enter it into the Joint Operations, Planning, and Execution System (JOPES) even as the actions the data reflected were being executed.[21]

Hundreds of units of all four services were submitting data to or making entries in the TPFDD—entries with so many errors that they were unreliable for determining lift requirements. It was discovered that JOPES could not handle partially deployed unit-type cases, making it impossible to track automatically what was deployed and what was not. It also became apparent that the Military Airlift Command's computer models could not analyze schedules or determine where intended flow would exceed throughput capacity. Consequently, bases became backlogged, and when they did the Airlift Command had no recourse except to interrupt the flow. This led to several total shutdowns while logjams cleared; cargo caught in the backlogs was often assumed lost and then reordered.[22]

The *Survey* states that abuse of the transportation priorities created many problems. In early September 1990, 52 percent of all sustainment cargo awaiting air shipment was coded at the top transportation priority, a situation wherein there were essentially no priorities. The lack of prioritization and frequent desired closure times of "now" created an airlift demand six to seven times capacity.[23] That capacity, in turn, was constrained by nearly useless automated information systems. Because "tooth" was being deployed before "tail," many units did not know where they would "bed down"; the only address on cargo meant for them was "Desert Shield." Most of this cargo ended up in Dhahran; there the pallets sat, and no one knew their intended destinations or priorities.

The *Survey* also notes that service supply and transportation systems had deadly deficiencies with respect to in-transit visibility.[24] Within supply systems, items were tracked by requisition number. A (different) control number was assigned to track them in the transportation system. With no mapping of requisition numbers to transportation control numbers, and massive amounts of material being moved, all traceability was lost. Eventually, late in the war, the Air Force Logistics Information File (modeled after the Army Logistics Information File) linked the supply and transportation systems; this provided intertheater in-transit visibility and helped keep track of parts as they entered the transportation system.[25] Another fix was the establishment of daily "Desert Express" flights from the United States into the theater. Desert Express was necessitated by the problems of priority abuse and in-transit visibility with respect to "war stopper" material.[26]

There were also significant difficulties with ordnance inventory. The hundred million dollars that had been spent on the Air Force Combat Ammunition System brought no benefit to users; ordnance information had to be created and maintained by hand throughout the Gulf War. Accordingly, the data lacked credibility for senior Air Force managers. In particular, what ordnance was on board arriving cargo ships was the "mother of all mysteries."[27]

Aircraft mission-capable rates, the *Survey* finds, were nearly as good as peacetime rates, but not better; higher rates originally claimed were artifacts of an ad hoc, manual reporting system. Automated maintenance management support was not available until December 1990, and the absence of configuration data, especially for engines, further compromised maintenance.[28] The absence of aircraft status information hampered attempts by various headquarters to determine the health of the force.[29]

Marine Corps Logistics Ashore. The Marine Corps deployment in the Gulf War was hampered, like that of the other services, by the lack of an OPLAN and TPFDD. It was, however, a brilliant confirmation of the efficacy of maritime prepositioning ships. The MPS squadron at Diego Garcia was ordered underway on 10 August, and it arrived in the port of Al Jubayl on the 16th. The personnel of the 7th Marine Expeditionary Brigade (MEB) flew in, "married up" with their equipment, and were in defensive positions north of Al Jubayl by 25 August. The Army 82d Airborne Division had troops on the ground earlier, but it was the Marines, with the armor and artillery delivered by the MPS ships, that offered the first credible deterrence to a mechanized attack.[30]

Al Jubayl was the Marines' sea port of debarkation, and the nearby King Abdul Aziz Airport was their air port of debarkation. Ad Dammam, fifty miles to the south, was the Army's sea port of debarkation. The Marines deployed somewhat differently from the Army. By 6 September, Brigadier General James A. Brabham had enough combat service support personnel in Al Jubayl to "stand up" the 1st Force Service Support Group, assume responsibility for all port operations, and take command of host nation, Army, and Navy material handlers as well as the Marine landing support battalion. Marine Corps 7th MEB helos arrived by C-5 Galaxy, but Marine tactical fixed-wing aircraft were stalled on the U.S. east coast for lack of Air Force tankers for in-flight refueling. The MARCENT commander, Lieutenant General Walter E. Boomer, finally asked for General Schwarzkopf's help in securing the Air Force tankers needed, and Marine F/A-18s began arriving in-theater on 23 August.[31]

The biggest Marine Corps logistics problem was related to intratheater ground transportation rather than organization or the availability of information about sustainment stocks. When the Marine defense perimeter moved from thirty to eighty miles north of Al Jubayl, and eventually considerably farther west, the lack of trucks and truck drivers became evident. Prior to the Gulf War, Marine Corps truck units had expected one-way line-haul distances of thirty to fifty miles; in Saudi Arabia they experienced distances of 175–200 miles.[32] There were not enough trucks, and there were not enough drivers to keep the trucks available running twenty-four hours a day. The Marines, who had no heavy-equipment transporters, had to drive their tanks from ports to their deployment areas. (The Army had only a few transporters, but it leased others from every possible source.) The Marines leased trucks and buses, called up reservist truck drivers, relied on the Army to haul its fuel, used Air Force C-130s and their own CH-53 helos for logistics, and even arranged for Army boats to ferry material and equipment up the coast from Al Jubayl to Ras al Mish'ab.[33]

All the Marine Corps generals involved have said that fuel, ordnance, and water were the commodities that drove the logistics situation.[34] Ordnance was often of highest concern. General Brabham has noted that thirty days of supply (DOS) of ammunition for a Marine division amounted to 265,000 tons. Moving ordnance put a tremendous strain on Marine Corps intratheater transportation assets. Lieutenant General Royal N. Moore, Jr., commanding general of the 3d Marine Aircraft Wing (MAW), had a different ordnance problem: he almost ran out of bombs. On Thanksgiving Day he wrote a message (with himself as action officer) to everyone in the bomb-related chain of command giving his requirements for sixty DOS. One reply indicated that since the 3d MAW was a Pacific wing, he could have only the Pacific ordnance allocation, not the Atlantic one. He responded that his wing had both Atlantic and Pacific squadrons and that, in case anyone had failed to notice, he was about to be involved in a war. Several weeks went by before he received a reply—in effect, "We don't think you need so many Mark 82 bombs." At one point during the war he was down to half a day's supply of Mark 82 bombs and a day and half's worth of Mark 83 bombs. General Moore recalls that he ended the war with a fourteen-day supply of ordnance. He has also estimated that 25 percent of his wing's sorties were flown without the preferred ordnance, weapons that would have increased target-kill probabilities.[35]

