AD-A113 929 RAND CORP SANTA MONICA CA F/G 15/7
AIR INTERDICTION: LESSONS FROM PAST CAMPAIGNS,(U)
SEP 81 E DEWS, F KOZACZKA MDA903-80-C-0412
UNCLASSIFIED RAND/N-1743-PAE SBI-AD-E750 417 NL

1 OF 1
AD A
113929

END
DATE
FILMED
05-82
DTIC

AD-E750417

AD A113929

A RAND NOTE

AIR INTERDICTION: LESSONS FROM PAST CAMPAIGNS

Edmund Dews, Felix Kozaczka

September 1981

N-1743-PA&E

Prepared For

The Office of the Assistant Secretary of Defense/Program Analysis and Evaluation

Rand
SANTA MONICA, CA. 90406

82 04 26 009

The research described in this report was sponsored by the Office of the Assistant Secretary of Defense/Program Analysis and Evaluation under Contract No. MDA903-80-C-0412.

The Rand Publications Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

Published by The Rand Corporation

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(12)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER N-1743-PA&E	2. GOVT ACCESSION NO. AD-A113 929	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Air Interdiction: Lessons from Past Campaigns		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Edmund Dews, F. Kozaczka		8. CONTRACT OR GRANT NUMBER(s) MDA903-80-C-0412
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Rand Corporation 1700 Main Street Santa Monica, CA. 90406		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Assistant Secretary of Defense Program Analysis and Evaluation Washington, DC 20301		12. REPORT DATE September 1981
		13. NUMBER OF PAGES 62
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release: Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

No Restrictions

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Area Denial
Tactical Bombing
Active Defense
Military Strategy
Military Intelligence
Military Research

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See Reverse Side

DD FORM 1 JAN 73 1473

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Presents the results of research on air interdiction in World War II, the Korean War, and the war in Southeast Asia. It outlines the lessons that can be learned from experience with air interdiction of ground-force operations, and suggests a number of factors that should be considered in planning and conducting an interdiction campaign. Section II describes the many different kinds of interdiction payoffs that have been sought and emphasizes their dependence on the specifics of the military situation on the ground. Section III describes the wide range of possible interdiction targets and discusses problems of matching targets with suitable weapons. Section IV illustrates the uncertainties that appear to be inherent in planning and conducting interdiction operations and emphasizes the need for timely intelligence, especially as to enemy responses. Finally, Section V provides what is, in effect, an annotated checklist intended for the use of those who are concerned with contingencies in which interdiction operations might be assigned a significant role.

12

A RAND NOTE

AIR INTERDICTION: LESSONS FROM PAST CAMPAIGNS

Edmund Dews, Felix Kozaczka

September 1981

N-1743-PA&E

Prepared For

The Office of the Assistant Secretary of Defense/Program Analysis and Evaluation

Rand
SANTA MONICA, CA. 90406

PREFACE

In September 1980 The Rand Corporation undertook a one-year study for the Director of Special Regional Studies in the Office of the Assistant Secretary of Defense (Program Analysis and Evaluation) on air interdiction in the Middle East. The main objective of that study was to determine the potential capabilities of U.S. aircraft to interdict invading ground forces. The results would identify effective aircraft, weapon systems, and concepts of operation. They would be useful in assessing the feasibility of alternative strategies for military operations in the Middle East and in suggesting ways to improve U.S. air interdiction capabilities.

This Note presents the results of supporting research on air interdiction in World War II, the Korean War, and the war in Southeast Asia. It outlines the lessons that can be learned from experience with air interdiction of ground-force operations, and suggests a number of factors that should be considered in planning and conducting an interdiction campaign.

This Note* should be useful to those in the Department of Defense who are concerned with the development of plans and capabilities for air interdiction in third-area contingencies that might occur in the future.

---

*Owing to a transcription error, some cross-references to the present Note in advance of its publication identified it as N-1742-PA&E (instead of the correct N-1743-PA&E).

SUMMARY

One of the most important conclusions to be drawn from an unbiased examination of interdiction experience is that the outcomes seldom came close to the expectations of the interdiction planners. Even when an interdiction effort has been judged successful, the achievement has not infrequently been quite different from the original objective. Misperceptions as to what was feasible, misunderstandings about the appropriate payoffs to be sought, differences of opinion as to the most suitable targets, and misevaluations about what was actually being accomplished were common in past interdiction campaigns.

Nonetheless, the interdiction mission provides some outstanding examples of the successful use of tactical airpower. And a succession of U.S. air commanders in three wars have chosen to allocate a large share of tactical air resources to the mission. In Korea and Southeast Asia, interdiction claimed something like half of all U.S. ground-attack sorties. As shown here in an Appendix on the Korean War, the interdiction sorties flown in that conflict totalled some 320,000, or nearly 9000 sorties a month on the average.

Almost every element of military strength and route structure can be an interdiction target, and on occasion has been. The focus here is on the interdiction of ground-force operations on land, including the movement of maneuver units, support and logistics elements, and supplies. Attacks against industrial targets, shipping and ports, air transport aircraft and facilities, and airbase runways are not addressed. In some military writings there is a tendency to define air interdiction narrowly in terms of attacks against fixed elements of route structure such as bridges, or even more narrowly in terms of route structure attacks that have supply denial as their objective. There is no justification for this limited view either in doctrine or experience. Where interdiction of ground operations has been unequivocally successful in the past, more often than not the target system included moving targets and the major payoff involved effects on force deployment rather than supply delivery.

The payoffs from air interdiction of ground-force operations are multiple, complexly interrelated, highly situation-dependent, and often difficult to assess, especially in advance. They include *destruction* of forces or supplies, *delay* in force or supply arrival or buildup, *diversion* of valuable resources from other uses, and *disruption* of control (that is, degradation of the efficiency with which the interdicted side can employ its assets).

One reason that interdiction payoffs are difficult to assess is that disruption of control, while acknowledged to be of great importance when it can be achieved, is not yet amenable to quantitative analysis. We do not know how to quantify the effects even of direct attacks against an enemy's command and control facilities, much less the effects of interdiction-caused disruption. Another reason is that the payoffs achieved through interdiction are usually quite sensitive to enemy choices, for example, he can accept delays so as to reduce his exposure to (and hence his losses from) air attack. Delays may or may not involve a substantial penalty. The value of delay can seldom be understood in terms of such "absolute" metrics as increased length of travel time or buildup time, or decreased speed: it must be assessed in terms of a particular operational context and the relative timing of events within that context. What the interdictor can do to improve his position in the time he may gain through interdiction is critical in assessing the value of delay--and hence in judging the payoff from the interdiction effort.

Because the interdicted side normally has a choice of several responses and a variety of possible active and passive countermeasures--trading off exposure for delay is only one example--a good interdiction plan anticipates enemy reactions and assesses the possible success of interdiction partly in terms of the costs each response imposes on the enemy if he chooses to adopt it. Too often in the past those responsible for planning and conducting an interdiction campaign have failed to perceive that they were engaged in a highly interactive measure-countermeasure operation, where the degree of success often depended on quick learning and a steady flow of timely information about enemy reactions.

Typically those who have planned and conducted air interdiction operations have been too optimistic; this is especially true of supply interdiction campaigns where in some instances the ambitious objective (never achieved) has been to force the interdicted side to withdraw because of supply shortages alone.

This optimism among U.S. planners has been the natural result of overestimates of enemy supply needs (perhaps conditioned by the very high consumption rates of U.S. units), together with underestimates of the flexibility and adaptability of transportation systems under attack. Given single-point estimated values for such logistic parameters as route-segment capacity, number of vehicles, inter-vehicular distance, speed of movement, hours operated per day, bridge and roadway repair times, and the like, one could calculate throughput rates for supplies or maneuver units. These calculations often appeared convincing, but they have turned out to be deceptive. Almost always they have been static or steady-state calculations ignoring quicker-than-average repair times, surge movements, network expansion, and other dynamic effects; they could seldom replicate accurately the full extent and complexity of the route networks; and they have almost always been deterministic, unable to represent realistically the effect of probabilistic inputs when the probabilities were other than zero or unity. (How, for a complex network, does one calculate the effect on aggregate throughput over time of dropping a bridge span with a probability of, say, 0.8, especially when span replacement times are estimated in a wide range rather than known precisely, and when there is some nonzero probability that a usable bypass exists?)

Some of these difficulties can no doubt be overcome in principle by means of computer-based models using Monte Carlo techniques, but the uncertainties surrounding many of the key inputs are likely to remain so large that modeling will provide at best only a gross indicator of network throughput capability under attack.

Although no general prescription can be given for interdiction success, experience and common sense suggest a number of factors that should be considered in planning and conducting an interdiction campaign.

1. Good pre-campaign intelligence is of prime importance for the interdictor, especially as to the physical environment, the most likely locations of assembly areas and supply depots, the details of route structure, the availability of route-repair materiel and temporary bridging, the natural and man-made opportunities for cover and concealment, the availability of local labor, and the strength of the enemy's air defenses.

2. Intra-campaign reconnaissance with good coverage in time and space is required by the interdictor for efficient targeting and quick response to enemy countermeasures, and is especially important when the interdictor is operating at the margin of his ground-attack capability, with no excess sorties available.

3. Enemy sanctuaries and the interdictor's rules of engagement can be critical in assessing the prospects for interdiction success: they may limit the areas that can be attacked, the frequency of attacks, and the types of permissible targets and weapons: and they may increase decision times in responding to enemy countermeasures.

4. The operational situation in the ground war is favorable for interdiction when the enemy (a) has an urgent need for movement for deployment or supply, (b) is highly mechanized and relies mainly on vehicular movement, and (c) is a naturally high consumer with few supplies forward when interdiction begins.

5. Mutually supportive air and ground operations by the interdicting side have characterized almost all successful interdiction campaigns although they have not always been so planned. Ground *offensives* that required the enemy to redeploy forces or consume supplies at a high rate have served both to create the conditions favorable for interdiction attacks and to exploit the results of those attacks. Such mutually supportive operations are much easier to plan for and achieve when the interdicting side is strong and has the initiative both on the ground and in the air. The U.S. force-interdiction effort early in the Korean War is a rare instance of successful interdiction when the enemy had the initiative on the ground.

6. The enemy's physical vulnerability to interdiction attacks is enhanced if his vehicles are easy to find on and off the roads, if good anti-vehicle air-to-ground weapons are available, and if the interdictor has the ability to find and attack vehicles at night. The lack of good nighttime capability has been a principal reason for the poor success of many interdiction campaigns. Enemy vulnerability is favored if the routes he uses have segments (such as bridges) that are easy to find and destroy, difficult to repair or replace, and difficult to bypass. The nature of the route *network* is important because it interacts with vehicle and route-segment vulnerability in determining the overall physical vulnerability of the enemy's movement system. A network favorable for interdiction is one that is sparse, with low-capacity segments, and choke points located so that a small number of cuts can produce major reductions in throughput, at least temporarily.

7. Limited enemy movement capability before interdiction begins favors the success of the campaign. "Capability" depends not only on network capacity but also on the availability of vehicles, fuel, manpower, and other inputs. Uninterdicted transport systems, even where the route network is sparse, are usually characterized by throughput capabilities many times larger than military *supply* requirements. In general, demand will press movement capability closest when the interdicted side is attempting urgent force movements, for maneuver units require many more vehicles and much more fuel and route capacity than would be needed for the supply flow required to sustain those units.

8. Ability to identify the enemy's scarcest transport inputs favors interdiction success. All the elements of movement capability are not equally scarce, and therefore some inputs can be attacked without appreciably reducing enemy throughput; this has sometimes been the case with route capacity and at other times with vehicles. An efficient choice of targets requires consideration of both vulnerability and scarcity.

9. With few exceptions, successful interdiction campaigns have been characterized by ample interdiction sortie availability. The availability of precision-guided weapons for bridge destruction will somewhat reduce sortie requirements, but large numbers of sorties are still likely to be required until fighter-bombers can readily acquire moving targets at night and in adverse weather and then achieve multiple kills per sortie.

10. Continuous application of interdiction pressure favors interdiction success, and is probably required for successful supply interdiction. This implies the availability of aircraft with night and adverse-weather capabilities and sufficient sorties so that competing demands for other missions will not cause gaps in the interdiction effort.

11. Enemy ground-based air defenses can be a serious constraint on interdiction effectiveness, as demonstrated in both Korea and Vietnam. In future campaigns enemy possession of highly capable air defense missiles and rolling air defenses appears likely to make this constraint even more serious. As a result, aircraft attrition rates may be somewhat increased, but to judge from past experience the principal consequence is likely to be a reduction in per sortie attack effectiveness: target acquisition degraded before weapon release, weapon accuracy degraded during delivery, and damage assessment degraded after weapon impact. This, together with the probable allocation of sorties for suppression of air defenses, reinforces the conclusion that large numbers of sorties will continue to be needed for interdiction success.

12. Almost without exception, the successful interdictor has possessed air superiority--usually theater-wide superiority. There are only a few instances in which interdiction was even attempted without it. If in the future an enemy combines formidable airpower with the initiative on the ground and strong ground-based air defenses, the competing demands of air-to-air combat, close support, defense suppression, and possibly airbase attack may impair the effectiveness of interdiction even when other conditions appear favorable. Certainly against such an opponent the prospects for successful, sustained *supply* interdiction appear slender indeed.

ACKNOWLEDGMENTS

The authors are grateful for helpful suggestions from a number of colleagues, including T. T. Connors and Donald E. Lewis at Rand, and Thomas L. McNaugher (now at Brookings). The Note benefited particularly from the comments of Lewis M. Jamison and T. M. Parker at Rand, who reviewed an earlier version. The interpretations of interdiction experience offered here are, of course, the authors' own.

NOTE ON SOURCES AND REFERENCES

Air interdiction operations have generated a vast literature, much of it prepared during wartime by U.S. and Allied military organizations in the form of internal papers and memoranda. A fully documented study would necessarily refer to this material. However, much of this material, especially the more quantitative part of it, is not generally accessible; for various technical reasons many of the most relevant documents still retain some degree of security classification and are therefore inappropriate for direct citation in a publication such as the present Note.

The purpose of the work reported on here was not, however, to prepare a documented history of interdiction, much less to provide a guide to the literature. Rather, the purpose was to distill the "lessons learned" from interdiction experience (as the authors see them), and to present these lessons in brief and readily accessible form. Therefore, relatively few citations are given, and these are, of course, all from the open literature.

