ORSA EDITOR'S PREFACE

There well may be no larger financial impact of operations research on the military community than that associated with sustainability. There are three reasons for this -- the savings are real, even in peacetime; the analyses are the particular province of operations analysts (rather than military strategists or equipment designers, for example); and most important, there are strong establishmentarian reasons for sustainability to be a major destabilizer of the defense economy.

Since this last issue is typically one that operations analysts are not specifically commissioned by the establishment to address, this preface may provide a rare and appropriate opportunity to focus on it. The best-recognized problem may in fact be the least important. That is the problem that sustainability considerations have had two natural enemies -- performance and cost. These are historically personified by combat arms (performance "types") and budgeters (procurement "types"). Although both sides pay more than lip service to sustainability, somehow it doesn't have a powerful cheering section, and therefore it tends to suffer. This suffering has been intensified by the proponents (both within the Defense Department and within the contractor community) of additional equipment -- whether new or old. Budgeting for future support is clearly a potential drag on procurement decisions. All these above issues have long been recognized and many of the papers within this volume address them explicitly. Even though these problems are far from being solved, at least they do not suffer from lack of recognition nor from dedicated and concerned defenders.

The really big problem is a deeper one. Although it is not logically subtle, it seems to lack any self-motivating constituency whatever. It is the time-deferral problem: the procurement decisions of one administration become the sustainability burdens of its successors. By their very nature, the acquisitions of Defense Secretary Weinberger will become the support costs of defense budgets over the next ten or twenty years. In the other direction, the procurements initiated under his administration -- large as they may seem to some factions -- have been correspondingly constrained by the current support-oriented expenditures.
necessitated by his predecessors' procurements. There can be no stronger motivations for a long-term, bipartisan defense planning process. Such a process must properly anticipate support costs. This means that the budgeting of sustainability at least implicitly permits the budgeting of future flexibility in procurement.

Penalties for ignoring this longitudinal problem are current, large and impossible to deny. The first is already stated -- the diminution of sufficient funds to apply to important new procurement. The second is less obvious and therefore more insidious: the pressure to under-support existing systems in order to save money. On this one, there is in fact a constituency for support made up of the combination of the support contractors, including hardware repair and replacement, and the operating forces. We have seen that their historical adversaries are those concerned with new procurements. Although this constituency would seem to be the "good guys" there is a second order issue that almost never gets a proper hearing -- just how "ready and supported" should our in-place equipment be. There is almost nothing easier than getting a jingoistic, religious endorsement for extremely high states of readiness. In fact, provision of such states would be so expensive as to wipe out almost all flexibility in procurement. It would clearly be inappropriate. This leads to the other critical aspect of budgeting sustainability. Not only do we need to foresee the costs, but we have to be careful not to demand more readiness than we actually need. We all know that there are two determinants of sustainability costs: the level of readiness (availability, reliability, or whatever) that is specified, and sustainability -- namely the cost of providing whatever may be the level of readiness. Unless it becomes a logical participant in negotiations regarding appropriate levels of readiness, the support community should not expect to be listened to with the respect it needs. It cannot unilaterally budget such levels -- at best all it knows is how to attain them efficiently and how much they will cost. Neither can levels be unilaterally specified by the operating forces. All they know is how important they are and not how much they will cost.

As this preface is being written, there are two sustainability stories in the news. One is the report of the (1986) Packard Commission on Pentagon reorganization, with its recommendations of a "Procurement Czar." It will be interesting to see how explicitly
these sustainability issues will be addressed by such a czar, assuming he is in fact crowned. The second is the latest crescendo of despair triggered by the Rogers Commission investigating the Challenger explosion -- the concern that the explosion was not properly accidental but rather almost a predictable result of systematic shortcomings in the support process and in its management. One cannot help but wonder how many defense support systems would withstand such a critical investigation triggered by a similar operating tragedy. This in spite of the well-organized "in-house" investigations that routinely are performed.

The delightful upshot (to an analyst) of this introduction is that there are huge current problems in defense budgeting, and that they require significant involvement from the analysis community.

John D. Kettelle
Editor-in-Chief,
ORSO Softback Books
March 1986
PREFACE

An unclassified mini-symposium on "Relating Resources to Readiness and Sustainability" was held in Arlington Virginia on the 13-14 August 1984. The Conference was planned by the Military Applications Section of the Operations Research Society of America, approved and funded by the parent society and chaired by Mr. Leo Rogin, Information Spectrum, Inc.

The undersigned and Leo Rogin while planning the conference invited LTC Jim Bexfield, the then-president of the Military Operations Research Society to participate in sponsoring the meeting. The MORS Board of Directors concurred and appointed Ervin Kapos as the MORS cochairman.

