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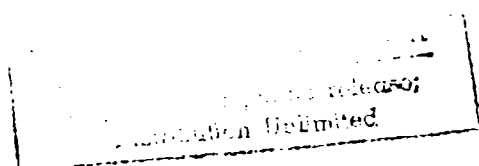


A RAND NOTE

**A Survey of Coalition Logistics Issues,
Options, and Opportunities for Research**

H. Wayne Gustafson, Richard J. Kaplan

August 1990



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→ Coalition logistics refers to collaborative support of military forces by allies, including host nation support, cooperative management of supply and maintenance, and shared logistics planning for codeveloped weapon systems. Coalition logistics has never been a dominant theme of combined operations in U.S. alliances. As a result, opportunities for coalition logistics are going unrealized or underexploited, and payoffs from pursuing these opportunities have not been analyzed. This Note reports on a survey of such opportunities as they pertain to the U.S. Air Force and outlines prerequisite research needed to capitalize on them. Despite formidable political and economic obstacles to implementing coalition logistics, there are trends at work that appear to augur favorably for that approach in the long run. The author suggests research areas for assessing the merits of possible directions for coalition logistics and to determine how to reduce the barriers to implementation. ←

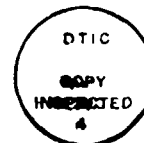
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PREFACE

All American wars in living memory have been coalition enterprises; yet tradition has it that military logistics is a national responsibility. The cost and complexity of modern weapons and their associated support systems make the notion of coalition warfare backed by strictly national logistics arrangements no longer credible or, for that matter, even realistic. There is much coalition logistics in the world already, and the tide seems to be on the surge.

The present Note is the chief product of an exploratory investigation of research opportunities in this broad and ill-defined domain of coalition logistics, the purpose having been to chart potentially profitable directions for further exploration. The work was carried out under the project entitled Coalition Logistics: A PAF Exploratory Project, in the Research Management Program of RAND's Project AIR FORCE, a federally funded research and development center for the United States Air Force.

The Note covers information of interest to any reader concerned with combat support of American arms in overseas arenas, but all the illustrative material is slanted toward an audience of sponsors, managers, and practitioners of Air Force logistics research. Many of the issues treated also have direct implications for other services, the Army in particular.

SUMMARY

Coalition logistics includes all forms of executed or planned collaborative support of military forces by allies. Despite ready availability of contemporary examples, coalition logistics is not a dominant theme of combined operations, or planning for same, in U.S. alliances. Quite the contrary, the prevailing international view, originally inspired by the United States, has been and continues to be that logistics is a national responsibility.

Now, economic and political trends tend to make the prospect of coalition logistics more attractive than before. Whereas U.S. military policy historically has espoused wartime unit self-sufficiency, the individual service counterpart to logistics as a national responsibility, times are changing. In the case of the U.S. Air Force, for example, recent USAFE (U.S. Air Forces Europe) and PACAF (Pacific Air Forces) logistics concepts of operations call for increased collaboration with allies.

This Note reports the findings of an exploratory survey of possible opportunities for coalition logistics that have promise for USAF and need to be researched. It was found that many openings exist for coalition logistics that are going unrealized or even overlooked; the payoffs from pursuing some of these opportunities could prove favorable but have not been analyzed; the political and economic obstacles to implementing coalition logistics can be, and traditionally have been, formidable; but there are trends at work that augur well for coalition logistics in the long run.

The U.S. foreign military sales (FMS) program and the NATO Maintenance and Supply Agency (NAMSA) are the Western world's two most prominent exemplars of coalition logistics. Both institutions, however, are geared predominantly to peacetime, with neither playing a serious role in USAF war planning. Moreover, because of policy and organizational constraints outside their control, both agencies will very likely be driven out of business in a major, protracted conflict.

Likewise missing from USAF war planning except in a limited way is any scheme of forward depot support. USAF combat elements fight thousands of miles from their home continent, but under today's policies their supply and maintenance depots remain, with minor exceptions, in the continental United States (CONUS). Yet capable depot

facilities, largely commercially owned, are available in both the European and Pacific theaters.

Another unexploited variety of coalition logistics is weapon-system-specific combat support. USAF and allied air forces operate quantities of weapons in common and intend to fight them in concert in war but have few if any arrangements for mutual supply and maintenance at the flightline and intermediate levels.

A final unexploited area is planning for logistics support of codeveloped and/or coproduced weapon systems during the acquisition process. This amounts to applying the DoD principles of integrated logistics support (ILS) in an international setting and with an eye to coalition warfare.

Under existing policies pertaining to issue priorities and transportation arrangements, logistics support to allies through the FMS program threatens to be cut off in time of war. Ad hoc measures no doubt would be conceived to ameliorate the adverse effects, but without peacetime planning, such measures probably would prove too little and too late.

The United States not only extends weapon system support to allies, nowadays it receives supply and maintenance support from them as well; and the trend in the latter direction is on the rise. As the United States in all probability will cut off FMS logistics in wartime, so may allies elect to play a similar game. We should therefore pursue the following avenues of research.

- Simulation studies are needed to assess the likely effects of FMS logistics cutoff on coalition combat performance. The underlying issue is whether the policies that presage FMS logistics cutoff in war should be moderated and, if so, in what ways.
- A survey is indicated to forecast the extent of USAF dependence on allied supply and maintenance support over the next decade or so, to estimate the consequences if this support were cut off in a contingency, and if said consequences appear serious, to ascertain how to alleviate them.

Sadly underutilized in peace, NAMSA appears in danger of fading away in war. This is because a primary line of business for the agency is brokering the very United States FMS logistics support that stands to be cut off. NAMSA is also organizationally

removed from the military command and control structure destined to manage any NATO war. Further, the very concept of a NAMSA is anomalous in an atmosphere of logistics as a national responsibility. These considerations give rise to the following proposed lines of research:

- The potential effects of FMS cutoff on coalition combat performance need to be understood by simulating wartime scenarios, as do the possible influence of partial or total wartime shutdown on the part of NAMSA. Because NAMSA is a principal conduit for FMS logistics, the destinies of the two institutions are intimately linked and ought to be investigated concurrently.
- Residing on the civilian, rather than military, side of NATO, NAMSA neither functions under the military command of Supreme Headquarters Allied Powers Europe (SHAPE) in peacetime nor transfers to SHAPE instantly at the onset of crisis. Only after the Alliance is heavily committed to war can the Supreme Allied Commander Europe (SACEUR) begin to exercise control over NAMSA by means of "operational directives." Research is suggested on what it would take to move NAMSA from its present organizational location into the mainstream of NATO operational logistics, to function in tandem with SHAPE's Logistic Co-ordination Centre and Logistics Readiness Centre.
- Finally, NAMSA cannot prosper in an environment where the doctrine of logistics as a national responsibility is interpreted to mean that the partners to an alliance may handle logistics entirely according to idiosyncratic rules. Effective wartime coalition logistics carries costs as well as benefits; and to secure the advantages, the participants must agree to pay the price. The time is long overdue to promulgate this concept.

Depot facilities capable of supporting American equipment have seemingly proliferated throughout the world. One of these, of course, is NAMSA, and another is USAF's own Support Group Europe (SGE); but in recent years there has also been a burgeoning of privately or governmentally held industrial facilities. In consequence, three lines of research are called for:

- Simulations of combat scenarios can investigate the wartime value of existing and contemplated forward depots to USAF and allied air forces.
- A closely related issue is the survivability of the indicated facilities. These are prime depots for allies who depend on them absolutely, and their vulnerability may threaten the combat performance of United States alliances as a whole.
- Of special interest to USAF in terms of forward depot support should be the wartime role of SGE. Whereas wartime combat support in Europe is managed by USAFE, SGE belongs to the Air Force Logistics Command (AFLC), putting it beyond the immediate jurisdiction of those directing the war. The question is, parallel to the case of NAMSA, how to draw SGE into the primary flow of operational logistics.

For some time, RAND logistics research has emphasized the advantages of mutual support among USAF combat elements as opposed to the traditional self-sufficiency doctrine. The findings have led to substantial USAF planning for increased mutual support and to USAFE infrastructure enhancements.

Research extending these concepts to the coalition arena is advised as follows:

- Existing forms of coalition logistics, such as the use of allied airbases by American forces deploying from CONUS, are nearly always weapon-system generic. This leaves considerable opportunity for expansion of collaboration into supply and maintenance of specific weapons possessed by multiple nations. The benefits of such allied mutual support depend, however, on the scale of operations undertaken. An important question for simulation studies to resolve, therefore, is the scale required to render weapon-system allied mutual support both militarily and economically attractive.
- Coalition mutual support, notably weapon system supply and maintenance, cannot be conducted effectively on a voluntary, ad hoc basis. Someone has to be in charge. The optimal form of organization for accomplishing the necessary control and coordination is an issue for investigation.
- Dependable transportation resources coupled with powerful, interoperable data and communications systems may be a further necessity of mutual

logistics support. Responsive resupply may be sufficiently critical as to justify dedicated transportation and data capabilities. Distribution channels and storage facilities for resupply at depot level may need rearranging to augment combined use of coalition resources.

In the absence of rationalization, standardization, and interoperability (RSI), efforts toward coalition logistics can do little more than nibble around the edges. At the same time, the traditional American concept of RSI, which is for allies to buy all their arms and logistics support from the United States, is no longer valid. The future of coalition logistics requires that an international version of ILS be incorporated into codevelopment/coproduction programs. The following three preliminary research endeavors seem prerequisite:

- Characteristically, the U.S. doctrine of ILS in system acquisition is inadequately implemented. Before we attempt to promote a similar policy for codevelopment and coproduction, it would be well to identify the major causes of weakness in American practice in order to avoid proliferating them. To this end, a research survey of domestic acquisition procedures pertinent to ILS is indicated, preferably structured like a management audit.
- Also prerequisite to planning coalition support of codeveloped weapon systems is superior mutual understanding of the logistics concepts, structures, and values of the partners. Many foreign countries have for a long time operated certain aircraft also in the U.S. inventory. Historical cataloging of the logistics structures that have grown up around these weapons in different environments should reveal areas where improvements could be made to both and where accommodation must take place for coalition logistics to succeed.
- Finally, before we embark on the promotion of coalition logistics in codevelopment/coproduction, a firmer feel is needed for the role of logistics in ongoing multinational acquisition programs. Following the design of codeveloped weapon systems from the beginning, tracing the introduction of logistic support elements into agreements, and tracking logistics implementation would give a better picture than now available of the place of logistics in a cooperative venture today.

The survey resulted in a grab bag of 14 recommendations for follow-on research, not all of which could be pursued with available resources. An attempt was made to lend better structure to the recommendations by rating them on five dimensions:

- Importance to the DoD logistics community given the current state of the world,
- Degree of success likely in attaining research and policy objectives,
- Relevance and importance to RAND research continuity,
- Practicality of start-up and execution, and
- Cost and technical feasibility.

The rating process identified five projects as deserving highest priority:

- Management structure for allied mutual support,
- Allied logistics concepts and structures,
- Infrastructure issues for allied mutual support,
- Issues of scale in allied mutual support, and
- Survivability of prospective forward depots.

Retrospective review revealed that all these suggested projects reflect the likely future trend toward more equal logistics cooperation with allies in place of the U.S. domination of the past, and most of them represent cross-cutting issues that transcend the specific contexts in which they were proposed.

The three lowest ranked projects were:

- Relocating NAMSA organizationally,
- Strengthening Support Group Europe, and
- Simulation of NAMSA wartime shutdown effects.

These came out at the bottom largely because of low probabilities both of achieving solid research results and of effecting substantial policy changes regardless of findings. Also, the projects pertain to unique organizations not envisioned for replication elsewhere. Thus, the generalizability of the findings would probably be limited.

ACKNOWLEDGMENTS

The project giving rise to this Note was conceived, planned, and initiated by Irving K. Cohen, who participated in much of the data collection and provided counsel throughout. Major General Edward R. Bracken, Director of Logistics Plans and Programs & Deputy Director of Logistics Readiness, was first to envision the importance of coalition logistics and to convince us of the value of research in this area.

Gratitude is extended to the many anonymous interviewees who supplied information and opinions.

Special appreciation is due Lt. Col. Ron Williamson (Ret.), AF/LEXX, who not only served most helpfully as our primary point of contact, but proved a veritable fountain of information himself.

Thanks also are owed Col. Thomas McDaniel, Jr. (USAF), of the U.S. Military Delegation to NATO, who besides being a leading expert and author of a forthcoming book on coalition logistics, greatly facilitated our passage through the twin labyrinths of NATO and SHAPE.

Robert M. Paulson kindly reviewed an earlier version of this Note and made many helpful suggestions for its improvement.

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GLOSSARY

AFLC	Air Force Logistics Command
ALC	Air Logistics Center (AFLC)
AWACS	Airborne Warning and Control System (E-3)
CENTAG	Central Army Group (NATO)
CHOP	Change of operational control (NATO)
CINCHAN	Commander in Chief, Channel (NATO)
CLSSA	Cooperative Logistics Supply Support Arrangement
COB	Colocated operating base
CONOPS	Concepts of Operations
CONUS	Continental United States
CVAI	Vice Chief of Staff, Acquisition International (USAF)
DSAA	Defense Security Assistance Agency
DTSA	Defense Technology Security Agency
EEC	European Economic Community
EPG	European Participating Governments (F-16 consortium)
EUCOM	European Command
FMS	Foreign military sales
ILC	International Logistics Center (AFLC)
ILS	Integrated logistics support
JCS	Joint Chiefs of Staff
JSP	Joint Support Plan
LCC	Logistic Co-ordination Centre (NATO)
LOC	Line of communications
LRC	Logistic Readiness Centre (NATO)
LSA	Logistic support arrangement (NAMSO)
LTDP	Long-Term Defence Plan (NATO)
MLC	Multinational logistics command
MLRS	Multiple Launch Rocket System
MOB	Main operating base
NAMSA	NATO Maintenance and Supply Agency
NAMSO	NATO Maintenance and Supply Organization
NORTHAG	Northern Army Group (NATO)
PACAF	Pacific Air Forces
PRI	Directorate of International Programs (USAF)

PWORC-E	Pratt & Whitney Overhaul and Repair Center-Europe
RSI	Rationalization, standardization, and interoperability
SACEUR	Supreme Allied Commander Europe
SACLANT	Supreme Allied Commander Atlantic
SCEPC	Senior Civil Emergency Planning Committee (NATO)
SGE	Support Group Europe (AFLC)
SHAPE	Supreme Headquarters Allied Powers Europe
SNLC	Senior NATO Logisticians Conference
STANAGS	Standard agreements (NATO)
TAC	Tactical Air Command (USAF)
UMMIPS	Uniform Materiel Movement and Issue Priority System
USAF	United States Air Force
USAFE	United States Air Forces Europe

I. INTRODUCTION

POLITICAL PERSPECTIVE

Soviet Foreign Minister Shevardnadze announced on October 24, 1989, that the Soviet Union is willing to consider dissolution of the Warsaw Pact if the Western world will consider dissolution of NATO. Early 1990 therefore may not seem the timeliest of occasions to be talking about increased efforts in coalition logistics to enhance war fighting capability, which is what much of this commentary does.

On the other hand, amity between the Soviet Union and the West is more likely to evolve in stages, concession by concession, than to emerge full-blown overnight. Meanwhile, as force reductions occur and NATO graduates into a more purely economic alliance—perhaps even embracing current members of the Warsaw Pact—the West presumably will want to maintain the strongest possible deterrent posture commensurate with contemporary force limitations. And that is where coalition logistics comes in.

Two primary scenarios are of interest. The first is where the call for overseas troop reductions leaves options as to the balance between support forces and combat forces. An element of such choice is likely even in the event of arrangements negotiated with the Warsaw Pact, and alternatives would be more or less wide open in the case of unilateral requirements imposed by Congress with a view to reducing costs and trade deficits. The second scenario is where a crisis erupts after reductions have been made and it becomes necessary to rebuild force structure overseas. Since wars have a habit of starting where least expected, this possibility cannot be ignored or dismissed.

Considerations of coalition logistics conceivably could wield a heavy hand in both these scenarios. In either situation it is at least imaginable that alliance war-fighting capability might be kept at a measurably higher level than otherwise if coalition logistics practices were adopted on as extensive a basis as feasible.¹

¹A third scenario, touched upon later but needing fuller articulation through future research, is that of a small-scale war in a remote part of the globe conducted in combination with an ally who operates a limited number of weapons of the same type as does the United States. A recent, if not very good, illustration might be the Falkland Islands conflict. The United States did not participate in the shooting, but the USAF did levy on some of its own front-line combat units to supply the British with munitions. The value of peacetime planning for wartime coalition logistics in scenarios of this sort deserves exploring, but the payoff seems more problematic than in larger-scale cases.

PURPOSE

The Concept

Coalition logistics may be defined for immediate ends as any form of executed or planned collaborative support of military forces by allies, where the distinction between executed and planned more or less parallels that between peacetime and wartime. As an instance of an executed (peacetime) form, DoD sells life-of-the-product logistics support (spare parts, test equipment, training, etc.) for U.S. weapon systems supplied to other countries through the Foreign Military Sales (FMS) program. As an illustration of planned (wartime) coalition logistics, the USAF participates in numerous bilateral agreements that make selected airbases of friendly nations accessible to deploying American aircraft in time of crisis.

Current Status. Despite ample availability of illustrative cases, coalition logistics is not a dominant theme of combined operations, or planning for combined operations, in U.S. alliances. Quite the contrary, one hears the shibboleth repeated over and over, almost ritualistically, especially throughout NATO (North Atlantic Treaty Organization) and SHAPE (Supreme Headquarters Allied Powers Europe), that although logistics may be an alliance concern, it is a national responsibility. If, as informants assert, this doctrine has abated in strength in NATO during the past several years, its recital has shown little diminution in frequency.

Although the principle of logistics as a national responsibility is subject to interpretation and by no means precludes coalition arrangements, its repeated espousal does act powerfully to inhibit the initiation of such arrangements. The slogan also relieves otherwise interested parties of the difficult attendant decisions and negotiations. In consequence, it may be concluded with confidence that room exists in the world for more coalition logistics than is to be found today.

At the same time, current economic and political trends, such as skyrocketing costs of armaments and pressures to withdraw U.S. forces from overseas, tend to make the prospect of coalition logistics more attractive than ever before. If, for instance, overseas forces must be reduced and a choice is available between war fighters and truck drivers, why not explore the option of bringing home the truck drivers and replacing them with host nation personnel? Such recourse might not only achieve the desired political objective, but preserve strong deterrence and save money for the United States in the bargain. The "unthinkable" converse alternative of turning the war fighting

functions over to allies and letting the United States handle logistics also is worth reviewing, and most of the material in this Note would be pertinent from that perspective, too.

Future Prospects. Historically, the American Army's logistical approach to war has been the expeditionary force designed to take everything it needs along with it. Until present times, this expeditionary force philosophy has been ingrained equally in Air Force doctrine through the policy of unit wartime self-sufficiency, the individual service counterpart to logistics as a national responsibility. Signs of changing times are seen, though, in that both DoD and the Air Force have begun to speak of increased coalition logistics in the future and the need to prepare for that eventuality now.

The DoD Logistics Strategic Planning Guide (DoD, 1988) predicts, for instance, that:

Economic interdependencies will cause the U.S. to use more systems and technologies developed outside the United States and to rely more on international sources for equipment, supplies and support. The use of concepts such as Host Nation Support Agreements, joint ventures, and co-production will increase.

The U.S. Air Force Logistics Strategic Plan (USAF, 1989) then goes on to turn this prophesy into an injunction by setting it as an Air Force goal to:

Ensure more cooperative support systems within each theater which enable logistics support of combat forces among services and allied nations.