CONTENTS

I. INTRODUCTION

The potential of air interdiction is now being evaluated in connection with force-projection contingencies and scenarios involving the use of rapid-deployment forces in third areas. The purpose of this Note is to aid in this evaluation by outlining the lessons that can be learned from past experience with the interdiction of ground-force operations on land.

The "lessons learned" are generalizations derived from the authors' continued study of a large number of interdiction campaigns, including World War II interdiction in the Western Desert and elsewhere in North Africa, STRANGLE and DIADEM in Italy, and the Transportation Plan-Interdiction Program preceding and accompanying the Allied landings in Normandy; Korean War interdiction, especially force interdiction in the early weeks of the war and the Stringle I, Strangle II, and Saturate supply interdiction operations in 1951 and 1952; and, in the war in Southeast Asia, the series of "out-country" campaigns against North Vietnam's supply system.

The text draws inferences and examples from these campaigns, but does not attempt to describe them in detail or put them in historical context; it is assumed that the reader will be sufficiently familiar with recent military history so that this is unnecessary. An Appendix on interdiction in Korea is added, however, for those who may wish more detail. The Korean War, especially in its early weeks, has many features similar to those to be found in some of the third-area scenarios now of interest.

Section II describes the many different kinds of interdiction payoffs that have been sought and emphasizes their dependence on the specifics of the military situation on the ground.

Section III describes the wide range of possible interdiction targets and discusses problems of matching targets with suitable weapons.

Section IV illustrates the uncertainties that appear to be inherent in planning and conducting interdiction operations and emphasizes the need for timely intelligence, especially as to enemy responses.

Finally, Section V outlines the findings of the study in terms of the major factors that have influenced interdiction success. It provides what is, in effect, an annotated checklist intended for the use of those who are concerned with contingencies in which interdiction operations might be assigned a significant role.

II. INTERDICTION PAYOFFS

The payoffs from air interdiction of ground-force operations are multiple, complexly inter-related, highly situation-dependent, and often difficult to assess, especially in advance.

The underlying interdiction scenario considered here is one in which the enemy to be interdicted is moving or desires to move his ground combat forces and/or their supplies or other elements of logistics support.* For example, the interdicted side may be invading territory, repositioning supplies, massing for a breakthrough, pursuing defeated forces, redeploying or reinforcing to resist attack, or withdrawing or retreating. In such a scenario, interdiction payoffs include the following components, often so overlapping and mutually reinforcing that it is difficult to discuss one without the other:

- *Destruction* or attrition of forces (maneuver units) and their support elements and supplies while en route either moving or temporarily stationary.
- *Delay*
  - the delayed arrival of particular units and/or supplies (slowed movement).
  - the delayed buildup of combat strength (units and/or supplies) due to a reduction in the rate of throughput (rate of throughput depends on the speed of movement, the quantity being moved, and losses en route to the destination).
- *Diversion* of resources, for example, combat and logistics assets used to defend the route, repair damage to route structure, prepare bypasses, and the like, and thus not available for other employment. Sometimes the enemy's nonmilitary manpower and other civilian assets are also diverted from other tasks in attempts to keep routes open.

---

*Thus some varieties of interdiction are not directly addressed here, for example, "source interdiction" (attacks against factories, oil refineries, and bulk, nonmilitary storage facilities); naval blockade and attacks on watercraft, waterways, and ports; attacks against air transport aircraft and facilities; and airbase runway interdiction.

- *Disruption* of control:

  If many of the enemy's units are slowed and attrited, if they are subjected to repeated, unpredictable delays and losses, and if their precise strength and location are not known to their higher echelons, the result can be described as disruption: a reduction in the ability of enemy commanders to plan and control the time-coordinated, mutually supporting moves of subordinate units. Disruption of this kind is a degradation of the efficiency with which assets can be used and hence, in its effects, it is similar to successful attacks against command, control, and communication (C^3) facilities.*

One of the reasons that interdiction payoffs are difficult to assess in advance is that the balance among the different effects is often very sensitive to the enemy's response. He has choices. For example, by bulling through he may be able to maintain speed but have to pay a heavy cost in attrition. Or, by accepting some delay (by moving mainly at night, for instance) he may be able to avoid serious attrition. Or, by increasing the resources committed he may be able to meet his movement goals in terms of both the timing and quantity of arrivals, but at the cost of substantial attrition en route, or of opportunities foregone for using the resources elsewhere, or of both.

Destruction of forces and their support elements and supplies en route is both an end in itself--the elements destroyed are permanently stopped and cannot be used in current or subsequent operations--and a means of achieving other interdiction payoffs. *The destruction of route structures* is usually not an end in itself, but must be evaluated in terms of its contribution to delay, diversion, and disruption.†

The demonstrated ability to destroy may sometimes be enough to achieve

---

*In general, the better the enemy's C^3, the harder it will be to achieve disruption through interdiction attacks. Note, however, that such attacks may force the interdicted side to increase the use of its C^3 facilities to reduce the disruptive effects of interdiction; and increased use of these facilities may have a cost in terms of their greater exposure to detection and hence their vulnerability to attack.

†Destruction of route structures can sometimes be counterproductive if it subsequently inhibits the interdictor's ground-force movements.

substantial delay and diversion of resources, for example, in causing the enemy to travel only at night or to mass air defenses (useful elsewhere) around critical route segments such as bridges. Engineer resources may be diverted from other tasks to the preparation of bypasses and alternative routes in anticipation of need, even when route structures remain largely undamaged.

Delay of one kind or another is typically a major element in the set of interdiction payoffs;* for example, delay in closing to contact, or in reinforcement, or in achieving a buildup of forces or supplies before an attack begins. We speak of delay rather than absolute immobilization, because, realistically, ground-force movements are almost impossible to stop for long periods. When a vehicle is destroyed, it is stopped, true, but the maneuver unit or supply convoy usually continues, perhaps after a short interval or even without slowing. But absolute stoppage is generally not necessary for meaningful interdiction payoffs. Effective delay is a matter of the right degree. Longer is often better. But usually (as in reinforcement of a threatened sector) there is a critical timing threshold. If the arrival of the reinforcements is delayed beyond a certain time, their usefulness in that operation rapidly diminishes, and additional delay may have little additional payoff. On the other hand, if the reinforcements arrive "in time," even if their movements are substantially slowed en route, there may be little payoff from delay.

The value of delay can seldom be expressed directly in terms of "absolute" metrics such as increased length of travel or buildup time or decreased speed ; it must be assessed in terms of a particular operational context and the *relative* timing of events within that context.

If the enemy is delayed, the interdictor gains time. But what the interdictor does or can do to improve his position in the time gained is critical in assessing the value of delay--and hence in judging the overall outcome of the interdiction effort. Strength in the air and a systematic interdiction plan courageously executed are not necessarily enough; time-urgent movement by the interdicted side is usually required for delay to have major payoffs.

---

*For tactical interdiction, at any rate. See Edmund Dews, *A Note on Tactical vs. Strategic Air Interdiction*, The Rand Corporation, RM-6239-PR, 1970.

Time urgency can arise through various causes, for example, the interdicted side may be seeking to take advantage of surprise, or to seize territory before the interdictor's ground forces can reach their planned defensive positions, or to defeat ground forces friendly to the interdictor before he can reinforce them. Such time-urgent scenarios are now of interest both for NATO planners and for those concerned with the design and potential effectiveness of rapid deployment forces.

Clearly it is an advantage for the interdictor if he is in a position through his own ground operations to *make* his opponent attempt highly time-urgent movements. And it is even more of an advantage for the interdictor if he has the initiative both on the ground and in the air, so that he can not only force his opponent to attempt time-urgent movements, but can control their time and place, and thus reap the benefits of coordinated air-ground planning and preparation.

The Allied interdiction operations supporting the World War II landings on the continent, especially the landings in Normandy, provide examples of successful interdiction with the interdictor having the initiative. The U.S. interdiction operations in the first weeks of the Korean War provide an example of interdiction success where the enemy was initially stronger and had the initiative on the ground, but was under great pressure of time to overtake and defeat the withdrawing defender before U.S. reinforcements could arrive. Because of current U.S. interest in scenarios not unlike that in the Korean War, a summary of the Korean interdiction experience is given in an Appendix to the present Note.

Both force deployment and supply may require time-urgent movements, but urgent force deployments usually provide the better opportunity for interdiction payoffs. The reason is that the movement of maneuver units generally requires much more route capacity than is needed to provide for their resupply,* and typically presents targets more numerous, more concentrated, and (arguably) more valuable.

If the interdictor does little or nothing to exploit the delay he imposes, his opponent's movements may lack real urgency, and the result

---

*J. W. Higgins, *Military Movements and Supply Lines as Comparative Interdiction Targets,* The Rand Corporation, RM-6308-PR, 1970.

may be to shift or expand the time scale of the conflict while doing little to change the outcome of particular ground-force operations. Something like this seems to have occurred in the supply interdiction campaigns in the later phases of the Korean War when the United Nations force buildup had stopped and the U.N. ground forces had assumed a basically defensive posture. Then the main effect of interdiction appears to have been only to slow the enemy's forward accumulation of supplies and hence increase the intervals between his offensives while possibly reducing their duration--an unspectacular result very disappointing for the U.N. Command,[*] but in the circumstances at least modestly useful and possibly (as some have argued[†]) the best use of the airpower available in the theater.

Delay is often a critical element in achieving the other interdiction payoffs. For example, it lengthens the time during which ground-force columns are at risk to air attack and, if vehicles bunch up behind a damaged route segment, it can produce a more concentrated set of targets for the attacker, thus facilitating *destruction*. The attempt to avoid delay can cause enemy *diversion* of major engineering, air defense, and manpower resources to the task of keeping routes open, and this can be true not only for urgent force movements but also for long-term buildups. In both Korea and Vietnam there was a massive diversion of enemy manpower to route maintenance and bridge and bypass construction. In both conflicts some estimates placed this diversion of enemy manpower as high as half a million personnel, including large elements of the civilian work force. Delay is usually a major factor when *disruption* occurs.

The two best-known and probably most successful large-scale interdiction campaigns (STRANGLE[**] and its continuation DIADEM in Italy,

---

[*] For an excellent brief discussion of supply interdiction in Korea, see G. A. Carter, *Some Historical Notes on Air Interdiction in Korea*, The Rand Corporation, P-3452, 1966. Like many studies of interdiction, however, this paper implicitly equates "interdiction" with "supply interdiction," and thus gives insufficient attention to the success of force interdiction in the early weeks of the war.

[†] See, for example, Department of the Navy, Office of the Chief of Naval Operations, Operations Evaluation Group, *Factors Influencing the Interdiction of Land Transportation*, OEG Study No. 552, Washington D.C., 1955, p. 12 (referred to hereafter as OEG Study 552).

[**] Somewhat confusingly, the same code name was also used later for two successive interdiction campaigns in the Korean War.

and the various interdiction operations that preceded and accompanied OVERLORD in Normandy) were successes primarily because they delayed the urgent redeployment of German forces attempting to counter Allied initiatives. In these campaigns the delays imposed on force movement were sometimes severe and widespread enough to be truly disruptive, for example, the disorganized way in which elements of the Panzer Lehr Division and some other divisions in the German mass of maneuver were thrown piece-meal into the Normandy battle.*

From what has been said about the importance of delay and the way its value is sensitive to the operational situation, it has to be acknowledged that the utility of interdiction is highly scenario-dependent. In particular, payoffs from damage to route structure are difficult or impossible to assess without a rather detailed two-sided scenario that enables one to evaluate the contribution of delay. In the absence of such an evaluation, a conservative analysis will treat the effects of route-structure attack as negligible, and will usually have to value interdiction primarily in terms of the attrition imposed on enemy maneuver units and logistic support elements. Attrition is

---

*For STRANGLE in Italy, see F. M. Sallagar, *Operation "STRANGLE" (Italy, Spring 1944): A Case Study of Tactical Air Interdiction*, The Rand Corporation, R-851-PR, 1972; also United States Air Force, Assistant Chief of Staff, Studies and Analysis, *The Uncertainty of Predicting Results of an Interdiction Campaign: Saber Measures (Alpha)*, Washington, D.C., 1969 (referred to hereafter as Saber Measures (Alpha)).

The classical instance of effective disruption by air attack of the time-urgent deployment of an armored division not otherwise at risk is that of the elite and superbly equipped Panzer Lehr Division, which at the time of the Allied landings in Normandy was stationed about 150 km away near Chartres. See the comments of the Panzer Lehr commander, General Fritz Bayerlein: "Interrogation of Lt. General Fritz Bayerlein," 12th Army Group and APWIU, 9th Air Force (Advance) #63/45, 9 May 1945 (U.S. National Archives). Also--less detailed but more readily accessible--United States Strategic Bombing Survey, Military Analysis Division, *The Impact of the Allied Air Effort on German Logistics*, Survey Volume 64a, Washington, D.C., 1947, pp. 34, 46, 135. In addition, *The Rommel Papers* (edited by B. H. Liddell Hart, New York, 1953) provide many important insights into the nature of the disruption produced by air interdiction, e.g., the remarks of Field Marshal Von Kluge at p. 485.

indeed sometimes the principal interdiction payoff--and a highly vaulable one--as it was in the U.S. armed reconnaissance attacks against enemy armored columns at the beginning of the Korean War (a true interdiction campaign although not always recognized as such). But as this Korean example illustrates, the value of attrition depends not only on its magnitude but on where and when the attrition is imposed.

In general, *attrition appears to be the payoff with value least sensitive to the particulars of the operational situation*--less sensitive, that is, than the value of delay itself and the payoffs (diversion and disruption) to which delay is a major contributor.* But *any assessment of interdiction that attempts to be scenario-free and gives credit only to force and logistics attrition may be seriously incomplete,* capturing only a fraction of potential interdiction payoffs. Nonetheless, if attrition is sufficiently heavy, this payoff alone may sometimes be enough to make air interdiction appear attractive.

---

*Attrition like delay is not a "pure" payoff. Attrition (or the threat of attrition) may have some indirect payoffs through the diversion of resources from employment elsewhere, for example, air defense resources. If attrition is heavy enough to be nearly catastrophic, disruption might also emerge as a payoff even in the absence of delay considerations. Destruction of vehicles contributes, of course, to delay; and if a sufficiently large percentage of a unit's vehicles is destroyed, the whole unit may be put out of action for a considerable time, and in this sense "delayed." Destruction of vehicles and supplies en route either reduces the rate of supply buildup below that desired or requires the interdicted side to increase the volume of inputs to compensate for attrition.