Through the good offices of Dr. Jay Mandelbaum, Office of the Secretary of Defense, Manpower, Installations, and Logistics the meeting was elevated to be in support of the Readiness/Sustainability Program of the Assistant Secretary of Defense (M,I&L).

The Honorable Lawrence J. Korb, ASD (M,I&L) presented the keynote address to more than 200 attendees. Concluding remarks were vividly conveyed by Charles W. Groover, Deputy Assistant Secretary of Defense for Program Integration.

Although there is progress being made in this field, there is still a great deal of work which needs to be accomplished before a satisfactory linkage is developed between enhancement of military readiness and changes in applied resources.

We are indebted to Information Spectrum, Inc. for providing a substantial amount of administrative support before, during and after the conference. Also Richard I. Wiles and Natalie S. Addison, Executive Director and Administrator of MORS very ably supported the symposium and helped make it an
event of benefit to all participants. We are also grateful to Dr. John Honig for volunteering to edit the papers of the conference and Miss Julie Abraham for her tireless effort in typing the manuscript.

To the committee, the speakers, and all participants goes the credit for a successful conference.

Alfred S. Rhode
Information Spectrum, Inc.
MAS Chairman (1982-84)
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GLOSSARY
INTRODUCTION

When policy makers in the Defense Department are faced with resource constrained budget decisions, they must be able to allocate the fraction of the total resources that should be devoted toward building future capability, i.e., research, development and acquisition of materiel and facilities, and the fraction that should be devoted toward maintaining a high degree of readiness of today's forces to fight a near term conflict, as well as the ability to sustain their war fighting capability over an extended period of time. It is the purpose of this monograph to provide some approaches to aid decision makers by providing them quantitative information on the impact of resource changes on readiness and sustainability.

Critics have recognized a sometimes perceived, and sometimes real, trend toward buying newer and more capable equipment at the expense of maintaining adequate ammunition levels, spare parts, repair and maintenance resources or a reasonable quality of lifestyle for troops. For example, an October 20, 1981 GAO Report summarizing their analysis of the acquisition of fourteen major programs states:

"Operation and support costs are generally greater in total than the weapon systems procurement costs and span a much longer period of time."

"Fielding all 14 new systems during the next decade is likely to seriously strain the Army's available long-term operation and support resources. Most of all these systems will require more people, with higher skills, at a time when competition for personnel may be more intense. They will also require more fuel and ammunition, imposing a greater logistic burden. These additional resources, as well as a greater expenditure for spare parts, will require increased funding over the next several years."
"Before beginning or continuing the acquisition of individual weapon systems, the Army should assess the systems' aggregate long-term support requirements. Also, it should determine whether sufficient funds can reasonably be expected to be made available to sustain, at the required degree of readiness, not only those systems that are still to be produced but also those already in the inventory."

More recently, Congressional criticism has been voiced which tried to show that the large additional expenditures for Defense in the Reagan administration have not yielded much improvement in readiness. In its response the Administration used different statistics and measures of effectiveness to prove that the criticism was really not justified.

Legislatively, Congress has also attempted to exercise control over the problem of assuring that adequate resources are applied to maintain the readiness of the forces. Specifically, the Defense Authorization Act of FY 1978 stated that

The budget for the Department of Defense submitted to Congress shall include data projecting the effect (on readiness) of the appropriations requested for materiel requirements."

The Defense Secretariat immediately recognized that one of the principal obstacles was the lack of an agreed upon and measurable standard for materiel readiness, and that materiel readiness is only a part of the whole equation.

This monograph is arranged into four topical sections. First, the challenge to the analysts is discussed principally with a paper by General Goodson, then the Assistant Chief of Staff for the Air Force for Studies and Analysis. This is
followed by a section on approaches to the problem. First some Navy approaches are discussed in a fairly general way and then some Army analyses and a non-Defense agency are covered.

The Models section presents descriptions of models and methodologies, some of them are currently actually in use. Quantitative analyses of various aspects of readiness and sustainability are treated in some detail, including some illustrative applications. The final section deals with the lack of data problem. In those cases where some peacetime operational data are available, the problem of converting those data to wartime expectations are discussed.

THE CHALLENGE

Former Secretary Korb, in his keynote address to the Symposium pointed out that not only are readiness and sustainability not completely understood concepts, but that they cannot be considered in isolation. Combat capability rests on all four pillars of defense, i.e. force structure, modernization, readiness and sustainability. The Secretary emphasized that the four are related and one cannot consider one without the impact on the others.

General Goodson, in the lead article of this monograph points out that the overriding problem facing the analytical community is the lack of common analytical framework within which we can determine the proper balance between force structure, modernization, sustainability and readiness. General Goodson discusses, in some detail, the implications of this shortcoming and suggests an approach for deriving such a framework.

