LOGISTICS AND TECHNOLOGY:
SOME THOUGHTS ABOUT FUTURE MILITARY IMPLICATIONS

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March 1971

P-4597
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ABOUT FUTURE MILITARY IMPLICATIONS 

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We are aboard a train which is gathering speed, 
racing down a track on which there are an unknown 
number of switches leading to unknown destinations. 
No single scientist in the engine cab and there may 
be demons at the switch. Most of society is in the 
caboose looking backward.

Ralph E. Lapp 
The New Priesthood

PERSPECTIVE

**the creation and support of military capability--and 
technology--the application of scientific knowledge to the industrial 
arts--are mutually interactive. Logistics uses technology to improve 
its service. Technology requires logistics to assure its sustained 
support. To the extent that the United States needs a military capa-
bility, logistics will be ultimately responsible for applying techno-
logical tools to meet military requirements. The long lead time be-
tween discovery and application of new technology requires considerable 
foresight in anticipating its reasoned rather than reactive application. 
Therefore, forecasting the impact that new technology might have on 
logistics is a purposive endeavor.

The functional structure of military logistics is not clearly de-
efined. Within the Defense Establishment a proliferation of agencies 
exist which are ostensibly organized for such logistics tasks as 

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**With respect to this discussion, the premise is that military 
effort is desirable into two principle entities: Logistics--the creation 
and support of military capability and Operations--the employment of 
military capability.
engineering design, research and development, installation and logistics. Supply systems, and "materiel." The degree to which these organizations adopt a mutually accommodating style of behavior, with emphasis on a compatible goal orientation, will determine their ultimate success in both efficiently and effectively applying technology to required military tasks. At some levels of institutional suboptimization logistics is maintenance, supply, transportation, and procurement. More broadly, the Joint Chiefs of Staff state that logistics is:

The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, those aspects of military operations which deal with: (a) design and development, acquisition, storage, movement, distribution, maintenance, evacuation and disposition of materiel; (b) movement, evacuation, and hospitalization of personnel; (c) acquisition or construction, maintenance, operation and disposition of facilities; and (d) acquisition or furnishing of services.

This definition is consistent with our view that military logistics is the creation and support of military capability.

The idea has considerable merit that there is an inherent stability in logistics processes, regardless of technological impact, kinds of logistics, and measures of performance. But the inherent stability of these terms of reference does not mean that logistics is unalterable. Changing doctrine, force mix, and organizational structures blend to redirect the relative emphasis on the subsets of logistics.

This paper examines the impact of new technology in terms of future (beyond current five-year forecasts) military operations to anticipate requirements and applications. Such technology may generate tradeoffs and phase out existing facilities, weapon systems, and even people. Existing organizational arrangements may also be affected, particularly those directly identified with logistics. In this regard, changes in organization for logistics will probably follow the format of the '70s: turbulence followed by cautious decentralization.

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APPROACH

This discussion focuses on two approaches for assessing the impact of new technology on logistics:

Deductive Impact: the voluntary accommodation of technology to facilitate the logistics process. Examples of such new technology include higher-speed communications, improved packaging techniques, comprehensive information systems, and improved materiel-handling equipment.

Inductive Impact: the forced response of the logistics system to support new technology, such as telemechanisms, space systems, and laser devices.

Both Deductive and Inductive impact, therefore, relate to changes which perturb the equilibrium of the logistics system by introducing new or novel process arrangements and resource demand patterns.

DEDUCTIVE IMPACT

The nature of the force that logistics must support in the coming decades will be a mixture of old and new. Force (weapon system) modernization is expensive and takes time; yet each new system introduced to the inventory will pose new support problems—some involving technologies that may not have been previously considered. Also, regardless of force composition, there will be the inevitable push for better management methods and techniques to perform the support task.

The latter does not change. The logisticians must support the mission, insure readiness and accomplish both these tasks while minimizing the consumption of all support resources: materiel, facilities, and manpower. The key to each support function's success is improved response. Most marginal improvements in response derive from applying new technologies to old problems. We can identify certain support functions in which technology has had or will have important impacts on response and cost.
Maintenance

Maintenance activities directly relate the utility of resource conservation to the military mission. Maintenance is also the largest consumer of logistics manpower. To increase the response of maintenance in keeping the weapon fleet at the highest readiness, resources must be directed to improving the reliability and maintainability characteristics of all systems with consequent reduction in the need for operational maintenance and after-production maintainability improvements.