III. INTERDICTION TARGETS, WEAPONS, AND PLANNING

Almost every element of military strength and route structure can be an interdiction target, and on occasion has been. In some military writings there is a tendency to confine interdiction to attacks against route structure, and sometimes to restrict it even further to those attacks against route structure that are designed to slow supply movement or reduce the rate of supply buildup. There is no justification for this narrow view. It is not supported by official Service definitions of the interdiction mission, nor is it grounded in historical experience. Interdiction is a broad concept. It is often convenient, however, to distinguish different target sets--fixed and mobile, for example--or different objectives such as those of force (mobility) interdiction, supply (logistics) interdiction, and source (industrial) interdiction.

Any list of potential interdiction targets should therefore be broadly comprehensive, including at least the following for the interdiction of ground-force operations on land:

- Forces (maneuver units), including armored and soft vehicles, tracked and wheeled vehicles
  - in assembly areas
  - moving en route
  - stationary between moves, e.g., in bivouac or awaiting route repairs
- Supply vehicles and support equipment
  - in rear-area depots
  - moving
  - stationary between moves, e.g., in bivouac or in forward depots
- Fuel
  - in depots in the rear and forward
  - in tank trucks and rail cars, moving or stationary between moves
  - fuel pipelines, "tactical" or permanent
  - pipeline pumping stations

- o Supplies other than fuel (cargo)
  - in rear-area depots
  - on carriers, moving or stationary between moves
  - in forward depots
- o Route structure
  - roadways and rail lines
  - bridges, viaducts, and culverts
  - temporary bridges and bypasses
  - ferries
  - tunnels and underpasses/overpasses
  - landslide areas
  - intersections
  - transshipment points
  - railway marshalling yards
  - fixed sources of power, e.g., railway electric power generators
- o Ground-based air defenses
  - moving
  - stationary between moves

Effective weapons are the often neglected key to successful interdiction operations.

No army was ever more dependent on a long and exposed supply line than the German-Italian forces in North Africa under Rommel--often they depended on a single coast road hundreds of miles long without the benefit of natural cover or even the protection of bad weather. It was a perfect set-up for interdiction. There *was* substantial interdiction success; supplies were always a serious problem, and air attack aggravated the problem; but for more than a year enough got through to sustain Rommel as a formidable threat to Suez and the Allied position in the Middle East. Various factors contributed to this somewhat disappointing result, but the main reason was that the small but efficient RAF forces in the theater were poorly equipped for interdiction attacks. There were few bombers,* many fighters were

---

*Roderick Owen, *The Desert Air Force*, London, 1945, p. 109.

capable of ground attack only by strafing with machine guns, and fighter-bomber bomb loads seldom exceeded one or two bombs with an aggregate weight of 500 lb.* Machine gun calibers were often too small and the rounds carried too few for really good strafing effectiveness per sortie, even against trucks. The availability of precision-guided electro-optical and laser-guided bombs, cluster-bomb units (CBUs), 20- or 30-mm cannon, or Maverick air-to-surface missiles would probably have transformed the situation dramatically.

Even late in World War II, in the air operations supporting the Normandy invasion (where the Allies had air supremacy, the sky was filled with Allied aircraft--5000 to 10,000 sorties *per day* were not uncommon--and air-to-ground rockets were available) the air forces found it difficult to kill armored vehicles in substantial numbers. The Panzer Lehr Division, which, as already mentioned, was badly mauled by air attack and lost unit integrity as a result of destruction and delays, suffered relatively few *tank* losses in its march to the Channel; its losses were mainly in soft vehicles.† The losses of unarmored vehicles, which included many fuel tankers, were serious indeed, but if effective anti-armor weapons had been available, this division would probably have ceased to exist as a fighting force before it reached the battlefield.

---

*Ibid., pp. 76-77, 89, 126, 215.

†Bayerlein, op. cit., p. 3. Perhaps the best evidence of the relative invulnerability of tanks to direct air attack by Allied fighter-bombers is given in a Royal Air Force survey of the vehicles left behind by the Germans in their precipitous escape from the Falaise pocket in August 1944: Royal Air Force Bombing Analysis Unit, *The German Retreat Across the Seine in August 1944*, Report No. 44 [London? 1946?], pp. 8-9, referred to hereafter as RAF Bombing Analysis Report 44. Out of some 40,000 to 45,000 motor vehicles and 800 tanks involved in the retreat, hits by direct air attack account for the loss of 9 percent of the motor vehicles, but for only 2 percent of the tanks. However, because of the fuel losses and congestion due to direct air attack, an additional 6000 to 8000 vehicles had to be abandoned, including most of the tanks.

Bridges have attracted attention as interdiction targets since the fledgling interdiction attempts in World War I. They normally represent choke points in route networks, they are usually easy to find from the air, they are often very difficult to bypass, and (compared with most other route structures) they take a long time to repair. Once seriously damaged, they lend themselves to good damage assessment. The problem has been to achieve real damage, such as destroying a pier or abutment or dropping a major span. In the past, with aircraft armed with free-fall bombs, sometimes hundreds of sorties were flown in vain against a single bridge. In the massive attacks against the German transportation system in World War II, bridges were only occasionally chosen as specific targets for the heavy bombers because they were regarded as so difficult to hit.* Instead, large area-type targets such as railway marshalling yards were generally preferred for heavy-bomber attacks, with bridge damage sometimes occurring as a by-product. Although medium bombers coming in at lower altitudes sometimes had considerable success in attacks against bridges in World War II and Korea, bridges continued to be quite difficult to damage until toward the end of the Vietnam War, when laser-guided bombs became available. Today, with various types of precision-guided bombs in or about to enter the inventory, bridges have become much easier to damage, at least in daylight and moderately good weather.

The greatly enhanced effectiveness of the new aircraft cannon and air-to-ground munitions suggests that interdiction may now be a more attractive use of airpower than ever before--*when* the operational situation is favorable and *if* the interdicting aircraft are not subject to unacceptable attrition or forced to adopt inefficient delivery profiles so as to enhance their survivability.

Another new factor that probably favors interdiction in certain scenarios is the growing mechanization and enhanced consumption rate of ground-force units in modern mobile warfare. Modern armies ride

---

*Edmund Dews, *NATO Inland Transport as a Potential Rear-Area Target System: Lessons from German Experience in World War II*, The Rand Corporation, N-1522-PA&E, 1980, pp. 13-19. Also Sallagar, op. cit., pp. 34-35.

to battle and require numerous support vehicles. Since World War II the number of vehicles in an armored or mechanized division has increased from two to three thousand to four thousand or more, and the size and weight of many vehicles has increased. Increased route capacity is therefore required for both redeployment and resupply, whereas ability to move across country has not improved conspicuously and in some instances may have actually declined.

The problem of the interdiction planner is to match his air resources (taking target acquisition, weapons, and delivery accuracies into account) against a set of targets which, if destroyed or damaged, will produce the most favorable *net payoffs* in the context of the particular operational situation. "Net payoffs" are emphasized because each target set implies a different payoff if damaged or destroyed, and a different cost, either in terms of aircraft lost or in terms of sorties diverted from other uses possibly of higher value. Moreover, each target-set/operational-situation implies a different commitment of air resources over time.

If, for example, attacks are initially confined to the suppression of ground-based air defenses, then subsequent attacks against forces, supplies, or route structure may be too late to achieve a significant payoff. Attacks intended to delay supply buildup usually, and attacks against route structure often, require the continuous application of air resources over time--over many days and sometimes many months. Without such a commitment and follow-through, the interdiction operation may fail completely; and the follow-through may be difficult to achieve because of rising, unforeseen demands for other uses of the same air resources, or simply because of restricted visibility or critical gaps in damage assessment. Moreover, even if supply interdiction is successful, the payoffs are often long deferred.

For these reasons there is growing awareness that attacks against forces en route--against maneuver-unit vehicles--can be particularly attractive if the operational situation is suitable: the target is fleeting but usually concentrated compared with resupply convoys; only a short-term commitment of air resources is needed to earn some immediate dividends; and experience suggests that such dividends can sometimes be very high indeed.

IV. MISEVALUATIONS, UNCERTAINTIES, AND COUNTERMEASURES

One of the most important conclusions to be drawn from an examination of interdiction experience is that the outcomes seldom came close to the expectations of the interdiction planners.

Even when an interdiction effort has been judged successful, it has been common for the achievement to be different from the original objective. Long-term supply interdiction was the primary objective in STRANGLE in Italy and the interdiction campaigns in Southeast Asia. But short-term delay of force redeployment was the main payoff in Italy.* And, at least according to some observers, the main payoff to interdiction in Southeast Asia was a "penalty" or cost imposed on the North Vietnamese and their suppliers:† a massive diversion of North Vietnamese military and civilian resources to route maintenance and bypass construction, and substantial economic costs imposed on the Soviets and Chinese who were replacing the trucks and supplies destroyed en route to the South.

In the first months of the Korean War, United Nations interdiction attacks against targets within North Korea were intended to cut off the flow of supplies following the North Korean Army southward, and attacks within South Korea against bridges and North Korean supply columns moving on the roads were intended to slow and weaken the North Korean pursuit of the withdrawing South Korean and U.S. forces. This initial supply interdiction effort in the North seems to have had little effect.

---

*Sallager, op. cit., pp. 60-79

†Secretary of Defense McNamara, for example; see United States Senate, *Hearings Before the Subcommittee on Department of Defense of the Committee on Appropriations and the Committee on Armed Services*, Ninetieth Congress, First Session, 1967, p. 70. Also Secretary McNamara's posture statement for Fiscal Year 1969: *Statement of Secretary of Defense Robert S. McNamara Before the Senate Armed Services Committee on the Fiscal Year 1969-73 Defense Program and 1969 Defense Budget*, 1969, Section III(D)(1).

Some modest delays and shortages[*] may have been achieved through supply interdiction in the South, but such delays as occurred appear to have been mainly the result of force interdiction. U.S. aircraft on armed reconnaissance in the South were able to destroy a substantial percentage of North Korea's small but initially dominant tank force--enough so that the retreating forces gained time and were able to survive, make a stand around Pusan, regroup, and when reinforced counterattack successfully. Here, force destruction (accompanied by delay and disruption) was the main interdiction payoff.[†]

Later in the Korean War when the situation had stabilized and the U.N. forces were on the defensive, supply denial was the objective of several long-continued campaigns. In the summer of 1951 a major interdiction campaign got under way. The several phases of the campaign lasted almost a year and, in terms of the total sorties committed over time, this was the largest strictly interdiction effort undertaken anywhere up to that date. North Korean rail and road transport was the target, especially rail. During the day, bombers attacked rail bridges, and fighter bombers attacked rail lines and flew armed reconnaissance missions against trucks and other vehicles on the roads. At night, intruder aircraft went after road vehicles. Judged by claims of targets damaged/destroyed, the results were formidable. Not counting the sizable contribution of naval air and the separate B-29 bomber force, in the first 6 or 7 months of the campaign the Fifth Air Force claimed (in round numbers) 16,000 rail line cuts, 1000 rail or road bridge cuts, and

---

[*] Supply interdiction in the South did eventually have some effect on supply availability, especially for the most advanced NKA (North Korean Army) units, but NKA orders to conserve ammunition were not issued until after the U.N. retreat had ended and the defense of the Pusan perimeter had begun. See Robert F. Futrell, *The United States Air Force in Korea 1950-1953*, New York, 1961, p. 165.

[†] In this instance U.S. fighter bombers were effective in killing enemy tanks because they were almost unopposed in the air, the ground-based defenses were extremely weak, and it was therefore feasible to make use of delivery profiles that gave reasonable accuracy with napalm and rockets against tank-sized targets.

damage/destruction of 500 locomotives, 10,000 rail cars, and 28,000 road vehicles (mostly trucks).* Even if these claims inflated actual results by a factor of 2 or 3, the materiel damage must have been heavy, and at first glance might appear to have been sufficient to bring North Korean transport almost to a standstill, especially on the sparse rail network.

Not so; supplies continued to flow in considerable volume. Eventually, this air interdiction campaign was judged too ineffective to justify its continuation, and after many months of concentrated effort and a hundred thousand sorties it was decided to try something else.†

Misperceptions as to what was feasible, misunderstandings about the appropriate payoffs to be sought, differences of opinion as to the most suitable targets, and misevaluations about what was actually being accomplished were common occurrences in past interdiction campaigns, including the ones generally regarded as successful. That this was so can easily be confirmed by an examination of the operations research literature generated by the Services during the various interdiction campaigns.** One excellent but still restricted study of supply interdiction concludes that the uncertainties surrounding *transportation* capabilities under attack are so great and the enemy's throughput needs are often so flexible and typically so difficult to estimate that, if X is the interdictor's best estimate of the enemy's required daily throughput, then interdiction success requires that the enemy's estimated throughput capability be reduced to no more than X/2 and, for

---

*These claims are for the Fifth Air Force alone, the largest element of the Far Eastern Air Forces (FEAF) Command. The total interdiction-related target-damage claims for the FEAF plus the Navy and Marine Corps are summarized in Appendix Table A-4 for the war as a whole.

†This long campaign consisted of two parts, "Operation Strangle" (the third of that name and the second in Korea) beginning in the summer of 1951, and "Operation Saturate" beginning in March 1952. For a good description of the Strangle II-Saturate operations and a frank discussion of their effectiveness, see Futrell, op. cit., pp. 413-438.

**Much of the analytical literature relating to the Vietnam War (and even the Korean War) still remains to be released from security classification and made available for general circulation. The validity of the generalizations just made is supported by the open literature, but generally in much less detail. For World War II, for example, see Saber Measures (Alpha); Dews, 1980, op. cit., pp. 14-15, 20; and especially Sallagar's superb study of the Allied interdiction effort in the Italian campaign, op. cit., pp. 60-67. For Korea see Carter, op. cit.; Futrell, op. cit.; and OEG Study 552. The last is analytically outstanding.

high confidence, to no more than X/10. Such considerations should be enough to cause future interdiction planners to bring a good deal of skepticism to the task and to be somewhat modest in their expectations.

A typical approach followed by interdiction planners has been to model the route network (for example, the rail network in Korea and the road network in North Vietnam and Laos); to design alternative attacks against route structure, vehicles en route, depots and assembly areas, or some combination of these different target sets; to predict attack outcomes; and to identify preferred campaign strategies, taking both expected aircraft losses and interdiction effectiveness into account. The usual measure of effectiveness is reduction in throughput over time (vehicles or tons of supplies arriving at the destination(s)). Other measures include delays in transit time from origin(s) to destination(s), cargo damaged/destroyed, vehicles or particular types of vehicles damaged/destroyed, and the enemy's resources consumed or diverted in his attempt to sustain movement and avoid losses.