Definitions of readiness and sustainability generally emphasize the ability of an organizational unit to deliver its product or service at a specified time and to continue to
deliver that product or service over an extended period of time. These definitions have two essential characteristics. They are output oriented and they must include time dimensions, i.e. time measures related to the responsiveness of the unit to deliver its service and the time extension over which it can deliver its service.

While there is no general agreement on how to measure "readiness" in a quantitative manner, there are surrogates in use, such as operational availability of materiel, as are discussed in a number of papers in this volume. Furthermore, as mentioned by Secretary Korb earlier, the marginal impact of more or less readiness on force effectiveness has not been understood or analyzed. This is also discussed further in a number of papers in this volume.

THE APPROACHES

In principal, the approach to relating resources to readiness is not difficult to conceptualize. The most difficult task is probably to define what is meant by readiness and sustainability. As mentioned before, there is no general agreement. Next, one must select some measurable parameters that indicate a level of readiness of sustainability or act as a surrogate.

The next step is to relate those measurable parameters in some way to resource requirements, and then one must wrap the whole thing up so that variations in available resources can be directly related to changes in operational readiness levels. Finally one must consider the whole thing in the total context of the other pillars of defense and a wide spectrum of potential warfighting scenarios, under stress conditions. Each of the above steps is complex and the combining of existing and generated input data is still an art. Papers related to all Services' approaches are included here.
Miller's paper discusses, in a general way, the parameters and dynamics involved in determining readiness of ships and relating resource requirements to readiness. Major historical trends in data are related to ship readiness. This includes data trends on ship age, ship manning and complexity, fleet asset value, operating and support costs and ship readiness measures (e.g. CASREPs and UNITREPs).

In a related general paper Horowitz discusses the relationship of resources to readiness of ships also, but the concepts are equally applicable to other systems as well. He discusses in some detail the problem of defining readiness, measuring readiness, relating resources to readiness and evaluating the importance of readiness. While the author correctly emphasizes that materiel readiness is only part of the measure of readiness, it is still the measure he uses in the paper because of the availability of data. In the non-materiel area, both the definitions and the necessary data are even harder to obtain.

The consistency of various data sources is established in the above paper. The resource portion of the paper includes an examination of down time and its cost, spare parts provisioning and overhaul analyses. Some needs for additional critical research are identified.

One of the principal factors affecting ship's readiness status is the policy used for determining stockage of spare parts. Levy's paper discusses CNA's work in developing the Modified Fleet Logistics Support Improvement Program (MOD FLSIP) and the policy implications involved. Specifically the paper deals with the policy of stocking spare parts either on shore or on board ship in a manner to keep the Fleet operating efficiently and yet to meet space and cost constraints. Based on CNA's analyses the Navy's policy was modified to place greater emphasis on stocking spare parts which are related to
Primary mission equipment. The change in policy affects a spectrum of stockouts for different types of ships. The stockout rates then had to be converted to a measure of operational availability. Sample results of expected costs and benefits of changing the spare parts stockage policy aboard different types of ships are provided.

Turning from ships to readiness and availability in naval anti air warfare, a methodological paper by Mohler, Kinney, Frank and DiFranco describes an analysis of resources related to combat effectiveness, specifically for Naval Anti-Air Warfare. They employ operational availability as a measure of materiel readiness. The required data for the latter can be derived from standard Navy reports on failure data. They then present a mathematical derivation for incorporating operational availability into combat effectiveness and finally discuss the relationship between various analysis approaches for resource employment and operational availability, such as the use of the Availability Centered Inventory Model, for example. The methodologies discussed in that paper are designed to make it possible to track quantitatively the impact of resource decisions on measures of combat effectiveness of anti-air warfare weapon systems.

Koletar's paper addresses quantitative measures for determining improvements in the Army's war fighting capability. It describes measures for the potential capability of an Army combat unit to fight, as modified by combat service support considerations. A U.S. Army Concepts Analysis Agency study on the Analysis of Force Potentials (AFP) developed static measures of relative combat potential (a great improvement over the earlier Fire Power Indices). A related study, "Measuring Improved Capability of Army Forces (MICAF)", provides a systematic approach for reporting changes in capability as a result of modernization. Building upon the AFP measures of force potential, various environmental and tactical
operations factors are introduced and they are further modulated by combat support and combat service support considerations; in other words readiness and sustainability factors. Combat Organization Potentials (COP) are then derived, e.g. for a particular type of division, and changes in COP over time, relative to a baseline, can be evaluated.

At the Mini-Symposium Jerome Bracken of the Institute of Defense Analysis presented the methodology which is employed in the IDA Paper PP-1680, February 1983 which analyzes relationship between budgets and unit readiness of Army divisions. The analysis involved statistical relationships based on historical readiness data and budget data. Predictive equations were used to estimate future unit readiness as a function of budget allocations.