Navy Logistics. Navy afloat logistics requirements in war differ little from those of peacetime. The principal difference is that in wartime live ordnance is expended and must be resupplied to afloat forces. NAVCENT had difficulty throughout the war in determining the ordnance situation. The Navy had created its Conventional Ammunition Integrated Management System (CAIMS) as an ordnance accounting system; it was unresponsive to operational commanders in the war.[36] Also, its data were of substandard quality. In peacetime CAIMS reports, month-to-month variations of 10 percent or more in the total number of weapons of a given type were not unusual. These variations could not be accounted for by new production or changes in the material condition of the inventory; instead, they were due primarily to uncorrected misreporting of issues and receipts. This problem was exacerbated during the buildup and war, when mismatches increased dramatically along with the scale of ordnance transfers, outstripping the ability of the people maintaining the system to rid it of errors.[37]

Additionally, the organization and presentation of data in CAIMS made it difficult to track inventories of commands smaller than numbered fleets (that is, Second Fleet, Seventh Fleet, etc.). CAIMS could not provide inventory totals for such component commands as NAVCENT or MARCENT, or for operational commands, such as battle forces or battle groups. Finally, NAVCENT did not have a CAIMS terminal; it could get CAIMS data only through Task Force 63 or 73 (the Sixth and Seventh Fleet logistics organizations), the Pacific Fleet headquarters, or the Depury Chief of Naval Operations (Logistics) in Washington. The impact was that operational commanders never had good ordnance inventory data.[38]

Another problem involved the distribution of people, mail, and cargo to operating forces from the Navy's forward logistics site in Bahrain. Logisticians in Bahrain had no access to the tactical picture; they did not know where their customers were, and as a result they were unable to distribute people or cargo to them expeditiously. (This situation remains unchanged, recurring as recently as Exercise STRONG RESOLVE in 1995.)[39]

Communications was also a problem for Navy logistics. Supply Corps officers attempting to obtain spare parts to correct equipment casualties had to rely on standard messages to relay their needs to inventory managers in the United States and elsewhere. The number of messages of all kinds being generated, however, inevitably became very large in the Gulf War, and accordingly the time it took to receive a message (especially standard requisitions, which could be sent only at a low "precedence") became very long. To get around the delays in message traffic, two reserve supply officers devised the Streamlined

Automated Logistics Transmission System. SALTS used (and still uses) personal computers to format and compress messages and (in the absence of landlines) the commercial International Maritime Satellite (INMARSAT) service to transmit them.[40]

Assessment of Gulf War Logistics. The Gulf War was a success by any measure, including logistics. No forces lacked for sustainability, and logistics support was sufficient for execution of the operational plan. Still, there were logistics planning and execution problems. Efficient deployment was hampered by the fact that there was no approved OPLAN or TPFDD when the crisis began. JOPES was new, and the TPFDD input process was too ponderous for crisis action planning; initial execution was carried out without JOPES, and TPFDD files were frozen. Air Force general Walter Kross, Director of Operations and Logistics (J-3/J-4) at U.S. Transportation Command when the war began, has said that on the fourth day after C-day (or commencement day, which was 7 August 1990), JOPES and TPFDD "crashed," and his worst nightmare ensued—doing the job with pencil and paper. JOPES came back on line on 24 August, and around 28 August the TPFDD was stable enough to use as a basis for planning.[41]

Deployment planning focuses on moving the maximum amount of forces and their support into a theater in the minimum amount of time. Deployment planning tools in 1990–91 did not address distribution within the theater; intratheater distribution was further hampered by insufficient surface lift and unknown initial bed-down locations. In-transit visibility of the things being airlifted and sealifted into the theater was an early and persistent problem. Lack of knowledge about what was coming into theater ports meant that Lieutenant General Pagonis could only track the material that had arrived; he could not project what the status would be a week or a month ahead. Ordnance was a logistics driver; related problems included determining requirements and how much ordnance of each type was available.

With no OPLAN or TPFDD, the performance of air and sea lift could only be tracked, not measured against a plan. Movement requirements so far exceeded normal air-lift capability that the mobility *requirement* effectively became the mobility *capability*.

Unit closure status could not be measured directly, because JOPES could not track partial unit movements. A unit is considered "closed" when a high percentage of its personnel, equipment, and sustainment material are at its assigned place; until then it is not considered capable of performing its missions. The inability to judge when units had closed, combined with asset visibility problems, meant that predictions about future closure and sustainability could not be made. Further, there was no software to relate intertheater lift plans with units, their intended locations, and intratheater lift capability. Much of what arrived at seaports or airports was reported simply as numbers of personnel, equipment, and of tons or truckloads; closure could therefore not be predicted. Ordnance receipt or movement was reported in tons or truckloads; the ordnance sustainability of individual units or forces could not be predicted in terms of days of supply of high-interest items.

> *Strategy provides the scheme of utilizing our forces, and Logistics provides the means therefor.*
>
> *Lieutenant Colonel George C. Thorpe, USMC**

Of the 9.7 million tons of equipment and material shipped in support of the Gulf War, a little over six million tons was POL.[42] Ordnance accounted for a fair proportion of the other 3.7 million. With imperfect intelligence about the enemy and *sufficiency* as a guiding principle in determining requirements, logisticians shipped far more ordnance into the theater than was used. The Air Force believes it expended sixty-nine thousand tons of the 350,000 tons of ordnance shipped into the theater for it—about 20 percent.[43] Other services estimate that they used even less. General John Foss of the Army has noted, "Probably the very worst decision of Desert Shield/Desert Storm was the decision to stock 60 days of supply and ammo in-country. It drove up force structure, it cost the Army lots of money and time, and over 90% was backhauled."[44] Whatever the correct numbers, it is clear that enough ordnance, in gross tons, was brought in to make the risk of running out minimal. A tremendous amount of effort, however, went into moving unneeded ordnance into the theater and then back out. Clearly, only better intelligence and a better requirements-determination process, not just an improved capability to track logistics flows, could have narrowed the gap between the amounts of ordnance shipped and expended.