In spite of some tempting advances in network flow mathematics,* the results of this kind of modeling have hitherto been quite discouraging whenever faced with the test of combat experience. Among the many problems, questions, and uncertainties are the following:

- What is the enemy mode of operation? Convoys? Unit sizes? Intervehicular and interunit distances? Straight-through movement or shuttle chains with inter-shuttle transshipment? Speed? Day or night movement? Hours of operation per day? Surge mode and capability?
- In general, how will different means of transport interact and reinforce each other? Air, rail, road (both wheeled and tracked vehicles), and porterage? In particular, how will airlift, including helicopter short-haul transshipment, be used to overcome delay or stoppage?

---

*The seminal work is that of L. R. Ford, Jr., and D. R. Fulkerson, *Flows in Networks*, Princeton University Press, Princeton, 1962; this book was in part an outgrowth of interdiction studies at Rand. During the Vietnam War, network theory was applied to the development of computer-based models for analyzing interdiction targeting options. One of the most frequently used was that of R. D. Wollmer and M. J. Ondrasek, *A Model for Targeting Strikes in an LOC Network*, The Rand Corporation, RM-5940-PR, 1969. Subsequently, a substantial advance was made by R. L. Helmbold, *A Countercapacity Network Interdiction Model*, The Rand Corporation, R-611-PR, 1971.

- To what extent is unprepared off-route movement possible? For tracked vehicles, for wheeled vehicles? Sensitivity to weather and season?
- What are repair times for damaged route structures of various types? (Note that average repair times may be quite misleading because they usually include both urgent and non-urgent repairs--and are usually based on imperfect intelligence.)
- Are local bypasses available? Can they be quickly constructed? What delays and constraints on types of traffic do they impose? Weight of vehicle? Tracked only? Sensitivity to weather and season?
- How does *uncertain* damage, e.g., an 0.8 probability of dropping a bridge span, affect movement and throughput over time in a route *network*? Expected value calculations with average repair times and movement rates are clearly inappropriate when enemy forces can leak and surge through the undamaged links.
- Given uncertainty about route structure, damage repair times, and surge capabilities, how frequently should attacks occur? What is the requirement for reconnaissance for damage assessment? What is the requirement for quick-reaction attacks, e.g., while enemy forces are surging across a newly repaired bridge?

Other uncertainties and problems could be mentioned, most of them having to do with the enemy's efficiency, determination, and choice of countermeasures.*

The upshot is that past attempts to model interdiction effectiveness have encountered so many and such large uncertainties concerning input values and have required so many simplifying assumptions that the outputs have been highly questionable--both for operational planning and for subsequent assessments of operational success. For example,

---

*For a discussion of some of these limitations, see J. W. Higgins, *Concepts, Data Requirements, and Uses of the LOC Interdiction Model as Applied to North Vietnam*, The Rand Corporation, RM-6065-PR, 1970, pp. 24-30.

during the Vietnam interdiction campaigns, estimates by different agencies of North Vietnam's supply throughput to the South often varied by factors of 2 or 3 and sometimes by much larger factors, depending on the choice among more or less equally plausible sets of assumptions. There was--and there still is--no way to be sure which results were most nearly correct, although some of the most optimistic estimates of interdiction effectiveness are now generally discounted.

Even with years of interdiction experience in Vietnam (with ample opportunities to conduct "experiments" with a variety of tactics, weapons, and target systems under fairly stable operational conditions), many important questions remained unanswered, or, rather, received various and generally inconclusive answers:

- What was the appropriate measure of effectiveness for the interdiction campaign? Reduction of monthly supply throughput? Diversion of North Vietnamese manpower? Economic burden imposed on North Vietnam's suppliers? Psychological pressure on North Vietnam's people or leadership? Improved morale for South Vietnamese and U.S. forces on the ground? (Many measures were proposed.)
- Should route structures have been targeted, or vehicles, or some combination of route structure and vehicles? For example, after a road link was cut, did vehicles bunch up behind the cut so that they became easy to find and attack, thus increasing total vehicle kills? Or was a pure kill strategy the way to maximize kills, or a pure cut strategy preferred as a way of maximizing delays? Or was a mixed strategy preferred even if cut-kill did not help to maximize vehicle losses?
- If vehicles were targeted, where were strikes most productive (near or remote from South Vietnam?) and should they be attacked on the move or in the truck parks?

- o If route structure was targeted, where were strikes most productive (near or remote from South Vietnam?) and what were the best target types--roadbeds, rail lines, passes, landslide area, bridges? (Bridges rightly became prime targets when guided bombs became available, but earlier this was in doubt.)
- o What was the right mix of night and day sorties?
- o What was the appropriate role of air-delivered, target-activated munitions (mines)? When should mines and immediate-destruct munitions be used? Separately? In sequence, with mines put in after roads were cratered or bridges dropped? (If sequencing was the preferred tactic, as often stated, why was it abandoned toward the end of the conflict?)

A major uncertainty facing the interdiction planner has to do with the enemy's responses: What countermeasures he will adopt and how effective they will be? Experience suggests that the interdicted side will learn and adapt quickly, and that a planner who fails to take into account this adaptive behavior is likely to overestimate interdiction effectiveness, and sometimes grossly exaggerate it. A good interdiction plan *expects* countermeasures, and assesses the success of interdiction partly in terms of the costs (delays, disabilities, losses, opportunities foregone) each countermeasure imposes on the enemy if he chooses to adopt it. To do this, the planner requires not only engineering expertise and detailed knowledge of route structure, terrain, natural cover, local weather, and enemy equipment, but also familiarity with measure-countermeasure experience in previous interdiction campaigns and good, current estimates of enemy responses.*

---

*According to Futrell, one of the major failures of the Fifth Air Force operational planners in the Korean interdiction campaigns was their neglect of enemy countermeasures. "Since operations officers very seldom asked for enemy reaction studies, air intelligence officers very seldom accomplished such studies." See Futrell, op. cit., p. 437.

For countering interdiction attacks against vehicles, one of the simplest and most effective responses has been to travel mainly at night or in otherwise restricted visibility. Even today few fighter bombers have a good nighttime ground-attack capability against small point targets such as vehicles on roads (whether moving or not), and the night-movement countermeasure should therefore continue to be quite effective until nighttime attack capabilities become available in quantity. An interdiction planner who assumes that the enemy will opt for daylight travel must accept a heavy burden of proof or risk serious miscalculation.

Rapid bridge repair and bypass construction is another obvious countermeasure, but one that has been frequently underestimated in interdiction planning. Quick repair of the route together with a nighttime surge of vehicles through the repaired segment has often served to defeat the planner's calculations, as, for example, in the supply interdiction campaigns in Korea and Southeast Asia. A closely related countermeasure is the construction of multiple new routes to supplement critical links or to bypass "choke points" in the original network. For bridges spanning rivers, the alternatives include fords, ferries, "underwater" bridges, swing bridges, and removable spans in place only when used, usually at night. For "dry" bridges (viaducts), there is usually less difficulty in finding or constructing bypasses. If, as rarely happens, alternatives cannot be found to allow the through movement of vehicles around or across damaged bridges, shuttle operations to and from the site can usually be established with transshipment of supplies by another mode of transport at the damaged segment. Short-link shuttle transport of supplies, although generally less efficient than through movement in peacetime operations, is highly flexible, degrades gracefully, and lends itself to a variety of associated countermeasures.

Failure to take enemy countermeasures adequately into account has been typical in the planning of interdiction campaigns, partly because of insufficiently detailed information about local geography but largely, it appears, because of unfamiliarity with the operational problems encountered as a result of enemy countermeasures in earlier interdiction efforts. In reading accounts of the many World War II, Korean, and Southeast Asian interdiction operations, one encounters the same lessons being "learned" again and again the hard way. It is almost as if each new group of interdiction planners approached the task *de novo*, without the benefit of corporate experience or historical knowledge.

The interdicted side must also learn, and this takes a certain amount of time, although such learning has generally been quick. In the more prolonged interdiction campaigns (long-term supply interdiction, for example) the typical sequence of learning and response has been approximately as follows:

- o A short period of initial interdiction success during which the interdiction planner congratulates himself, and the interdicted side suffers substantially but quickly learns to adapt by changing operational modes and experimenting with various countermeasures.
- o A period during which interdiction effectiveness is substantially reduced by enemy countermeasures, but during which the interdictor continues to think he is doing reasonably well.
- o A period (often prolonged) during which the interdicting side suspects that all is not well, but the evidence is not clear. Internal arguments develop, institutional positions are taken, and there is substantial delay before the need for new interdiction measures is agreed on, or it is decided to abandon the campaign.
- o If new interdiction tactics are adopted or new interdiction weapons brought into play, there may be a fresh period of success, but the sequence of measure and countermeasure is likely to be repeated.

To the extent that this characterization is valid, it suggests another reason* why short interdiction campaigns aiming at near-term payoffs (force interdiction, for example) may have the best prospects

---

*The reason suggested previously is that success in long-term campaigns (against supply buildup, for example) usually requires near-continuous air pressure, and continuity may be lost because of competing demands for air resources or because of periods of adverse weather--or even because the interdictor lacks good nighttime capabilities.

for success: such campaigns generally give the enemy little time to develop effective countermeasures.

This characterization may raise a question in the reader's mind: Is it true that the interdictor learns more slowly than the interdicted, and if so, why? Our examination of the history of interdiction campaigns supports an affirmative answer and suggests several reasons why this should be so. First, it is the interdicted side that is being hurt, often badly hurt; the incentives for change are strong. Second, the interdicted side almost always is able to make more rapid, accurate, and complete damage assessments. It knows what is really being accomplished and what is not--where the leaks are that can be quickly exploited.

The interdictor, on the other hand, must work with inferior information derived from often over-optimistic pilot claims and sometimes misinterpreted photography with, at best, spotty coverage in space and time. In the past, at any rate, problems of this kind have been almost unavoidable, as anyone who has worked with sequences of World War II, Korean, and Vietnamese reconnaissance materials and damage assessments can testify;* it is a problem inherent in the

---

*For example, the U.S. Strategic Bombing Survey concluded that the Allied damage assessment charts were "of no value" for judging the number and location of rail-line cuts achieved by air attack in Western Europe: U.S. Strategic Bombing Survey, European War, Transportation Division, *The Effects of Strategic Bombing on German Transportation*, Report No. 200, 1947, p. 63. In fact, the damage claimed was much *less* than the damage actually achieved, with the result that line-cutting attacks probably received insufficient emphasis. On the other hand, as discussed in the Appendix to the present Note, the U.S. assessment of enemy tanks killed in the early weeks in the Korean War probably overstated actual kills by a factor of two or more. For another Korean War example of the difference between claimed and actual damage, see Futrell, op. cit., p. 423; also pp. 418-419. Assessment of damage inflicted by night attacks against moving vehicles is particularly difficult.

In their escape from the Falaise pocket in 1944, the German divisions moved to the Seine mostly on secondary roads whereas the Allied air attack concentrated on the main roads, with the result that traffic on minor roads was frequently unmolested: Royal Air Force Bombing Analysis Unit, op. cit., p. 20. It seems clear that the effectiveness of this 2-week-long force-interdiction effort could have been substantially greater if the more heavily traveled roads had been more systematically targeted. Failure to do so seems to have been due partly to inadequate reconnaissance information (explained to some degree by adverse weather) and partly to inflexibility in adapting the interdiction effort to the information that did become available during the course of the operation.

limitations of human observation and the existing level of technology, although it has sometimes been aggravated by reluctance to provide well-equipped reconnaissance aircraft in adequate numbers together with rapid-turn-around photo-interpretation.

Enemy deception through the use of camouflage and decoys can also degrade the quality of the information available to the interdictor, for example, the concealment and simulation of supply dumps in North Africa and truck parks in Vietnam, and the replacement of damaged bridges by underwater structures and by swing bridges hidden along the banks when not in use. The use of smoke can make it difficult to employ some types of precision-guided weapons against bridges, even if the location of the bridge is accurately known.

Whether good information will continue to be lacking is an interesting question. Can new sensors, either aircraft- or satellite-borne, provide the kind of detailed, prompt, and accurate damage assessment that interdiction planners would like and usually need?

In the absence of good information, the interdiction planner not only lacks the means for quick learning and change of strategy, he is also denied the efficiency of shoot-look-shoot tactics; he must play a probabilistic targeting game with its penalties of sometimes over-killing (waste) and sometimes underkilling (failure). This can have serious consequences, especially for long-term supply interdiction campaigns in which success depends on continuous denial of movement on critical segments of a complex route network all the features of which may be imperfectly known.

V. STUDY FINDINGS: THE FACTORS INFLUENCING INTERDICTION SUCCESS

No general prescription can be given for interdiction success, but experience and common sense suggest a number of factors that should be considered in planning and conducting an interdiction campaign.

PRE-CAMPAIGN INTELLIGENCE

The availability of good pre-campaign intelligence can make a major contribution to interdiction success, and its absence can be seriously prejudicial. Important areas of information include:

- What are the enemy's probable objectives? What is he likely to be trying to do and with what urgency? What are the plausible scenarios in the absence of an interdiction attempt?
- The probable size and makeup of the elements to be interdicted, for example, the number of divisions moving or requiring supplies, the mix of wheeled and tracked vehicles, the weights of the heaviest vehicles (a question of bridge support), and the accompanying ground-based air defense weapons.
- The probable approach routes, both main and secondary, together with the potential choke points.
- Accurate, detailed, and up-to-date route maps, showing secondary and tertiary roads and cart tracks as well as main highways; rail lines and sidings; tunnels, bridges, viaducts, and culverts; towns and villages. (Absence of such maps has been a severe handicap at the beginning of some interdiction campaigns, in Southeast Asia, for example.)
- Engineering details of bridges, viaducts, and tunnels to assess their vulnerability to attack, their probable repair times, and the ease with which they can be bypassed, for example, the heights of bridges above terrain, their type of construction, and the length of the longer spans.