Finally, there are also agencies outside of the Department of Defense concerned with military readiness, specifically the Federal Emergency Management Agency. Lindsay describes a Federal Resource Assessment System which is designed to permit Federal agencies to evaluate their capability to support military mobilization. The principal objective of this resource system is to determine potential wartime shortages and bottlenecks. The paper describes a plan of action for developing such a system, as well as a structure for such a system and analytical processes involved. The system described is still to be developed.

THE MODELS

This section of the monograph includes papers which discuss a number of models and their applications designed to assist the decision makers in evaluating the effect of resource variations on readiness.
O'Malley describes the application of LMI's Aircraft Availability Model. This model relates funding for repairable spare parts to peacetime materiel readiness. The model has been used to analyze the spare parts portion of the budget and Air Force Program Objectives Memoranda and to make logistic procurement decisions.

The changes in the number of available aircraft in a specified time period as a function of different funding levels is determined. The impact of multiyear funding and that of different spares mixes on aircraft availability can be determined. The model also shows the impact of changes in the flying hour program and the shortcomings when employing estimates based on cost per flying hour methodology. The complications resulting from differences in lead times for spare parts procurement, when trying to fund for spare parts, is further illustrated.

Dahlberg, Waak and Kline, in an extensive theoretical paper describe Opus 7, the last complete version of their multi-echelon, multi-indenture optimization model. This model permits the selection of one of several optimization criteria, such as operational availability, waiting time, probability of no back orders or mission effectiveness. Opus 7 specifically added sustainability as a measure of effectiveness and permits tradeoffs of availability and sustainability.

As an example, the paper applied the methodology to determine the mix of spare parts with respect to (a) system availability and (b) sustainability during scenarios where repairs and replenishment of LRUs and SRUs are severely disturbed, as would be the case in a wartime situation. It is shown that provisioning of spares optimized for undisturbed peacetime scenarios will not produce optimal results in disturbed scenarios sufficient to sustain a sudden surge.
capability. The latest version, Opus 8 further permits both availability and sustainability to be optimized simultaneously without methodological restrictions.

The Grenetz paper describes a multi-echelon, multi-level maintenance and inventory simulation model, called the Maintenance Optimization Design Simulation (MODS), which is designed to facilitate analyses of operational availability and combat sustainability of airborne weapon systems. The model has been implemented on a personal computer to support "hands-on" analysis and facilitate visual feedback. The derivation of the methodology is described in quite some detail. The model can be used to examine design decisions, such as whether to perform Conversions-In-Lieu-Of Procurement (CILOP) programs or Engineering Change Proposals (ECP) as alternative strategies toward force modernization. Both, organizational and intermediate level maintenance are modelled. The input data availability problems are discussed and future directions for further research are identified.

A comparison of two models in actual use by the U.S. Air Force is presented in the Folkeson and Hodgson paper. The benefits that can be achieved from improved Aircraft Battle Damage Repair capability was examined using two models in parallel. One was a simple simulation which examined the potential increase in sorties generated as a function of number of repair teams, expected repair times and combat damage rates. The other model was the much more complex Theater Simulation of Airbase Resources Model (TSAR). The models generated comparable results, however, the more complex model could address further specific questions of interest.

A systems dynamics approach for modeling readiness of avionics systems under wartime conditions is reported by Calvo and Veach. Readiness is defined as the squadron's ability to satisfy a pre-specified flying rate. It describes the
Simulation of Operational Availability/Readiness Model (SOAR) which can be used to analyze the impact of varying the repair shop throughput rate. The method is best suited for comparisons to a baseline or for tradeoff estimates. Alternative support concepts and resource changes can be examined. An example for analyzing a fault tolerant, dynamically reconfigurable system is included.

In a related, theoretical paper, which was presented at the symposium, Professor S. S. Brier of George Washington University described "An Application of Empirical Bayes' Techniques to the Simultaneous Estimation of Many Probabilities". This method was applied to an example from the U.S. Marine Corps Combat Readiness Evaluation System (MCCRES). The study finds that the empirical Bayes' methodology leads to a very tractable means of estimating a collection of vector parameters and offers considerable improvement over the typical method of estimating each vector separately. (This paper could not be included in this monograph because it has already been published in the open literature.)

Berg's paper analyzes the expected impact of the level of ordnance available (ordnance inventory levels) on fighting capability. The Center for Naval Analyses' Ordnance Programming Model addresses both, level of ordnance issues, for example, how long can we fight with today's stocks of ordnance, as well as balance issues, for example, what is the impact of changing the mix of weapons or adding new weapons. The model analyzes specified missions and yields appropriate measures of effectiveness. To illustrate the model typical results are shown which include analyses of the impact of threat levels, the impact of varying projected inventory levels, by year, comparative sustainability effect in a scenario for varying levels of ordnance and inventory, and others.
Democko's readiness simulation model has been applied to determine torpedo asset readiness. That is defined as the ratio of ready-for-issue warshot torpedoes to all available torpedoes (including exercise torpedoes, down torpedoes, etc.). Asset readiness can be an objective function to be maximized subject to budgetary constraints. The model is a discrete event simulation. Over the life cycle of a torpedo there are a number of causes for changing readiness states (with associated transition probabilities) and the flow through this network is simulated.