And taking it from there, both the U.S. Air Forces Europe (Metzler, n.d.; USAFE, 1988) and Pacific Air Forces (Browning, 1989) Logistics Concepts of Operations (Log CONOPS)² expand this injunction into more concrete coalition logistics goals such as greater reliance on allied transportation resources, increased use of host nation contractors, and augmentation of allied war reserves.

It is not known how the impending formation of the European Economic Community (EEC) in 1993 (actually December 31, 1992) will influence the future of

²USAF produced a generic Log CONOPS in 1987 (Bracken, 1987; Trainor, 1988; USAF, 1987), which is embedded in the Logistics Strategic Plan just referenced. The Major Commands responded to this USAF Log CONOPS with more specific ones tailored to their unique circumstances.

coalition logistics. Some Americans are apprehensive that the EEC may lead to European industrial cartels tending to freeze out the U.S. defense industry (Canan, 1989). Other authorities, however, believe there is little reason to expect that the Europeans will cooperate with each other any better than they have in the past. Inasmuch as the majority of Europe watchers are adopting a wait-and-see attitude, that is what will be done here. Whatever the long-run effects of the EEC, they are not likely to be sudden enough to contradict the hypotheses and conclusions of this analysis.

Presentation Overview

This Note reports the findings of an exploratory survey of opportunities for coalition logistics that seem to have potential for the U.S. Air Force. The objective was to identify important research needs, several of which were outlined in a RAND internal proposal. In a sense, the purpose is to amplify that proposal and explain the rationale behind it.

Emphasis on NATO. Inasmuch as NATO has been the leading U.S. military alliance for two generations, much of the information collected to date, and the bulk of illustrations presented here, pertain to that organization. This concentration on NATO for purposes of the survey should not, however, obscure the aim of the proposed follow-on research to elucidate generalizable principles. After all, as Correll (1989) observes, "alliances are not eternal."

Although the present survey of research opportunities is weighted toward NATO, there is equal long-range interest in alliances in the Pacific theater, alliances with individual third world nations, and alliances not yet formed or even imagined. In a 1985 analysis of potentialities in southwest Asia, RAND broke important ground respecting coalition logistics in the third world.³ Follow-up of this and related work through further research is implied in the current document, though not discussed in detail.

Role of Scale. Related to the third world issue, an important question for research to examine is the scale of operations necessary to make given forms of coalition logistics profitable to the parties concerned. Regardless of diseconomies of scale, a country that acquires even a few modern weapons is compelled to achieve the capability to support them. Typically, this means adoption of logistics facilities and procedures designed for

³Coalition logistics in undeveloped theaters of war also is an area of expertise of Major General D. E. Watts (USA, Ret.), who has briefed RAND on that topic and is preparing a paper for publication.

larger fleets of weapons; and this implies, in turn, facilities likely to go underutilized. Can enhanced coalition logistics take advantage of such situations to the mutual benefit of the participants; and if so, how substantial do the benefits have to be to justify the cost?

Preview. To convey in a few words the gist of what follows:

- Many openings exist for coalition logistics that are going unrealized or even overlooked;
- The payoffs from pursuing some of these opportunities could prove favorable but have not been analyzed;
- The political and economic obstacles to implementing coalition logistics can be, and historically have been, formidable; but
- There are seemingly irreversible trends at work that augur well for coalition logistics in the long run.

What is indicated for the immediate future is systematic analysis of some principal opportunities to find out to what extent coalition logistics is an end worth struggling for.

MOTIVATION

Host Nation Support

U.S.-German Agreement. The expectation of fighting any future war on other countries' soil generates problems of deployment and sustainment for the United States that far transcend those envisioned by its allies. An obvious means of relieving these logistical burdens is to persuade host nations to share them, and considerable strides in this direction have been made over the past several decades. The most notable example is the 1982 agreement between the United States and West Germany (Agreement, 1982; Houck, 1986; Firengle, 1986) in which the Germans undertake to furnish some 93,000 wartime military support personnel in recompense for a U.S. statement of intent to field ten combat divisions (six more than now) and 88 air squadrons (60 more than now) in NATO within ten days of crisis onset.

Clearly, the security benefit sought from this type of arrangement is to get more combat power in place faster by reducing the airlift needed for support personnel and equipment. In addition, however, host nation support furthers the long-standing goal of

Congress to increase defense burden sharing by allies (Cooper and Zycher, 1989; DoD, 1989; Kitfield, 1988).

Among the provisions of the U.S.-German agreement is the furnishing of 8,700 host nation personnel to support U.S. Air Force operating bases, with the following logistics related services to be provided (EUCOM, 1986):

- Ammunition storage, handling, and transportation
- Petroleum, oil, and lubricants (POL) storage, handling, and transportation
- Maintenance services
- Transportation services
- Storage and handling of materiel
- Assembly and transportation of extra fuel tanks
- Preparation of meals
- Medical support
- Fire protection and aircraft crash rescue services
- Snow clearance and runway cleaning
- NBC (nuclear, biological, and chemical) defense, self-protection
- Operation of command and telecommunications facilities
- Local procurement of materiel
- Administrative support
- Provision of accommodation to the extent possible.

Implications. Whether any sort of wartime logistic support of U.S. forces by foreign nationals can be carried off effectively is a controversial matter. For one thing, many commanders argue that combat forces and their support units must train together, a difficult proposition when they are stationed on different continents and resources for exercising combat deployments are constrained. Nevertheless, supposing that the above listed forms of support can be effected successfully in wartime, why should not the same principle be extended to American forces located overseas during peace? Why must the U.S. Air Force keep more than a small administrative cadre of support personnel overseas in peacetime? Moreover, assuming the host nation could be persuaded to share predominantly in the cost of providing the needed support, the United States would stand to foster several political and economic desiderata in one stroke: (1) Unweakened

deterrent presence of combat elements in threatened theaters; (2) faster closure in case of war; (3) fewer American military personnel overseas in both peace and war; and (4) reduced peacetime military expenditure, with advantage to the balance of trade.

The idea of substituting host nation personnel for American nationals in the above fashion is far from new. Many thousands of such persons are employed by the U.S. armed forces already, and expansion of this work force was a cornerstone of a RAND analysis published in 1973 (Komer et al., 1973 a, b) on how to reduce U.S. troops in central Europe by up to 30 percent with the least adverse effect on deterrence. In today's atmosphere of relaxed East-West relations and heightened budgetary pressure, it is possible to carry the thought to a more daring denouement, which is that host nations could take over full operation of the noncombat functions of U.S. military facilities overseas. Fixed assignment of U.S. military units to foreign countries might be abandoned in favor of shorter rotational tours not requiring movement of dependents and other encumbrances entailed by permanent change of station. Rotational deployment along these lines would seem especially feasible in the case of the Air Force, where not only the personnel but the weapons of war are highly transportable.

Research Incentives

As seen, host nation support, which is only one of many varieties of coalition logistics, by itself affords multiple directions for investigation as well as multiple criteria for evaluation. Some of these value criteria pertain to war-fighting capability and effectiveness, others to politics and economics. Questions about host nation support that spring to mind include: What is the full extent of such support to the USAF at present, and how much money does this save today? How much does existing support reduce wartime deployment lift requirements and increase combat readiness and sustainability? What would be the potential benefits and wartime risks of enhancements as discussed above? What would be the political repercussions, both internationally and within the U.S. military establishment, of radically augmenting host nation support? How would U.S. personnel react, e.g., to having all base services, including food and medical, run by host countries? What effects would be felt from the loss of U.S. military and civilian jobs? And, from the allied perspective, how would host nations feel about having American troops continuously in their midst unaccompanied by families?

Coalition logistics, in short, is a domain of countless ramifications. As no single review could hope to cover the subject in entirety, we have exercised much selectivity in

identifying research needs for elaboration, singling out what seem to be the most glaring omissions and recommending the ones whose remediation would yield the greatest good over the long haul. Plainly, this is a judgment susceptible to error.

Until recently, one would have argued with little hesitation that interest should focus mainly on value criteria associated with combat effectiveness. Now, with international tensions diminishing, the political and economic aspects of coalition logistics rise in importance. Where formerly a question as to the worth of coalition logistics in, say, winning the hearts and minds of third world nations would have paled into insignificance alongside one of increased combat sustainability with regard to the threat of a European war, the imbalance between these two value criteria nowadays appears less sharp.

In view of today's rapidly shifting geopolitical sands, one of the more valuable contributions that research in coalition logistics could make would be to formulate suitably balanced "objective functions" for weighing the costs and benefits of available alternatives. It seems doubtful, however, that a single, generic objective function could be devised to fit all coalition logistics manifestations and scenarios. Accordingly, the development of evaluation criteria should be a discrete, formal phase of each follow-on research project undertaken.

Finally, one powerful incentive for embarking on analysis of coalition logistics is simply that the Air Force appears to have no other work in this field, or at least no defined program of research, under way (AFCOLR, 1988). This is not to imply that commands, such as USAFE (U.S. Air Forces Europe) and PACAF (Pacific Air Forces), are neglecting to address the topic or to carry out relevant studies. On the contrary, a baseline step contemplated for any subsequent research is to catalogue what these commands are doing in the way of extending coalition logistics and what their plans are for the future.

TERMINOLOGY

Ashcroft (1969) characterized the word logistics as "a generic term to describe an incoherent range of miscellaneous functions." This definition seems even more apt in reference to "coalition" logistics.

There can be no question that the Central European Pipeline System, which supplies POL to military forces throughout much of NATO, exemplifies coalition

logistics, as does the U.S.-German host nation support agreement—and likewise for NAMSO, the NATO Maintenance and Supply Organization, and for international stockpiles of munitions earmarked for wartime proprietorship by allied commanders in chief.

The terminological relevance of other prospective examples, though, is less evident. Consider a commercial repair facility in an allied nation that is used in peacetime by both the military of that nation and American forces stationed there. If this combined use is coordinated between the two countries by formal agreement, and if the facility is supplied with equipment furnished by the two governments with a view to wartime capacity expansion, again it is easy to embrace this case under the coalition logistics rubric.

But what if mutual use of the indicated repair facility is not deliberate, arising only incidentally out of peacetime economic causes? Does it still count as coalition logistics? The attitude adopted here is that precise definition does not matter. Whether or not the incidental combined use of a logistics resource formally ranks as coalition logistics, such an event may constitute an opportunity for expansion of a good thing into something better and deserves to be recognized as such. If the accidental arrangement that prevails is economically and militarily advantageous to all parties, maybe there is richer ore to be gotten from the same mine. The purist may wish to think of the circumstantial sharing of a logistics resource as "incipient" coalition logistics.

As a matter of fact, to jump the gun a little, the increasing incidence of commercial supply and repair facilities in potential theaters of conflict throughout the world is one of the principal observations of the present survey. Judged strictly from the viewpoint of military efficiency, these resources appear on balance to be underutilized by the United States, sometimes, for instance, playing no role in war plans. In spite of various political, economic, military, and technological objections to greater use of these facilities, we believe the opportunity they represent for increased logistical flexibility deserves more careful consideration than formerly accorded.

The NATO E-3A (AWACS) fleet, which NATO owns outright,⁴ is fully supported logistically with NATO funds under NATO management. This extreme and exceedingly rare form of coalition logistics would be called "integrated" by Ashcroft

⁴More accurately, the fleet is owned by the combined NATO nations. For legal purposes, the aircraft are registered to Luxembourg and display that country's flag.

(1969, 1970), as opposed to looser combinations referred to interchangeably as common, cooperative, collaborative, allied, international, or joint logistics. For present purposes, we intend the term *coalition logistics* to cover the whole waterfront. The only terminological nicety attempted is to reserve the expression "joint" logistics for coordinated arrangements among different military services of the same country—as in joint chiefs of staff. Even this convention cannot be adhered to absolutely, however, as will be seen later on when it comes to joint support plans.

INFLUENCING FACTORS

Unity of Command

It is a widely accepted axiom that coalition warfare is most effective when there is unity of allied command. Yet in NATO, owing to the doctrine that logistics is a national responsibility, logistics unity of command scored on a ten-point scale would rate perhaps a two or a three. A few military provisions have been made in the direction of combined logistics management, but these are loose and peripheral. As an example, Allied Command Europe has a Logistic Co-ordination Centre (LCC) with the wartime mission "to provide a permanent link for consultation and co-ordination on logistic requirements between the Allied nations and SACEUR [Supreme Allied Commander Europe] so that his operational decisions can be consistent with logistic capabilities." (SNLC, 1989.) And associated with the LCC is the Logistics Readiness Centre (LRC), which is a "control organization set up in war to monitor logistic activities and reporting and to assess logistic preparedness in SACEUR's area of responsibility." (SNLC, 1989.)

Despite its charter, however, the LRC is empowered to reallocate resources among national forces only provided the countries owning those resources have earmarked them explicitly for that purpose in LOGSTAR II reports submitted in peacetime once a year. Other than that, both the LCC and LRC are without command authority; and even if they had such authority, they would be unable to exercise it because of almost total lack of real-time visibility over national assets. Apart from annual LOGSTAR II reports and unremarkable telephone/facsimile/CRT communications facilities, the LCC and LRC effectively are blind.

Although not often stated as starkly as this, the absence of unity of command in NATO logistics is well known (e.g., Griffith, 1983) and has already been competently and extensively analyzed a number of times. As mentioned before, Ashcroft (1969,

1970) set himself the task of inquiring what it would take to achieve "integrated" logistics wherein NATO would become, logistically speaking, very like a nation. His treatment of this question gives fascinating insight into the problems of moving a mammoth political bureaucracy but comes to no conclusion other than to make it clear that the issue is monumentally difficult.⁵

Short War Orientation. As just one indication of the difficulty, the consensus at NATO and SHAPE from time immemorial has been that any war to be fought in Europe will last only a few days because of rapid escalation to the nuclear stage.⁶ What then is the point in worrying about wartime logistics, integrated or otherwise?⁷ Given this as the prevailing attitude, the only selling point for integrated logistics is for it to make political and economic sense in peacetime. And although wartime agencies such as the LRC may have some political value, it is hard to conceive of any peacetime role for them that would generate economic yield.

Granting the likelihood of a short war, Lawrence and Record (1974) nevertheless advocate a multinational logistics command (MLC) for central Europe, arguing that it would reduce the total peacetime requirement for support forces by cutting down on duplication of effort across nations:

The responsibilities of the MLC commander would be to assure uniform support for all national forces operating in NORTHAG [Northern Army Group] and CENTAG [Central Army Group], to establish logistics policy, conduct detailed logistics planning, assign missions and allocate resources to multinational support forces under his control, and to set priorities for support.

An MLC, thus, would fall somewhere between integrated logistics and the committee-like LCC/LRC of today.

Recognizing the desirability of increased unity of command in logistics, but intimately aware of the political obstacles to bringing it about, R. W. Komer and several

⁵But not unresolvable, as the examples of NATO AWACS and the Central European Pipeline System demonstrate. NATO holds, operates, and maintains these resources, along with various others, in integrated fashion.

⁶Another argument is that the Warsaw Pact is so geared to blitzkrieg that it must win in a matter of days or lose. See, e.g., Canby (1972).

⁷Since NATO's persistent logistics shortfalls are a primary cause of the widespread belief in the necessity for nuclear escalation, this is circular reasoning. All the same, it is the institutionalized position.

colleagues at RAND in the mid-1970s recommended beginning on a still smaller scale with a NATO line of communications (LOC) command in central Europe to control the ports, transportation resources, and communications facilities needed for the massive force augmentation and follow-on support that would be expected in a major war of conventional arms. Presumably, the LOC command might sow the seed for a multinational logistics command that might evolve into more advanced forms of logistics integration. In fact, a much watered down version of the LOC command recommendation was implemented in 1979 in the form of a Multi-National Logistics Coordination Center (Brown, 1980; Heiser, 1979) modeled on the committee pattern of the higher echelon LCC.

Odds Against Integration. To anyone who may be enthused by the preceding ideas and proposals for enhanced logistics integration, the best advice we can offer is not to hold your breath. Ashcroft wrote some 20 years ago, and total progress in the interim toward logistics integration in NATO, especially wartime integration, falls somewhere between faint and nil. Witness, for instance, this testimony from a panel of experts as recently as 1988:

NATO logistics are severely limited, largely due to a lack of integration and central direction. NATO commanders lack authority over logistical support. A participant suggested that NATO should implement the logistics recommendations it adopted in the Long Term Defense Program of 1978, which stressed the need for multinational logistics as a NATO, rather than a national, responsibility. In this regard, NATO commanders should have authority for logistical control rather than sovereign nations. (GAO, 1988.)

Some observers no doubt would dispute this negative assessment of progress; but the fact remains that if war came tomorrow, SACEUR and the other major NATO commanders (SACLANT—SAC Atlantic—and CINCHAN—Commander in Chief, Channel) would start out having essentially no direct dominion over the logistics resources or infrastructures of the forces under their command. They could order national combat forces to redeploy in accordance with tactical demands, but they would have neither authority nor command and control facilities to dispose the military transportation facilities required to bring such redeployment about.

To illustrate more concretely, USAFE's nonnuclear fighter aircraft would CHOP (change of operational control) to SACEUR, but transport aircraft flown by USAF's Military Airlift Command would not. In the case of civilian transportation resources

such as railroads, highways, and civil aviation, NATO has developed elaborate mobilization plans under the direction of its Senior Civil Emergency Planning Committee (SCEPC), and authority over those resources is scheduled to transfer to the major commanders in war. The SCEPC mobilization plans themselves might afford food for research, but this survey did not delve deeply enough into them to offer suggestions.

In any event, the forced conclusion would seem to be that if coalition logistics depends on unity of command as a prerequisite, its future is anything but bright, at least in the NATO arena. This leaves progress in logistics cooperation to be achieved, if at all, the same way as posited by D. Greenwood of the Centre for Defense Studies, for arms cooperation—by collaboration *à la carte*.⁸ The success of coalition logistics appears to depend, in other words, on striking lucrative targets of opportunity rather than on concentrated assault. The question is whether there are enough such targets of sufficient aggregate scope to make development and implementation efforts worthwhile.

Rationalization, Standardization, and Interoperability

Just as unity of command would favor coalition logistics, so would international uniformity of equipment and procedures, a desideratum of alliances advocated formally by the U.S. Congress since 1975 (Callaghan, 1975; Cook, 1980–1981; DSMC, 1981) under the heading of rationalization, standardization, and interoperability (RSI). Since that time, not reams but carloads have been written about RSI (more than a little of it devoted to explaining what the words signify), and we have no intention of reviewing that literature. The issues of interest are what has been accomplished and what the outlook is.

Highly qualified authorities differ on both counts. Komer and colleagues were negative as to the condition of RSI in NATO in 1975 and formulated 145 RSI proposals that eventually evolved into the NATO Long-Term Defence Plan (LTDP) of 1978 (Cornell, 1981; Heiser, 1979). Soon after that, however, Secretary of Defense Brown (1980) was quite positive in evaluating progress against the LTDP, commenting on upward of 40 different advances in the realm of logistics alone. These two evaluations might lead one to believe that a surge of progress suddenly occurred after 30 years of RSI stagnation.

⁸A cogent characterization attributed to Greenwood by Mayer (1979).

RSI Measurement. It is hard to measure RSI objectively, however, and relevant quantitative analyses are difficult to come by. In a survey of current developments in NATO, Canan (1985) waxes enthusiastic about RSI achievements and future prospects. Three years later, however, the Logistics Management Institute prefaces a report on how to evaluate progress in RSI with the comment that "the inability to communicate and to share logistics resources with our allies are two of the most critical issues facing U.S. Army commanders in Europe." (Keenan, 1988.)