- Details of the terrain for assessing the potential for off-road movement and the ease with which bypasses or temporary bridges can be constructed at possible choke points: steepness and roughness of terrain, soil type, width and depth of rivers (by season), slope of river banks, location of fords, and the like.
- Probable areas of strong and weak ground-based air defenses.
- The location and amount of prepositioned route repair facilities and supplies.
- The location of probable transshipment points and the type and quantity of material-handling equipment available.
- The size and characteristics of towns and villages en route, particularly as to their ability to provide the enemy with food, fuel, water, and concealment.
- The distribution and characteristics of the indigenous population in the area; in particular
  - will they welcome or sympathize with the interdicted side and give it covert or open support, for example, willing manpower for route repairs and information about little-known bypasses?
  - will they oppose the interdicted side, covertly or openly, making it necessary for the latter to divert resources for population control and route security? Will they provide information on unit movements and bivouac locations to aid in interdiction targeting?
- Climatology and typical weather patterns in the theater, *interpreted* in operational terms to show how they affect:
  - route capacity, off-route trafficability, bypass construction, and the fording of rivers (ice and snow can be a serious impediment to the movement of tracked vehicles on steep mountain roads, for example).
  - the ability of aircraft to find and attack small surface targets, especially with guns and guided weapons, both at night and in the day.

- The mode of operation of the enemy in both the uninterdicted and interdicted cases; in particular, what will be his most likely countermeasures if interdicted or threatened with interdiction?

INTRA-CAMPAIGN RECONNAISSANCE

For efficiency in interdiction and the speedy countering of enemy countermeasures, accurate, timely, night-and-day information is an enormous advantage: information about the enemy's mode of operation; the routes closed, useable, and in use; the location of moving and stationary vehicles and air defenses; the number of vehicles reaching their destination; the number and location of vehicle kills; the extent of route-structure damage; and the progress made in repairing damage and constructing bypasses. In past campaigns such information has been sparse and of uncertain quality, especially as to the situation at night, and this has contributed significantly to the success of enemy countermeasures.

Unless there is a marked increase in the quantity, variety, quality, and timeliness of such information in future interdiction campaigns, it will be impossible to "fine tune" the interdiction effort. To have high confidence of interdiction success, it will be necessary to provide for many more interdiction sorties than would be required under conditions of full information.

SANCTUARIES AND RULES OF ENGAGEMENT

Interdiction success is favored if the enemy is everywhere and always open to attack. In World War II, generally speaking, the only limits on interdiction targeting were those inherent in the physical environment, the military situation, and the military capabilities on each side. Within extremely broad limits, the interdictor felt free to attack the targets that appeared most relevant from a military point of view.

The United States and its Allies usually respected the territory and airspace of neutral countries and nonbelligerents, but in any case the enemy was not critically dependent on them for supplies or for access to supplies or for force movement. Targets in enemy territory (and, with few exceptions,* even targets in enemy-occupied countries such as France, Belgium, and The Netherlands) could be selected and attacked in accordance with their perceived importance to the success of the interdiction effort. Such targets included ports, marshalling yards, rail centers, rail lines, and road and rail bridges in densely populated areas where collateral damage and civilian deaths could not be avoided.

In Korea and Vietnam the situation was very different.

Although North Korea's neighbor Communist China was a major combatant in the Korean War, its territory was a sanctuary--by political decision it was off limits to U.N. air or ground attack.† This sanctuary became the generous source and staging area for a steady flow of military units and equipment, supplies, trucks, rail cars, and locomotives--of all the kinds of things useful for conducting the war or nullifying the effects of interdiction. It also provided safe bases for Chinese fighter aircraft operating over North Korea.

The political decision to treat Chinese territory as a sanctuary may well have made good sense in terms of limiting the war and achieving overall U.N. objectives, but the existence of this inviolable source of supplies, transport, and manpower was unquestionably a major factor contributing to the failure or near failure of the supply interdiction. effort in Korea.

In the Vietnam War, Communist China again played a significant supporting role, providing supplies and transport to the North Vietnamese, but in this conflict China's direct military involvement appears to have been limited mainly to anti-aircraft defense of the rail lines of communication leading from the Chinese border to Hanoi. The USSR was North Vietnam's main source of arms, trucks, and other military supplies. Soviet supplies crossed China by rail, but for the most part they reached North Vietnamese ports in Soviet vessels. Although the rules of engagement decided on in Washington changed from time to time, they were

---

*Because of concern about civilian casualties in German-occupied Western Europe, the British War Cabinet did become involved in decisions about the choice of marshalling-yard targets for attack by heavy bombers in the "Transportation Plan" for strategic interdiction. See Russell F. Weigley, *Eisenhower's Lieutenants*, Bloomington, Indiana, 1981, Vol. 1, pp. 91-93.

†Futrell, op. cit., pp. 184-185, 208-210, 227-229.

generally even more hampering to interdiction than they had been in Korea. Not only were Chinese territory and a zone along the Chinese border understandably off limits, but also often prohibited were large areas adjacent to Hanoi and Haiphong, the principal port. During most of the war, interdiction targets in or near major population centers were off limits unless they were on specific target lists approved in Washington. For re-attack, additional approval involving long decision time was often needed. The rules of engagement were quite restrictive even in areas remote from China and the major North Vietnamese cities and ports. Because of bombing restrictions, many small towns and villages in North Vietnam became sanctuaries where enemy supply convoys could rest, refuel, repair vehicles, and establish depots. Although there is a popular impression that the interdiction campaign in Vietnam involved a very free-wheeling if not "indiscriminate" use of airpower, the truth is quite different. A massive interdiction effort was made, but it was nonetheless a constrained use of airpower in a limited war.

Will sanctuaries be established and inhibiting rules of engagement be adopted in possible future conflicts where interdiction is attempted? One cannot be sure, but in some third-area contingencies this seems not unlikely. Planners should be aware that rules of engagement can be critical in assessing the prospects for interdiction success. Such rules may limit the areas that can be attacked, the frequency of attacks, and the types of permissible targets and weapons; and they may increase decision times in responding to enemy countermeasures and other changes in the military situation.

OPERATIONAL SITUATION IN THE GROUND WAR

The enemy to be interdicted should ideally (1) have an urgent need for movement, (2) be highly mechanized and therefore rely mainly on vehicular movement, and (3) need to travel substantial distances. This implies:

- For force interdiction, that the interdicted side has strong incentives to reach specific objectives within time constraints, both the incentives and the constraints being preferably enforceable by the interdictor.

- o For supply interdiction, that
  - the interdicted side is a naturally high consumer, and high consumption rates can be enforced by the interdictor.
  - the interdicted side has been unable to accumulate substantial forward stockpiles before interdiction begins and cannot "live off the country"; the supplies needed must be moved forward.

Absence of a favorable operational situation on the ground goes far to explain the limited success of the supply interdiction efforts in Korea and Southeast Asia.

AIR-GROUND COORDINATION

Mutually supportive timing of the interdictor's air and ground operations is often a key to success in both force and supply interdiction. The aim is to enhance the utility of the interdiction attacks:

- o By increasing the vulnerability of the interdiction target system to air attack (for example, by ground operations that force the enemy to attempt urgent, high-volume movement for redeployment or resupply or both).
- o By increasing the total military payoff from whatever level of interdiction is actually achieved (for example, by timing ground operations so that they derive maximum benefit from the enemy's interdiction-produced disabilities).

In general, mutually supportive timing is easier to plan for and achieve when the interdicting side is strong and has the initiative both on the ground and in the air. If the interdicted side has the initiative on the ground (through superior strength or, as in Vietnam, through guerrilla tactics that make it possible for him to engage and disengage more or less at will), there may be few opportunities for the interdictor to enforce a need for high-volume vehicular movement.* Moreover,

---

*Some of the scenarios involving U.S. intervention with rapid-deployment forces may be regarded as exceptions to this generalization. In these scenarios, the enemy seeks to seize territory or secure major objectives in the short time available before the interdictor's intervention forces can arrive on the scene in substantial numbers; the first few weeks of the Korean War provide an analogy.

if the interdicted side has the ground initiative, it is likely to be difficult for the interdictor to schedule his interdiction efforts in advance, especially in the case of force interdiction, which must then be opportunistic, a quick response to an imperfectly foreseen and fleeting opportunity.

Air-ground coordination for interdiction effectiveness can present complex problems of inter-Service decisionmaking and operational tradeoffs. Good coordination should not be taken for granted. It is not enough that the military situation allows air interdiction and ground operations to be mutually supportive--positive action must be taken to make them so. For full effectiveness, interdiction may sometimes require only slightly less intimate air-ground coordination than close air support. The view that interdiction is an "independent" air force mission is only occasionally valid,* and, certainly where force interdiction or "battlefield" interdiction is concerned, adherence to this view is likely to waste valuable air resources.

VULNERABILITY OF VEHICLES

Success in interdiction is favored when it is easy to find and destroy a large fraction of the vehicles involved in a movement, either a force deployment or a supply operation. This implies:

- Weak or suppressed enemy air defenses (both fighter and ground-based defenses) along the routes.
- Little or no cover for enemy vehicles, including both natural cover (e.g., woods) and towns and villages where vehicles can find concealment or sanctuary.

---

*F. M. Sallagar's conclusion about STRANGLE in Italy is that its success was redeemed by the appropriately timed Allied ground offensive which STRANGLE "was to have made unnecessary." Sallagar, op. cit., p. 42.

- o Suitable air-to-ground weapons (especially ones that allow multiple kills per sortie against armored vehicles).
- o Ability to find and attack targets at night.

The most common and successful means of protecting vehicles en route has been for them to move at night and take cover during the day.

VULNERABILITY OF INDIVIDUAL ROUTE SEGMENTS

Success in interdiction is favored when it is easy to cut a substantial number of route segments (by damaging roadways, rail lines, bridges, tunnels, and the like) and keep them continuously cut over time. This implies:

- o Weak or suppressed air defenses (both ground-based and fighter defenses) in the vicinity of the target and in the enemy rear area.
- o Suitable air-to-ground weapons, especially guided bombs that make it possible to destroy a bridge or a tunnel with only a few sorties.
- o Route structures that are
  - easy to find and to destroy with a few weapon-delivery sorties.
  - difficult (slow) to repair (this is often a function of the manpower and materiel available locally).
  - difficult (slow) to bypass (the adjacent terrain is unsuitable for off-route movement or rapid construction of bypasses).

Note that the vulnerability of individual route segments depends on the capabilities of both the attacker and the defender, the physical characteristics of the target, and the nature of the surrounding terrain.

NATURE OF THE ROUTE NETWORK AS A WHOLE

The nature of the route *network* is important because it interacts with route-segment vulnerability in determining the *overall* effect of attacks against fixed route targets, and because it affects potential vehicle dispersion and the ease with which vehicle targets can be found and attacked. Interdiction is favored if the undamaged network has little or no throughput capacity excess to military movement needs. Constrained network capacity implies:

- A sparse road and/or rail network, with few main, through-routes.
- Mostly low-capacity links: narrow roads and single-tracked rail lines, narrow tunnels, poor roadbeds and road surfaces, sharp curves and steep gradients, poor maintenance, degraded capacity in rain and snow.
- Choke points located so that a small number of cuts can produce major reductions in network throughput, at least temporarily.

UNINTERDICTED MOVEMENT CAPABILITY

Movement *capability* depends not only on the capacity of the route network but also on the availability of vehicles, fuel, supplies, manpower, and other inputs. (See the discussion of interdiction targets in Section II, above.) Interdiction is favored if, before the campaign begins, movement capability has little excess over military demands or even falls short of those demands. As mentioned earlier, this is most likely to occur when the interdicted side is attempting urgent force movements, for maneuver units require much more route capacity and fuel and many more vehicles than are required by the supply flow necessary to sustain those units.

Uninterdicted transport systems, even where the route network is relatively sparse, are usually characterized by throughput capabilities many times larger than military supply requirements. This was true in

Korea and Vietnam, although (because we do not have access to enemy data there) we are not able to quantify with confidence the excess of capability over demand. For STRANGLE in Italy reasonably good data are available, and the results are revealing. The interdiction planners estimated that the supplies needed by the German armies in Italy amounted to no more than about 7 percent of the uninterdicted throughput capability of the rail system. To achieve a reduction of greater than 93 percent was certainly a formidable enough task. But the task was understated because the calculations involved a substantial overestimation of German supply requirements as we now know them to have been. For assured success as a pure supply-interdiction campaign, it appears that STRANGLE would have had to reduce the rail system to no more than 1 or 2 percent of its uninterdicted throughput capability, while also causing serious damage to the (admittedly far less capable) long-haul truck and watercraft supply systems.[*] This reduction was not achieved, although the damage done to road and rail transport during STRANGLE contributed to the effectiveness of force interdiction in the next phase of the conflict in Italy.

ASSESSMENT OF THE CRITICAL TRANSPORT FACTORS

Fuel, vehicles, route capacity--all the inputs used by the enemy to achieve force mobility or supply throughput--will not, in general, be equally available at a given moment or over time. For any given state of the enemy's transport system--before interdiction begins or after the system has been damaged--most inputs can be somewhat reduced without appreciably reducing the enemy's movement capability, but one input (usually only one) must be fully utilized to achieve full capability.[†] This constraining or critical factor has sometimes been regarded as necessarily defining the preferred target system.

---

[*] Sallagar, op. cit., pp. 24-32.

[†] This occurs because transport systems are seldom perfectly optimized in terms of the balance of their inputs, that is, all inputs are not equally scarce. The lack of balance is especially marked when military transport makes partial use of (and has priority in the use of) transport systems originally designed for civilian needs.

But it is not this simple. It is not always easy to identify the critical factor. And it does not follow that the factor that is *initially* critical should be selected. Attacks against it may be too costly, or they may achieve only a very gradual degradation of the enemy's capability, while that capability still remains excess to his requirements. It may be better to choose an initially non-critical but more easily or rapidly degradable target system--route network capacity has sometimes been favored on such grounds.

It is not surprising, therefore, that major uncertainties as to the best interdiction target systems together with many shifts in target emphasis have been common in past campaigns.* Interdiction success is favored:

- o If the scarcest input needed by the enemy for force movement or resupply can be clearly identified by the interdictor before and during the course of the interdiction operation.
- o If this critical factor is relatively vulnerable to air attacks carried out with acceptable attrition rates.
- o If it cannot be repaired or replaced or substituted for as quickly as it is damaged or destroyed.

---

* For the many disagreements and changes of focus in the planning of the strategic and tactical interdiction campaigns preceding and accompanying the Allied landings in Normandy, see, for example, Roderic Owen, *Tedder*, London, 1952, pp. 238-248; also Weigley, op. cit., Vol. 1, pp. 83-94. With respect to interdiction in Korea, the Navy's Operations Evaluation Group comments that the years-long interdiction effort was characterized by 13 different phases with continually changing target emphasis: "Bridges, railroad cuts, rail destruction, vehicles, and supplies each had their turn as a primary target" (OEG Study 552, op. cit., p. 10).