The current doctrine for logistic support of joint operations, like that in effect during the Persian Gulf War, lays down that logistics is a command function and that there should be a single command authority responsible for it.[45] Doctrine also says, however, that each service is responsible for the logistic support of its own forces. In Operations DESERT SHIELD and DESERT STORM, indeed, each service component was responsible for sustaining its own forces; there was no single command authority for logistics. General Pagonis believes that the third star he was awarded during the Gulf War "symbolized the importance of a single and authoritative logistics point of contact."[46] His 22d Support Command did represent the single point of contact for *Army* logistics, but he had little information about Air Force or Marine Corps logistics, and absolutely none about

*George C. Thorpe, *Pure Logistics* (Kansas City, Mo.: Franklin Hudson, 1917; repr. Newport, R.I.: Naval War College Press, 1997), p. 5.

the Navy or coalition forces. Thus there was no comprehensive logistics picture for the joint force commander.[47]

Logistics Initiatives since the Gulf War

During a conflict, logistics rises in everyone's awareness, but it usually recedes quickly once hostilities end. However, logistics has not been relegated to oblivion since the Gulf War. Logistics was conspicuous in that conflict, and many of the problems noted here have since received attention, for several reasons. The size and cost of the force and the logistical posture called for in that conflict by the joint force commander, and the time required to build it up, were all impressively large. Because of the sensitivity of the host nations to large numbers of non-Arab personnel, the large "footprint" of coalition forces and of their logistics seemed a liability. Then too, the size of the footprint meant that there were a number of very attractive targets, which might have been attacked by a more capable enemy. These considerations, merged with the vision of a revolution in military affairs, have generated interest in streamlining logistics.

A further reason for postconflict interest in logistics at this time is economic in nature. With no clear, capable enemy in the post–Cold War environment, there has been great pressure on the defense budget. Force structure (personnel, ships, aircraft squadrons, army divisions) has been significantly reduced, but modernization of the remaining forces will be underfunded unless further economies can be found, necessarily in infrastructure and operations. Thus, smaller, more responsive logistics approaches that require less investment and money to operate are being aggressively pursued. The notion that the services should adopt advanced business practices abounds in the professional literature. *Information* is the key to the needed reengineering of logistics.[48]

At or near the head of the list of Gulf War logistics problems was asset visibility, including in-transit visibility (ITV). Prototype ITV systems were employed as early as in Haiti and are in use today in Operation JOINT ENDEAVOR in Bosnia. ITV systems comprise the U.S. Transportation Command's Global Transportation Network, the Defense Automatic Addressing System–CONUS Freight Management, the Air Force Consolidated Aerial Port System II, and the Army Movements Management System. Radio-frequency tags affixed to containers or air pallets record their contents and transmit their data when queried by fixed or hand-held interrogators. The shipping industry has been using this technology for many years. Beyond tags and interrogators, the keys to an effective information system are a relational database, a standardized electronic data interchange, and wide-area communications allowing all commercial and military databases and tracking systems to transmit data into the network.[49]

Efforts to create smaller, more responsive logistics operations are under way in the Army (under the name of "Velocity Management") and in the Air Force ("Lean Logistics"). The goal of Velocity Management is to make Army logistics as fast and efficient as in a Fortune 500 company.[50] Velocity Management, which focuses on responsiveness, postulates that moving supplies is cheaper than stockpiling. The Army Materiel Command has stockpiles worth fifty-nine billion dollars but needs twenty-six days to meet customer demands, while civilian distribution systems do so in two or three days. The first target of the Army Velocity Group was thus order-and-ship times (OST). It achieved significant reductions in OST in the first year (1995), but the stated goals—seven days for high-priority requisitions for the mainland United States and fifteen days for high-priority overseas requisitions—would hardly impress any Fortune 500 company.[51] Velocity Management is also looking at repair-cycle times, the processes that determine inventory stockage objectives, and battlefield distribution.[52]

The Air Force's Lean Logistics initiatives have a similar goal: to make logistics simultaneously more effective and more efficient. The Air Force is moving from a supply (inventory)-based logistics system to a transportation-based one. The Air Force is counting on fast logistics-cycle* times and reductions in logistics-cycle variability to shrink stockpiles of its most expensive spare parts. The initial focus of Lean Logistics is to reduce cycle times in all segments of the repair pipeline. The Air Force also sees information as the key to process improvements.[53]

The objectives of both Velocity Management and Lean Logistics are to improve responsiveness while reducing stockpiles, facilities, and personnel. Saving money and reducing footprint and vulnerabilities are clearly desirable by-products as well. This sounds like a win-win situation. It can be achieved by improving the performance of the logistics systems, and the key to improved performance, in turn, is information—timely information about assets held, assets needed, and transportation capabilities.

The Navy is developing a concept known as "Sea Based Logistics" to support the Marine Corps's doctrine of "operational maneuver from the sea." The objective is a reduced footprint ashore, to minimize vulnerability. Reducing shore-based logistics would also reduce manpower ashore and result in lighter, more agile tactical forces operating on land. The Naval Doctrine Command declared in 1997, "Sea Based Logistics becomes reality with the fusion of four key changes to the way we operate and provide sustainment. The first is operating from a base of ships at sea where we might ordinarily establish a base of operations on shore. The second involves wholesale reductions in logistic demand. The third is implementation of in-stride sustainment. The last is the ability to smoothly transition to joint and much larger operations."[54]

The service initiatives aiming at smaller, more efficient, more effective logistics dovetail with the road map for future joint warfighting laid out by the Chairman of the Joint Chiefs of Staff in "Joint Vision 2010." That white paper

*The time from the generation of a requisition to the receipt of the material by the requisitioner.

sees information superiority as enabling the operational concepts of dominant maneuver, precision engagement, full-dimensional protection, and focused logistics.

> Focused logistics will be the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations. Information technologies will enhance airlift, sealift, and pre-positioning capabilities to lighten deployment loads, assist pinpointing logistics delivery systems, and extend the reach and longevity of systems currently in the inventory. The combined impact of these improvements will be a smaller, more capable deployed force. It will require less continuous support with a smaller logistics footprint, decreasing the vulnerability of U.S. logistics lines of communication.[55]

Thus the logistics arena has not become dormant since the Gulf War. Still, the efforts described above, though they depend on greater use of information technology, do not directly address the subject of logistics command and control. However, there are several additional initiatives under way that do.