If this held true after 13 years of striving for RSI, it is not easy, in spite of Canan's optimism, to be sanguine about the future.⁹ Based on the limited figures available, it is even arguable, if one wants to play devil's advocate, that the long-term trend in NATO runs counter to RSI. For example, a statistic pertinent to Air Force logistics is that whereas the central region NATO nations, excluding France, currently fly 11 basic kinds of fighter aircraft, a decade ago they flew 13. This seems like progress. Basic kind, however, means generic make such as Tornado, F-104, F-16, and so on. In light of the proliferation of variant models of each basic type over the past ten years, it would be easy to make a case that, logistically speaking, there are *more* different fighters now than there were before.

An encouraging sidelight to the preceding statistic is that the projected number of different fighters for the same countries by the year 2000 is down to only six (F-16, F-18, F-4, Tornado, EFA, Harrier). However, a skeptic with respect to forecasting might be inclined to scoff that RSI always looks better in the offing.

To be sure, equipment commonality constitutes only the most visible aspect of RSI. The rest of the iceberg encompasses operational and administrative practices such as command and control methods, training regimens, requisitioning procedures, and prioritization rules. Because of historical U.S. leadership in arms dissemination in the free world, many American logistical practices have been adopted elsewhere, and a certain amount of RSI has occurred as a result.¹⁰ It is not altogether evident, however, that RSI arising from Americanization of allied methods contributes to progress toward coalition logistics.

⁹Lord Carrington, former Secretary General of NATO, is alleged to have remarked some years ago that the only thing common to NATO equipment is the air in the tires. It seems unlikely he would find reason to alter this judgment today.

¹⁰NATO, for example, has adopted the U.S. federal stock numbering scheme as well as the U.S. priority-of-issue system, UMMIPS, discussed below.

Indeed, a problem of the first magnitude in promoting coalition logistics is the traditional posture of the United States toward RSI, which is that the proper way to accomplish standardization is for allies to arm with American military equipment, then support it throughout its lifetime with American-furnished training and logistics. Valid though this view may have been at one time, it does not register well with allies nowadays, especially those with highly developed arms industries of their own.

The writers lack adequate foundation to reveal the true status of RSI. Taylor (1982) observes: "It is difficult to assess the prospects for NATO RSI." Maybe there is hope, maybe not. In any case, RSI does not seem an attractive star to hitch one's coalition logistics wagon to. If coalition logistics must depend on RSI and await its arrival, the prognosis seems forlorn.

RSI Not the Answer. Not only that, there is ample evidence that commonality in weapons does not in itself foster coalition logistics. As illustration, the United States agreed in 1976 to co-manufacture the F-16 Fighting Falcon as a member of a consortium involving Belgium, Denmark, Holland, and Norway, the purpose being to increase sales and reduce unit costs. The set of agreements defining this consortium is two centimeters thick (F-16, 1988), yet the entire subject of logistics is covered on a single page under the heading of "Principles for Logistics Cooperation."

Though the principles stated are sound—e.g., "Organizational and intermediate level maintenance will be standardized to the fullest extent possible to obtain maximum interoperability"—the agreement binds no one to anything, nor does it establish any mechanism for bringing logistics cooperation about. In consequence, each of the five participating nations today supports its F-16s by individual means. Mere ownership of a common weapon did not in this case give rise to coalition logistics. This is not to say, however, that international cooperation in F-16 logistics is nonexistent, only that it is at best a weakly developed art.

To conclude, if RSI stands inescapably on the critical path to coalition logistics, one appears left with the choice of girding for an interminable quest or of sounding taps for the venture before it begins. Consequently, a vital question for the proposed research is whether routes to coalition logistics can be found in a world where RSI is always just around the corner.

Protectionism

A factor perpetually at work against all forms of arms cooperation is the fear of adverse effects on sovereign economic, political, and, in the case of developed nations, technological affairs. If, for example, host nation support for U.S. forces saves money, it is likely also to take jobs away from American nationals. There is the risk, moreover, that the allies providing the support may falter in time of crisis. An obvious danger is that they may disagree as to the immediacy of the threat and refuse to mobilize in synchrony with the United States. In making recommendations and decisions about coalition logistics, these and related concerns have to be weighed and added to the balance.

Although the United States has the reputation of ranking high among protectionist countries, all nations know and play the game. When other countries develop and produce armaments, it is common, if not customary, for them to close the bidding to U.S. industry; ostensibly, informants say, U.S. companies often outbid foreign firms in open competition. By way of reciprocity, therefore, when the U.S. military is examining purchase options among American and foreign goods, foreign items are handicapped by having 50 percent added to their prices.

Offsets. For U.S. companies to do arms business abroad, offsets are becoming a necessity (Berry, 1988; Levite, 1989). For instance, to sell AWACS aircraft to the United Kingdom and France, Boeing agreed in 1986 to spend 130 percent of the purchase prices in those countries. Thus, the UK and France get the AWACS system plus, so to speak, a 30 percent profit to their economies in extra business. Assumedly, Boeing held or anticipated enough credits in the countries in question, and secured enough added longevity to its AWACS program, to make the deal feasible (Hessler, 1988). Plainly, such advantageous terms could not be offered repeatedly.

To make sure it is not left out, the United States has entered the offset contest by demanding and receiving assurance from Japan that 40 percent of the development work on the Japanese FSX, an offshoot of the American F-16, will be done in the United States (Farnsworth, 1989). President Bush has vetoed a further attempt by Congress to impose a like 40 percent offset on any future *production* (Pine, 1989). And so it goes. It must be taken for granted that any proposal for coalition logistics has to include political, economic, and technological quid pro quo attractive to all parties.

Specialization. On the rationalization side of RSI, proposals have been advanced over the years to the effect that the members of a military alliance should specialize in what each can do best. Greenwood (1986) suggests, for instance, that the United States should carry a larger share of the air defense burden in NATO while decreasing its ground forces correspondingly.

Much the same instincts that engender protectionism also argue for balanced national military forces. This is a stumbling block to specialization. Nobody wants one arm powerful and the other atrophied, and this attitude applies just as strongly to logistics support as to weaponry. World history undoubtedly leaves lingering concerns in everybody's mind as to who will be on which side come the next war.

Although task specialization will not be treated as a separate topic here, the idea of such specialization is implicit throughout. Were Germany, say, to take over administrative management and operation of U.S. airbases there, with USAF combat units situated as guest occupants on a rotational basis, a degree of national role differentiation obviously would be entailed. At the same time, the differentiation would not go so far as standing down parts of the German Air Force in favor of German hosting of increased numbers of American combat air units.

Realignment of combat missions and armaments among allies goes beyond the scope of this commentary. Still, the more any such realignment should take place in future, the more sense it would make to consider logistics specialization as a prime area for coalition logistics research.

Changing Times. There have been times when national protectionism effectively precluded any prospect of arms cooperation, including coalition logistics. The change in the air at present, one that lends currency to proposals for research, is that practically everything appears to have become negotiable.

ORGANIZATION

In spite of having little more than scratched the surface of coalition logistics, this survey managed to turn up a formidable assembly of information from a wide array of sources. The following sections attempt to organize and condense that material into comprehensible units and to translate it into definable problems for research.

No first-time voyager into the realm of coalition logistics can avoid encountering the free world's two most prominent exemplars of that discipline, the U.S. foreign

military sales program and the NATO Maintenance and Supply Agency, NAMSA. Sections II and III discuss the impressions gained of these two institutions and the research opportunities they present. A common feature is that both agencies are primarily peacetime structured, with prospects of going out of business in time of war. Analysis is therefore needed to determine the merits of reorienting them in the direction of wartime combat support and the steps required to bring such an end about.

Section IV addresses forward depot support. Although U.S. troops overseas are thousands of miles away, their supply and maintenance depots remain, for the most part, in CONUS. Yet, capable depot facilities, chiefly industrial, are available in-theater. Research is indicated to figure out whether and how to integrate these facilities more fully into the combat support system, particularly in wartime.

Section V covers weapon-system specific combat support. USAF and its allied air forces operate many weapons in common and intend to fight them in concert in war, but they have few if any arrangements for mutual logistics support at the flightline and intermediate levels. Investigation is called for to ascertain the costs, benefits, and political feasibility of supporting these common weapons cooperatively.

Section VI treats planning for logistics support of codeveloped or coproduced weapon systems during the acquisition process. This amounts to applying the DoD principles of integrated logistics support (ILS) in an international setting. Not only do system codevelopers need to consider how to support their systems in peacetime, they need to envision combat scenarios in which the weapons may be deployed and operated on a coalition basis in war. Case studies of codeveloped weapons are in order to discover effective ways of introducing international ILS onto the scene.

Section VII attempts to evaluate 14 recommendations for specific research in terms of importance and temporal priority.

BIASES AND LIMITATIONS

Several biases and limitations in the material presented should be explicitly pointed out:

- First, this document is a broad-brush survey and commentary that does not hesitate to record impressions, opinions, and hearsay as well as fact. It is not, in other words, a formal research report. It tries to identify promising leads

for research that, if diligently pursued for long enough periods of time, might result in formal reports.

- Second, the findings offered derive from selective review. Not every source of information on coalition logistics could be visited nor everything learned from those that were visited. Important omissions are likely. (This statement is not intended to excuse errors of fact or judgment.)
- Third, heavy emphasis is placed on USAF concerns as opposed to those of other services. No apology seems in order for this, though, as the services share many logistics problems.
- Fourth, stress is placed on weapon system supply and maintenance rather than such other vital logistics domains as munitions; fuel; transportation; base operating support; and combat support command, control, and communications. When it comes to implementation, the latter areas probably offer richer ground for coalition action than do supply and maintenance. With respect to basic principles, however, it is arguable that all fields of logistics have much in common. Thus, research on coalition supply and maintenance may be expected to yield findings of more general applicability.
- Fifth, a pervasive underlying bias will be discerned toward what might be called sustainability logistics in a protracted conflict. A brief nuclear holocaust no longer appears very probable, and other, older scenarios need to be resurrected. Although other countries may be able to dispatch their wars quickly and cleanly on occasion, hostilities the United States becomes involved in do not customarily exhibit these properties.
- Finally, in spite of changes in the air calling for increased emphasis on economic and political values in judging the worth of pursuing coalition logistics enterprises, the analysis throughout will be seen to stress the criterion of wartime combat effectiveness.

II. FOREIGN MILITARY SALES

BACKGROUND

The term *security assistance* will be used here in a limited sense¹ to mean the transfer of American military goods and services to friendly foreign countries. The United States procures military materiel from other nations also, of course, but that is another subject. The State Department is responsible for security assistance general oversight and overall policy. Negotiation and management of the transfers is vested in DoD, with the Defense Security Assistance Agency (DSAA) having the dominant role. The *Security Assistance Management Manual* (DoD 5105.38-M) is the "bible" on policy and procedures.

One type of transfer is direct sales to foreign governments by American manufacturers. For example, the British and French are currently purchasing E-3A AWACS fleets from Boeing Corporation and its subcontractors. In direct commercial sales such as these, the customers must figure out how to handle logistics any way they can. A recurrent problem has been belated discovery by purchasers that the U.S. government owns some of the technology the buyers thought was included in the deal they made with the manufacturer. This misunderstanding has led to painful complications in obtaining logistics support for the technology. A prime example is where the buyer receives software in the form of object code, only to learn that the U.S. government owns the source code and is in no way obligated by the commercial sale to furnish updates.

Although the State Department and DSAA both must approve direct sales, these agencies are not responsible for the manufacturer's truth in advertising. Far from it, they must be cautious of excessive intervention in free enterprise and so try to remain aloof. Nevertheless, the dissatisfied buyer tends to blame DoD for his problems, and DoD, which had little to do with the transaction, now must bend over backward in the interest of maintaining good international relations. Consequently, it is understandable that DoD ardently favors Foreign Military Sales, a government-to-government transfer mechanism for which it is directly responsible.

¹The basic textbook of the Defense Institute of Security Assistance Management (DISAM, 1988) takes seven pages to define security assistance in all manifestations.

Foreign buyers are attracted to direct sales by the incentive of lower prices. Even if aware of possible future logistical problems, they tend to rate logistics support lower in importance than do American counterparts (Kim, 1987). In an attempt to clarify the various differences between FMS and direct sales, DSAA recently issued a widely distributed pamphlet comparing the two point by point (DSAA, 1988a).²

The Army, Navy, and Air Force each has an infrastructure for managing security assistance relevant to its own pursuits. In Air Force headquarters, policy is dealt with by the Directorate of International Programs, AF/PRI, and administration of FMS is handled by the International Logistics Center (ILC) of the Air Force Logistics Command (AFLC). Overall guidance for Air Force security assistance is found in AF Regulation 130-1 (AFR 130-1).

LOGISTICS SUPPORT

The Air Force—and no doubt the other services—is justifiably proud of its devotion to logistics in administering FMS. In the case of major weapon systems, the ILC begins a negotiation by conducting site visits to assess prospective buyers' support capabilities, then consults with the customers on the best ways to meet deficiencies. If it appears the logistics deficiencies cannot, or will not, be remedied, the Air Force may refuse the sale. For an informative case study of the logistics planning process as applied to the sale of F-16s to Venezuela, see Davis (1986).

Both initial and follow-on support are offered in several areas including spare parts supply and repair, support equipment, technical data, and training. Once committed, the United States agrees to continue any such support as long as the system remains in the U.S. inventory, active or reserve. Provided he can afford it, the FMS customer gets very fine logistics support indeed. To a weapon purchaser interested in performance (rather than, e.g., glitter), one of the attractions of American arms is that no competitive supplier comes close to matching FMS in the realm of logistics.

In all services, the chief avenue to FMS follow-on spare parts supply is the Cooperative Logistics Supply Support Arrangement, or CLSSA, in which the purchasing

²From the standpoint of the purchaser, neither the direct sales nor the FMS approach can be said to be intrinsically superior. The two avenues simply offer different options. Direct sales are cheaper, and the customer may be able to negotiate offsets. FMS eliminates many loose ends the buyer otherwise would have to follow up on his own. If direct sale is more *à la carte*, FMS is more *table d'hôte*.

country "buys into" the DoD supply system and then receives support much as if it were part of the U.S. military establishment. In the Air Force, defective components enter the same repair pipelines as U.S. components and are treated indistinguishably. The Army and Navy, however, segregate foreign components and return to the country the exact items submitted. Governing policy on CLSSA is expounded in DoD Directive 2000.8 (DoDD 2000.8). Details of Air Force CLSSA are found in AF Manual 67-1(b).

Owners of equipment also in the U.S. inventory, called standard items, can contract for logistics support through FMS whether the equipment was obtained through FMS or by direct sale. Most direct purchasers thus avail themselves at least of CLSSA.

PEACE vs. WAR

CLSSA has a catch-22, however, in that in buying into the U.S. military supply system, the customer willy-nilly, and maybe unwittingly, buys into the Uniform Materiel Movement and Issue Priority System or UMMIPS (DoDD 4410.6; AFR 27-1; AFM 67-1(a)). Under UMMIPS, the Joint Chiefs of Staff are responsible for setting basic movement and issue priorities and, not unnaturally, do this in such a way that U.S. combat forces always enjoy higher priorities than foreign countries.

The Catch

This difference in priorities may have little or no effect on service in peacetime when stocks are bountiful; but in wartime scarcity, there is every expectation that CLSSA simply would dry up. The supply channels directed toward allied countries may remain in place, but little or nothing is likely to flow through them.³ Indeed, to go even further in asserting that U.S. military interests will take precedence over those of DSAA in crisis, the Joint Chiefs of Staff have issued a memorandum (MJCS-115-86) specifically declaring their intent in wartime to consider reclaiming and reallocating any and all materiel in the direct commercial sales and FMS pipelines.

UMMIPS priorities pertain, furthermore, only to release of materiel. Shipment of goods to their destination is without military priority. Except for classified, hazardous, or

³The Falkland Islands war, in which the United States shipped munitions from its own unit stocks to the British, has been cited as a counterexample. In that case, however, the United States was not itself at war or experiencing scarcity. What the Falkland Islands crisis illustrates, if anything, is the dangerous propensity of allies to depend on U.S. bailout.

commercially unshippable items,⁴ which DoD delivers at least as far as CONUS ports of debarkation, FMS customers are on their own with respect to transportation (AFR 130-1; DISAM, 1988). Most, if not all, employ commercial freight forwarders, and DSAA recently published a pamphlet to aid them in selecting reliable firms (DSAA, 1988b). Nonetheless, in spite of the ingenuity often exercised by private transportation companies, their dependability in time of war is subject to conjecture.

It follows that what is possibly the single most potent source of logistics support for American-made arms possessed by friendly countries is for peacetime application only. When war comes and the United States really requires allied help, a principal mechanism for supporting allied weapon systems may be expected to vanish. Evidently, moreover, there is no planned wartime mechanism to replace it. Allies depending on FMS logistics support either must have the foresight and capital to provision in peacetime sufficiently for war, including development of alternative sources of supply, or they must rely on the hope that the U.S. military will find ad hoc means of bailing them out, such as a change of heart as to UMMIPS priorities on the part of the Joint Chiefs—who, incidentally, have Congress peering over their shoulders all the while.

In fact, everyone waffles. Allies make contingency plans and seek alternative sources, while tacitly expecting the United States to bail them out. Meanwhile, the U.S. military—the Air Force, at any rate—officially denies plans to rescue anybody, knowing full well that the United States always does so when the crunch comes. The net result is that no ally is adequately provisioned for war with respect to American-made weapons, and the U.S. military has no compensatory stockpiles in reserve.

In some wartime scenarios, weapon system attrition rates are so high that little follow-on logistics support is required; in others, nuclear escalation obviates the need for logistics. However, in equally probable scenarios, combat success depends crucially on sustainability; and among the first things likely to happen in war is that a major potential source of allied sustainability will be summarily cut off.

The Small War Case

The preceding discussion of FMS logistics cutoff refers primarily, of course, to big wars. Were Venezuela, say, to be attacked by Cuba and were the United States to go to the aid of the former, there might be enough materiel in U.S. supply pipelines for this

⁴Additional item-by-item exceptions may be made at the discretion of DSAA.

ally to continue receiving logistics support despite its UMMIPS priority and transportation disadvantages. Or, conceivably, the Joint Chiefs of Staff or higher authority might raise Venezuela's priority temporarily and supply it with DoD transportation.

But what then if the Soviets came to the aid of the Cubans, encouraging Nicaragua to join the hostilities, and so on. Could this sort of scenario escalate to the point of U.S. supply shortage, and if it did, would Venezuela's new priority continue to hold? If not, and if FMS logistics cutoff now occurred, would the United States find alternative means of bailing Venezuela out? Or is any such scenario simply too absurd to speculate about in the first place?⁵

Whatever the answers to these questions, the position of the FMS customer in regard to wartime support of his weapons through FMS logistics is precarious. Venezuela can anticipate losing out whether its own war gets too big or some other war the United States is involved in gets too big. Indeed, the consensus belief of working-level personnel at the Air Force's International Logistics Center is that the ILC will be shut down in wartime and its employees reassigned to other jobs. No such policy or plan exists; it is just that no one interrogated in this survey can visualize any alternative.⁶

RESEARCH IMPLICATIONS

The above analysis of logistics with regard to security assistance necessitates revisiting the question concerning what value criteria to invoke in assessing coalition logistics opportunities. If security assistance is not intended to promote the combat readiness and sustainability of allies, then harping on the imminence of wartime cutoff of FMS logistics support, as done here, is irrelevant. Assuming, however, that wartime effectiveness holds an important place in the spectrum of FMS value considerations, two

⁵As absurd, for example, as the notion that the United States might one day invade Panama?