In the above paper a baseline for the monthly asset readiness level over a twenty year period was developed and the impact of a number of factors shown. These include the impact of exercise requirements, changes in spare parts provisioning policy or manpower reductions at maintenance and repair installations. Democko's model appears to be useful for logistics planning but it can also be used for the determination of optimal resource allocation.

Bigelow describes a model called ORACLE (Oversight of Resources and Capability for Logistics Effectiveness). The U.S. Air Force Logistics Command employs its D041 management information system to manage the large number of parts and components for which it is responsible. The D041 information system is also used to estimate materiel acquisition requirements. However, that system is very large and cumbersome. ORACLE aggregates the D041 generated data into a smaller data bases, which can be put on portable microcomputers. The data can then be handled like spreadsheets. The method is particularly suited for short response time PPBS actions where the employment of the D041 information system is too cumbersome and too slow.

Another major, frequently neglected, contributor to readiness, besides materiel readiness is personnel readiness.
It is generally assessed using surrogate measures, which describe the characteristics of the force such as strength, grade mix, skill mix, and stability. To assist in using these measures to establish personnel policies, improved, efficient methodologies are needed. George Miller describes in detail a methodology that relates potential policy changes to changes in values of the measures. The method described by Miller is the Army Manpower Long Range Planning Model, which consists of two components.

A flow model predicts the future inventories, over time, for a large number of personnel descriptor classes (distinguishing personnel quality, experience, skills, etc.). The second component, and optimization model, prescribes rates at which personnel should flow through the manning system in order to achieve user-selected objectives. The model uses a programming methodology which allows interactive, sequential consideration of multiple objectives in deriving personnel plans. Cost estimating relationships are also part of the system. The paper describes the two models and the derivation of the underlying methodology in considerable detail. Applications of these models for planning personnel readiness are also presented.

THE DATA

Having selected an approach to the analysis and an appropriate model the final key problem analysts always face is the lack of good, applicable data. Regardless of how good the model is, the results are not more valid than the inputs used. The data problems the analyst must solve include the lack of consistent data even on existing data collected from peacetime situations into a wartime environment where the logistic and maintenance support are significantly stressed.
General Goodson's article, for example, lays to rest some "common beliefs" regarding the generally assumed relationship between aircraft readiness, maintenance and consumption of spare parts as a function of aircraft hours flown. He cites a number of actual data obtained during exercises of a stress situation in which the commonly held beliefs were found to be too simple. In fact it was demonstrated that a large increase in number of flying hours flown over a restricted period of time resulted in less maintenance and higher operational availability than the comparable values for much less aircraft utilization. While General Goodson believes the relationship between consumption of spare parts and aircraft hours flown to be true in a general sense, one cannot consider the simple statistical relationship without considering equally important contributing factors such as aircraft utilization, maintenance policy and the smart commander's adjustment of maintenance and logistics policy.

Swindel's article deals with an approach for converting "actual" peacetime airlift data into "expected" wartime airlift data. The Wartime Assessment Surge Capability Analysis Model (WASCAM) is proposed as a key to wartime effectiveness analyses. The model generates estimates of key operational parameters, e.g. wartime utilization rates, mission capable rates, sortie generation rates and mission completion rates. These rates can then be used as inputs to one of a number of existing wartime effectiveness models to estimate the total airlift fleet wartime effectiveness.

In a more rigorous analytical treatment, Kahan also deals with an approach for adjusting peacetime data to wartime data. The Dyna-METRIC model determines the impact of a wartime 30-day surge condition. A dynamic queuing model relates the expected number of parts in the pipeline to expected number of parts in the pipeline the previous day. A wartime feedback factor is then applied which provides adjustment for the "actual" number
of sorties flown versus the "planned" number of sorties flown. In addition an adjustment is made for attrition of the sorties flown.

Rolf Clark's paper discusses Navy's historical operating and support factors in some detail. Specifically he quotes analytical factors related to Navy force levels, force characteristics and force ownership, derived from the very extensive data base residing at the Navy's Resource Dynamics Project at George Washington University in Washington, D.C.

He demonstrates the danger of using oversimplified rules of thumb based on data from the 1970's to arrive at conclusions regarding the Navy's current resources devoted to readiness. This involves detailed discussion about the dynamics of the stable funding period of the 70's versus the growth period of the 80's. Clark tries to show that serious undercosting in the 70's has now been superseded by more realistic, albeit higher, cost estimates. He also indicates that the relative growth of the Navy's budget and the lesser growth of the Operations and Maintenance portion of the Navy's budget are not sufficient evidence, per se, to indicate that O&MN is underfunded. In fact, he claims that such underfunding is not the case.