One is the Army's Experimental Force (ExFor). ExFor is based on the application of digital C4I* technology to existing armor, mechanized, and infantry battalions. The 4th Infantry Division, based at Fort Hood, Texas, is currently the Experimental Force in a technology demonstration sponsored by the Secretary of Defense. For this demonstration, one of its armored brigades, with an attached light infantry battalion, has been designated as Task Force XXI and fitted with the new equipment. Every vehicle (land or airborne) now has a Global Positioning System receiver, sensors for "seeing" the battlefield, and a tactical internet connection. Every vehicle has the capability to send its position and what it sees to the commander and to receive and display the picture fused from the inputs of all Task Force XXI vehicles on or above the battlefield. Since what is seen includes the enemy as well as all Task Force XXI units, the result is real battlefield awareness, the basis for a command and control system for the commander.[56]

The ExFor technology demonstration is relevant to logistics command and control, because the logisticians are included in the tactical internet, and each vehicle in the force reports its levels of fuel and ammunition to them. With nearly real-time information about who needs what, the logisticians can be proactive in providing the right material to the right place at the right time.

A second initiative is that of the Defense Information Systems Agency (DISA), which is addressing the fact that joint task forces do not have integrated combat support capabilities. DISA is developing the Global Combat Support

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*Command, control, communications, computers, and intelligence.

System (GCSS) to provide interoperability across combat support functions, as well as between combat support and command and control functions.[57] System characteristics will include a common hardware and software environment, shared databases, and communications. The combat support applications to be included in GCSS include asset visibility, logistics, finance, procurement, medicine, transportation, and personnel—a wide range. Nonetheless, the GCSS applications in finance and procurement are administrative and therefore not of first-order importance to the warfighter. Maintenance, which can be thought of as operational, is not presently addressed in GCSS. Finally, it appears that the present goal of GCSS is only to track the status of the activities in its application areas.

The two dominant characteristics of these logistics initiatives are that they report *data*, and that the data are for *tracking* something. Instead, the goal of a combatant logistics command and control system should be to *process* data to produce *information*—for *planning, tracking,* and *prediction*.

CLCC System Requirements

One can ask what General Schwarzkopf really needed to know about his logistics situation in the Gulf War. It has been postulated that the feasibility and timing of Operation Desert Storm depended solely on knowing that forces were ready, in the right places, and that their sustainment stocks were adequate for the task about to be undertaken.

By contrast, the joint force commander would have needed to know—had Iraq invaded Saudi Arabia in the fall of 1990, or had the strategic initiative not rested with him—the location and closure status of all units as well as their fuel and ordnance situations in order to evaluate his own alternative courses of action. That is to say, the joint force commander needs unit closure information while the deployment surge is under way. For units that have not closed as of a given time, he requires a prediction of when closure will occur. Once a unit has closed, the commander needs the data provided by the Status of Resources and Training System. SORTS is the principal means by which the U.S. armed forces provide unit location, identification, and general status to the National Command Authority (the president and Secretary of Defense), the Joint Chiefs of Staff, unified commanders in chief, and other operational commanders.

SORTS categories include status of personnel, supplies on hand, equipment and training status, and readiness in each primary mission area, as well as an overall assessment. Overall and "resource-area" status is reported in terms of C-ratings. C1 denotes that a unit is capable of the full wartime mission for which it was organized; C5 is the lowest rating and indicates that the unit is unprepared to undertake wartime missions. There are also mission-area ratings, M1 through M5, for each of the primary mission areas assigned to a unit.[58] Updates are reported under SORTS within four hours of any change in status.

The joint force commander, however, also needs information about the status of such major systems as ships, aircraft, tanks, artillery, or air defense missile batteries in greater detail. Such information is usually displayed by SORTS in terms of the number of such systems that are fully mission capable and partially mission capable, and in terms of the operational ready rate (the number of a given type fully or partially mission capable, divided by the total number of such systems). For systems not mission capable, the commander needs to know whether they are awaiting maintenance or supply action. This data needs to be reported daily, for units and individual systems. The information can be aggregated to whatever level is desired, but a combatant logistics command and control (CLCC) system should have unit and system detail on call.

As an example, the availability of barrier-breaching and mine-clearing equipment was at one point crucial in planning the Gulf War ground campaign. Originally there was only enough such gear for a single corps; the plan at first was for one of the two corps to make a breach in the Iraqi defensive berms and minefields and for the other to pass through it behind the lead forces. Everyone hated this plan. Eventually the amount of the necessary equipment in-theater grew large enough to allow the combat elements of both corps to make their own breaches and frontal attacks. The need for such equipment was situation specific, but a CLCC system must be able to tailor the logistics picture to the actual needs of the joint commander at any time.

Clearly, logistics is the hard part of fighting a war.

Lieutenant General E. T. Cook, USMC
Commanding General, II MEF, in the Persian Gulf

Information about sustainment stocks also is vital to the joint force commander, who must judge whether forces have the necessary sustainability for the operations at hand. Fuel (or water) stocks accounted for in terms of tons, barrels or gallons, or ordnance in terms of tons, truckloads, or rounds, must be reported in more operational measures. Through the use of appropriate models and planning factors, each can be converted into days of supply, a meaningful metric. For instance, gallons of water can be translated into DOS by dividing the quantity in gallons by the number of gallons per man per day allowed by the planning factor, times the population to be sustained. Further, however, since it is not good enough to have sufficient material in-theater if it is not in the hands of the users, logistics data at the unit level needs to be available, even if it is eventually aggregated. One unit with too much, and another with too little, must never be presented as two units with just the right amount. Clearly, a CLCC system must have the flexibility to report on any commodity and at any level that the joint force commander thinks important.