⁶According to Air Force official histories (Richardson, 1979, 1980, 1981; Cauty, 1982; Wolf, 1983), ILC was far more wartime oriented a decade or so ago than it is today. At that time, apparently, considerable stress was placed on regarding security assistance partners as prospective wartime allies. Accordingly, the ILC participated extensively in AFLC command post exercises; and exercise scenarios included hypothetical coalitions with allies in Asia, Latin America, and elsewhere. Beginning about 1983, however, this flavor vanished from the histories altogether. An interesting research excursion might be to discover what brought about the metamorphosis. One hypothesis advanced to the writers by an "old timer" is that it had to do mainly with a change in AFLC commanders.

broad directions for research are suggested by the discussion, simulation of cutoff effects and reverse security assistance.

Simulation of Cutoff Effects

Although a shutdown of security assistance logistics is probable in wartime, the military and political effects of such an eventuality are by no means evident. Moreover, no one interviewed to date about FMS logistics has offered any firm conception of what these effects might turn out to be.

Obviously, the results to be expected depend heavily on the scenario. In one case, the country that was cut off would not be engaged in the war but would be obliged to stand down portions of its military forces all the same. In another, the country in question might be engaged in combat alongside U.S. forces, perhaps under combined command. In the first scenario, the repercussions would be mainly political, unless, that is, an unfriendly neighbor complicated the situation by attacking the FMS ally at the moment of its greatest weakness. In the second scenario, the consequences would be chiefly military, undoubtedly ameliorated to the extent possible by ad hoc lateral support.

In scenarios of both types, simulation modeling of representative wars seems an essential ingredient of analysis. Even for the ally not involved in combat, one would want an estimate of the effect of FMS logistics cutoff on force readiness and sustainability. For if the negative effect were to prove small or could be relieved by extraordinary self-help measures, the adverse political ramifications presumably would be negligible. In the other scenario, where the ally's military capacity is sharply reduced, whatever the exact political consequences might be it clearly would be desirable to avoid them if at all possible.

For purposes of order-of-magnitude problem identification, rudimentary pencil-and-paper modeling ought to suffice. How many allied weapons depend on FMS for support? What is the combat value of these weapons? What extraordinary methods of support might be feasible (such as buying back spare parts from countries not involved in the war)? What is the worst that could happen to allied warfighting capability if all the indicated weapons became inoperative? For greater precision where warranted by the results of these inquiries, computer models such as TSAR (Emerson and Wegner, 1985a) and Dyna-METRIC (Isaacson and Boren, 1988; Isaacson et al., 1988; Pyles, 1984) could be employed.

To take an example, more than 300 C-130 Hercules transport aircraft had been put in the hands of allies throughout the world by the end of 1987 through FMS and Military Assistance (DSAA, 1987).⁷ These aircraft presumably are vital to the combat operations of the countries owning them. If a substantial proportion were to be grounded because of FMS logistics cutoff, the consequences unquestionably would be detrimental. The issue for research would be "How detrimental?"

Through site visits and interviews, it should be possible to identify those C-130 components most dependent on CLSSA support and to estimate the effect on aircraft operability if this support were lost. By assuming plausible war scenarios, this estimate then could be translated into undelivered cargo, and the undelivered cargo into loss of combat capability. The resulting approximation would be crude, but should give a sufficient suggestion of problem magnitude to decide whether more refined simulation seems worthwhile.

Were analyses along these lines across several weapon systems to reveal that CLSSA cutoff leads to substantial impairment of the allied war effort, the next question would be how U.S. forces might fare if UMMIPS priorities were reset and transportation furnished, putting allies in a given theater on the same footing as U.S. units there, so that CLSSA support to allies could continue. The outcome of this investigation could lead, in turn, to changes in the current priority policy that puts all combat coded U.S. forces ahead of all foreign countries.

Reverse Security Assistance

Historically, the United States dominated the Western world in military technology and arms export for so long that many in the security assistance bureaucracy firmly believe that things must necessarily remain that way. But things do not always stay the same, and they have not been the same for quite some time. The United States may be the free world's technological leader still, or even the whole world's leader, but there is plenty of competition and it is gaining fast (Senate, 1979; Stevenson, 1988; *Daily Breeze*, 1989).

The chauvinistic definition of security assistance given at the start of this section—a one-way flow from the U.S. outward—no longer is valid. If press reports of

⁷Under Military Assistance, the United States gives another government money with which to finance purchases through FMS. From the standpoint of logistics, therefore, this form of security assistance is the same as FMS.

the issues at dispute can be trusted, there is no better illustration of the changing state of affairs than the recent negotiations (actually, renegotiations) between the United States and Japan concerning technology transfers pertinent to the FSX aircraft undergoing codevelopment by the two countries. The Japanese contended that their technological contributions to the effort are as valuable as those of the United States and, further, that they were prepared to go it alone in the event agreement could not be reached (Sanger, 1989).

The next upgrade intended for the American E-3 AWACS is slated to include a radar computer having a bubble memory proprietary to Japan and to be repaired only by that country. U.S. plans for peacetime support of this device have been thought through and appear reasonably sound. Let us hope now that the Japanese do not reciprocate in the matter of priorities to accord the E-3 radar computer the same logistics treatment in wartime that they can look forward to in connection with their own American-made, FMS-supported equipment.

In short, the time has arrived, or at least is arriving quickly, for a fresh look at security assistance logistics as a wartime coalition enterprise rather than as a peacetime "we build, you buy" proposition exclusively. In the future, foreign military purchasing may demand equal time with foreign military sales. What options are available for assuring wartime logistics support of equipment from other countries? What reciprocities to assure such support are acceptable and cost-effective? These are only two of many issues deserving better resolution.

Research on reverse security assistance can be pursued to some degree in connection with specific extant examples such as the E-3 radar computer. However, since military dependence on foreign equipment is only now emerging as a problem, it is uncertain whether a broad enough range of cases can be identified from Air Force experience to construct meaningful scenarios for investigation. Here, as in everything logistic, the leveling influence of scale must be considered. For an E-3 radar computer alone, the best hedge against wartime supply cutoff may be peacetime stockpiling; but with increasing numbers of foreign-made items, that solution could rapidly grow too costly.

A second vehicle for study of what might be most appropriately labeled "mutual" security assistance logistics is afforded by weapon system codevelopment, a subject to be examined below. In codevelopment, the partners have the opportunity—to date, seldom

grasped—to plan for coalition logistics support while the prime equipment is being designed.

In retrospect, the nature of the research called for in the context of reverse security assistance has been left rather vague; yet in the present state of knowledge, it is difficult to see how to make the treatment more concrete. Therefore, the first action needed is an effort to articulate the problem clearly.

III. NATO MAINTENANCE AND SUPPLY AGENCY

BACKGROUND

Mission

Chartered in April 1958, the NATO Maintenance and Supply Organization is composed of a board of directors and associated executive committees plus an operating arm, NAMSA.¹ NAMSA is headquartered at Capellen, Luxembourg, and employs approximately 1,150 people. Overview descriptions can be obtained from Cauchie (1989), Goller (n.d.), Kitfield (1988), NAMSA (1988), Smith (1986), and Spaulding (1979-1980). Accounts of the agency's early history will be found in Carver and Walsworth (1976) and Mendershausen (1960, 1961).

Although NAMSA operates in several logistical domains, including test equipment calibration and materiel warehousing, its dominant activity over the years has been procurement of weapon system spare parts. If several countries need the same spares, NAMSA ordinarily can get better prices by consolidating their orders. Also, NAMSA may have better worldwide access to vendors than individual nations, and so can stimulate broader based competition. On the demand side, in addition, NAMSA strives to spread its purchasing as equitably as possible among the parties to a procurement agreement.

NAMSA was created at the instigation of the United States, which wanted a central point of contact in Europe for coordinating logistics support deriving from U.S. foreign military sales. The idea was for NAMSA to serve as a kind of international clearinghouse for American security assistance logistics. However, for reasons obscured in antiquity, this role never fully, or even substantially, materialized. Explanations offered nowadays by informants include: NAMSA is meant for multinational collaboration, and hence it is reluctant to participate in the purely bilateral arrangements that characterize FMS; and to act as an FMS middleman, NAMSA in effect would have to duplicate the vast U.S. infrastructure already dedicated to FMS logistics, which would be both cost-prohibitive and unwise.

¹NAMSO was known originally as NMSSS, the NATO Maintenance and Supply Services System, and NAMSA as NMSSA (the NMSS Agency).

Unfulfilled Potential

Whether these are historically valid reasons or rationalizations after the fact is uncertain. In either event, it appears that NAMSA was born in a cloud of confusion as to function that has not greatly dispelled in the succeeding 30 years. For instance, Ashcroft (1969) asked: "If great benefits are potentially available through the use of NAMSA, why are they not sought out more eagerly, and why is the work of NAMSA not greatly enlarged?" And again, in 1985, a management audit (NAMSO, 1985a) concluded with this question: "Why . . . has the use of NAMSA seemed to stagnate at the same levels of responsibility in terms of weapons supported, inventories managed, and even physical size of staff and facilities as in the early 1970's?"

At a level of effort of 1,150 people, NAMSA plainly cannot be a leading player in NATO logistics overall, and what proportion of total common-weapon spare parts procurement it handles, if known, is not readily available. Indeed, since its customers tend to employ NAMSA disproportionately in relation to the more expensive, high technology items, it is difficult to think even what the correct denominator would be for calculating this fraction. Certainly, though, the agency has the potential to do a large enough share of spares procurement to make an important difference, and both NATO and NAMSA seem on a perpetual quest to fulfill that potential. Why NAMSA's promise goes forever unrealized is a persistent enigma. As Kitfield (1988) notes: "Many Alliance observers say NAMSA is a good idea whose time has come—and gone—and come again." And even the aforementioned management audit (NAMSO, 1985a) departed the scene in perplexity: "Is NAMSA a 'relic' from a by-gone era without a future role; or does NAMSA represent an embryonic 'rudiment' awaiting nourishment and encouragement to blossom?" If an embryo, then judging from the gestation period, one speculates that NAMSA must be a form of century plant.

THE UNITED STATES AND NAMSA

History

It was understood from the beginning that the United States would support its own weaponry without recourse to NAMSA (Carver and Walsworth, 1976; Mendershausen, 1960). When NAMSA's services shortly were extended to the F-104 aircraft and the Nike, Honest John, and Sidewinder missiles (Ashcroft, 1969), the United States participated only indirectly as a principal supplier of spare components for consumption

by other countries and as a grantor of Military Assistance funds in support of less developed NATO nations.

During the 1960 and 1970 decades, the U.S./NAMSA relationship remained remote. Then, in 1980, came the NATO Mutual Support Act (NMSA, 1980), which authorized acquisition of a limited amount of logistic support from NATO allies for U.S. forces in Europe. The passage of this act marked the beginning of heightened interest on the U.S. side in coalition military arrangements generally and U.S. use of NAMSA in particular. Probably the main contribution of the act was to eliminate U.S. legalistic objections to logistics cooperation deriving from previous foreign aid regulations such as the "buy American" law (Cook, 1980-1981).

That it is safe to take 1980 as baseline zero for U.S. involvement in NAMSA is seen from this 1987 comment attributed to J. Compton, Director of International Logistics, Office of the Secretary of Defense, Production and Logistics. "When we first started looking at what the United States was doing in NAMSA three to four years ago, we found that it was doing next to nothing." (Kitfield, 1987.) Nowadays the United States is doing more, but mainly on the Army side in connection with such weapons as the Patriot ground-to-air missile system and the multiple launch rocket system (MLRS). As far as the Air Force is concerned, Compton's evaluation continues to apply.

USAF Avoidance

Both NAMSA and the Air Force make capital of 1985 and 1987 agreements for NAMSA to store USAFE war reserve materiel prepositioned in Europe in anticipation of wartime deployment, which materiel, according to Smith (1986), "consists of aircraft support equipment, vehicles, personnel support assets, and aircraft consumables." However, as the Air Force does not preposition prime equipment such as airplanes and reparable spare parts, but rather transports these items to their combat locations when the time comes, the materiel stored by NAMSA constitutes only a drop in the bucket compared with the total reserves required for war. This is not to deny that each drop helps, but rather to indicate that USAF use of NAMSA remains, comparatively speaking, negligible.

There is evidence that USAF avoidance of NAMSA is not due merely to lack of familiarity. At the time NAMSO was created, according to Mendershausen (1960), at Chateauroux, France, there was an American supply depot designated by the abbreviation AMFEA and employing some 6,000 people. AMFEA was managed by

USAF and, apparently, handled European and Turkish security assistance logistics for all services. DoD was about to close this depot and move its functions to CONUS. Rather than let that happen, NAMSA took over the depot² as its initial operating activity and engaged USAF to continue managing it until 1961. NAMSA started out in life, therefore, as a U.S. Air Force affiliate.

Precisely what happened when management of NASCC reverted to NAMSA in 1961 would need deeper investigation. Carver and Walsworth (1976) only assert that performance deteriorated so drastically as to require a new beginning in 1964. One must presume that neither DoD nor USAF found its experience with NAMSA pleasing during this interval.

In 1974, AFLC (Klang, 1974) reviewed 11 maintenance work loads with a view to transferring them to NAMSA. Only two were recommended for transfer, whereas five were rejected and the rest tabled. In the cover memorandum it is stated that AFLC agreed to use NAMSA in 1971 to support the Bullpup missile, but with disappointing results. For one particular, "NAMSA used almost two years of the five year life of the agreement to determine the stock level of spare parts to be stored at NAMSA."

This is not to assert that the Air Force's enduring view of NAMSA is justified. However, USAF's reluctance to employ the agency stems from more than historical accident. Further, it seems unlikely that the Air Force's opinion of NAMSA would have failed to rub off a bit on its sister services over the years. At any rate, in spite of increased U.S. attention to NAMSA in recent times, NAMSA has not found itself overtaxed with work, and no growth is planned currently. This demonstrates that any latter-day increase in U.S. participation has been modest at best.

AILMENT DIAGNOSIS

Need for Surgery

All outside observers so far encountered agree there is something wrong with NAMSA, but there is little concurrence as to the nature and cause of the ailment. Most diagnosticians seem to believe that what is needed is some kind of therapeutic adjustment such as increased operating efficiency, more aggressive marketing of wares, or a less political general manager. In 1985, for example, a management audit reported 100

²Thereafter called NASCC, the NATO Supply Center, Chateauroux.

recommendations of this variety, including a proposed cosmetic change of name to NALSA, the NATO Logistics Support Agency (NAMSO, 1985b), apparently to express the idea that NAMSA is more than just a spare parts shop.

Even after observing 30 years of listlessness on the part of the patient, no one seems willing to consider radical surgery. Possibly the most extreme proposal for change has been to expand NAMSA into a European defense supply agency on the pattern of DoD's Defense Logistics Agency (Ashcroft, 1969). However, this would constitute more an extension of what NAMSA already does than a basic revamping of approach.

Major Problems

It is hypothesized that only a much deeper cut of the knife is likely to excise NAMSA's three fundamental maladies. First is the NATO doctrine that logistics is a national responsibility, a tenet with which NAMSA, as a loyal subsidiary of NATO, scrupulously complies. In the words of a former general manager, NAMSA never attempts "to encroach upon national responsibilities. We only get involved when nations see a clear advantage in using NAMSA." (Cauchie, 1989.) In view of this timidity, which is partially self-imposed, it is small wonder that NAMSA stays relegated to a minor role in the overall scheme of things.

NAMSA's second fundamental problem is that, like FMS, it is a resource geared to peacetime that appears in danger of drying up in time of major war. The basis for this conjecture is not that NAMSA as an organization is unprepared for war but that its pipelines of supply seem likely to dwindle away.³ Although the United States consumes little from NAMSA, the equipment NAMSA supports—such as NATO's fleet of E-3 AWACS aircraft—is largely American-made, so the U.S. military-industrial complex remains NAMSA's predominant supplier. Brokerage of FMS logistics alone is said to account for 40 to 50 percent of NAMSA's current intake. In war, this pipeline can be expected to shut down owing to the UMMIPS priority allocation and uncertain FMS transportation treated above.

One of NAMSA's functions is to develop alternative sources of supply. What justification is there for supposing, however, that other nations furnishing stock to NAMSA will not divert those items to their own use in wartime just as will the United

³And its work force. Many employees who are military reservists of their native countries stand to be called to active duty.

States? Further, where the technology in question is proprietary and has not been licensed elsewhere, no alternative source is possible. Therefore, whatever NAMSA may contribute to the combat readiness of NATO forces in peace, its promise in its present configuration and orientation for contributing to sustainability in war is questionable.

The third problem is that NAMSA is located organizationally in the wrong part of NATO. To oversimplify, NATO is bifurcated into a civilian side that deals with politics and economics and a military side that addresses combat management. In continental Europe, NATO's military branch is SHAPE, and NAMSA, which resides in the civilian part of NATO, is largely disconnected from SHAPE, and therefore from SHAPE's war planning process, in peacetime and during the onset of crisis. Only after NATO is heavily committed to war is there provision for SACEUR, the head of SHAPE, to place requirements, called operational directives, on NAMSA (NAMSA, n.d.a); and by that time, as just argued, NAMSA conceivably may be in the process of going out of business. As a result, its wartime viability is dubious. Chiefly what it has to offer customers is the prospect of peacetime cost savings rather than enhanced combat sustainability.

RESEARCH IMPLICATIONS

The extent to which the cited deficiencies of NAMSA are problems worth attacking depends on one's choice of value criteria. This study assumed that warfighting capacity is a critical desideratum for the agency. But even granting the salience of this view, no one can supply ready remedies for NAMSA's problems. For one thing, the ailments may be incurable, but the search for solutions affords a variety of opportunities for research.

Organizational Location

From the standpoint of formal arrangements, the military side of NATO has been aptly depicted as a logistic nightmare. Some of the reasons for this characterization were seen in the discussion of SHAPE's LCC/LRC in Sec. I.

Nevertheless, the military establishments of the several NATO countries are, in general, on excellent terms with one another and may be expected to cooperate willingly in wartime. Efforts at cooperation in logistics will be severely hampered, however, by virtual absence of facilitating arrangements such as common data and communications

systems and preplanned multinational logistics command and control procedures. Methods of cooperating will have to be contrived in the heat of battle on an ad hoc basis. Also, such cooperation as occurs will have to be authorized by committee, so to speak, as, apart from the LCC/LRC, nobody will be in overall charge. Under logistics as a national responsibility, the logistics components of national military forces do not CHOP to NATO centralized control.

Thus, whatever the value of the functions performed by NAMSA in peacetime, there is a void in wartime logistics coordination in NATO so acute it threatens to cost the West the war. This suggests research to see if NAMSA should be repositioned in the NATO organizational structure—under SHAPE—and assigned a dramatically altered role. Uppermost in priority in the new assignment would be to prepare NATO logistically for conventional war; relegated to a subordinate place would be the present mission of saving money in peacetime through mass purchasing. Chances are, even so, that owing to wider demands for its services, NAMSA would save the NATO countries more money than it does now.

Komer and colleagues advised in 1976 that the major NATO commanders (e.g., SACEUR) be called upon to recommend the kind of wartime logistics organizations they need. Research on the question of relocating NAMSA should follow up to see if this consultation was carried out and, if so, what the major commanders', notably SACEUR's, proposals consisted of. Then the same inquiry might be repeated in light of current progress in arms control. Although NATO's thinking continues to be governed by visions of a war concluded quickly by nuclear escalation, that view was even more pervasive in the 1970s.

In a recent issue of *NATO Review*, the incumbent SACEUR (Galvin, 1989) remarks that "a number of initiatives are underway to improve the overall management of those services that support NATO's forces in war." Obviously, one of the first orders of research business should be to find out what these initiatives are and where, if at all, NAMSA fits into them.