Another principal value of the paper is the large amount of actual operating and maintenance data from the 1970-1984 time period and projected data for the 1985-1990 time period, indicating the scope and type of data available from the George Washington University project.

One of the management decision issues that is not discussed anywhere in this monograph is the translation of overall Service funding changes into specific funding changes that relate to or impact readiness. The most common procedure for allocating overall funding changes has been to "fence" particular, preferred programs to be "protected" from cuts and
then "salami slice" the rest by applying cuts relatively uniformly. This, again is largely due to the inability to analyze quantitatively, and in near-real time, the impact of a particular funding reduction on operational readiness. The general cut is generally a poor method, however, it is the only ball game in town until the analytical community comes up with better methods that can be used by decision makers in near-real time (2 – 3 days turnaround).

The papers presented in this monograph represent a selection of papers that were given by the authors at a Mini-Symposium entitled "Relating Resources to Readiness and Sustainability" in August 1984. Since there was a year's delay between the time the papers were actually presented and the time the monograph was being prepared, a number of the authors chose to make some adjustment for work actually completed in the interim. However, that additional work is only briefly mentioned and the papers were not changed in substance.

The keynote speech by the former Assistant Secretary of Defense Lawrence J. Korb, the luncheon speech by Lieutenant General Benjamin F. Register, Deputy Chief of Staff for Logistics, Department of the Army, and the concluding remarks by the former Assistant Secretary of Defense Charles W. Groover provided very useful information on the environment in which this decision process operates, but unfortunately were not available to the Editor for inclusion in this monograph.

The organization of the monograph is the editor's and represents a logical grouping rather than the order in which the papers were actually presented.

John Honig, Ph.D., Washington, D.C.
READINESS AND SUSTAINABILITY:
HOW'S YOUR ESTIMATES?

Brigadier General Wilfred L. Goodson*
Assistant Chief of Staff, Studies and Analysis
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My previous assignment was as the Deputy Chief of Staff for Plans in USAFE. I found it to be a thoroughly delightful job, because I could dabble in such heady matters as strategy, tactics and force dispositions. I was rather taken by all that and having great fun, until one day I was waving my hands over a map, explaining how if we would just do this thing or that, it would be quite a coup and how certain I was that the world would be safer for democracy as a result of it. My old friend --then B/Gen, now M/Gen-Lou Curtis, who happened to be the Chief Logistician of USAFE at the time, brought me down to earth rather abruptly. Without saying a word, he handed me a paper on which the following was written:

"Logisticians are a sad and embittered race of men, very much in demand in war, who sink resentfully into obscurity in peace. They deal only with facts but must work for men who merchant in theories. They emerge during war because war is very much fact. They disappear in peace because in peace, war is mostly theory. The people who merchant in theories, who employ logisticians in war and ignore them in peace, are called generals. Logisticians hate generals.

"Generals are a happily blessed race who radiate confidence and power. They feed only on ambrosia

General Goodson is now retired from the U.S. Air Force.
and drink only nectar. In peace they strive confidently to invade a world simply by sweeping their hands blandly over a map, pointing their fingers decisively up terrain corridors and blocking defiles and obstacles with the sides of their hands. In war they must stride more slowly because each general has a logistician riding on his back, and he knows that any moment the logistician may lean forward and whisper in his ear, 'Oh, you can't do that.' Generals fear logisticians in war, and in peace generals try to forget logisticians.

"Marching along beside generals are strategists and tacticians. Strategists and tacticians don't know about logisticians until they grow up to be generals, which they usually do.

"Sometimes a logistician gets to be a general. In such a case he must associate with generals whom he hates. He has a retinue of strategists and tacticians he despises, and on his back is the logistician whom he fears. This is why a logistician who gets stars also get ulcers and cannot eat his ambrosia."

With regard to the basic problem of understanding logistics and its contribution to overall war fighting capability, I'm afraid that we analysts might fairly be confronted with the same charge leveled at the generals. We simply don't know very much about logistics, the chief fare of readiness and sustainability.

There is one overriding, basic analytical problem facing the analysis community today: There is no satisfactory common analytical framework within which the proper balance among
force structure, modernization, readiness and sustainability can be achieved. I want to talk about that analytical problem today and the difficulties which our not having one has brought. I will tell you that among the important impacts of not having one are:

(1) It is obviously much more difficult to achieve balance among force structure, modernization, readiness and sustainability. (2) It leads to reporting systems of very restricted scope and meaning, which can only be properly understood within the stated restrictions. (3) Because of the restricted meaning of reporting systems, there is and will remain potential for considerable misunderstanding and misinterpretation of results of resource allocation decisions.