SORTIE AVAILABILITY AND BASING

Past interdiction campaigns have consumed sorties in enormous quantities. This is especially true of long-term supply interdiction campaigns such as those in Korea and Southeast Asia, where well over 10,000 interdiction sorties were flown in some months. Improved weapons now greatly reduce the number of sorties required to destroy certain fixed elements of route structure (bridges, for example); and weapons now under development will also improve effectiveness per sortie against vehicles.

Nonetheless, for interdiction effectiveness a large number of sorties is still likely to be required daily. This appears to be true especially *if* it is important to destroy a substantial percentage of the enemy's vehicles *and* he moves mainly at night when (given existing aircraft equipment and weapons) fighter-bombers would average only a fraction of a kill per sortie. In addition to numerous sorties, long loiter times are desirable, to maintain air presence and to search for dispersed and fleeting targets. These considerations imply:

- The commitment of a large fraction of U.S. tactical airpower.
- Airbases well manned and equipped for the generation of high sortie rates.
- Well-defended and secure airbases, not at serious risk to enemy ground or air attacks, both of which would reduce the sorties generated (and, of those generated, probably reduce the share available for interdiction).
- Airbases near enough to the target area for missions with large weapon payloads and long loiter times. The use of tankers for aerial refueling should be minimized for a variety of reasons.

Note that airbases that are both "secure" and "near the target area" may be difficult to find in the future, although U.S. air has often had the benefit of such bases in the past. Basing was a serious problem at the beginning of the Korean War, as discussed in the Appendix.

CONTINUOUS APPLICATION OF INTERDICTION PRESSURE

Not only are large aggregate numbers of sorties usually required, but the distribution of sorties over time is important. Successful interdiction--especially supply interdiction--usually requires the *continuous* application of interdiction pressure. This implies:

- The uninterrupted generation of sufficient *interdiction* sorties, day after day and night after night.
- Aircraft capable of finding and attacking interdiction targets at night.
- Long periods of generally good weather, *or* aircraft capable of finding and attacking interdiction targets in adverse weather.

The uninterrupted generation of interdiction sorties implies either a *very* large sortie generation capability, or the absence of higher-priority competing demands for air resources. In the past the U.S. Air Force has generally had both advantages. It enjoyed theater air superiority or acquired it before attempting interdiction. The U.S. Army either possessed the initiative or was strong enough on the ground so that it did not require massive close air support. The Air Force and Army could agree on a time-phased strategy: first air superiority, then interdiction, then close support. Thus in almost all past U.S. interdiction campaigns competing demands for sorties seldom presented serious problems.* *The* serious problem was to make the available sorties continuously effective day after day, including nighttime and periods of adverse weather.

THE ENEMY'S GROUND-BASED AIR DEFENSES

As observed earlier, interdiction success (as for any ground-attack mission) is sensitive to the effectiveness of the enemy's ground-based air defenses. But how sensitive? And how effective are the ground-based defenses likely to be?

---

*There are exceptions, of course. In the Korean War the close air support mission (and even the airbase attack mission) sometimes competed with interdiction: Futrell, op. cit., pp. 411, 430-432.

The current trend seems to be toward more effective ground-based systems, both missiles and guns. Some systems are carried on tracked or wheeled vehicles and are capable of firing on the move. And these are not limited to the NATO and Warsaw Pact armies; they are proliferating elsewhere, especially in the Middle East, Southwest Asia, and North Africa. Thus both stationary and moving targets can be better defended against air attack than in the past.

Because of the improvement in air defenses, some analysts expect much higher aircraft attrition rates than in the past. Historically, attrition rates have been controlled by modifying tactics, and it is realistic to expect that this will be done (and generally ought to be done) in the future. Where air defense systems pose a serious threat, the attacker will attempt to kill or to suppress the defenses, or will choose attack profiles or weapons that limit the exposure of his aircraft to the air defenses, or more probably, he will adopt some combination of these responses. But these responses usually impose a cost on the attacker, sometimes a very significant cost. The effect of improved ground-based air defenses is not simply (perhaps not even mainly) to increase the loss rates for the attacking aircraft. While air assets are being used to kill or suppress ground-based air defense systems, fewer sorties (or smaller payloads per sortie) are available for assignment to other target systems such as interdiction. Over the long term, attacks against air defenses may increase the aggregate number of other ground-attack sorties that can be flown, but in the short term such attacks may conflict with the immediate need for a large number of interdiction sorties for exploiting time-limited opportunities.

When target-approach and weapon-delivery profiles are chosen so as to decrease the exposure of the attack aircraft to ground-based air defenses, the usual result is either (a) the use of less effective weapons, or (b) weapon employment in an "off-design" mode, that is, weapon delivery with less than the full accuracy inherent in the design of the aircraft-plus-weapon system. For a given amount of target damage, the number of weapon-delivery sorties required may be increased many times when exposure-limiting attack profiles are employed.

Such profiles also often make it difficult to locate (much less identify and discriminate among) small targets, especially if they are moving. Thus target acquisition is degraded before weapon release, weapon accuracy is degraded during delivery,* and damage assessment is degraded after weapon impact.

The result is that ground-based air defenses, even if they exact only modest attrition, can have a significant effect on the conduct and success of an interdiction campaign. In Korea, the force interdiction effort early in the conflict was successful against enemy tanks because fighter-bombers could fly low over enemy columns almost with impunity, and thus deliver napalm with target-practice accuracy.† Later in the war, however, in the "Strangle II" and "Saturate" campaigns against North Korean rail and truck transport, increasingly heavy ground-based air defenses (automatic weapons and anti-aircraft artillery) forced the fighter-bombers "to abandon their highly effective [shallow-angle] glide attacks and substitute less accurate, but also less vulnerable, dive-bomb attacks."** The air defenses also attracted a significant share of the air effort, thus reducing weapon deliveries against the transport system. In North Vietnam, ground-based air defenses were even denser and more numerous than in Korea, and produced similar results.

AIR SUPERIORITY

The possession or lack of air superiority is likely to be critical to interdiction success, because it affects the numbers of sorties available for the interdiction mission, and, especially, sortie availability for uninterrupted commitment to interdiction over time. This may seem obvious once it is mentioned, but it deserves to be stated explicitly because the historical experience of U.S. airpower is such

---

*For all free-fall weapons and for many types of guided munitions.

†Napalm required low-level delivery. Its effectiveness in Korea was greatly enhanced by certain design defects of the World War II tanks used by the North Koreans.

**Carter, op. cit., p. 10; see also p. 12.

that U.S. air superiority is often taken for granted. In almost all the interdiction campaigns undertaken by U.S. forces in the past, U.S. air either had the time and resources to fight for and win air superiority before interdiction began (as in World War II), or possessed air superiority from the beginning of the conflict (as in Korea and Vietnam).

Air superiority is clearly not a sufficient condition for interdiction success, but for long-term supply interdiction it is probably a necessary condition, and it is highly desirable even for relatively short-term force-interdiction operations of the kind now contemplated in some scenarios involving rapid-deployment forces. We suspect that there may be some tendency to underestimate the problems of carrying out an interdiction campaign in the face of formidable or superior enemy airpower,* simply because U.S. air lacks any extensive or recent experience of this kind. And these problems may be compounded if the enemy combines formidable airpower with the initiative on the ground. The pressing, simultaneous demands of airbase attack, offensive and defensive counterair operations, and close support of friendly ground forces may impair the effectiveness of interdiction even when other conditions are favorable for interdiction success.

---

*Even though the United Nations forces had overwhelming theater air superiority in the Korean War, the local presence of Chinese Migs in the far north often "forced" the U.S. fighter bombers to abandon attacks on the rail system in that part of North Korea: Carter, op. cit., p. 10. In most instances, the reason for mission abandonment was simply that the U.S. fighter-bombers jettisoned their ground-attack ordnance so as to increase their speed and maneuverability in the presence of enemy fighters. "Forced" jettisoning of this kind is a common occurrence, and its effects must be taken into account whenever the enemy is able to sortie fighters in the vicinity of the intended targets or along the approach routes.

Appendix

AIR INTERDICTION IN THE KOREAN WAR

INTRODUCTION

This brief overview of air interdiction in the Korean War (1950-1953) is appended for those who may wish additional details about a conflict that, especially in its early weeks, was characterized by features to be found in some of the third-area scenarios now being examined by military analysts.

THE PHYSICAL ENVIRONMENT

The Korean peninsula is some 400 nm long. It is about 300 nm wide in the north (from the mouth of the Yalu River to the Soviet border) and about 140 nm wide in the vicinity of Taegu in South Korea. The peninsula narrows to about 100 nm at two locations: from the mouth of the Han River west of Seoul to the Sea of Japan; and from the mouth of the Chongchon River (near Sinanju) to Hungnam on the east coast.

The entire peninsula is extremely mountainous, especially in the north and east, with peaks rising to over 8000 ft. Coastal plains are rugged, with steep-sided canyons and valleys. Along the northeast coast, the mountains descend sharply into the Sea of Japan in some locations. Streams in North Korea are generally less than 2 meters deep during low water periods; only the lower reaches of most rivers are deeper year-round. Between late March and late September, streams reach their highest level, and flooding is common. Especially in the highlands, ground is frozen from early November to mid-April.

Conditions are unsuitable for off-road, cross-country movement of both tracked and wheeled vehicles over 85 percent of Korea. From this point of view, the terrain was favorable for interdiction. Moreover, at the time of the conflict, the rail and road network was quite sparse.

The weather in Korea is monsoonal in nature. November to March is marked by a flow of cold polar air from Central Asia. June through August is the summer monsoon season, with warm, moist air flow. Temperatures in the northern highlands are typically -10°F to -20°F in the month of January. Rainfall averages 20 to 30 inches annually in the northeast highlands and 50 to 60 inches in central and southern Korea. Winter flying weather is generally good, with good visibility and 30 to 50 percent cloud cover; in the summer cloud cover increases to 60 to 80 percent.

OUTLINE OF GROUND OPERATIONS: THE FOUR PHASES

I. Retreat to the Pusan Perimeter.

The North Korean invasion of South Korea began on 25 June 1950. The forces of the Republic of [South] Korea (ROK) were much weaker than the North Korean Army (NKA), which had superior equipment. Unlike the ROK army, the NKA possessed a substantial number of tanks (mostly medium tanks), perhaps about 500; of these, about 300 were committed in the first few weeks of combat, giving the NKA a small but dominating armored force. Seoul, the South Korean capital, fell on 29 June, and, although the elements of two U.S. divisions were hurriedly airlifted into South Korea, this reinforcement (arriving piecemeal and with only light armor) was insufficient to stop the NKA from continuing its rapid, tank-lead advance. The Allies were forced to retreat southeastward with the NKA in hot pursuit, and it was not until August, after some 7 or 8 weeks of combat, that a firm defensive position was established around Pusan (see Fig. A-1).

II. Buildup, Breakout, and Pursuit to the Yalu.

Phase II included the buildup of Allied forces within the Pusan perimeter; the Allied landing behind enemy lines at Inchon, near Seoul; the breakout from the perimeter just after the Inchon landing; and the retreat northward of the battered and disorganized NKA

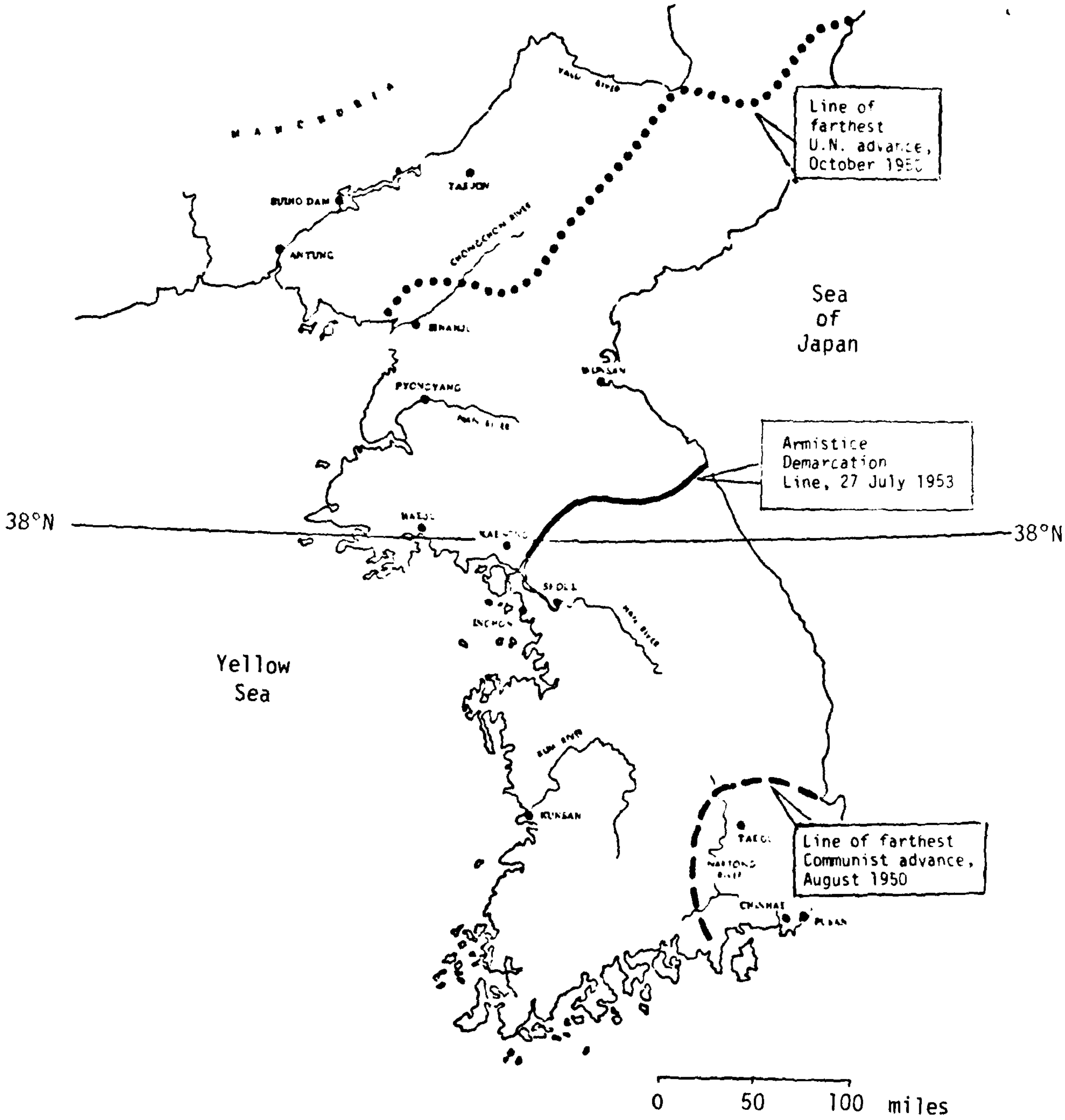


Fig. A-1--Korea, showing lines of farthest advance of
U.N. and Communist ground forces

pursued by the forces of the United Nations Command (UNC).* The Inchon landing and the subsequent breakout from the Pusan perimeter occurred in mid-September 1950, and within little more than two weeks the NKA had been routed and expelled from South Korea. The pursuit continued into North Korea, and by 25 October the UNC forces were approaching (and at one point had reached) the Yalu River, over which some of the remnants of the NKA were escaping into Chinese territory.