Wartime Shutdown

NAMSA's plan for war is to go on doing what it does in peace. Above, however, a wartime shutdown is predicted. Somewhere between lies the truth.

As it cannot be known what will happen in war, the next best thing, to invoke appropriate hedging behavior, is to ascertain what difference it would make how

NAMSA fares insofar as the combat performance of the Alliance is concerned. This, clearly, is a matter for simulation of combat capability under alternative war scenarios, with issues for exploration not unlike those treated previously in connection with FMS shutdown. In the event NAMSA were partially or totally incapacitated, what would happen to the combat availability of the weapon systems NAMSA supports? What emergency supply processes could be substituted, and how well might these work? How would the lost availability of weapons affect combat performance? And so on.

To the degree that NAMSA serves as an intermediary in FMS logistics, analysis of the effects of NAMSA shutdown would be embedded in investigation of the effects of FMS logistics cutoff. Logically, and for efficiency, therefore, these two research pursuits should be tightly linked.

Questions pertaining to the effects of NAMSA support on weapon availability would call for one-sided simulation of logistics processes using capability assessment models such as Dyna-METRIC, TSAR, and AURA (Shishko and Kamins, 1984). Questions concerning battle outcomes as a function of weapon availability would require two-sided war gaming through simulators such as the RAND Strategy Assessment System—RSAS (P. Davis, 1985; P. Davis and Winnefeld, 1983; Schwabe, 1988).

National Logistics

Evidently, in the early days of NATO it was the United States that promoted the notion of logistics as a national responsibility in order to get other countries to absorb a greater proportion of the military support burden. Consequently, now that the United States wishes to encourage internationalization of logistics—again so as to increase burden sharing—it finds itself hoist on its own petard.

All the same, for NAMSA to get anywhere, the dragon of national logistics somehow or other must be slain; and little NAMSA (rather, NAMSO) hardly can be expected to play St. George. The issue must be resolved at the highest levels of NATO; and if it is true that the United States caused the problem in the first place, then the United States must assume leadership in altering course today.

There is an undeniable possibility that the concept of logistics as a national responsibility may evolve away of its own accord in response to changing times. That is what Komer et al. (1973a) thought might be the handwriting on the wall even then: "The sacrosanct NATO principle that logistics is a national responsibility may have to go." The question arises, however, of how long one is willing to wait. Whatever mutation in

logistics policy may have occurred in the 17 years since the foregoing appeared, it has had no perceptible effect on NAMSA. On the record, therefore, any kind of positive action is more promising than continued patience. Perhaps an appropriate research program can identify the necessary actions.

Since responsibility for logistics within a military alliance permeates all phases and aspects of coalition logistics throughout the world, there is some anomaly in introducing the issue here under the heading of NAMSA. Let it be understood, therefore, that NAMSA has supplied only the initial occasion for raising a general theme that will be revisited repeatedly.

IV. FORWARD DEPOT-LEVEL SUPPORT

ALLIED DEPOT SUPPORT

The U.S. Air Force is supported by large, government-operated supply and maintenance depots called air logistics centers (ALCs). Besides serving as administrative interfaces between the USAF and commercial firms, these depots carry out extensive supply and repair activities in their own right. ALCs operate warehouses that receive, store, and ship materiel and also shops that refurbish airplanes, components, and support equipment.

In comparison, other countries tend to lack government depots capable of performing maintenance, warehousing, and shipping. Allies who are FMS customers may buy into the U.S. depot system through CLSSA; but where their arms are not American-made, they rely more than does the United States on direct support from industry. Furthermore, even CLSSA customers are constantly on the lookout for alternatives, such as offsets, that would return more of the economic benefit to their own industry and enhance their military self-sufficiency.

Though real, the cited difference in depot-level practice is less than absolute. The air forces of allied countries do have some supply and repair depots of their own. The Dutch, for instance, are said to possess overhaul capability for the Pratt and Whitney F-100 engines that power their F-16 aircraft. In addition, most of the so-called commercial firms that perform military supply and maintenance for foreign countries are wholly or partially government owned or heavily subsidized. From a practical standpoint, the distinction between a government factory and a military depot, especially in wartime, is not all that easy to discern.

All the same, there can be little question that allied air forces obtain larger fractions of their supply and maintenance support directly from private industry than USAF does. The apparent effect has been to foster internationalization and growth of the commercial depot maintenance business. The historical changes contributing to this trend are too numerous and complex to review here. They include, however, the international leveling of technological expertise over the last 40 years and the consequent shift away from American arms, the movement toward codevelopment and coproduction arising from the catapulting costs of weaponry, and the eternal nationalistic drive for military self-sufficiency.

THE AMERICAN CONNECTION

The past decade or so has seen a mushrooming of overseas industrial facilities, particularly in the USAFE and PACAF theaters, capable not only of meeting the support needs of allies but also of carrying out a wide range of depot-level supply and maintenance functions for American aircraft. In many cases, the organizations in question possess this capability because they either manufacture components for USAF aircraft or are subsidiaries or affiliates of firms that do. By and large, these facilities are available to USAF for the asking; some use is made of them at present; and recent USAFE plans (Metzler, 1989; USAFE, 1988) indicate intent to expand this utilization in Europe as time goes on.

Potential Advantages

Although intentions can change and are changing as this is written, a prime scenario in Air Force thinking has it that resupply from CONUS ALCs will be cut off for approximately the first 30 days of a war. The expectation is that air transportation will be unavailable for resupply purposes during that period owing to the higher priority of troop transport. Assuming overseas supply and repair establishments can do the required job, therefore, a potential advantage they afford is geographical proximity to the expected scene of combat. To employ their services, comparatively short-haul transportation, often even ground transportation, would suffice.

Possible derivative benefits of forward depots would be reductions in deployment airlift requirements and peacetime stockpiles of spare parts and repair equipment. To compensate for the predicted 30-day cutoff from CONUS resupply, aircraft units deploying to war carry with them enough spare parts and repair capacity to last until the ALCs come back into play. It takes several C-141 StarLifters to haul the spare parts and related support materiel for just one squadron of fighter airplanes. If overseas repair capacity could be counted on to substitute for some of these materiel shipments, some of this airlift could be diverted to troop transport and other vital applications. Further, money would be saved in peacetime because CONUS units with deployment missions could manage with smaller unit stockpiles of war reserve spares and repair equipment; portions of these stockpiles could be replaced by the expectation of receiving timely depot repair on arrival in theater.

The prospective merits of forward located, depot-level supply and maintenance facilities are attractive enough that AFLC set up such an organization of its own in 1983

called AFLC Support Group Europe (SGE) at RAF Kemble in the UK (SGE, 1987a,b). The underlying idea apparently was for SGE to serve USAFE more or less as NAMSA serves U.S. allies. As of 1987, SGE employed 240 direct labor personnel, which by this measure would make it approximately one-quarter the size of NAMSA.

A Case Example

Among the overseas commercial repair depots we visited during the survey was the Pratt and Whitney Overhaul and Repair Center-Europe (PWORC-E, pronounced por-see) at Maastricht Airport in Holland (Pratt & Whitney, 1989; Weisman, 1988). PWORC-E is 85 percent owned by the American firm of United Technologies Pratt and Whitney, 15 percent by Dutch interests. It was established in 1982 to satisfy an offset commitment on the part of United Technologies to the northern NATO countries, known as the European Participating Governments (EPG), that fly the F-16 A/B, which uses the F-100 engine.

Finding the EPG F-100 engine business insufficient to maintain financial stability, PWORC-E shortly expanded into other product lines and markets, including the USAFE market, which the Managing Director claims essential to maintaining a healthy business base. He asserts that without work from USAFE—and this, of course, bears examination from a more disinterested perspective—not only PWORC-E but many other European in-theater commercial depots would be unable to survive.

A virtue of the American market from PWORC-E's viewpoint is that whereas most F-16C/Ds flown by USAFE have General Electric engines, the F-15 Eagle also operated by USAFE is powered by F-100 engines, and two per machine at that. One of the components of this engine requiring repetitive depot repair is the universal fuel control. To date, PWORC-E has refurbished on the order of 750 of these devices for USAFE and has an unusually large current backlog of 180, which at a normal level of effort amounts to six months' work.

PWORC-E's license from the Dutch government declares it to be a critical resource, which must remain open for business in the event of war. According to PWORC-E sources, however, USAFE and AFLC have placed no requirements on the depot concerning efforts wanted in wartime. Currently, USAFE/AFLC are negotiating wartime surge arrangements with other overseas depots, including their own SGE (Metzler, 1989). Perhaps PWORC-E is on the list for later.

As a sidelight to the PWORC-E visit, we learned that Pratt and Whitney maintains a "parts bank" at Amsterdam, stocking a range of Pratt and Whitney items for sale to all legitimate buyers. Thus, anyone with an urgent need and willing to pay a premium price for, say, an F-100 engine component can back a truck up to the loading dock and drive away with one on short notice. Apparently, parts banks of this nature selling the wares of arms producers are not uncommon in Europe. If so, these facilities offer an additional logistics resource that might have value in war. However, we do not know the extent to which USAF deals with, has wartime plans for, or monitors the inventories of such firms.

NAMSA and SGE

As indicated earlier, NAMS is primarily an administrative and contracting agency rather than a supply and maintenance production organization. Granted that NATO is not a country, the example of how NAMS provides logistics support to NATO's AWACS fleet is informative. The AWACS airframe is a Boeing product, and some of the aircraft's high technology components remain U.S. government proprietary. The rest of the on-board equipment is manufactured by various companies throughout Europe and Canada.

The U.S.-proprietary equipment is necessarily supported through FMS logistics, for which purpose NAMS acts administratively as the customer. To discharge the remainder of its depot responsibility for AWACS, NAMS negotiates and oversees commercial contracts with roughly 15 primary suppliers (NAMS, n.d.b). The agency does not, however, do day-to-day management of depot support. This duty is contracted to a depot-level maintenance manager—currently Domier of Munich, also a major producer of AWACS electronic components. Under Domier's oversight, for repair engines go to Greece, landing gears to Holland, avionics equipment to Italy, and so forth.

NAMS itself furnishes some transportation, does some receiving and shipping, and stocks some critical, high cost, long-lead-time AWACS components. In the main, though, it is a coordinating middleman; and even there, it engages Domier as a middleman's middleman to do the active work of supply and repair administration.

Judging from its 1987 annual report, SGE appears to think of itself, in opposite fashion, as a production shop first and a contracting agency second (SGE, 1987b). Still, in 1987 it issued new contracts in the amount of \$21.6 million, for a total value outstanding of \$79.6 million. PWORC-E's work for USAFE, for example, is governed by contracts negotiated by SGE. SGE is at once, therefore, a forward located depot-level

supply and maintenance resource for USAFE as well as a point of coordination and financing for other depot-level resources throughout the NATO theater.

Risks and Obstacles

Several USAF informants registered concern about wartime use of overseas depots because of their vulnerability to enemy interdiction. If warehouses and shops are close enough to the front to be accommodated by short-haul transportation, they are close enough to be bombed or sabotaged.

Certainly this concern is legitimate. CONUS depots are indubitably more secure. However, allies close to the likely scene of conflict do not enjoy the benefit of secure depots in any circumstances.¹ Rather, they must rely on the very ones that USAF authorities express reluctance to use for fear they will be destroyed. Either the allies depending on these depots have a different estimate of the risk, or they have realistic contingency plans, or they are foolhardy. The truth, possibly, is "some of each."

Another deterrent to using overseas depots is that, like all forms of coalition logistics, it costs American jobs. This unquestionably has been a long-standing factor in the limited U.S. use of NAMSA today. It is an issue even for the American SGE, which is staffed primarily by British nationals.

Also mentioned previously as a ubiquitous consideration is the risk of undependability on the part of allies. PWORC-E, for example, is a chiefly American-owned firm, but almost entirely European staffed. What if those employees should take a view of the war differing from that of the United States? Suppose they should feel that their country has been "railroaded" into a war not worth fighting?

Still another problem is that wartime special arrangements have to be paid for whether they are used or not. If, for instance, USAFE/AFLC should want an overseas depot to surge beyond adding work shifts and increasing overtime, it might be necessary to equip the organization with extra test equipment and other materiel to be mothballed in peacetime. Such mothballed materiel has an opportunity cost that must be entered into the equation.

¹Even if allies were to buy American-made equipment exclusively and procure all depot support from the United States through FMS logistics, they probably would find themselves cut off in time of major war, because of UMMIPS priorities and FMS transportation shortfalls. And even if JCS relented on priorities and supplied U.S. military transportation, there still would be a cutoff for 30 days or so because of competing transportation needs.

A final difficulty is that nobody knows how wartime depot-level maintenance requirements will compare with those of peacetime. Although some kinds of equipment may be found to thrive on combat use, increased sortie rates surely will produce greater overall maintenance needs per individual weapon. But at the same time, battle attrition will reduce the number of weapons to be fixed, and damaged weapons will furnish more opportunities for equipment cannibalization at the flight line and intermediate maintenance levels. It is hard to plan a wartime depot-level supply and maintenance operation confronted with such uncertainties.

RESEARCH IMPLICATIONS

Wartime Capabilities

To date, such use as USAF has made of in-theater depot-level supply and maintenance facilities has tended to be peacetime directed and opportunistic. If capable facilities happen to exist and their bids are competitive, contracts for work may be issued. Until quite recently, however, these overseas facilities, at any rate the ones in the NATO theater, have played little or no part in USAF war plans. On the contrary, to the extent wartime surge contracts have been entered into, they typically have had the purpose of clearing up peacetime backlogs rapidly, not of enhancing wartime resupply capacity over the long run. The conventional view over the past two decades has been that wartime resupply after the first 30 days or so of combat is expected to come from CONUS depots.

Some limited change in this policy now is being seen. A few contracts have been negotiated with in-theater depots to repair exchangeable aircraft components in wartime, and consideration is being given to further arrangements covering battle damage repair of aircraft (Metzler, 1989). In addition, one may anticipate greater opportunistic exploitation of in-theater depot support in war than in peace; for then, military expediency will override many of today's constraints. The question is whether wartime arrangements should be left to opportunity or should be planned for ahead of time and, where indicated, paid for in advance.

The answer to this question hinges in large measure on how much added military advantage might be reaped from the latter approach, which suggests a need for combat simulation studies using capability assessment models such as Dyna-METRIC and

TSAR. Given that USAF plans to fight for 30 days without depot support, what improvement in combat performance might be achieved with participation by existing in-theater depot facilities? If the potential gain is impressive, what alternatives can be considered—such as intervention by CONUS depots earlier than 30 days—and how do the alternatives compare? What costs and risks would be entailed by wartime reliance on in-theater depots, and would the benefits outweigh the drawbacks?

The notion of sustaining combat without forward depots is inconsistent with experience in World War II as well as the Korean and Vietnam conflicts. One can argue with reason, of course, that future wars will be unlike those of the past. Still, in light of history's tendency to repeat itself, research along the lines posited seems all the more pertinent.

Wartime Survivability

Inasmuch as one of the disadvantages of overseas depots is vulnerability to attack, another matter for research involving combat simulation is facility survivability. This avenue of investigation is especially apt in that the survivability of rear-area facilities has been a major theme of inquiry by RAND for many years.² Most if not all the depots in question are at airports; therefore, RAND's TSARINA model for assessing damage due to airbase attack (Emerson and Wegner, 1985b) would lend itself to this application with little if any modification.

Should vulnerability analysis indicate a high probability of severe and lasting damage to existing depots, collateral questions would arise as to the cost and benefits of hardening, dispersing or otherwise securing these facilities from attack. And if security procedures were to appear promising, after that would come the question of who should pay. In Europe, NATO pays to harden warehouses and repair shops on military airbases under the infrastructure program. Should alliances also pay a share of the cost of hardening privately held depot facilities?

Support Group Europe

Although considerably younger than NAMSA and a differently oriented type of organization, SGE already seems to have fallen into much the same frustration and

²Most of this work is subject to security restrictions. Unclassified examples may be seen in Dews (1980 a,b).

impotency as the more venerable institution. In USAFE's own words (Metzler, 1989): "Since it opened in 1983, AFLC-Support Group Europe (SGE) has not realized its full potential in support of USAFE peacetime and wartime capability."

Some hypotheses as to the reasons for this stagnation are apparent. For one thing, even though SGE is an agency of AFLC, it takes bread from the tables of CONUS AFLC and industrial workers every time it engages in business. For a second, SGE (also NAMSA) is without venture capital to cover the start-up costs of new lines of activity. And for a third, though geographically safer from potential foes than depots on the Continent, it still would lie within range of attack if high enough priority were placed on it as a target.

A less obvious hypothesis, perhaps, is that like NAMSA, SGE is not located organizationally where it belongs. How can a forward-located depot be responsive to needs in its theater unless it is intimately linked to all other logistics functions there? Just as NAMSA needs to be moved from its present peacetime-oriented, civilian environment into SHAPE, so, perhaps, should SGE be transferred from AFLC and USAFE.

In view of the seeming parallels between SGE and NAMSA, initial examination of the two agencies should be made together. If the parallels noted here are found to hold, what is learned about one organization would lend insight into the other. On the principle of "physician, heal thyself," SGE might be the logical place for Air Force sponsored research of this sort to start. It also might be easier to negotiate administrative arrangements for research pertaining to a USAF institution than to one that is part of NATO and little patronized by USAF.³

³The reference here is to breaching red tape, not to securing cooperation. One would expect to find NAMSA, as always, most cooperative.

V. MUTUAL SUPPORT

BACKGROUND

The concept of mutual support is as broad as the whole domain of logistics, and hence can encompass just about anything one might choose. It can pertain, for instance, to cooperation within or between the military services of one country as well as to cooperation between or among nations. In the USAF Log CONOPS (USAF, 1987) and Logistics Strategic Plan (USAF, 1989), "mutual support" is used exclusively to refer to resource sharing among United States Air Force elements. Sharing between USAF and a fellow service or an ally is known as "joint/allied support." As seen below, however, Congress has adopted the term *mutual support*, in the NATO Mutual Support Act of 1979 (NMSA, 1980), to mean essentially what the USAF logistics community denotes *allied support*. In consequence, semantic confusion is easy to come by in dealing with the subject at hand.

In this section, what chiefly will be treated under the caption of mutual support is logistics cooperation between U.S. and allied combat airbases in potential theaters of conflict, which, in USAF logistics language, is allied support. In the interest of clarity, therefore, this will be called "allied," or "coalition," mutual support. When mutual support strictly within USAF is intended, it will be designated "internal," or "USAF," mutual support. "Joint" mutual support among sister services of the same country is not addressed in the present document.

Mutual support falls under the general heading of operational logistics, defined by DoD (1988) as the "ability to mobilize and sustain personnel and equipment in wartime operations."

Following this definition, it will be taken for granted that the first purpose of mutual support is to enhance fighting capability in war. This is not to shun any economic and political benefits that may accompany or be designed into mutual support arrangements. Indeed, unless the economics and politics of the situation weigh favorably, the chances of implementing mutual support proposals, whatever their combat value, are gravely diminished.

For some time, RAND logistics research has emphasized advantages of mutual support among USAF combat elements compared with the traditional self-sufficiency

doctrine. Because of the advantages of scale, two squadrons with the means to share materiel and logistics personnel are aggregately more sustainable in war than two squadrons fighting separately. In consequence, although self-sufficiency may be imposed in wartime by force of circumstances, it should be regarded as a contingent mode of operation rather than a preferred one.

This previous research has led to, among other things, the European Distribution System (EDS), a fleet of small aircraft dedicated to shuttling engines, spare parts, and other critical materiel among USAFE airbases (GAO, 1986; Seaquist, 1988).¹ It also has influenced recent attention to internal mutual support in the USAF, USAFE, and PACAF Log CONOPS (Logistics Concepts of Operations) mentioned before (Bracken, 1987; Browning, 1989; Seaquist, 1988; Trainor, 1988; USAF, 1989; USAFE, 1988).