Further, I will tell you that my experience has been that we can do better than we predict, and that we, in the analytical community, need to do a better job of predicting our true capability. Finally, I'll come back to the overriding analytical problem: to devise a satisfactory analytical framework under which force structure, modernization, readiness and sustainability can be brought into proper balance.

Dr. Korb has spoken of the lack of a satisfactory framework. Without such a framework, seasoned military judgment, unassisted by analysis on this subject (some would say unencumbered by analysis) has to be applied to the problem of achieving the proper balance. That isn't all bad—in fact it is generally quite good—but as such judgments are based on different perceptions of how some future conflict might proceed, decisions often lead to considerable controversy. Further, they are made at such an aggregated level that the players have to stop and agree to some sort of rudimentary framework before they can even discuss the subject.
The second impact is that without a common overall framework, those in charge of operating the forces are being forced to create internal reporting systems of restricted scope and meaning. Those who create such reporting systems understand them very well; they understand their restrictions; they understand their limitations; they understand what they mean; and more importantly, they understand what they don't mean. Unfortunately, any reporting system or restricted scope and meaning can eventually lead to misinterpretation or misunderstanding of the results. Some recent headline cases show this: Report: "A comprehensive congressional survey has concluded that the military readiness to fight is declining and that American forces cannot sustain combat against the Soviet Union or many lesser powers". Response from the Department of Defense: It's not so. Report: "Readiness and sustainability of U.S. armed forces declined further during the third year of the Reagan administration and increased military budgets have not improved the situation." Counter from the JCS: "That's incorrect." Report: "Critics cannot understand why the Reagan administration has been unable to find enough money for things like ammunition and spare parts in budgets that every year set records for defense spending." Question: Is it really true that we have not spent money on spare parts and ammunition? The facts are that 1980 we spent $90M for aircraft replenishment spares. By 1984, it was more than 4 times as much, at $3.9B! We can now fly 62% more combat sorties in NATO than we could in 1980. One can continue down the list of things that have improved in an absolute and real sense in our capability to fight—in our readiness and sustainability. So how can people look at the reporting system and misinterpret how ready our forces are for combat? The short answer is that the reporting system currently in use has a very precise but restricted meaning and scope, both of which change over time. Its design was intended for short term management by people who clearly understand its limitations, and not for long term comparisons by anyone—especially by those who don't understand its limitations.
As Dr. Korb suggested, combat capability does not reside just in readiness and sustainability, but rests on all four pillars of force structure, modernization, readiness and sustainability. Now without further instruction, my mother may not be able to understand all of the intricacies and subtleties of our internal reporting system, but I believe that if she were informed that over the last four years that we have:

-- 1100 new fighter aircraft
-- 11% more combat units
-- a 29% increase in daily lift capability due to C141 stretch and C5 wing modifications
-- a 33% increase in new air-to-air missiles (3300 in 1980 and 14,200 in 1984)
-- a 14% increase in air-deliverable munitions capacity in Europe
-- an 8% reduction in aircraft waiting for spares since 1981
-- a 10% increase in wartime fuel reserves
-- the ability to support 62% more war time sorties in NATO
-- a 100% increase in chemical suits for Air Force personnel located in high threat areas
-- a 27% increase in tactical flying hours (up from 15 hours per pilot per month to 19 hours per pilot per month)
-- and on and on.

I suspect she would rightly conclude that we are indeed much more ready, much more sustainable, and because we have done this in as balanced a way as any of us know how, we have considerably greater combat capability than we had four years ago. That is not to say that problems don't remain. They do. Among others, munitions storage and distribution problems exist in Europe. They have to do with infrastructure funding and
priorities within the alliance. There other examples, but by and large, it is clear that great progress has been made.

Furthermore, my experience has been that we actually can do better than even we predict we can do. Let me give you an example. I had a great deal of experience in bringing both the F-111F and the F-111D to maturity. Those of you familiar with those airplanes may recall that the F-111F has a relatively good reputation for reliability and maintainability in comparison with the D model, which had the reputation of being difficult to maintain and a large consumer of spare parts. Now the difference of consumption rates of spare parts was real. However, for a variety of reasons, which time precludes me from going into, I conclude that it was less due to the intrinsic design of the aircraft than from the philosophy which guided the operation and maintenance practices of the two units which brought them on line. In the beginning, one unit was more tolerant of system errors and system discrepancies, preferring to continue to operate in a degraded systems mode if the mission could still be safely and adequately accomplished. The initial operating philosophy of the other was to demand full up systems for normal peacetime operations. Naturally the latter mode placed a greater demand on the supply system.