III. Chinese Intervention and the Second Loss of Seoul.

Phase III began with the intervention of the Chinese in support of the NKA on 25 October. Early in November the Chinese Communist Forces (CCF) launched a major, surprise attack against the spreadout UNC forces, which, again conducting a fighting withdrawal, reached the vicinity of the 38th parallel by mid-December. Early in January, the NKA/CCF launched another offensive, resulting in the loss of Seoul for the second time and a further UNC withdrawal to a line well to the south of that city. The UNC then counterattacked, and by April 1951 drove the enemy to a line north of the mid-December position.

IV. Defensive, Position Warfare.

The fourth and last phase of the war was a long period of essentially position warfare, extending from April 1951 to the cease-fire on 27 July 1953. The period of armistice negotiations (from July 1951 to July 1953) saw much bloody fighting but relatively small shifts in the line of contact between the opposing sides, which remained near the position established in April 1951. The UNC ground forces during this period were basically on the defensive, although they conducted counterattacks and limited offensive operations.

AIRBASE AVAILABILITY

For the U.S. Air Force, a major problem early in the war was the unavailability of suitable airbases on the Korean peninsula. The brunt

---

*The United Nations Command was established late in July 1950; eventually it included British Commonwealth and other national elements as well as the U.S. and ROK forces, but the two latter continued to make up by far the larger part of the UNC forces in Korea.

of the task of air support of the retreating ROK and U.S. ground elements fell initially to the F-80s of the Fifth Air Force,* operating from airbases in southern Japan. From these bases their short range allowed for only a few minutes in the target area on most missions. When Fifth Air Force received F-51 Mustangs, the ability of this aircraft to operate from austere air strips permitted basing in Korea, so that the range of fighter operations was extended. However, USAF fighter units were forced to withdraw to Japan during most of the period when UNC ground forces were contained within the Pusan perimeter. With the breakout and the Inchon landings, units were moved to Korea as soon as suitable airfields could be established. At the height of the UNC ground-force success, when UNC forces reached the Yalu, a Fifth Air Force fighter unit was stationed at an airfield near Pyongyang, the North Korean capital.

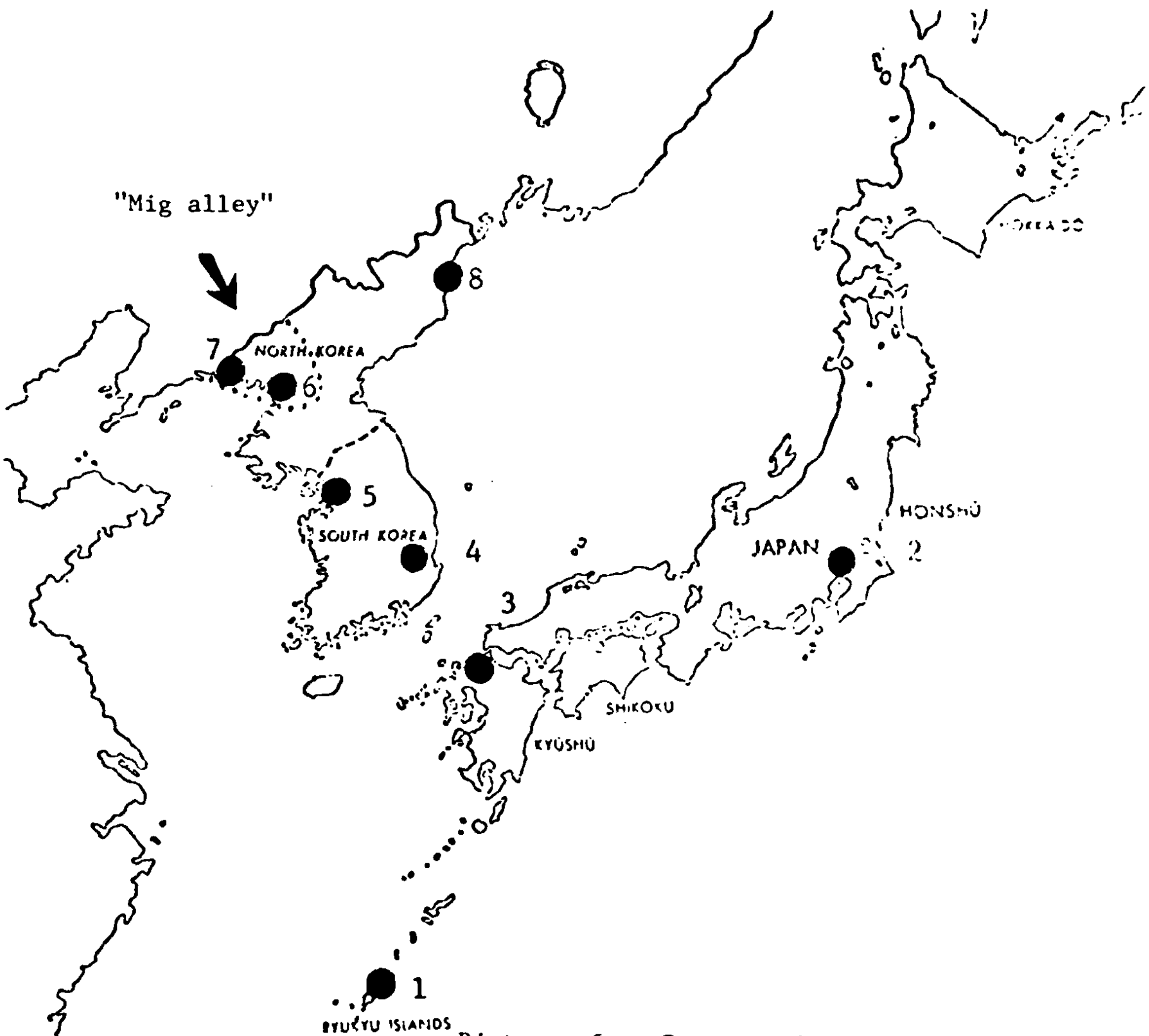
After stabilization of the battle lines, Fifth Air Force fighter and light-bomber units were deployed at many bases in South Korea, the F-86s being located at Seoul and other northerly airfields to enable them to operate in northwest North Korea. Fig. A-2 shows the distances between representative bases and target areas.

UNITED NATIONS AIR STRENGTH

During the entire war, the UNC enjoyed air superiority except for brief periods locally in northwest North Korea, when Chinese Mig-15s challenged USAF fighters and bombers, especially in the vicinity of the Yalu, in an area that came to be referred to as "Mig Alley." Because they could operate from sanctuary in China, the Chinese suffered only air-to-air losses. Until the Chinese intervention, the UNC air forces roamed over Korea virtually at will, with little opposition from surface-to-air defenses. With the entry of the CCF, however, anti-air defenses became increasingly effective, forcing changed tactics and increased allocations of sorties to defense suppression.

---

*The Fifth Air Force was the largest subordinate command of the U.S. Far Eastern Air Forces (FEAF) and, being based in Japan, the Fifth Air Force was the command closest to the Korean theater of operations.



Distance from Bases to Target Areas (nautical miles)

Bases	4 Taegu	5 Seoul	6 Sinanju	7 Yalu	8 Rashin
1 Okinawa	603	700	812	868	980
2 Yokota	588	691	794	850	654
3 Itazuki	187	327	486	532	532
4 Taegu	-	140	289	346	411
5 Seoul	-	-	150	207	326

Fig. A-2--Base-to-target distances in the Korean theater

The principal aircraft used by the UNC for interdiction in Korea were World War II piston-engined bombers and short-range, low-payload fighter-bombers. The fighter-bombers had no night nonvisual attack capability, a serious deficiency in view of the enemy's adoption of nighttime movement for resupply operations. The B-29s had a radar bombing system, but its accuracy was modest at best.

At the outbreak of the war, FEAF had 9 F-80, 3 F-82, 2 B-26, 1 RF-80, and 2 C-54 squadrons deployed in Japan, mainly on Honshu. A few more fighter squadrons were in Okinawa and the Philippines, and one Strategic Air Command bomber group equipped with B-29s was based on Okinawa. By the end of the war, the FEAF included 17 wings in direct support of the UNC: 3 B-29, 7 F-84/F-86, 2 B-26, 1 RF-80, and 4 troop carrier wings. Data on FEAF's combat-ready, ground-attack aircraft at representative periods of the Korean War are summarized in Table A-1.

In addition, FEAF possessed a varying mix of F-82, F-86, and F-94 air-defense fighters, with average combat-ready strength varying from a total of 10 aircraft a day in July 1950 to 237 a day in June 1953. For most of the Korean War, the Marines maintained a complete operational Marine Air Wing in the theater; and the Navy's Carrier Task Force 77 maintained two and sometimes three carriers off the Korean east coast, each carrier normally having a complement of five squadrons.

INTERDICTION SORTIES FLOWN

During the 37 months of conflict before the signing of the Armistice in July 1953, the Air Force, Navy, and Marines flew a total of nearly 740,000 combat sorties, as shown in Table A-2. It is difficult to be precise about the proportion allocated to interdiction, but it is clear that by far the largest share of the total was devoted to the interdiction mission. Including "armed reconnaissance," FEAF's interdiction sorties totaled over 220,000. This amounts to 48 percent of all FEAF combat sorties, or 55 percent of all FEAF combat sorties if reconnaissance other than armed reconnaissance is excluded. If, as

Table A-1

FEAF'S COMBAT-READY BOMBERS AND FIGHTER-BOMBERS, MONTHLY AVERAGES OF NUMBERS AVAILABLE DAILY

Month for Which Average Calculated	Bombers			Fighter-Bombers				Total Bombers and Fighter-Bombers
	B-26	B-29	Total Bombers	F-51	F-80	F-84	Total Fighter-Bombers	
Jul. 1950	30	49	79	14	69	None	83	162
Dec. 1950	65	63	128	71	118	27	216	344
Jun. 1951	58	68	126	66	94	50	210	336
Dec. 1951	73	57	130	38	47	70	155	285
Jun. 1952	69	64	133	28	54	80	162	295
Dec. 1952	98	54	152	34	74	159	267	419
Jun. 1953	107	76	183	None	5	195	200	383

SOURCE: United States Air Force, Historical Division Liaison Office, *USAF Tactical Operations--World War II and Korean War*, 1962.

Table A-2

TOTAL COMBAT SORTIES BY FAR EASTERN AIR FORCE AND U.S. NAVY AND MARINES, 1950-1953

Type of Sortie	Number of Sorties (June 1950 through July 1953)	
FEAF sorties (by FEAF classification)		
Interdiction (including armed reconnaissance)	220,168	
Close support	92,603	
Counterair--offensive	73,887	
Counterair--defensive	12,931	
Strategic	994	
(Subtotal: FEAF sorties excluding "reconnaissance" but including "armed reconnaissance")		(400,583)
Reconnaissance (excluding armed reconnaissance)	60,971	
(Subtotal, FEAF combat sorties)		(461,554)
Navy and Marine sorties (by Navy classification)		
Offensive	204,995	
Defensive	44,160	
Reconnaissance	26,757	
(Subtotal, Navy and Marine combat sorties)		(275,912)
TOTAL ALL SORTIES	737,466	

SOURCE: For FEAF sorties, see United States Air Force, Historical Division Liaison Office, *USAF Tactical Operations--World War II and Korean War*, 1962.

For Navy and Marine sorties, see Donald William McMaster, "The Evolution of Tactical Airpower, with Particular Emphasis upon its Application by the U.S. Navy and the U.S. Marine Corps in the Korean War, June 1950--July 1953," University of Maryland thesis, 1959.

seems plausible, at least half of the 205,000 Navy and Marine "offensive" sorties were devoted to interdiction, the total for the interdiction mission would amount to over 320,000 sorties, or between 8000 and 9000 a month on the average. The monthly interdiction total varied considerably, of course, depending on aircraft availability, weather, the ground-combat situation, targeting strategy, and other factors. In some months the total for interdiction was well above 10,000 sorties, but in the first few months of the conflict the total was substantially lower because fewer aircraft were available. In the initial 5 weeks of combat, from 25 June 1950 through 2 August 1950, the total number of sorties flown, including all combat missions, was less than 8000; and of these some two-thirds were low-payload F-80 sorties, many of them committed to close air support rather than interdiction.

ORDNANCE TYPES AND AMOUNTS EXPENDED

Except for a few experimental weapons,* the normal ordnance used was that of the last years of World War II: conventional general purpose bombs, unguided rockets,+ napalm, and machine guns. Only the B-29s and B-26s had range-payload capabilities that made it possible for them to reach enemy targets with substantial bomb loads, especially in the early weeks of the war when few or no South Korean bases were available and bases in Japan had to be used even by the short-ranged fighters. In this period of the war the F-80s relied almost entirely on machinegun fire and rockets, averaging only about two rockets fired per sortie. The F-82s could do somewhat better, averaging about 5 rockets fired and some 600 lb of bombs delivered per sortie. But even the F-51s averaged less than 1000 lb of bombs per sortie.

A large fraction of the small bomb tonnage dropped by fighters in this period was napalm. In the almost total absence of enemy air defenses, low-level delivery profiles could be adopted that gave sufficient accuracy for napalm to be used effectively against tanks and other vehicles, particularly those in column on the roads.

---

*The primitive--but promising--guided bombs of the RAZON and TARZON types. Only a few hundreds were employed. It is difficult to understand why a more determined effort was not made to exploit their potential, especially against bridges.