Improved reliability calls for improved technology all the way from the design stage through operational service. Technology improvements can come in areas such as computer-assisted designs for aerodynamic shapes, new materials and circuits, novel manufacturing methods involving numerically controlled production equipment, and chemically milled shapes and surfaces. Improved test equipment and the application of radiology (X-rays) and atomic trace materials to the quality control process can also be useful in improving a new weapon's quality.

Maintainability is enhanced through rapid fault identification and repair processes. Because shorter response times reduce the times the system is not operationally ready, both military and industry have employed technology to reduce fault identification processes in the design and operational areas. Self-test and quick access features are incorporated in unit designs. To achieve quick turnaround and servicing goals, modules and subsystems are combined in line-replaceable units (LRUs). To reduce field level maintenance resources, noncritical and inexpensive components are designed for throwaway replacement. Complete systems incorporate in-use/in-flight maintenance diagnostic equipment to eliminate lengthy test operations after the system reaches a maintenance facility.

Increasingly, centralized maintenance activities use versatile general purpose automatic test systems (GPATS) that can isolate faults and inspect complete systems in their operating modes. Also, computer assisted automatic scheduling systems now insure best use of repair facilities and quick-throughput of critical items in the repair and overhaul process.

In combination, these examples of new maintenance technology have great impact on response and cost.
Supply

Essentially all supply activities are in some degree related to the inventory management process, which includes the processing and communication of information, and the warehousing, processing and transportation of materiel. Technology is employed extensively to help supply managers transform consumption data into useful information for stockage and procurement decisions. At the consumer level (Base) the inventory management system has been successively automated. Computer plans now exist for modernizing depot level information management with systems designed to use third-generation computing capabilities. Extensive use is planned of time-shared interactive computer techniques in a real-time mode. Developing experience in total system design should permit greater asset visibility to the point where a central logistics "push" system is both feasible and desirable. There are organizational implications to be considered in this regard. This Air Force Advanced Logistics System is probably one of the most ambitious plans ever attempted to use new data processing technology.

Systematic modernization of materiel handling and movement processes is also in progress. The Air Force Logistics Command has under way an extensive program to automate its warehousing, packing, packaging, and preservation functions. Warehouses that employ automatic and computer-controlled conveyor and sorting systems are now in operation. New materials and processes to accomplish corrosion control and preservation and packing are now used extensively. New techniques are being absorbed almost as rapidly as they can be developed.

The improved Services-wide communication system couples the information processing and materiel movement capabilities into a responsive resupply instrument. The AUTODIN system for handling great volumes of inventory data has been augmented with communication satellites that greatly reduce data flow-time from overseas bases. This communication capability is being constantly improved.

Transportation

The ultimate purpose of the supply activity is the timely delivery of usable materiel to meet consumer requirements. Transportation (the
Distribution Function) provides the linking mechanisms. The Air Force pioneered in developing airlift technology, and most technical material moves by air. Most commercial transports were developed as a result of a military requirement. The C-5, C-142, and C-X are examples of how the military requirements pushed the limits of technology in large size, long range, and V/STOL aircraft.

Other types of transportation made extensive demands on new technology. Documentation of military movements has been automated, and air terminal operations and materiel handling have been improved by new conveyor and palletizing systems. Both air and surface shipments are now "containerized," and technological changes have been made in materiel-handling concepts and equipment.

New requirements for operational mobility have engendered changes in transportation services demands. Because of its fast response to time-urgent requirements the focus is on airlift. Low altitude delivery systems and paradrop methods (LAPES, etc.) have been improved and combat support requirements have generated demands for new technology in rubber and plastic fuel systems and pipelines, and in combat delivery of munitions and other consumables. Additional methods will be devised to further improve the ability to sustain prolonged aerial resupply operations.

Procurement

Weapon system procurement programs have focused on logistics efforts in a continuing desire to reduce lead times and increase efficiency. This has resulted in the extensive use of new structural materials such as titanium, magnesium and beryllium alloys, boron and carbon composite fibers, and honeycomb structures. Application of value engineering and product improvement programs financed by the military have advanced such new techniques as computer controlled machine tools, and potted and miniaturized circuitry. Logistics influence in the early stages of Weapon System Design has proved to be especially beneficial.

Logistics considerations also led to procurement programs designed to encourage development of storage and retrieval technology for miniaturizing blueprints, drawings, and reproduction data for all military
production, as well as stimulating programs for timesharing and interchange of design data between industry and the Government.