The notion underlying the current section is to extend to the coalition arena the fruits of earlier investigations bearing on USAF. If, for example, a USAFE EDS is a good idea for internal mutual support of American forces in wartime, why not consider converting it into a NATO EDS that spreads comparable advantages through the whole Alliance?² Or, if it yields efficiencies of scale to share repair resources among American F-16 bases in wartime, why not carry things a step further by sharing repair with allies who also own and operate F-16s?

COLOCATED OPERATING BASES

Joint Support Agreements

Lewis, Don, Paulson, and Ware (1986) point out that in a 1985 major NATO war, something like two-thirds of U.S. fighter and reconnaissance aircraft would have found themselves operating from colocated operating bases (COBs), which typically are peacetime/wartime main operating bases (MOBs) of other countries. Although we have not updated the Lewis et al. figures in detail, there is reason to believe the fraction of COB-based aircraft would be higher than two-thirds today, and higher still in the future.

¹There is also an on-again, off-again Pacific Distribution System whose immediate status we do not know. A factor unfavorable to USAF mutual support in the Pacific theater is the much larger distances among airbases there.

²The idea of expanding the role of EDS to serve allies has been suggested before by both RAND (Rich, Stanley, and Anderson, 1984), which even can be construed as recommending an international EDS, and the GAO (GAO, 1986).

Allied MOBs, being permanent facilities, characteristically are well furnished with logistics capability. USAF has long pursued agreements with allies for host nation support of units deploying to colocated bases, which support may include civil engineering services such as fire fighting and base damage repair, base security, food and medical services, fuel and munitions storage and handling, and sharing of shops and other maintenance facilities. These agreements are known in NATO as joint support plans (JSPs),³ the adjective "joint" connoting, in this instance, combined, cooperative, or coalition support.

In addition to covering the types of support to be rendered by the host nation, JSPs may address the wartime organizational structure of the combined airbase to the level of specifying that certain work groups, such as cooks and fuel handlers, are to be merged under common command. This sets a precedent for further combining of work functions should analysis indicate the advisability of doing so.

Aircraft Cross-Servicing

COB joint support plans provide for host nation support of the United States by allies and are not really joint. A more reciprocal kind of arrangement widely engaged in by USAF (and the other services) is cross-servicing of weapon systems, the wartime purpose of which is to enable the aircraft of one ally to be refueled and rearmed, when circumstances so dictate, at other allies' airbases. This of course requires the fuel and armament fittings of participating aircraft to be standardized, which has been one of the major achievements of NATO's longtime quest after RSI. It is said that standardization of fuel fittings alone has entailed negotiation of 150 NATO standard agreements, or STANAGS.

The cross-servicing effort was greatly abetted in 1980 by passage of the NATO Mutual Support Act (NMSA, 1980), subsequently extended to cover Australia, Israel, Japan, Korea, the Philippines, and other non-NATO countries. For reference, the DoD implementing documents for NMSA are DoDD 2010.9, which contains a copy of the Act, and DoDI 2010.10. The governing Air Force regulation is AFR 400-9.

Under NMSA, U.S. forces in NATO and the other listed countries can purchase from or exchange with allies logistics supplies and services to a limit, as of 1989, of \$150

³The terms JSP and COB appear to be of NATO origin. Here, however, they will be employed in reference to all theaters.

million per year for the total military. In war, of course, this would amount to no more than a pittance, but the Act is important in allowing thoughts of coalition logistics to surface that might have been unthinkable before. The most direct combat benefit of NMSA is to enable active practice of cross-servicing during allied training exercises. Specifically, the Act defines the logistics supplies and services to which it applies as:

[F]ood, billeting, transportation, petroleum, oils, lubricants, clothing, communications services, medical services, ammunition, base operations support (and construction incident to base operations support), storage services, use of facilities, training services, spare parts and components, repair and maintenance services, and port services.

Inasmuch as the cost ceiling would be expected to go away in war, this definition opens a very wide door for exploration of allied mutual support opportunities.

Allied Mutual Supply and Repair

Most if not all existing plans for cooperation under JSPs and NMSA apply to activities that are weapon-system generic. Even where maintenance shops are to be shared, those included in the plans are of a universal nature such as sheet metal shops and machine shops. As far as can be determined, there are no plans for cooperation when it comes to aircraft-specific tasks such as flight line troubleshooting and intermediate level component repair.

In a deployment, however, some USAF units will bed down at COBs already housing the same or similar types of aircraft, while others will operate from COBs geographically close to allied bases possessing the same or similar aircraft. Even where colocated or proximate aircraft differ, they may have numerous airborne components and ground support items in common. This would be true, for example, of the American F-15 and the northern European F-16A/B, which have virtually identical engines, as well as of the F-16C/D (American and Turkish) and the F-16A/B (American and European), which use different engines but are alike in many other features.

These considerations suggest the possibility of extending JSPs in certain instances to cover weapon-system-specific supply and maintenance functions. Further than that, they suggest potential value in converting some bilateral JSPs into multinational agreements, presumably, in the case of NATO, under the auspices of a revitalized NMSA.

Although much research would have to be done to formulate detailed recommendations concerning allied mutual support in supply and maintenance, some reinforcing evidence is already available. With respect to F-15s and F-16s, a simulation study by RAND in 1986 showed that if ground personnel can be suitably cross-trained, appreciable improvements in combat performance may be obtainable by maintaining both kinds of aircraft as a single force, the more so the smaller the sizes of the cooperating units. Similarly, Appendix A describes an advantageous outcome of simulating allied mutual supply and repair between American F-16C/Ds and European F-16A/Bs.

Since COBs are unoccupied by U.S. forces in peacetime, any arrangements made for allied mutual support in aircraft-specific areas would have to be practiced often enough to keep skills sharp and organizational cohesion tight. How much practice this would require, and what kind, are topics for research just as important as analysis of effects on combat capability. As discussed by Lewis et al. (1986), adequate exercising of the COB structure even under extant JSPs is already a hard problem. Adding training for allied mutual support into the bargain would not make the solution any easier.

RESEARCH IMPLICATIONS

Even before the NATO Mutual Support Act, a certain amount of logistics support among friendly military forces took place in the form of casual borrowing and lending, and one undoubted effect of NMSA has been to heighten such activity. This type of cooperation no doubt also would carry over into war and hence affords at least a finger hold for getting research under way. A survey of the nature, extent, and practical benefits of these ad hoc exchanges is plainly indicated. Assuming, however, that there is little formal administrative machinery to support them, their timeliness, scope, and dependability in time of crisis are subject to question. In war, even voice telephone service among allied airbases may not be routinely available.

Allied mutual support, therefore, is more than something two or more parties just decide to do and begin doing. Effective allied mutual support in combat hinges on reliable communications, assured transportation, some relinquishment of sovereign authority to a central administrator, and a fair degree of visibility by that administrator over sharable logistics assets.

Insofar as allied mutual support is confined within COBs, communications and transportation should constitute little or no obstacle. In that case, almost certainly, the main barrier would be one of achieving compatibility of data systems. If allied mutual support is expanded to include clusters of COBs and MOBs, communications and transportation could become serious problems. Unless the bases of a cluster were near enough together to be served by ground transportation, a service on the order of EDS would need to be brought into the picture. In addition, communications links among COBs might be needed that currently do not exist.

The foregoing brings three avenues for research immediately to mind. The first has to do with the scope of operations both possible and necessary for coalition mutual support. The second concerns the management structure essential to running an allied mutual support operation. The third pertains to the added infrastructure required for transportation, communications, asset visibility, and other prerequisites.

Issues of Scale

A major appeal of mutual support is economy and efficiency of scale. Within limits, the more resources brought together under common management, the more flexibly—therefore effectively—they can be used. At the same time, growth in scale beyond a certain level customarily exhibits diminishing returns. It is important to determine both lower and upper bounds on the scope of operations desirable for allied mutual support.

Small AWACS Fleet. A candidate weapon system to serve as a vehicle for exploring the low end of the range is the E-3 AWACS. For European wars of the future, it is envisioned that NATO's AWACS fleet will operate in concert not only with those of France and the UK but also with a contingent from the United States. Even so, unless existing fleets grow or other countries come into the picture, the total force would amount to less than 40 airplanes.⁴

Currently, each owner maintains its own fleet, or plans to when delivered, independently of the rest.⁵ Moreover, each owner's AWACS differs substantially in

⁴Future AWACS purchasers may include Japan and Australia. If so, this would increase the prospective scale of E-3 mutual support, but at the cost of greatly magnifying the distances separating the home countries of the participating fleets.

⁵A feature common to the non-U.S. fleets is that all use varying degrees of FMS logistics support, which, as elaborated previously, is subject to wartime cutoff.

makeup from those of the others, so that some supply and maintenance functions necessarily must remain unique to each fleet. In light of these equipment differences and the small number of aircraft involved, the questions to be asked, then, are What scope is possible for AWACS mutual support, and Would that scope be sufficient to make economic and military sense? Unless initial investigation were to uncover clear-cut overriding objections to AWACS mutual support, simulation of wartime and peacetime scenarios by means of models such as Dyna-METRIC and TSAR would be clearly the way to proceed toward an answer.

Large F-16 Fleets. As a vehicle for searching out the point of diminishing returns in scale, the F-16 is by far the leading candidate. Overseas MOBs that field F-16s are of considerable size already, the MOB at Hahn AB in Germany housing an entire wing in peacetime. As a result, it could turn out that coalition mutual support fails to improve Hahn's combat potential materially. It would be more of a surprise to learn that putting a single deployed USAF squadron into mutual support with a colocated allied F-16 MOB does not enhance the performance of the U.S. force. And more surprising yet would be to discover that allied mutual support does the deployed squadron little good even when, as Lewis et al. (1986) warn, some of its self-sufficiency support materiel fails to arrive owing to the uncertainties of war.

Where the scope of operations is limited, internal USAF mutual support employing EDS might be able to do as much for combat performance as coalition mutual support between colocated USAF and allied units. In that event, the logical conclusion might be that each owner of a sizable fleet of F-16s should practice mutual support within its own service, putting coalition mutual support into operation only where the country in question operates a small fleet, such as a squadron or two.

Endless other possible conclusions may be conjectured. Perhaps, for instance, the equipment differences among fleets of F-16s will defeat what otherwise would be notable benefits of scale from allied mutual support. Or maybe to achieve sufficient scale for effective operations, vulnerable communications and transportation resources have to be stretched beyond safe limits. Again, the indicated approach to examining these and related issues is simulation of hypothetical mutual support scenarios using appropriate computer models.

Management Structure

The question of what organizational structure to adopt to manage coalition mutual support harks back to the topic of unity of command. A mutual support operation cannot run by itself. Somebody has to be in charge. Equally important, someone has to take the initiative in setting up the operation in the first place. These are tough matters to deal with, particularly in a lingering atmosphere of logistics as a national responsibility. But if coalition mutual support ever is to happen, they must be confronted.

The USAF Case. Not only are these hard issues in the coalition case, they are far from easy with respect to mutual support within a USAF whose management structure is designed around the long-standing logistics doctrine of unit self-sufficiency. Before USAF can seriously entertain plans for weapon-system-specific mutual support with allies, it has to figure out how to manage mutual support among its own elements. Calling for increased internal mutual support, as the new Log CONOPS does, is a far cry from explaining how to run it effectively. For example, can it, and should it be, directed by existing USAF logistics readiness centers, or are new organizations in order? How much central visibility over local assets is necessary? How much authority over those assets must unit commanders cede to central administrators?

These questions have been taken under advisement by the Air Force, and efforts are under way to obtain answers. The same questions also parallel queries that have to be raised regarding managing coalition mutual support. The advisable course for coalition logistics research, therefore, might be to piggyback on USAF experience in enhancing internal mutual support over the next few years. What is learned in that context should have considerable transfer to the combined operations arena.

If the principle of unity of command is valid, then management responsibility for coalition mutual support ultimately should be vested either in one member of the coalition—without doubt, the United States—or in a combined agency. For European coalitions of more than two parties, it is clear that as long as NATO remains a strong military union, that alliance should be the agent. Yet, as has been discussed, NATO's primary logistics instrument, NAMSA, is ill-conceived and ill-placed to carry out operational logistics; and SHAPE's operational logistics arm, the LRC, is feebly chartered and poorly equipped for the allied mutual support job.

The AWACS Example. As a conceptual straw man for purposes of fixing ideas and focusing research attention, one might think of transferring to other weapon systems

the NATO AWACS precedent of an international supply and maintenance organization. Obviously, of course, the first place to consider transferring this concept would be to the expanded wartime AWACS fleet that includes French, British, and American aircraft. Other prospects for international logistics organizations would be the F-16 and the C-130 aircraft, both of which are widely and numerous held by allies around the world.

In addition to being international, the NATO AWACS supply and maintenance function is highly civilianized. Reportedly, 90 percent of flight line and intermediate level maintenance is done by civilians. Although no one can foretell what may be wrought by inauguration of the European Economic Community as of January 1993, an ever more internationalized labor force seems one reasonable guess. The Germans do not own F-16s and therefore might not participate in a NATO F-16 supply and maintenance organization, but it is imaginable that American F-16s at USAFE MOBs on German soil might one day be maintained by military and civilian personnel drawn from the F-16-owning countries of Norway, Denmark, Belgium, Holland, Turkey, Greece, Portugal, and the United States. This same combined maintenance force would be prepared by peacetime exercise to meet the wartime arrival of hundreds more USAF F-16s at numerous COBs across the theater.

Even if such an arrangement could be made to work and the United States could come to trust it, the peacetime logistics force would be too small to handle a major deployment, still leaving a heavy burden of supply and maintenance on USAF's shoulders, especially at COBs that house incompatible allied aircraft. Hence, the airlift required for deployment could be reduced only fractionally. A vital task for research would be to estimate the magnitude of that fraction. Once more, this would call for analysis of deployment scenarios with the aid of suitable simulation models.⁶

Cross-Servicing Today. By way of tuning up for simulation studies of more complicated management structures for coalition logistics, research should begin by taking a hard look at aircraft cross-servicing plans and arrangements as they exist in NATO and elsewhere today. As far as we could ascertain in this survey, cross-servicing seems to be an article of faith adopted as policy without detailed analyses of wartime

⁶A complementary way to reduce the airlift requirement would be to preposition more materiel at the COBs, especially bulkier and heavier items. Prepositioning is an idea that goes back many years and has been more heavily endorsed by the Army than the Air Force. Although we do not address prepositioning, it should be included as a main variable in the research proposed.

operations to back it up.⁷ If so, important research questions that deserve answering include: How often will cross-servicing be demanded in battle, and can existing capabilities meet the demand? What proportion of cross-servicing attempts will result in successful sortie generation, and what are likely to be the principal causes of failed attempts? Can cross-servicing be effective in wartime if managed on the spur of the moment by "hot planning" only, or is a supervising organization with data and communications capability essential to get the most out of it?

Infrastructure Issues

Once it is decided how to manage allied mutual support, the management entity needs infrastructure to function. What additional communications facilities are required to connect allies together? What does it take to enable critical data systems to interface? Are dedicated fleets like EDS and the sometime Pacific Distribution System an acceptable answer to the extra transportation load, and, if so, can and should they be made international? What backups would be needed if allied mutual support communications and transportation should break down from overload or enemy interdiction?⁸

Insofar as coalition undertakings are concerned, all of this is practically virgin territory. With logistics as a national responsibility, existing alliances have scarcely addressed these matters, let alone resolved them.

The same assertion is less true, however, on the operations side. Since allied units are intended to fight under unified command, greater attention has been paid over the years to problems of command and control of combined combat operations. Supposedly, for example, the NATO AWACS and the U.S. AWACS can interoperate harmoniously in war. Only when it comes to logistics do they go their separate ways.

Research on the infrastructure elements necessary to facilitate allied mutual support might determine whether any existing or planned developments in combined

⁷A 1988-1989 project under USAFE/NATO auspices called Constant Companion is said to address the entire area of dispersed operations, base sharing, and cross-servicing. This effort bears further looking into.

⁸Some studies at RAND still in progress examine some of these issues from the point of view of mutual support internal to USAF. One study focuses on the vulnerability of the USAFE combat support infrastructure to enemy attack. Another looks at how to sustain USAF mutual support under disruptions to the infrastructure. The bottom line to the latter, incidentally, is that expeditious interbase transportation looks to be more the key to the problem than either communications or data systems.

operations command and control have potential application to managing coalition mutual support. For instance, the EIFEL command and control system (Canan, 1985) that supports NATO Allied Tactical Operations Centers (ATOCs) may have its shortcomings, but it is cons ahead of anything similar on the logistics side.

Other directions for allied mutual support infrastructure research have been touched on above in passing. One of these is analysis of requirements for logistics data system compatibility among allies. And data systems compatibility is without value in the absence of data-grade communications capability. In principle, the latter capability can be ensured easily enough within COBs; but if considerations of scale demand that allied mutual support extend beyond individual bases to be cost-effective, the situation is far less clear. Finally, in the case of allied mutual support outside the range of ground transportation, the issue of assured airlift must be resolved.

VI. CODEVELOPMENT/COPRODUCTION

BACKGROUND

Arms codevelopment refers to collaborative design and development of weapons by allies, coproduction to collaborative weapon manufacture. Both types of venture afford an opportunity to plan logistics support for new systems on a coalition basis. Only in codevelopment, however, is it possible to introduce considerations of coalition logistics into a weapon's original design characteristics.

RSI

DoD and NATO have paid vast lip service over the years to the concept of rationalization, standardization, and interoperability, but with disappointingly small result. Noteworthy strides have been made in standardizing fuel fittings, munitions fittings, stock numbering, and the like, but all this is at the periphery. The central confounder of RSI is international anarchy in weapon design, for which the only visible hope of major remedial breakthrough lies in increased codevelopment and coproduction.

Technological protectionism is a fierce antagonist of codevelopment and coproduction.¹ Foremost in arms sophistication, the United States is understandably among the most protectionist of nations. Any technology put into the hands or minds of U.S. allies, no matter how close and trusted, is subject to very careful scrutiny. DoD's overall guardian of technology is the Defense Technology Security Administration, whose organization and mission are described in a recent brochure (DTSA, n.d.). In the Air Force, scrutiny over technology transfer is exercised by AF/CVAI, the International Affairs Division, Office of the Vice Chief of Staff.

Codevelopment and coproduction do not lead to RSI automatically. Stern discipline must be imposed to prevent such enterprises from shredding out along national lines and wandering down divergent paths. One vital element of such a discipline is potentially available, at least theoretically, in coalition logistics.

¹This is equally true, of course, of the nonmilitary sector. See, e.g., Dickson (1989), Pollack (1989), and Uchitelle (1989).

American Inexperience

Historically the world's richest nation and leader in arms technology, the United States has had little motive in the past to participate in codevelopment or coproduction. Arms cooperation was a one-way street in which the United States sold weapon systems to foreign countries together with the accompanying logistics support (Taylor, 1982). Not only were the weapons plentifully available to sell, much of the time they existed in such surplus as to be given away; and even then it often has been a struggle to get the recipients to buy even minimally into such support programs as CLSSA.

Now many allies are catching up economically and technologically and are no longer happy with hand-me-down war-fighting gear. Even wealthy third-world nations want the newest and best, and the more advanced industrial countries have considerable capability to develop such equipment on their own. This situation, combined with geometrically increasing costs of military equipment, has strengthened an emerging propensity to cooperate in both the development and production of weapons.