The commander also needs to know the capacity of his intratheater lift. This depends on aircraft and airfields, rail lines and rolling stock, trucks, drivers and highways, ships, and port or logistics-over-the-shore capabilities. Capacity is not, however, merely a matter of numbers of vehicles and facilities—these are inputs; the outputs are tons, people, or equipment that can be transported so many miles per day. Capacity relates not only to getting sustainment stocks to users in the field but to moving forces to where the joint force commander has determined they need to be. Transportation capacity will vary over time during a campaign as a function of capabilities, infrastructure improvements, enemy a- tions, human fatigue, and simple wear.

On 27 December 1990, General Schwarzkopf asked General Pagonis if new logistics bases could be established and stocked, and VII Corps and XVIII Airborne Corps repositioned, in the two weeks between the 16 January and 1 February in order to support the "left hook" flanking maneuver. Pagonis had to rely on the facts known to him at that time and on his years of experience. He knew that the Pentagon would supply anything it could, but he also knew that the Army and the other services had already contracted for nearly every truck and bus the Free World had to offer, and that as far as surface transport went, the hundreds of thousands of troops, the tons of material, and the millions of gallons of fuel would all have to move over two paved highways. Pagonis responded that he could not accomplish the move within the time allotted but that in the next two days he and his staff would determine how long it would take. In those two frantic days the general and his logistics cell "used every precious minute reshuffling and reshaping, cutting and pasting the plan."[59] Pagonis had no automated database or software for planning or predicting intratheater movement capability. At his meeting with Schwarzkopf on the 29th, Pagonis stated that it would be possible to accomplish everything necessary in twenty-one days.

In the future, determining transportation capacity will require a fairly comprehensive, computer-based model. The Army has been developing what it calls the Knowledge-Based Logistics Planning Shell; one of its capabilities is to recommend shipment transportation routes.[60] This Army system, or part of its structure, may be a starting point for the intratheater transportation-capacity model needed in a CLCC system.

CLCC System Data and Planning Factors. A combatant logistics command and control system would necessarily be based on common definitions. This has to be done astutely, and not just for uniformity's sake. Consider logistics planning factors. For many commodities (food is a good example), a logistics planning factor in pounds per man per day is quite reasonable. Everyone wants to eat every day, whether a force is engaged or not, on the offensive or defensive. Water requirements measured in gallons per man per day are similarly appropriate. A planning factor for ordnance use in tons per unit per day, however, is suitable only for, perhaps, determining gross transportation requirements. In contrast, true operational planning requires planning factors for each type of ordnance and each phase of the operation. In particular, a metric of pounds (or tons or units) per man (or unit) per day is not useful for weapons used in response to an enemy's initiative; a planning factor in pounds per man per day, or pounds per unit type code (UTC), is completely inappropriate for Army Patriot or for Navy Standard missiles. Every aspect of that way of measuring is wrong for such ordnance, but especially the *per-day* dimension; when the enemy is initiating the action, we have to think *per event.* Nonetheless, current JCS logistics planning factors for ammunition are in units of pounds per UTC per day.[61] This is a metric left over from the Vietnam era, and it is time to do better.

Whatever the logistics planning factors, they have to make sense to the service producing the data and to the joint force commander. The JCS planning factor for ship fuel consumption is "gallons per ship per day," whether the ship is in transit at twenty knots or loitering on station at eight knots. Presumably the single number is used for simplicity. To the extent that the goal in logistics is to have the right material available at the right time and place, however, the use of highly aggregated averages is both inefficient and risky.

Additionally, attention must be paid to the units in which fuel is reported. Quantities of fuel may be reported in tons, pounds, barrels, or gallons. Tons are significant to the transporters, pounds to the aviators, and barrels or gallons to other operational forces, sea or land based. Are units of fuel measurement important? In a Seventh Fleet exercise, ULCHI FOCUS LENS 96, the commander of the amphibious task force was surprised to be informed by the exercise controllers in Seoul that his ships were out of F-44 jet fuel. This was clearly not the case. It developed that the computer-based simulation model being used by the controllers, known as RESA, treated F-44 in pounds only. Ship F-44 capacities in gallons had not been converted to pounds; since a gallon of F-44 weighs 6.71 pounds, RESA and thus the controllers were understating the ship's capacities by a factor of nearly seven. Once the controllers understood the problem, they attempted to input the F-44 capacities in pounds, but they could not—the field for this data in RESA was too short.

As already noted in connection with the 22d SUPCOM LOGSITREPs, reporting ordnance quantities in terms of truckloads or short tons is not terribly useful. While it is desirable to be able to "roll up" data from the detailed to the broad-category level, the detail is important and necessary. Reporting that *x* tons of bombs are available is misleading if they are all five-hundred-pound Mark 82 bombs, with no Mark 83 or Mark 84 bombs available, or if there are plenty of bombs but no laser guidance kits for them. Everyone, especially the service component and joint force commanders, wants to know the detail if there is a problem; the logistics command and control system must be built around such detail. The word "logistics" is from the Greek *logistikos*—not meaning the "maintenance and movement of forces" but rather meaning "skilled in calculation." Logistics necessarily involves a lot of detail and calculation, even if the details are eventually aggregated into, say, a green-amber-red presentation format.

CLCC System Functionality. The combatant logistics command and control system, if it is to have real value to the joint force commander, should be able to plan, track, and predict logistics information pertaining to planned or actual operations. All of these capabilities involve more than the display of available data. They involve software that can convert data into information, through logistics models of the processes involved.

It is often noted that operational planning is about 90 percent logistics planning. The services have planning systems, but the one that counts is the JCS Joint Operations, Planning, and Execution System: the plan for the deployment surge associated with any operation plan resides in JOPES. Because closure information is crucial, it should be available within a CLCC system. The Joint Staff notes that "the 3-series designation [of the forthcoming Joint Publication 3-35, *Joint Deployment/Redeployment Doctrine*] recognizes deployment as the first obstacle to effective combat operations, bringing increased attention to the deployment phase by both logistics and operations communities." Further, "the Defense Advanced Research Projects Agency's Advanced Logistics Program is already exploring opportunities to converge operations and logistics information systems as an operational plan is executed."[62]

A CLCC system should also have the ability to plan in-theater distribution. JOPES is focused on rushing forces into a theater; it has already been observed how, in the Gulf War, forces and gear thrown into the theater sat on the airport tarmac for lack of a distribution plan and capability. Two of the tenets of the joint Focused Logistics concept—"joint reception, staging, onward movement and integration (JRSOI)" and "theater distribution"—are aimed at correcting this deficiency. In Focused Logistics,