+Mostly 5-inch High Velocity Aircraft Rockets (HVARs).

Although fighter-bomber payloads were never large, even when FEAF aircraft could be based in Korea, the wartime total of air ordnance delivered by FEAF in interdiction attacks was impressive, as shown in Table A-3. The Navy-Marine Corps all-mission total was also impressive (see Table A-3), and presumably about half was delivered against interdiction targets.

DAMAGE INFLICTED

As would be expected from the vast number of interdiction sorties flown and the great volume of ordnance delivered, heavy damage was inflicted on a variety of interdiction targets. The damage *claimed* for the war as a whole is summarized in Table A-4. Without on-the-spot physical inspection or access to reliable enemy records, it is always difficult to evaluate claims of this kind. Historically, there is much evidence that such claims tend to overestimate the materiel damage actually done.* Moreover, even if a claim to having "damaged/destroyed" a target is literally accurate, it is often not clear whether the target is claimed as being *destroyed* or *damaged*, and, if only damaged, whether the damage was slight or severe. *But even if the* claims in Table A-4 are thought to be exaggerated by a factor of 2 or 3, the aggregate physical damage inflicted during the Korean interdiction campaigns must be reckoned as formidable indeed.

SUPPLY INTERDICTION: RESULTS DOUBTFUL

During the Korean War as a whole, by far the largest fraction of the air interdiction effort was aimed at limiting or cutting off enemy supply movement. Supply-interdiction sorties were flown in every phase of the war and outnumbered force-interdiction sorties in every phase except possibly the first. The fraction of total sorties allocated to supply interdiction was especially large during the more-than-two-years-long Phase IV, when the line of contact had

*But this is not always so. As mentioned earlier in the text, during the World War II bombing of the German transportation system, Allied claims understated the success of air attacks in cutting rail lines.

Table A-3

AIR ORDNANCE EXPENDITURE, 1950-1953

Type of Ordnance	Amount Expended
FEAF Expenditure on *Interdiction Alone* (Including Armed Reconnaissance)	
Bombs, excluding napalm (tons)	218,448
Napalm (tons)	3,815
Rockets (rounds)	97,885
Ammunition (thousands of rounds)	73,358
Navy and Marine Corps Expenditure, *All Missions* (About Half for Interdiction?)	
Type of Ordnance	Amount Expended
Bombs, including napalm (tons)	178,399
Rockets (rounds)	274,189
Ammunition (thousands of rounds)	71,804

SOURCES: See Table A-2.

Table A-4

INTERDICTION TARGETS CLAIMED AS DAMAGED OR DESTROYED,
JUNE 1950 THROUGH JULY 1953

Type of Target	Number Damaged/Destroyed		
	FEAF Claims	Navy and Marine Corps Claims	Total Claims
Bridges	3,082	2,005	5,087
Rail lines (cuts)	22,828	Not stated	22,828 + (?)
Locomotives	1,954	391	2,345
Rail cars	35,986	5,896	41,882
Vehicles	104,186	7,437	111,623

SOURCES: See Table A-2.

been more or less stabilized, and the United Nations forces had assumed a generally defensive posture. With varying focus of effort almost every component of the enemy supply transport system was targeted: route structures including rail lines, roadways, rail and road bridges; and movers including locomotives, rail cars, trucks, and other road vehicles. As suggested by the claims summarized in Table A-4, the aggregate damage to the enemy supply system was enormous.

The overall effectiveness of supply interdiction in Korea must be regarded as doubtful, however, especially after the UNC breakout from Pusan. Clearly the results were disappointing to many Army and Air Force officers, who had high expectations of airpower derived from successes in World War II. Even after the admittedly unsatisfactory results of supply interdiction in the spring and early summer of 1951 (the first Korean "Strangle" operation, focusing on roadways and trucks), there was high optimism about the major new rail interdiction campaign (also called "Strangle") that began in mid-August of that year.[*] Some senior officers pointed out that interdiction success might be more difficult to achieve in Korea than in Western Europe in World War II, because of major differences in the ground situation.[†] But the Fifth Air Force Operations Directorate seems to have believed that U.N. airpower could make the enemy's rail system in North Korea inoperable. It was thought that the destruction of the rail system, supplemented by air attacks against roadways and trucks, would force the enemy to retire northward to shorten his lines of communication, perhaps even without the pressure of a U.N. ground offensive.[**]

These expectations were never to be fulfilled. After some initial interdiction successes, the enemy's countermeasures became more and more effective, and by the end of December 1951, Fifth Air Force intelligence acknowledged that the enemy had "broken our railroad blockade of Pyongyang and . . . won . . . the use of all key rail arteries.[††]

---

[*] Strangle II was followed early in 1952 by operation "Saturate," which focused more narrowly on rail *lines* as the target system and was more centrally planned and controlled.

[†] General Vandenberg, for example; see Robert F. Futrell, *The United States Air Force in Korea 1950-1953*, New York, 1961, p. 403.

[**] Ibid., p. 407.

[††] Ibid., p. 413.

It is not surprising, therefore, that by the spring of 1952 FEAF had adopted a new and much more modest goal for the rail interdiction program: "To interfere with and disrupt the enemy's lines of communication to such an extent that he will be unable to contain a determined offensive by friendly forces or be unable to mount a sustained offensive himself."* But whether the enemy would be unable to contain a determined U.N. offensive was never put to the test. And whether the enemy was himself unable to mount a sustained offensive depended on the meaning attached to "sustained."

Certainly the enemy was able not only to supply his divisions with their daily consumption needs but also to build up substantial supply dumps in the forward areas. In July 1951, before the beginning of Strangle II-Saturate, enemy ground troops fired only about 8000 artillery and mortar rounds. In May 1952, after 10 months of rail interdiction, they were able to fire over 100,000 rounds. In the same month, just after he handed over the Supreme Command in Korea, General Ridgway stated that he thought the enemy forces opposing the Eighth Army had achieved "a substantially greater offensive potential than at any time in the past." The Commander of the U.S. Seventh Fleet in Korean waters asserted later that "The interdiction program was a failure. It did *not* interdict. The Communists got the supplies through; and for the kind of war they were fighting, they not only kept their battleline supplied, but they had enough surplus to spare so that by the end of the war they could even launch an offensive." The Commandant of the Marine Corps publicly stated that Operation Strangle was "recognized as a fizzle."†

---

*Ibid., p. 408.

†The quotations in this paragraph are taken from Futrell, op. cit., p. 435.

The doubtful success of the repeated supply interdiction campaigns in Korea was the consequence of many factors, of which the following appear to be the most important:

- Enemy equipment, consumables, trucks, railway rolling stock, and locomotives flowed into the theater from "sanctuary" areas where they were available in large quantities.
- Enemy consumption rates were naturally low and, especially after the ground war became stalemated, the enemy could usually manage his consumption so as to avoid any serious, unintended drawdown of stocks.
- Even though the United Nations forces had air superiority and could generate an average of nearly 9000 interdiction sorties a month, there were insufficient sorties available to achieve the required degree of damage.*
- U.N. aircraft had only modest ability to attack moving targets at night even during clear weather, and essentially none in adverse weather.
- The operations officers who planned and conducted the supply interdiction campaigns gave insufficient attention to enemy countermeasures, both before and during the operations.†
- The enemy reacted quickly and developed effective countermeasures: camouflage; travel mainly at night; surprisingly rapid repair of rail lines, roadways, and bridges; shuttle movement with transshipment across route cuts; proliferation of anti-aircraft weapons.**

---

*According to Futrell, the main causes of interdiction failure were (1) insufficient aircraft strength (sortie availability), and (2) neglect of enemy countermeasures: Futrell, op. cit., pp. 436-437. For the question of sortie availability see also Alfred Goldberg (ed.), *A History of the United States Air Force 1907-1957*, Princeton, 1957, pp. 253-254.

†Futrell, op. cit., pp. 436-437.

**See Felix Kozaczka, "Enemy Bridging Techniques in Korea," *Air University Quarterly Review*, Winter, 1952-1953, pp. 49-59.

SUCCESS IN FORCE INTERDICTION: TIMELY KILLS AT CRITICAL TIMES

Because most of the interdiction effort in Korea was devoted to attempts at supply denial, the success of force interdiction in the first months of the war has often been overlooked. During the U.N. withdrawal from the Yalu after the Chinese intervention, and especially in June, July, and August, during the retreat to the Pusan perimeter, the UNC ground forces were hard pressed and fought mainly rear-guard actions. In both these phases of the war, airpower played a major role in attriting the enemy, delaying his advance, and (to some degree) disrupting his operations.

During the Allied retreat to the Pusan perimeter, the enemy's pursuing columns, spearheaded by tanks, were the major threat. The ROK forces had almost nothing with which to oppose the NKA tanks (neither tanks of their own nor effective antitank weapons), and the U.S. ground elements had initially only a few over-age light tanks, bazookas, and some mines that they were ill-trained to use.* To avoid disaster it was necessary to blunt the enemy's tank-led thrusts, and in doing this U.S. airpower made a critical contribution by killing tanks in and behind the battle area. This was achieved partly in close support attacks but mainly in what was then called "close interdiction"--the equivalent of what is now often referred to as "battlefield interdiction." The targets were maneuver units, especially units on the roads moving up to the point of contact but still outside the close support zone.

Against tanks the most effective air weapon was napalm, which, as explained earlier, could be delivered with the needed accuracy because of the benign air environment and the usual absence of ground-based anti-aircraft weapons other than machine-guns and small arms. The F-51 (Mustang) fighter-bombers delivered napalm, and the F-80s (more numerous but with lighter payloads) used rockets against tanks.

---

*Before the war, the U.S. view was that the difficult terrain and sparse road network made Korea generally unsuitable for tank operations. The effectiveness of the NKA tanks and the mobility of NKA forces came as an unwelcome surprise.

The number of enemy tanks damaged/destroyed in these force-interdiction attacks is difficult to determine with precision, partly because the distinction between close support and force interdiction is sometimes fuzzed, and partly because tanks, if only damaged, could often be recovered, repaired in the field, and employed again.

In September and October 1950, U.N. operations research survey teams searched all the major routes of armored movement south of the 38th parallel and along the Kaesong-Pyongyang Highway, and located 180 NKA tanks *destroyed* in combat and left behind--a number no doubt less than the total number destroyed, but in any case well over half of all the NKA tanks committed in the invasion.* Of these 180 tank kills, the survey teams attributed 102 (57 percent) to air action,† 39 (22 percent) to U.N. tank fire, and the remainder to a variety of other causes, including infantry antitank rockets (bazookas).** Some of the 102 tanks lost to air attack were no doubt destroyed after the final Pusan defense lines were established or in the NKA retreat after the U.N. breakout in September. But it seems likely from prisoner-of-war reports and pilot claims that most of these tanks were destroyed earlier during the critical period of the U.N. retreat toward Pusan when, except for U.N. airpower, the NKA tanks dominated the battlefield.

---

*The official U.S. Army history suggests that the NKA committed no more than about 150 tanks in the invasion of South Korea: Roy E. Appleman, *U.S. Army in the Korean War, South to the Naktong, North to the Yalu*, Department of the Army, Washington, D.C., 1960, p. 10. But this is certainly an underestimate; somewhere between 250 to 300 appears more realistic, not counting an uncertain number of replacements.

†Sixty of the 102 were credited to napalm, suggesting that the small force of napalm-delivering F-51s played a truly crucial role, especially after 1 August, when napalm began to be used more frequently.

**Appleman, op. cit., p. 602, takes these results from a report of the Army's Operations Research Office (ORO), but speculates that some of the tanks credited by ORO as air kills may first have been immobilized by bazooka fire. When one considers that the survey teams were able to examine only the principal avenues of armored movement, it seems likely that the actual total of air kills was somewhat larger than the 102 they were able to identify. Nonetheless it is clear that the FEAF claim of 243 NKA tanks destroyed (and 221 damaged) in the first *5 weeks* of the war must be regarded as exaggerated, perhaps by as much as a factor of 2. What is certain is that NKA armor suffered such heavy losses early in the war that it never again constituted a major threat--and this was accomplished in large part by air interdiction.

Futrell cites some revealing prisoner-of-war responses:*

- "En route from Kwangnung area the 8th [NKA] Division was attacked many times by aircraft and lost ten 76 mm. field guns, three 122 mm. howitzers, 20 tanks, and 50 trucks loaded with ammunition and equipment."
- "At a point two or three kilometers from Hamchang the unit sustained an air attack in which it lost six tanks, four trucks and 150 men. Four planes participated in the attack."
- Less than half the tanks of the NKA's 16th Tank Brigade survived air attack to go into combat against UNC ground forces.

This timely destruction of a substantial fraction of a key component of enemy ground strength *before it could close to contact* transformed the situation on the ground--even though the actual number of tanks destroyed was small relative to tank losses in other wars before and since.

Although air target-kill claims were no doubt exaggerated, a relatively small force of aircraft, with poor range-payload characteristics compared with current U.S. tactical aircraft, and carrying what must be considered primitive armament by today's standards, did destroy or damage a large percentage of the enemy's armored and other vehicles in a short but critical period. Many senior U.S. Army officers on the scene freely conceded that, were it not for the contributions made by tactical air in the early hectic weeks of the war, the ground forces might well have been pushed into the sea. In November 1950, General Walton Walker, commander of the Eighth Army, told the USAF Evaluation Board:

> I will gladly lay my cards right on the table and state that if it had not been for the air support that we received from the Fifth Air Force we would not have been able to stay in Korea.†

---

*Futrell, op. cit., p. 165.

†Appleman, op. cit., p. 477.

Several factors contributed to this force-interdiction success:

- The U.S. (later U.N.) air forces had something like absolute air superiority over South Korea throughout the retreat to the Pusan perimeter.
- The North Korean forces had not expected U.S. air intervention, had fielded few anti-aircraft weapons, and had given scant attention to training for dispersion, camouflage, and other passive measures for reducing the effectiveness of air attack.* Such measures had to be developed belatedly in the field.
- The difficult terrain and sparse road network in Korea were favorable for force interdiction. Although their possession of tanks conferred on the North Koreans a great operational advantage, it was not possible to use tanks in extensive cross-country movements on wide fronts: tank thrusts had to be channeled in narrow corridors on or near the roads where they were relatively easy to find from the air.
- The situation on the ground was urgent; the North Koreans had to achieve their objectives quickly or face a superior intervention force.

---

*Futrell, op. cit., p. 160.

FILMED

5-8