All these have contributed to the development of an integrated management approach to the awesome task of identifying, acquiring and applying all resources needed for the logistics task. Logistics has employed operations researchers and management technologists for new and better management science techniques. Thus, logistics planners have often led in the application of operations analysis, simulation, testing and design review to the complex of computers, automation, software and people that constitute the tools of management. So far, this has appeared to be a never-ending process; the future means more of the same.

**INDUCTIVE (OR REACTIVE) IMPACT**

Unlike deductive impact (the voluntary exploitation of new technology to improve logistics processes), inductive impact forces the logistics system to redefine itself in terms that meet the support requirements of the new technology. Some examples are discussed in this section. Although far from inclusive, they represent the challenges and opportunities that will soon face the logistics manager.

**Materials**

Metal and glass fiber composites, reinforced plastics, and reinforced ceramics are now displacing conventional metals in some applications, leading to new manufacturing methods for many products. Aircraft and ships, tanks and trucks, and any stress-bearing structure presently made of metal can be developed without riveting, milling or rolling operations. Molding and adhesive bonding are now being used with potential weight savings of 25 to 30 percent of aircraft gross weight. An instance of this is the use of Boron-Epoxy and graphite-epoxy materials for military aircraft components. The Douglas A4 aircraft has been fitted and successfully flown with elevators of these materials. The Boron or graphite fibers are woven into a tape. The latter is saturated with epoxy resin and wound on a mandrel to the desired configuration. Metal fittings, such as hinges, are integral
to the structure. The surfaces meet strength requirements under rigorous conditions.

Other new products are now being used to turn out flame resistant materials that will not produce fumes or smoke at high temperatures. These are designed to meet the FAA requirements for transport aircraft interiors; but will undoubtedly find many applications in military aircraft. The new materials include the polyurethane and polycarbonate thermoplastics. These are much more difficult to form than the materials now used; the best efforts of the materials' manufacturers and aircraft companies are being devoted to new fabrication methods. To meet these and other opportunities, new industries, materiel handling methods, and maintenance techniques must be developed.

Electronics

Microminiaturization and printed circuits lend themselves to ultracompact weapons that are easy to handle and store. The high density of such circuits requires sophisticated system maintenance. Perhaps even a unitized and completely centralized maintenance capability must be used to eliminate the investment costs in personnel and equipment of decentralized operations.

Sensors

Satellite reconnaissance systems can be used to spot actual or potential areas of conflict, and thus present to the decisionmaker more valid data upon which to base the need for the introduction of troops or air strikes. This concept, eventually, may eliminate the need for many ground forces, forward areas contingency depots, and "just-in-case" military units positioned around the world. Instead, home-based operational forces capable of supporting themselves logistically in the field, and backed by a world-wide high-speed air transport system, can deal realistically with those emergencies uncovered by real-time reconnaissance. Such operational methods can significantly reduce troop and weapon requirements and thus the logistics load. More emphasis will be placed on distribution systems and less on forward area prepositioning and investment.
V/STOL Aircraft

Large and small capacity V/STOL aircraft will make combat areas more readily accessible, and challenge the logistics system to develop emergency airfield preparation techniques, support highly dispersed operations, and recover damaged weapon systems from remote areas.

Telemechanisms

Keeping the human operator in the control loop while displacing him from the weapon system itself is an attractive proposition. In addition to saving lives, we can save weight by designing around payload and performance requirements rather than people. The class of devices designated "telemechanisms" are those which transfer real-time sensory information to a remoted human operator who, in turn, effects real-time control of the device. Telemechanisms have many advantages over manned systems: 1) the ability to operate at performance levels beyond normal human endurance, and 2) the ease of commitment to high-risk missions. Initial constraints will probably be found in the technical sophistication required by the telemechanisms and the inertia of the crewed weapon concept.

Airborne telemechanisms (telecraft) can be designed for very long endurance surveillance missions; equipped with stand-off missiles, patrol the intercept corridors leading to North America; and fly interdiction missions using extended loiter techniques to confirm target parameters and select attack modes. Similar applications are found for ground based telemechanisms (teleoperators). Mobile surveillance devices, remoted infantry, and laser-equipped target nominators are on the long list of applications. Equally at home in the water, telemechanisms could be used for active trailing of submarines, deep-sea exploration, and surface patrol.

The implications for logistics are especially significant. The need for crew support such as physiological conditioning, quarters, and medical attention will be greatly decreased. A single qualified operator can command several systems simultaneously, thus reducing the operator to telemechanism ratio. Centralized command and control centers
will reduce facility redundancy. On the other hand, however, operator training, maintenance, and R&D costs will probably be quite high owing to the sophistication of communications requirements, electronics, and tracking packages using laser and optical devices. Telemechanisms will perhaps have their greatest impact on organizational forms for maintenance. We anticipate that the initial tendency will be to emulate the maintenance concepts presently used for manned systems; however, for less complex telemechanisms existing organizational arrangements should accommodate the classic producer to user case without the burden of intervening logistics. This suggests that an eventual transition to pure logistics and pure operational commands is possible.