> planning and executing deployments is supported by JOPES, but this system has significant limitations that impact on JRSOI operations. JRSOI is designed to eliminate much of the confusion associated with people and equipment arriving in theater in disorganized pieces and break down the bottlenecks that have historically existed in large-scale joint operations. Theater Distribution calls for a comprehensive in-theater distribution system for deployment, sustainment, and redeployment of units, personnel, materiel, and equipment that is seamlessly integrated with the strategic logistics system.[63]

There is also a need to plan for the replenishment and therefore the sustainability of a force. How much replenishment is required can be derived from the forces involved and what they are doing, through models that predict the consumption of material in each of the classes of supply. Food, water, and some amount of fuel are always required, and ordnance becomes a major issue when the force is engaging the enemy. Climate can affect daily food and water requirements, as well as that for clothing. Replenishment, to give forces the necessary sustainability, requires as much planning as their deployment.

In addition to supporting planning, the CLCC system should be able to track the status of closure, unit SORTS data, the status of major systems and equipment, and sustainment stocks. Tracking of closure information provides closure status for units which have not yet arrived at their assigned places. Comparing closure data with the deployment plan offers a way of evaluating how the deployment is going. SORTS data reports the location and readiness of individual units, and end-items are normally reported by SORTS in terms of the number on hand, authorized, mission capable, and not mission capable (and whether awaiting maintenance or parts.) Sustainment stocks should be tracked in days of supply rather than in tons, gallons, or units. In order to report DOS for commodities of interest, the raw data must be converted using population data and logistics planning factors, or usage models for commodities whose consumption should not be estimated in units of pounds per man per day.

Finally, a CLCC system should be capable of prediction: of closure, of sustainability, and of movement capacity. This is important in general, because it is not sufficient to have fuel and ordnance in theater if it cannot be transported to the forces that need it. There can also be a need to move the forces themselves, as was seen in the Gulf War's left-hook movement. More specifically, a CLCC should be able to evaluate alternative courses of action involving logistics issues, to pose and answer "what if?" questions. The ability to predict allows interaction between logistics and operational planning and execution; it requires explicit logistics planning factors, models of consumption (ordnance, spare parts, fuel, rations, etc.), models of intertheater and intratheater transport capabilities, and a great deal of in-transit visibility information. Predicting closure involves information on material received and on the way, and planned shipment dates. Prediction of sustainability requires data on stocks held, stocks flowing into the theater, and models of their usage.

The Tactical Logistics Support System. There exists now a logistics support system that allows the planning, tracking, and prediction of logistics sustainability, on the scale of a Navy carrier battle group or battle force. It is known as the Tactical Logistics Support System (TACLOGS), and it resides as a tactical application within the Navy's Global Command and Control System–Maritime (GCCS-M).[64]

GCCS-M had its origins in the Joint Operational Tactical System (JOTS), created by Vice Admiral Jerry O. Tuttle in the mid-1980s. The purpose of JOTS was to allow naval task groups to operate, for the first time, with a shared, comprehensive tactical picture of friendly and hostile forces. JOTS took from datalinks the position, course, and speed of friendly ships and merged them with surveillance and intelligence data on hostile positions. The result was a "fused" tactical picture, which was then broadcast to all command centers and ships.

TACLOGS was developed as a supplement to JOTS. The commander of the U.S. Second Fleet had posted in his afloat command center signs instructing battle watch officers to be able at all times to answer four questions: Where is the enemy? Who has him engaged? How are we doing? What is our sustainability? JOTS provided most of the information needed about the first three questions, but it did not consider logistics and thus was mute on the fourth question. What the commander was getting in his morning logistics briefings was one-or-two-day-old data on events (like refuelings) and commodity levels.[65]

Sustainability is about the future, not the past, and it can only be addressed through prediction, specifically of the use and replenishment of the commodities that limit sustainability. The critical commodities for ground forces are fuel, water, and ordnance, but for ships in combat they are only fuel and ordnance; ships make fresh water from sea water. Thus, to a first-order approximation, the sustainability of naval forces in combat can be predicted if the consumption and replenishment of fuel and ordnance can be modeled. This is what TACLOGS does.

It predicts the use and replenishment of fuel and ordnance by individual ships of the battle group or force on the basis of the passage of time or the occurrence of specific events. Fuel includes both ship-propulsion and aircraft fuel. TACLOGS projects ship-propulsion-fuel consumption with an algebraic expression whose parameters depend on ship class and speed. Aircraft-fuel usage predictions come from postulated norms of flying activity, as a function of threat level and the requirements of specific events (raids, strikes, or antisubmarine prosecutions). The only ordnance for which daily usage is modeled is sonobuoys, and the rate depends on the undersea warfare threat level. All other ordnance usage is associated with events; none is predicted on a pounds-per-man-per-day basis.

Relevant data (fuel capacities, nominal ordnance loadouts, usage and replenishment planning factors, etc.) for all Navy ship classes, aircraft, and ordnance types are contained within the TACLOGS software, making setup fairly painless. Almost all data may be edited, and all predictions can be updated from daily operations summaries from individual ships, so that prediction errors are not perpetuated. The bottom line is the ability to produce reports listing the fuel and ordnance states of individual ships and predicting these states for each of the three next days ahead—thus addressing the fleet commander's sustainability question, at least in the short term. At the conclusion of a major fleet exercise the commander of the Second Fleet stated that TACLOGS had allowed him for the first time "aggressively [to] pursue tactical logistics."[66]

TACLOGS can also be used for planning and training. It can "steam" the ships of a battle group while in fact they are in port, requiring no real fuel. Similarly, simulating ordnance-using events (raids, strikes, and submarine prosecutions) in the computer identifies for planners where shortages of weaponry will arise. Even if a battle group has its own logistics ship or ships to meet short-term needs, the loads of the logistics vessels themselves must soon be replenished. The necessary "consolidations," or transfers of cargoes at sea, must be explicitly provided for, and TACLOGS can be used to plan them. In the training mode, TACLOGS can introduce the battle group staff to the sustainability problems they are likely to face so they will have solutions in hand when they go to sea.