Whereas codevelopment and coproduction are familiar in Europe (Cornell, 1981; Covington, Brendley, and Chenoweth, 1987; Creasey and May, 1988; Lorell, 1980; Rich et al., 1981), they are fairly new to DoD (GAO, 1979), and even more so to USAF. Although U.S.-European manufacture of the General Dynamics F-16A/B is one of the largest coproduction efforts ever undertaken, before this year's start on the Japanese FSX, USAF has had no experience in codeveloping an aircraft meant for operational deployment. And even at that, the FSX is an oddity in that the United States has no plans to procure the weapon for its own use. Hence, any prospects for coalition logistics in connection with the FSX would arise from similarities between it and USAF's related family of F-16s.

U.S. Logistics vs. Other World

If the time seems ripe for coalition logistics research to get in on the ground floor of an impending trend toward codevelopment and coproduction, the lack of U.S. experience in the latter areas makes it hard to say exactly how or where to begin. Since the Europeans have more background, one might be tempted to start by seeking the benefit of their coalition logistics expertise derived from codevelopment of aircraft such as the Tomado and the European Fighter Aircraft. Any such investigation, however, is likely to bear small fruit.

Although U.S. logisticians lament the lack of attention to logistics so often evident in the design of U.S. weapons, at least they have succeeded in promulgating throughout DoD a doctrine of integrated logistics support, which says, in a few words, that the ability to support a weapon in the field is as important as any other design criterion (Paulson, Waina, and Zacks, 1971). DoD (USDA, 1988) recently has made it plain, moreover, that the same principle extends to codevelopment and coproduction:

Cooperative projects should assign a full-time professional logistician at the same time as the primary financial and technical managers are assigned. The logistician is to be responsible directly to the program manager for formulation of all integrated logistics support plans and coordinating all national requirements in such a way that logistics support receives the same consideration and planning as the financial and technical aspects of the program.

In addition, the Senior NATO Logisticians Conference has recommended guidelines of similar spirit for weapons codeveloped under the NATO aegis (Grossman, 1989). Even though logistics stays a national responsibility and compliance is to be voluntary, these proposed NATO guidelines confirm at least that international attitudes toward logistics cooperation are beginning to moderate.

Nevertheless, among U.S. allies, with at most one or two exceptions, logistics continues to have very low priority in weapons design and is something to become concerned about, if at all, only after a system is being fielded. No doubt this perception is due in part to rampant spread of the insidious idea that logistics is a national responsibility. But whatever its source, the prospect of coalition logistics during codevelopment or coproduction is doubly forbidding.

Another basic difference between the United States and the rest of the world in the way things are done logistically is the existence of the DoD depot structure and the management function vested, in the case of USAF, in AFLC. Once a weapon system is produced and delivered to the field, logistics support of the system is transferred from the developing agency (usually the Air Force Systems Command) to AFLC. The latter organization then controls and monitors the day-to-day maintenance of airplanes, manages the inventory of spare parts, runs depots that repair recoverable items and warehouse materiel, and organizes procurement of follow-on parts and equipment. Most foreign countries place the management of logistics much more with the operational

forces and retain a direct dependence on the equipment manufacturer long after delivery of a system into the inventory.

CURRENT EXAMPLES

Research on coalition logistics in codevelopment and coproduction presumably should follow a case study paradigm. In getting started, however, it is not essential that all programs chosen as cases include ongoing coalition logistics activity or, for that matter, that all of the cases even be genuine. A prototypical collage of actual programs, for example, might provide a superior research vehicle.

To convey an idea of what the cases for potential study consist of, we briefly review some existing codevelopment and coproduction programs. This may help to provide insight into the opportunities available as well as stumbling blocks in the way of realizing them.

X-31A

The X-31A is a purely experimental aircraft being built to evaluate new technology. Only two copies are to be fabricated, and no follow-on production is contemplated. The endeavor is financed by industries of the United States and West Germany with substantial assistance from the two governments. The U.S. financing is funneled through the Defense Advanced Research Projects Agency (DARPA), which exercises some degree of control over the project's organization.

The firms involved are Rockwell International and Messerschmidt-Bolkow-Blohm (MBB). The new technology being developed and tested is aircraft maneuverability below stall speeds. The X-31A is essentially a Mach-2 fighter that can stop, point, shoot, and then regain control and be on its way. Both firms were interested enough in pursuing this technology that a handshake between the two presidents was sufficient to start the project. It operates under a very general memorandum of understanding between the United States and West Germany, but no other formal arrangements have been made. Descriptive literature on the X-31A is found in AFMag (1987), Rockwell (1989), and Schefter (1989).

The aircraft were expected to fly in early 1990. Anything learned in the process of testing them presumably will become the joint property of the parties to the venture. Most likely some agreements have been made as to the proprietary nature of design and

operational principles, but these are not public. The engine thrust-vectoring technology, for example, came from the German side and will probably remain there.

Problems of protectionism can arise, however, even in so uncomplicated an undertaking as this. The fuselage is being assembled in Germany, the wings in the United States. Final assembly will be in the United States; and to ensure that the wings would mate with the body when it arrived, Rockwell shipped a template of the wing mounting to Germany. This led to a six-month delay in shipment while the template was cleared of technology transfer prohibitions.

Since no operational function is planned for these aircraft, the implications for real-world logistics are trivial. Nevertheless, closer examination of the program undoubtedly would yield useful insights and hypotheses relevant to coalition logistics.

FSX

The FSX project has been much discussed in the past year, most of the issues being economic and political rather than military. The program was formulated and approved during the final years of the Reagan administration and was reopened with vigor early in the Bush presidency. As indicated before, the major question was transfer of technology, with Congress asking if the bargain was not too much to the advantage of the Japanese.

The main issue raised for public consumption was one that long antedated the FSX (GAO, 1982), whether the technology being given for use in military aircraft would facilitate development of commercial aircraft as well, thus putting the U.S. civilian industrial base in jeopardy. The renewed negotiations assured Congress that U.S. proprietary interests would be adequately protected and that the benefits of the joint venture would be shared equitably. The Japanese have argued, and some American representatives have admitted, that in actuality, the transfer of technology balance may favor the United States.

Although U.S. withdrawal from the combined venture was threatened, it was understood that the Japanese would go ahead on their own or, worse, enter into an arrangement with a European consortium (Zakheim, 1989). It appears to have been difficult in the extreme for both DoD and U.S. industrial organizations to give up the idea that they could just sell off-the-shelf equipment to a modern country. Over the lifetime of the program, which is projected to extend into the twenty-first century, the United States is expected to derive about \$2.5 billion in development and production work.

The FSX is based on the F-16, and it is expected that interoperability benefits will accrue to both countries as a result. Secretary of Defense Cheney mentioned in a statement to Congress (Cheney, 1989) that fueling, ground support equipment, and certain maintenance functions would be compatible. Logistics arrangements to exploit these compatibilities have yet to be worked out.

There can be more to coalition logistics, however, than equipment compatibility. Future war plans very well may call for Japanese FSXs and U.S. F-16s to engage in coalition warfare and operate from the same or geographically proximate bases. If so, scenarios of this type of operation need to be called forth and examined for their logistics implications. Maybe, for instance, ground support equipment should not only be made compatible but designed to accommodate collaborative flight line and intermediate maintenance activities of the future. Even though the United States will not procure the FSX, the program offers a fertile field for coalition logistics research.

F-16

The F-16 is a U.S. proprietary (General Dynamics) aircraft. However, to increase the scale of production and reduce unit costs, the United States was joined in 1976 by Belgium, Denmark, the Netherlands, and Norway to build about 1,000 of these fighters. Parts are made in all five countries, and aircraft assembly facilities exist in the United States, Belgium, and the Netherlands.

Although the original intent was to maintain identical aircraft—and the basic integrity of the airframe has remained intact—national variations soon started to creep in. Either for political or operational reasons, different countries decided to concentrate on different combat missions, therefore different weapon configurations.

Obviously, the more modifications made by individual users, the greater the difficulty of managing logistics in common. Current planning calls for two upgrades to the European F-16s in the near future—the first, the operational capabilities upgrade, to enhance combat capability; the second, the mid-life upgrade, to improve reliability and extend the service life of the aircraft. In principle, these upgrades should increase the commonality between the European F-16 and the latest American version, the C/D. However, history has shown repeatedly that programs promising better RSI seldom end up delivering it.

The Europeans are not alone in generating variations. After each few American F-16s are produced, a "block" of changes is introduced into all subsequent aircraft, the

changes usually coming in the area of more sophisticated weaponry. In the case of the American fleet, however, great effort is put forth to keep the ground support and test equipment "downward compatible," meaning that the most recent test equipment can service all aircraft produced earlier. A European F-16 therefore stands a better chance of getting repaired at an American F-16 base than the other way around. A simulation described in App. A shows what might be possible in the way of allied mutual support at a European base if its repair facilities were kept updated to handle U.S. aircraft.

A consideration in thinking about F-16 coalition logistics in Europe is that European maintenance technicians tend to be either civilians or military personnel with long-term commitments in a single occupation, often at a single location. The result is that they are generally more experienced than their American counterparts and less concerned—at any rate, less optimistic—about career change. These workers might be more readily adaptable than U.S. military personnel to differences or changes in maintenance requirements arising from variations in aircraft configuration.

Today, USAF is relegating all its F-16A/Bs to the reserve and National Guard forces. These aircraft are highly similar to European F-16s, and, in fact, some spare parts for them are produced only in European facilities. At the same time, in a European war, many reserve and Guard squadrons are slated to deploy from CONUS just as early as most active TAC (Tactical Air Command) units. Thus, American A/Bs will find themselves fighting from locations proximate to European A/Bs, so a fair degree of mutual supply and maintenance would be possible without any peacetime cross-training or upgrading of test equipment.

Another coproduction arrangement, this time for the F-16C/D, has been initiated with Turkey, where planes have been in production since late 1988 with a total of 160 planned. To bring this program about, both General Dynamics and General Electric, the latter the manufacturer of the F-110 engine, entered into joint ownership of production facilities with Turkish Aircraft Industries (Flight, 1985).

For a time there was much discussion about a now defunct follow-on to the F-16 referred to as the Agile Falcon (AFMag, 1989). It appears that some of the northern European countries were much interested in the codevelopment and coproduction aspects of this proposed program but far less excited about eventually purchasing any of its very expensive products. Had a program been undertaken under such circumstances, it would have amounted to a kind of FSX arrangement "in reverse." In any case, the abortive

negotiation affords a further example of how the basic driving forces in the European community are more economic than military.

MLRS

To find a codevelopment/coproduction program actively encompassing a degree of coalition logistics, it is necessary to look outside the Air Force to the Army. The Multiple Launch Rocket System (MLRS) qualifies in this regard because the logistics arrangements have been more formalized than in other cases. Both the rocket and the self-propelled loader launcher (SPLL) used to fire it have been the result of multinational development and production. This development and production effort confirmed the widespread opinion that multinational projects tend to be less efficient than single nation ones, especially in the case of the SPLL, where the delay is estimated to have been four years.

Organization. The EPG, consisting of the UK, France, and West Germany, was formed in 1979 with a memorandum of understanding involving those three countries and the United States. Italy joined in 1982. The original design of the MLRS envisioned the same basic job as current artillery, but at greater distances and with greater firing speed.

In 1985 a more sophisticated capability was added to the system in the form of the terminally guided warhead (TGW), involving a more elaborate form of multinational cooperation. A corporation named after the four companies involved was formed, MDTT, Inc. for Martin Marietta Aerospace, Diehl GmbH & Co. (West Germany), Thomson-Brandt Armements (France), and Thorn-EMI Electronics Ltd. (UK) (Army 1989). Sixty percent of the work was designated for European firms, and it was specifically agreed that at the end of the development program each of the contractors would possess all of the technology required for full production. Again the time factor became of major concern when it was announced that the development time allowed was 98 months. A large amount of this seemingly excessive length was attributed to the condition in the agreement stipulating that each of the contractors had to have qualified representatives from each of the other firms on its design team.

In 1984 the United States, UK, Italy, Germany, and France declared themselves to be partner countries in the MLRS weapon system partnership (WSP).² The designated

²The WSP concept of operations for NAMSAs was formulated by Mendershausen (1961).

operational unit of the partnership is NAMSA, and the stated objective is to provide the partner countries with "the study, determination, establishment and operation of facilities to ensure at all times the availability to the Partner Countries of the materiel and services needed for the efficient and economical logistic support of their units." (NAMSO, 1984.)

The WSP was accompanied shortly by a logistic support arrangement (LSA) expressing general intent to cooperate logistically. It was not until 2-1/2 years later, however, that the specific tasks to be performed under the LSA were explicated in a NAMSO directive (NAMSO, 1987). The LSA covers the MLRS delivery vehicles (SPLLs) only, not the rockets or any items of noncommon configuration. The following support services are made available by NAMSA to the participating countries on a voluntary basis:

1. Supply from central stocks
2. Brokerage supply
3. Redistribution of excess
4. Mutual emergency support
5. Centralized/consolidated procurement of parts
6. Direct exchange
7. Depot level maintenance of electronic assemblies
8. Depot level maintenance of automotive, mechanical, and hydraulic assemblies
9. Technical/engineering support
10. Transportation upon request.

U.S. Noninvolvement. The United States has elected not to participate in numbers 1, 2, 3, 5 and 8, and Germany has omitted number 6. Otherwise, all countries have signed up for all activities. American abstention from so many activities obviously makes the partnership primarily a European affair. As discussed before, American abstention has characterized the U.S./NAMSA relationship from the outset. In practice, NAMSA is and always has been for others.

While a commendable step in the direction of coalition logistics, the MLRS weapon system partnership punctuates the point that NATO logistics still is very much a national responsibility. What the LSA does is create a consolidated store enabling those

who want to buy there to reduce their peacetime costs. How the store would operate in wartime, however, or whether it even would continue to exist, also are important coalition logistics concerns that research needs to address.

RESEARCH IMPLICATIONS

The DoD doctrine of ILS says that logistics support should be a major consideration in weapon system acquisition from the earliest stages of design. Rarely, however, is this concept followed in a meaningful way. Cost and deadline considerations—not to mention just plain apathy—all too often cause logistics to fall by the wayside during development, and what remains in the way of logistics planning at the time of delivery is invariably inadequate. Among other problems, funding for spare parts usually is grossly below the level established as reasonably early in the design process, and the management structure for system support typically falls into place only long after the weapon is put into operation, and then slowly.

Now the cost of weapons is increasing, arms technology is spreading, and pressure for RSI is growing to the point that even the United States must seek help from allies in system development and production. Multinational logistics support of these codeveloped/coproduced weapons in peace and war is clearly desirable from both an economic and a military standpoint. The question for research is what can be done in this new area to avoid the problems and inefficiencies of past unilateral acquisitions. What steps should be taken to ensure that multinationally developed weapons have reasonably cooperative logistics systems to support them, and what studies are needed to facilitate these actions? How and in what stage of the codevelopment process should logistics considerations be formulated, and what must be done from a managerial point of view to ensure their implementation?

Because the field is in its infancy and fraught with ambiguity, it is neither appropriate nor timely to attempt mapping out any sort of definitive research program in codevelopment/coproduction logistics. We therefore suggest three near-term projects that would be prerequisite to any longer-term pursuit and whose outputs would be expected to lead to more comprehensive, long-run proposals—domestic system acquisition, foreign logistics, and ongoing codevelopment.

Domestic System Acquisition

Before the United States seeks to sell the rest of the world on coalition logistics in system development, a good idea would be to try to find out why ILS is no more effective in *domestic* system acquisition than it is. Hypotheses abound, such as:

- Acquisition managers and design engineers do not understand logistics or appreciate its importance,
- Logistics deficiencies often are difficult for program reviewers and auditors to spot,
- The U.S. logistics community is divorced organizationally and functionally from the acquisition community, and
- The reward system provides insufficient accountability for ILS.

No doubt all of these and numerous other explanations are correct in part. To shed brighter light on the issue, a research survey of the entire ILS process is indicated, cast in the form of a management audit with the criteria of success carefully and explicitly delineated. Policies, procedures, organization, staffing, and budgeting all should be examined in relation to the total machinery of acquisition. Several specific acquisition programs reputed to be exemplars of good and bad ILS should be included in the investigation as case illustrations. The findings of such a survey would have dual application, one in planning for coalition logistics, the other in enhancing the effectiveness of ILS in unilateral acquisitions.

Foreign Logistics

Another prerequisite to planning coalition support of codeveloped weapon systems is better mutual understanding of the logistics concepts, structures, and values of the partners. For example, American logisticians tend to prize combat performance capability, but logisticians of other nations often think more in terms of technological advantage and peacetime economics.

As an aid to understanding foreign logistics, a historical look needs to be taken at the logistics management structures and activities of countries that have been operating common weapons for extended periods of time. Mostly these weapons will turn out to be U.S.-built combat aircraft, dominant among which are the C-130, the E-3, and the F-4

Phantom. Newer but also with some history behind it is, of course, the F-16.³ All these systems have had considerable operational experience under different nations; and although part of the logistics structure was delivered along with the equipment, the point of interest would be to see how this structure has evolved in different circumstances and what differences from U.S. practice have arisen.

An exercise like this should help reveal major areas where improvements could be made to both foreign and American procedures and where accommodation must take place for coalition logistics in codevelopment and coproduction to succeed. Not only policies and procedures, but attitudes and customs, are sure to require much adjustment. Out of such a study should emerge tentative guidelines for coalition logistic support as well as important system design criteria to facilitate coalition logistics operations.

Ongoing Codevelopment

A final prerequisite to long-range research aimed at establishing rules for coalition logistics in codevelopment/coproduction is study of the negotiation, management, and functioning of existing multinational acquisition programs. The process of following the design of weapon systems from the very beginning, tracing the introduction of logistic support elements (if any) into the agreements, and then tracking the implementation of logistics, by whatever means it gets accomplished, would give a far better picture than now available of the place of logistics in a cooperative venture today.

The disputes, the failures, and the successes all would be instructive. Doing this type of research "live" while a project is in an early stage is vastly more useful than trying to reconstruct events after the fact. On the U.S. side, at any rate, people tend to leave projects rapidly, and those that remain forget what they did or thought at the time, with the result that critical decisions may be lost entirely. The output to be sought from this research is a baseline for formulating management guidelines and recommendations to approximate ILS in an international setting.

³European weapons such as the Tornado, Mirage, and Jaguar also would bear examining. Their obvious disadvantage from a comparative study perspective is that USAF does not operate them.

VII. RESEARCH PRIORITIES

PRIORITIZING SCHEME

The preceding sections outlined a grab bag of 14 recommendations for follow-on research in coalition logistics. In light of competing demands for research resources, it is unimaginable that all 14 proposals could be pursued in the foreseeable future. This section attempts to lend better structure to the grab bag by grouping the proposals into priority categories.

As a way of being systematic about assigning priorities, we applied an informal multidimensional decision analysis methodology (von Winterfeldt and Edwards, 1986) to score each research recommendation on a set of five weighted priority criteria. The criteria adopted were as follows:

- Importance to the DoD logistics community given the current state of the world
- Degree of success likely in attaining research and policy objectives
- Relevance and importance to RAND research continuity
- Practicality of start-up and execution
- Cost and technical feasibility

Although all of these are complex dimensions, the first one proved especially awkward to rate in that the state of the world has altered materially since the survey started. Our thinking during data collection was biased toward the value criterion of combat effectiveness. However, thanks to ongoing change in the apparent threat from the Warsaw Pact, the foremost theme in American military planning right now is cost containment, which very well may end up spelling large-scale force reduction. Had this turn of events occurred, or been foreseen, before we completed field work for the survey, our inquiry could have been structured more toward the economic and force structure implications of coalition logistics.