Long Endurance Vehicles

Nuclear powered sea surface vehicles and aircraft, particularly those remotely manned will permit reduction of backup forces and reduce the corresponding logistical load. Costs will probably be concentrated in the investment and R&D areas. Consolidated bases will lessen the impact on logistics distribution systems.

Thinking Munitions

Electro-optical, laser, and unjammable radar-directed munitions will permit lower circular error weapons' delivery, thus decreasing the need for a hot production base to support massive, saturation bombing strikes. This should decrease the requirements for large-quantity munitions storage and shipment installations, with a consequent reduction in explosive handling facilities with their potential hazards.

Image Transmission

Unjammable communications and image transmission will permit face-to-face discussions to be held over long distances, diminishing the need for intermediate information filter points and greatly facilitating decisionmaking. Microminiaturization permits the communications of a large force to be decentralized and direct contact between the wholesaler of supplies and the individual consumer. Such communication, incidentally, will also permit existing command and control arrangements to be more adaptive.
Surface Effect Vehicles (SEV)

This new technology will enable truly self-sustaining and mobile "force packages" to be rapidly deployed. The SEV's mobility will require a balance between maintenance and supply self-sufficiency and a highly responsive external distribution and support system.

Reusable Boosters

A capability to recover and refurbish rocket boosters can reduce space systems costs by as much as 50 percent. Even greater potential exists if the launch vehicle itself can be reused. Maintenance technology, operation costs, and acquisition strategy will be heavily affected.

Outer Space Storage

Use of outer space as a storage area for just about anything presents special problems in maintaining the inventory location of materiel. Space would be an ideal place to store very dangerous or bulky objects. The conventional warehousing and issue task takes on unique dimensions in this case, as does the notion of logistics responsibility for maintaining a prescribed environmental condition in space.

Automatic Test Equipment

With one piece of test equipment, a complex weapon system designed as an integrated unit can be preflighted and its faults isolated down to modules and below, and even smaller. The requirement for bulky equipment, extensive facility investment for testing and many support specialities is reduced while highly mobile operations are enhanced.

Another important dimension of this area is the near-term promise of systems and subsystems which are self-diagnosing and self-scheduling for inspection or repair. By transmitting (automatically or by interrogation) their state of health, the systems and subsystems can be incorporated into a master scheduling framework which maximizes use of maintenance resources subject to actual maintenance requirements.
CONCLUSION

New technology will permit almost unlimited development of applications in logistics command and control. Such advances permit even higher goals of system reliability to be set, perhaps to the point where systems are virtually failure proof. Elimination of most operational logistics and the aggregation of items at retailed level would result from such development and, ideally, weapons system logistics would stop when the system is delivered to the user.

The impact of new technology makes it apparent that improvements in communication speed, support of deployed units, and ability to deliver ordnance from long-range standoff distances with relative impunity combine to reduce the need for intervening organizations between the retail and wholesale logisticians and the weapon system. When the time comes that effective military operations can substitute telemechanisms as proxies for man, there will be an increased emphasis on command and control. At this point the wholesaler and the consumer of supplies become one.

We are aware that no such machine-to-machine military world is near at hand. Manned military forces will be needed on many different grounds, particularly on the sub-technological level, which reaches back, rather than forward, for the instruments of war. What the British call "the poor bloody infantry" still fights our hot wars, using last generation equipment and coercion methods to pursue its ends. Here, the threat of technological escalation may be as essential to future consideration and planning as is the threat of nuclear escalation today.

If future logistics techniques are called upon to support different generations of technology across different conflict levels, both decentralized and centralized support systems will be necessary. While some forms of technology—such as improved means of communication—suggest opportunities for new organizational arrangements—perhaps moving from decentralized to centralized operations—the key element in actually affecting such arrangements should be the prevailing operational and logistics doctrine.
The constant of change is all-pervasive. Technological innovations have had a pronounced effect on the way we conduct our logistics business. Manual processing of supply orders to the Quartermaster has given way to high-speed mechanized requisitioning and automatic status reporting, much in the same way that the superlative SPAD has been superseded by Mach 2.0 swing-wing aircraft design technology. Today's calculated revolution in logistics and technology should produce some equally spectacular results.