Time to Do Better

Focused Logistics, one of the four operational concepts of "Joint Vision 2010," has become the umbrella under which all the initiatives in logistics have been gathered. Many are fixes for Gulf War problems (in-transit visibility, joint reception, staging, onward movement and integration, and theater distribution). Some arise from shrinking service logistics systems and the need to operate them more economically (Velocity Management and Lean Logistics). Others are associated with information technology (information fusion and the Global Combat Support System). However, systems like the Global Combat Support System, as long as their focus is on tracking data, will not fulfill the role of a combatant logistics command and control system. The Joint Staff's *Focused Logistics Roadmap*, which promotes an initiative called "Joint Theater Logistics Command and Control," is also not a logistics command and control system; it is, rather, an organizational concept for supporting the in-theater portion of a major regional contingency or a small-scale combat operation.[67] Thus, logistics command and control remains to be addressed.

This article has described the joint force commander's need for logistics information. There are several implications. The first is that commanders, not just logisticians, need logistics information; that to exercise control at the strategic, operational, and tactical levels of war, commanders must also exercise *control over logistics*. The second implication is that *information* is needed, not just data. The paradigm is that data processed through logistics models produces information useful for creating a logistics picture of the battlefield, for predicting sustainability, and for evaluating alternative courses of action.

If we are to plan sustainment and predict sustainability on the basis of stock-level data, we must have models of the use and replenishment of such logistics commodities as fuel, water, and ordnance. Such models use logistics planning factors, but they must do more than that: they must reflect both friendly operations and those of the enemy, insofar as they affect the use of fuel and ordnance. Of course "garbage in, garbage out" still applies; the logistics planning factors need to be current and valid. This is not now the case.

The joint force commander must plan the deployment and employment of his forces. He also needs to plan for their sustainability. Current doctrine states that the services have the responsibility of sustaining their forces, but the commander has an interest here too. He needs a logistics command and control system that will allow him to plan the sustainability of his forces, track their stocks of supplies, and make running predictions. Otherwise, he is doomed to having to use brute force, like requiring sixty days of supply to assure that sustainability will be adequate. In the words of the *Gulf War Air Power Survey*, "Pushing more and more supplies and people into a theater with the hope that if enough is pushed forward some will get where they belong is one solution to lack of knowledge of where things are and what is needed. It is the substitution of mass for knowledge, and we saw that take place in the Gulf conflict just as in previous conflicts."[68] It is truly time to do better.

Notes

1. *Doctrine for Logistic Support of Joint Operations*, Joint Pub 4-0 (Washington, D.C.: Joint Chiefs of Staff, 27 January 1995), pp. II-5, II-6.

2. In August 1990, CINCCENT set the buildup requirement at thirty days of supply in all supply classes except III and VI (POL and personal demand items). In November 1990, CINCCENT raised it to sixty days in classes I and V (subsistence and ammunition/ordnance).

3. Charles C. Krulak [Brig. Gen., USMC], "A War of Logistics," U.S. Naval Institute *Proceedings*, November 1991, p. 56. The Marine Corps combat service support area at Al Khanjar encompassed 11,280 acres.

4. Julian Thompson [Maj. Gen., Royal Marines, Ret.], *The Lifeblood of War: Logistics in Armed Conflict* (London: Brassey's, 1991), p. 196.

5. *Phase II Report: Development of Logistics Planning Factors in South Vietnam* (Los Angeles: Planning Research Corporation, 31 July 1968), pp. 1–21.

6. *Desert Storm Reconstruction Report*, vol. 9, *Logistics*, CRM 91-185 (Alexandria, Va.: Center for Naval Analyses, October 1991), p. 1-6.

7. U.S. Navy Dept., *The United States Navy in Desert Shield/Desert Storm* (Washington, D.C.: Office of the Chief of Naval Operations, 15 May 1991).

8. Eliot A. Cohen et al., *Gulf War Air Power Survey*, vol. 3, *Logistics and Support* (Washington, D.C.: U.S. Air Force Dept. and Govt. Print. Off., 1993), pp. 98, 115.

9. Ibid., p. 58.

10. Ibid., pp. 5, 16.

11. Joint Pub. 4-0, pp. II-5, II-6.

12. William G. Pagonis [Lt. Gen., USA, Ret.], *Moving Mountains: Lessons in Leadership and Logistics from the Gulf War* (Boston: Harvard Business School Press, 1992), pp. 88, 90, 123, 128, 205.

13. Ibid., p. 1.

14. Joint Pub. 4-0, p. I-7.

15. Pagonis, pp. 88, 98, 185. Seven of his daily situation reports were obtained from the Army History Office, at Fort Leavenworth, Kansas.

16. F. Earl Kennedy [Capt., USA] and Daniel C. Parker [Chief Warrant Officer 4, USA], "Transportation Impact of the Battlefield Distribution Concept for Force XXI," *Mobility News Bulletin*, April 1995, p. 16.

17. For troop rotation, Representatives Les Aspin and William Dickinson, *Defense for a New Era: Lessons of the Persian Gulf War*, House Armed Services Committee (Washington, D.C.: U.S. Govt. Print. Off., March 1992), p. 6. For Saudi sensitivities, Pagonis, p. 75. United Nations Security Council Resolution 678 of 29 November 1990 gave Iraq until midnight, New York time, on 15 January 1991 to comply with eleven prior resolutions and withdraw its forces from Kuwait.

18. Days of supply is a convenient way of converting a quantity (of rations or water, for example) into operationally meaningful terms. A stock can be expressed as days of supply if population data and planning factors (consumption per man per day) are known. MARCENT and CENTAF rarely reported population data to the 22d SUPCOM.

19. 22d Support Command, Logistics Situation Reports of 1 October 1990 and 1 December 1990, Army History Office, Fort Leavenworth, Kans.