Undoubtedly there are some "big ticket" items with regard to cost reduction among the 14 research projects—those having to do, for instance, with incorporating integrated logistics support in weapon system codevelopment programs. However, the

cost avoidance implications of each project will have to be determined in the course of future investigation. Meanwhile, there are applications of coalition logistics not treated in the 14 recommendations that could be of more direct import for cost containment than the recommendations themselves. Two of these deserve special mention, host nation support and improved FMS programming.

HOST NATION SUPPORT

From the Air Force's point of view, possibly the largest potential for cost reduction through coalition logistics lies in getting host nations to assume greater responsibility for administrative operation and management of overseas bases, a subject treated above but not singled out for specific research attention. A major reason for the latter omission is that increasing the overall level of host nation support would seem to be more a matter of implementation than of research.

Not only do many precedents exist as stepping stones for expanding host nation support, but much experience is available with the legal forms, such as joint support agreements, for administering it. Considerable analysis of options would be wanted along the way, as well as new and improved approaches to implementation. Nevertheless, in view of the widespread success of and familiarity with host nation support in evidence, it was hard to conceive of a study effort in this area with programmatic overtones, and none was proposed.

IMPROVED FMS PROGRAMMING

A way for the Air Force not merely to conserve costs through coalition logistics but to earn greater income therefrom would be to increase foreign military sales and associated logistics support at better profit margins. AF/PRI and AFLC/ILC have anticipated this idea, however, and have already set efforts under way to program the eventual sale of obsolescing weapons with accompanying logistics support before the weapons are placed in long-term storage and their logistics pipelines have dried up (Rankin, 1988; Schonenberg, in press).

Again, extensive analysis will be needed in support of the process, but the requirement for systematic research, if one is there, once more eluded us. The Air Force appears to have its program for revenue enhancement and cost avoidance through FMS sales fairly well in hand.

RECOMMENDED PRIORITIES

Table 1 summarizes how the priority rating of projects turned out. For convenience of discussion, three arbitrary clusters were defined, "highest," "middle," and "lowest." As the leftmost column of the table indicates, the projects in the middle cluster came out very nearly tied.

Since the rankings were arrived at by composite ratings across multiple diverse dimensions, there is no inherent reason for the clusters to reflect particular themes. In retrospect, however, most of the projects in the highest priority category have ramifications well beyond the specific context in which they were proposed. Moreover, all the top priority projects reflect the growing attitude that in times to come, the United States will be cooperating in, rather than dictating, the logistics policies of its alliances.

Table 1

RECOMMENDED PROJECT PRIORITIES

Rank	Designation	Section in Text Reference
Highest Priority		
1	Management structure for allied mutual support	V
2	Allied logistics concepts and structures	VI
3	Infrastructure issues for allied mutual support	V
4	Issues of scale in allied mutual support	V
5	Survivability of prospective forward depots	IV
Middle Priority		
7	Countering the national responsibility bugaboo	III
7	Audit of domestic integrated logistics support	VI
7	Logistics in ongoing codevelopment	VI
10	Simulation of FMS logistics cutoff effects	II
10	"Reverse" security assistance planning	II
10	Capabilities of existing forward depots	IV
Lowest Priority		
12	Relocating NAMSA organizationally	III
13	Strengthening Support Group Europe	IV
14	Simulation of NAMSA wartime shutdown effects	III

For any application of coalition logistics, it is important to understand how allies think about and execute logistics support, what kinds of management and infrastructure arrangements for cooperative ventures are necessary and feasible, and what magnitude of scale it takes to justify coalition logistics enterprises. These are cross-cutting issues of the kind often identified for RAND research attention.

The three items in the lowest priority category tend to lack this cross-cutting feature. Both NAMSA and SGE are unique organizations, and no one encountered during the survey seemed to regard either as a model or even a prospect for propagation elsewhere. Thus, it is not clear that what might be learned from these projects would be widely generalizable. That is not, however, why they landed in the bottom priority grouping. Among other reasons, they scored very low in our judgment on the degree of success probable in attaining research and policy objectives. Even if the projects were carried off successfully from a technical point of view, changing the world to conform to the findings still would be, in all likelihood, very difficult.

The six projects in the middle priority group fell there, for the most part, because they focused on narrowly defined aspects of logistics. No matter how important or difficult the problems represented, they lacked the broader policy implications of the higher ranked projects.¹

The overarching thought that has emerged from this prioritizing exercise is that U.S. logistics policy with regard to allies is on the verge of undergoing some radical changes, and the projects of highest priority have to do with how those changes should be made. Existing ways of doing things need to be called into question in redefining our logistics relationships with allies, and such reformulation could benefit substantially from a well-designed and executed research program along the lines suggested.

¹This certainly is not true of countering the bugaboo of logistics as a national responsibility. That project arrived in the middle group because, in spite of its great importance and sweeping scope, it appears an awesomely difficult problem.

Appendix A

COALITION LATERAL SUPPLY AND MAINTENANCE: A HYPOTHETICAL ILLUSTRATION

INTRODUCTION

Rationale and Purpose

On the assumption that USAF units having mobility missions may be called upon to deploy to and fight from austere equipped sites, current war planning is predicated on the ability of such units to be supplied and maintained entirely within the USAF logistics system. Yet, when wartime deployments occur to locations rich in support resources, many supply and maintenance requirements probably could be met locally given adequate planning. To the degree this is so, use of precious transportation capacity to deploy organic supply and maintenance capability would appear superfluous.

One form of support potentially available from allies who operate aircraft similar to those of the United States is base-level lateral supply and repair. Among the foremost candidate aircraft for this kind of support is the F-16 Fighting Falcon, which some 16 other countries either operate or are in the process of acquiring. It seems logical, therefore, to consider how much combat benefit might accrue from F-16 allied mutual support in the event USAF were called upon to fight in partnership with one of these countries.

To explore this question as well as to illustrate one of the directions for research proposed in the parent document, we carried out a simulation to see what might happen if base intermediate maintenance facilities were shared between a host European F-16A/B MOB and either one or two squadrons of USAF F-16C/Ds deploying to (or near) that MOB in wartime. Version 6 of the Dyna-METRIC model¹ was employed for this purpose. Full details of the scenario will not be presented, but the main essentials were as follows:

¹Documentation of Version 6 was not yet available at time of writing. However, the general principles underlying earlier versions remain unchanged. For basic descriptions of Dyna-METRIC, see Isaacson et al. (1988), and Pyles (1984).

The Scenario

The European host MOB was assumed to possess 36 A/B aircraft, a single stand of avionics (i.e., weaponry) test equipment, and unlimited quantities of other authorized intermediate-level test and repair equipment.² This equipment and all other base maintenance facilities, except those for engines, were presumed updated by peacetime prearrangement to accommodate C/D aircraft.³ Additionally, an unlimited stock of shop replaceable units (SRUs) to repair C/D line replaceable units (LRUs) was made available at the MOB.

Engines were excluded from the analysis because of fundamental incompatibilities between aircraft types (different engine designs and manufacturers). Both the overgenerous supply of C/D SRUs and the exclusion of engines from the simulation may lend an optimistic bias to the results to be reported, and interpretations should be tempered accordingly.

In the absence of information about European sortie rates, failure rates, repair times, spare parts stockage, and the like, the MOB was endowed with the known characteristics of a USAFE base housing 36 F-16s. This seems a reasonable approach for purposes of a preliminary what if exercise.

The U.S. aircraft were assumed to deploy to the MOB (rather, from the U.S. perspective, the colocated operating base, or COB) on day 0 of the war and, simultaneously with the European aircraft, to commence a 30-day flying program comparable to that on which war reserve spares kit (WRSK) computations were based in 1988. A deploying squadron was presumed to arrive with a full authorized WRSK. There was no combat attrition of aircraft or facilities during the scenario, and both U.S. and European units were cut off throughout from external support.

Two principal cases were considered, one in which the deployed U.S. fleet and the European F-16 fleet each operated self-sufficiently for 30 days, the other in which the

²Lacking data on European repair policy, USAF policy was simulated, under which the median nonavionics component was found to have only a 4 percent chance of being repairable at base level in the first place. Thus, the unrestricted supply of nonavionics test and repair equipment assumed here afforded little benefit. The median avionics component, by contrast, proved repairable at base level 72 percent of the time.

³F-16 ground support equipment is "downward compatible," meaning that the latest version can service all aircraft previously produced. The stated assumption could be satisfied, therefore, by keeping the MOB furnished with ground equipment of the latest issue. To a large extent, this would be a matter of keeping computer software updated.

mutual support initiatives of priority lateral supply and repair were in force. Similarly, two values of variance-to-mean ratio (VTMR) of spare part demand rates were examined. One corresponded to the value assumed in WRSK calculations (VTMR = 1.0 demands per flying hour or dpfh), the other representing a level of demand disorder more characteristic of that believed to prevail in actual peacetime operations (VTMR = 2.3 dpfh).⁴ Altogether, therefore, eight condition combinations were addressed: (one or two U.S. squadrons) × (mutual support vs. no mutual support) × (two levels of VTMR).

Normally, priority repair and distribution imply compatibility of data and communications systems. On the grounds that this compatibility might not obtain between USAF and the host air force (not to mention problems of differing language and administrative procedures) and that the prioritizing might have to be done by ad hoc methods, a time penalty of two extra days was added to each lateral repair transaction, and one extra day to each lateral supply exchange.

RESULTS

Simulation Outcomes

Figures A.1 and A.2 display the simulation outcomes for the case of a single deploying squadron. Each figure compares lateral repair and supply to no mutual support for the European force (the MOB) and the U.S. force (the COB) separately. The measure of merit is the percent of fully mission capable (FMC) aircraft at each point of the 30-day scenario. Figure A.1 pertains to the placid VTMR of 1.0 dpfh, Fig. A.2 to the more turbulent value of 2.3 dpfh. In neither instance is there detriment to the performance of the host MOB due to mutual support, whereas by the end of 30 days, the U.S. squadron benefits between 14 and 17 percent, or between three and four FMC aircraft. In Fig. A.1, allied mutual support affords some small advantage also to the MOB, ostensibly because of lateral supply.

Similar results were obtained for the condition of two deploying U.S. squadrons, except that the added scale for sharing increased the benefits to both COB and MOB by several percentage points. With VTMR = 2.3 dpfh, for instance, allied mutual support was seen to provide the combined force of 84 F-16s with 11 additional FMC aircraft at day 30.

⁴For fuller explication of VTMRs, see Crawford (1988) and Hodges (1985)

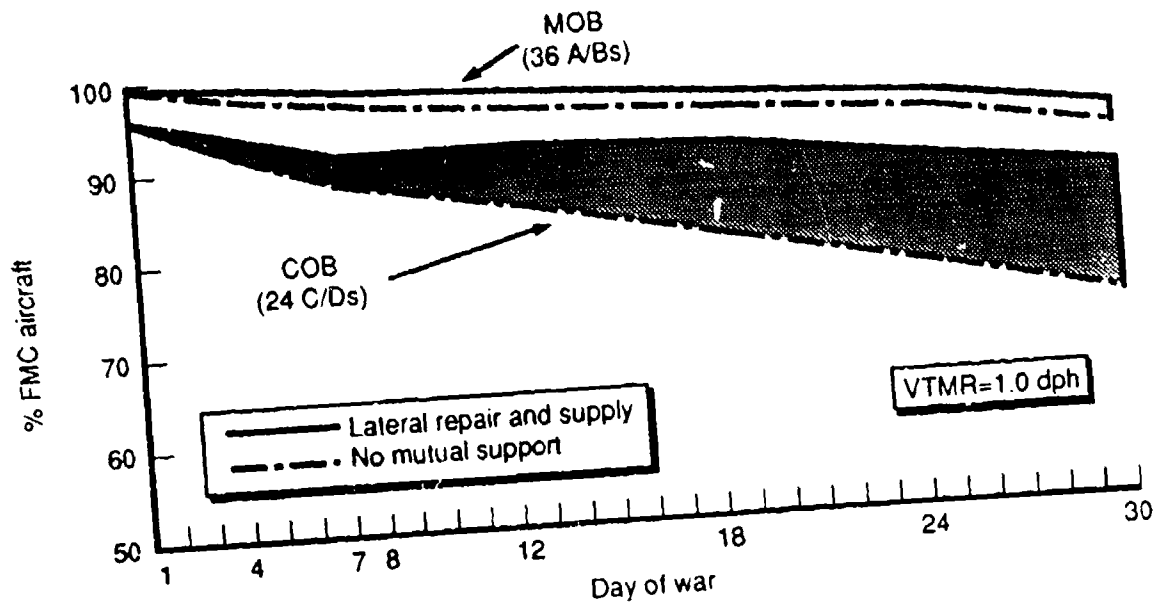


Fig. A.1—Allied mutual support effects: One deploying squadron with VTMR = 1.0 dph

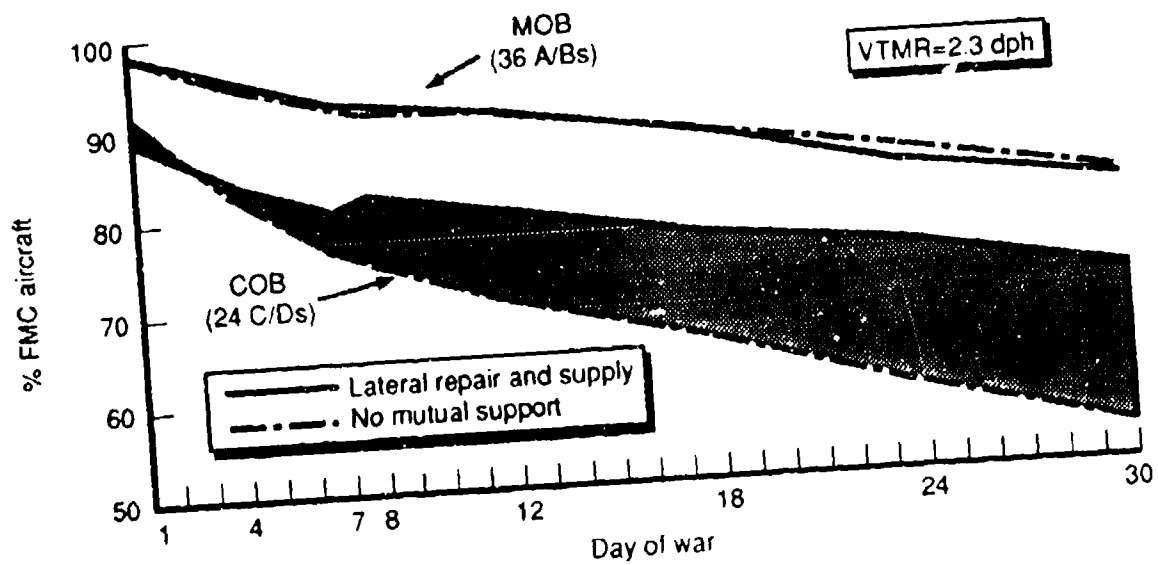


Fig. A.2—Allied mutual support effects: One deploying squadron with VTMR = 2.3 dph

These simulation outcomes compare favorably with previous RAND findings where the aircraft all were identical. Here, the A/B and C/D aircraft were represented by 229 and 226 components, respectively, of which only 102, or 45 percent, were common to both. As a consequence, the effect of lateral supply by itself (4 percent FMC improvement at day 30 for the COB) was small compared with that of lateral repair by itself (12 percent FMC improvement at day 30).

The cost and effort to achieve coalition lateral supply no doubt would be less than that of keeping host nation repair facilities always upgraded to support the latest F-16 modifications. This type of consideration adds complexity to the cost-benefit equation that further research in this area would need to explore.

Obviously, different parameters for the scenario—such as a more strenuous flying program, less repair capability on the part of the MOB, or longer repair and supply transaction times—could lead to results at variance with those shown. Hence, examination of scenario sensitivities would need to be done before Figs. A.1 and A.2 could be construed as more than merely illustrative.

Policy Implications

If base level mutual support of F-16s and other aircraft between the United States and its allies were to be found feasible and advantageous, several policy implications are imaginable. One is that USAF might need to arrange with allies to keep their repair facilities compatible with U.S. equipment, then practice lateral supply and repair during peacetime either as an everyday matter or by means of frequent exercises.

A further implication might be that U.S. units deploying to allied bases having the compatible repair capability delay or forgo deployment of their own organic capabilities other than engine repair. Yet another implication, this one transcending USAF alone, might be that allied nations having F-16s engage in increased mutual supply and repair among themselves.

Appendix B

SOURCES

SITE VISITS

The preponderance of information and opinion presented was derived from site visits documented by informal trip notes not explicitly referenced in the text. Below is a list of facilities at which substantial interviews or information exchanges were carried out.

NORTH ATLANTIC TREATY ORGANIZATION (NATO)

NATO Headquarters, U.S. Mission and Military Delegation
SHAPE (Supreme Headquarters Allied Powers Europe), LOGMAN Division
SHAPE Technical Centre
NAMSA (NATO Maintenance and Supply Agency) Headquarters

DEPARTMENT OF DEFENSE

Non-Air Force

DARPA/ASTO (Defense Advanced Research Projects Agency/Aero-Space Technology Office)
DISAM (Defense Institute of Security Assistance Management)
DSAA (Defense Security Assistance Agency)
DTSA (Defense Technology Security Agency)
EUCOM (European Command) Headquarters
FEMA (Federal Emergency Management Agency)
NDU/MCDC (National Defense University, Mobilization Concepts Development Center)
OJCS/J4-LRD(IL) (Office of the Joint Chiefs of Staff, International Logistics)
OSD/P&L-IL (Office of the Secretary of Defense, Production and Logistics-International Logistics)
OSD/P&L-P/IA (Office of the Secretary of Defense, Production and Logistics-Production/International Acquisition)
OUSDRE (Office of the Under Secretary of Defense, Research and Engineering)

Air Staff

CVAIP (Office of the Vice Chief of Staff, International Affairs Division, Foreign Disclosure Policy Office)

LEXX (Logistics and Engineering, Logistics Plans)

LEY (Logistics and Engineering, Maintenance and Supply)

LEYY (Logistics and Engineering, Maintenance and Supply, Aircraft Systems)

PRIE (Directorate of International Programs, Asia Division)

PRIM (Directorate of International Programs, Policy and Management)

PRIP (Directorate of International Programs, Weapons Programs)

Other USAF

AFIT (Air Force Institute of Technology)

AFLC/ALC-OC, E-3 AWACS System Program Manager

AFLC/ALC-OO, F-16 Fighting Falcon System Program Manager

AFLC/CASEUR (Air Force Logistics Command, Contracts Administrative Services Europe)

AFLC/ILC (Air Force Logistics Command, International Logistics Center)

AFLC/XPS (Air Force Logistics Command, Management Science)

USAFE (U.S. Air Forces Europe) Headquarters

552nd AWACS Wing, 28th Air Division, Tinker Air Force Base

COMMERCIAL FIRMS

British Aerospace

Rolls Royce

Pratt & Whitney Overhaul and Repair Center-Europe

CONSULTANTS

Three consultants to RAND played valuable roles in providing information and guiding the investigation:

Trafton J. Loveland, U.S. Mission to NATO, retired 1988—for 21 years Director of NATO's Infrastructure, Logistics, and Civil Emergency Planning Division; member of NAMSO Board of Directors.

William A. Smiley, Col. USAF, retired 1988—Director of the Joint Chiefs of Staff Logistics Concepts and Analysis Division (1985–1988); Senior Staff Officer for Logistic Plans and Operations, Allied Forces Central Europe (1976–1980).

David E. Watts, MG USA, retired 1986—Director of Logistics and Security Assistance, U.S. Central Command (1983–1986); Deputy Chief of Staff for Logistics, U.S. Army Europe (1980–1983).

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