20. Cohen, p. 26.

21. "JOPES is the Chairman of the Joint Chiefs of Staff's . . . joint planning system. It covers the planning spectrum from the National Command Authorities (NCA) through the Chairman, to the combatant commanders (the CINCs) and the joint task force commanders. . . . JOPES furnishes joint commanders and war planners at all levels standardized policies, procedures, and formats to produce and execute a variety of required tasks to include: planning—writing operations plans (OPLANs) . . . ; and execution and deployment (time-phased force and deployment data [TPFDD]) management. . . . The JOPES software applications . . . assist the planners to: development detailed deployment requirements[;] estimate logistics and transportation requirements and assess operation plan transportation feasibility[;] prioritize, replan, and track deployment status during execution[;] and refine deployment requirements and monitor the deployment." U.S. Army Command and General Staff College, "Text Extract," *User's Guide for JOPES*, 1 May 1995, http://www.cgsc.army.mil/djco/courses/c500/1sn9/table.htm (31 December 1998). See also Armed Forces Staff College, *Joint Staff Officer's Guide 1997*, AFSC Publication 1 (Norfolk, Va.: National Defense Univ. Press, 1997), p. 6-86 (also online, at http://www.afsc.edu/pub1/afsc0000.htm) for a comprehensive discussion of JOPES and the planning aids available, esp. chap. 6 on "deliberate planning."

22. Cohen, p. 5.

23. Ibid., p. 19.

24. Ibid., p. 12.

25. Ibid., p. 13.

26. Ibid., p. 6.

27. Ibid., p. 10.

28. Ibid., p. 18.

29. Ibid., p. 17.

30. Norman Friedman, *Desert Victory: The War for Kuwait* (Annapolis, Md.: Naval Institute Press, 1991), p. 140.

31. "Desert Storm: The Marine Commanders," interviews with Generals Boomer, Brabham, Krulak, Hopkins, Moore, Myatt, and Keys, U.S. Naval Institute *Proceedings*, November 1991, pp. 47, 59.

32. Aspin, pp. 66–7.

33. Ibid., p. 67; and "Desert Storm: The Marine Commanders," pp. 53–4.

34. "Desert Storm: The Marine Commanders," pp. 47–80.

35. Ibid., p. 67.

36. *Desert Storm Reconstruction Report*, p. 3-17.

37. Ibid., pp. 3-16, 3-17.

38. Ibid., p. 3-17.

39. Commander in Chief, U.S. Atlantic Fleet (N41), memorandum, subject: Exercise Strong Resolve '95 Logistics Operations Report, Norfolk, Va., 22 May 1995. Informal staff liaison indicates that the problem continues and was an issue in Exercise MARCOT/UNIFIED SPIRIT 98 in June 1998.

40. Phil Sheridan, "SALTS Established in Bosnia," *Navy Supply Corps Newsletter*, May/June 1996, p. 27.

41. Cohen, p. 84.

42. A Military Sealift Command briefing of 6 March 1991 reported that the MSC had transported 3,148,884 tons of dry cargo and 6,032,488 tons of fuels. Cohen, p. 3, indicates that 540,000 tons of cargo were airlifted.

43. Cohen, p. 11.

44. John W. Foss [Gen., USA, Ret.], "Challenge for Operations Research in the Coming Decade," *Phalanx* (newsletter of the Military Operations Research Society), March 1994.

45. Joint Pub 4-0, p. II-7.

46. Pagonis, photo caption pp. 106–7.

47. This conclusion is supported by the *Gulf War Air Power Survey*, which notes (p. 57) that "no office or function was charged with (and staffed for) command or orchestration of CENTCOM logistics at the overall theater level."

48. See, for example, the *1997 Quadrennial Department of Defense Review Report*, which speaks to the roles of leading-edge business practices and information technology in transforming military logistics operations.

49. Larry D. Johnson, "User's Guide to ITV," *Army Logistician*, September–October 1996, pp. 24–5.

50. Dallis Barnes [Capt., USA] et al., "Velocity Management," *Quartermaster Professional Bulletin*, Autumn 1996, pp. 34–6.

51. Thomas W. Robison [Maj. Gen., USA], "Velocity Management: A Status Report," *Army Logistician*, March–April 1996, p. 5.

52. George Akin [Maj., USA], "Battlefield Distribution," *Army Logistician*, January–February 1996, p. 6.

53. Gary Melchor [Lt. Col., USAF], "Lean Logistics: Logistics of Tomorrow Here Today," *Mobility Times*, July 1996, pp. 30–1.

54. "Sea Based Logistics: A Naval Concept," draft, Norfolk Va., Naval Doctrine Command, 14 July 1997. In 1998 the Naval Doctrine Command was disestablished and its functions subsumed into the Navy Warfare Development Command, newly established at the Naval War College in Newport, R.I.

55. John M. Shalikashvili [Gen., USA], "Joint Vision 2010," *Joint Force Quarterly*, Summer 1996, p. 44.

56. William J. Perry, speech to the AIAA Missile Sciences Conference, Naval Postgraduate School, 3 December 1996; also Michael R. Lwin [Capt., USA] and Mark R. Lwin [Capt., USMC], "The Future of Land Power," U.S. Naval Institute *Proceedings*, September 1997.

57. "Global Combat Support System (GCSS)," Defense Information Systems Agency briefing slides, 11 June 1996.

58. See *CJCS Guide to the Chairman's Readiness System*, CJCS Guide 3401 (Washington, D.C.: The Joint Staff, 1 October 1995), pp. 5–6.

59. Pagonis, pp. 138–9. Of course, the maneuver was not executed solely by surface transportation. Air Force C-130s were to average more than twice the planned wartime sorties per day during the realignment.

60. Richard S. Camden, "Knowledge Based Logistics Planning Shell," U.S. Army Research Laboratory, Aberdeen Proving Ground, Md., July 1993.

61. AFSC Pub. 1, p. 6-86.

62. John M. Shalikashvili [Gen., USA] and John J. Cusick [Lt. Gen., USA], *Focused Logistics Roadmap* (Washington, D.C.: The Joint Staff, 1997), p. 5.

63. Ibid., p. 13.

64. See David Schrady, *User's Guide for TACLOGS: Battle Group Tactical Logistics Support System*, Technical Report NPS-OR-96-016 (Monterey, Calif.: U.S. Naval Postgraduate School, December 1996).

65. The author was present when such information was briefed to Commander, Second Fleet, during Fleet Exercise 2-89, February 1989.

66. "Bravo Zulu" ("Well Done") message from Commander, Second Fleet, to Commander, Logistics Squadron 2, upon the completion of Fleet Exercise 1-91/2-91, November 1990.

67. Shalikashvili and Cusick, p. 23.

68. Cohen, p. 393.

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