But there was a more subtle effect which, for our purposes today, is far more important to understand. I finally came to grips with it early in 1977 at Cannon AFN with the F-111D. We performed an operational experiment in Feb 1977, the results of which are very instructive. It has to do with what happens internally to the aircraft systems over time. The objective was to fly as many sorties as possible with one squadron of aircraft in a one day period. We used the Korean scenario, with roughly a 155 mile mission distance, with two targets for every sortie. We dropped practice munitions, required munitions uploading between every sortie, and did other servicing as required. The rule we established was that as
long as the basic airframe, engine, flight controls and at least one weapon delivery mode were operational, no maintenance would be performed on the aircraft. However, we did track the status of each of the major components of the systems on each of the 24 aircraft. We began the exercise at 0700 in the morning. Ten hours later, we had flown 123 sorties with the 24 aircrafts. Flying 123 sorties in the F111D, using 24 aircraft over a 10 hours time period equates to a sortie rate that is approximately 5 times higher than anyone had projected possible in wartime surge, and roughly 12 times higher than was commonly experienced in peacetime.

So you say, "Of course, but naturally such a rate cannot be sustained for any period of time. Your consumption of spares was obviously much higher than normal, and you would have run out of spares before long." Now that suggestion makes considerable sense. After all, the notion that the number of spares needed in the long term is proportional to how much you fly is the basic engine which drives our spares requirements calculations! Unfortunately for us analysts, there is not the slightest shred of evidence from this experiment which suggests that the proportionality is true. Our consumption of spares was actually less than we normally encountered with that same 24 aircraft. Ah, but you say, "Well, since you didn't work on the airplanes, then at the end of the day, you obviously had a bunch of sick airplanes on your hands, and you used the same spare parts as predicted, but you just used them up later during your 'recovery' period." Again, the facts are quite different from that very intuitively appealing explanation. The facts are that the fleet was in far better condition at the end of that day's flying activity than at the beginning. We know the airplanes got better because we tracked every major component and its status on every airplane, on every phase, of every sortie flown that day, so that we knew precisely when each system went down, when it healed itself, etc. Example: When we began the exercise, there were a few fully operational
aircraft, more with mild to moderate problems, and six aircraft that were in very sad shape. On two of the six bad aircraft, the inertial navigation system would not even uncage, and the entire fire control system was down, including the radar. The only things operable were in the basic airframe, engine, flight controls, and a hot manual pickle button. In short, in terms of systems capability it was very much like a very expensive, older model F4. By the end of the day, without having any maintenance performed on any of the aircraft, each of the six was Code I, which is to say, they were in excellent operating condition with no major systems down. No maintenance had been performed on any of them. No spares had been used. Through the process of exercising the systems—turning them on, turning them off, resetting flags, and warming them up they had "repaired" themselves. Question: How does that square with our commonly accepted practice of making our estimates of spares consumption on the basis of the proportionality of spares consumption to flying time? Is that the proper analytical technique for forecasting spares requirements? My own experience tells me that it doesn't yield very good results. Though I am still inclined to believe that, by and large, such a relationship exists. But other things are at least equally important and cannot be ignored: When you fly versus when you do certain maintenance; the rules you use for when to fix certain failures on the airplane; and so forth. I had similar experiences as Commander of the 401st Tac Fighter Wing flying F4Ds and as Commander of the 50th Tac Fighter Wing as we were bringing the F-16 on line. In both cases, through the proper marriage of operations, maintenance and supply, we were able to fly a considerably higher number of sorties and more overall flying time than was programmed, and with no more spares being consumed in the process.

The uncertainty in our ability to predict what sortie rate we can fly as a function of the input of spares, is very unsettling, because that has to be one of the basic building
blocks for an analytical framework in which to make force structure, modernization, readiness, and sustainability trades. Why can't we predict sortie rates properly as a function of the inputs? I'm convinced that it gets down to the concept of operations being modelled properly—and that varies from wing commander to wing commander. In order to predict it properly you've got to get out there and get into the real works of the problem. You have to measure times for events, and why a certain piece of ground equipment is not where it is supposed to be, and how can you arrange things so that it will more automatically be at the right place at the right time. Why did the munitions show up late, or why did they show up early? Most of all, you have to account for creative adjustment by smart commanders. That really can't be done from our offices in AF/SA or from the offices in the Rand Corporation or ANSER or any other analysis outfit. We've really got to get our hands dirty and help the operators and maintainers in figuring out what the right concept of operations is at any particular location in order to maximize sortie output as a function of resources available.

Another reason we are unable to accurately predict output is that we are very conservative in uncertainty. There's a great deal of uncertainty in making many of these estimates, therefore, there's lots of cumulative conservatism. Logisticians happen to be more conservative than most groups. That's probably because they, more than most other groups, know just how difficult the logistics business is; they know how difficult it is to get the spare parts to the right place at the right time; they know how difficult it is to predict what munitions will be required, particularly since they don't have the future commander available to ask what his concept for prosecuting the war is going to be. So we tend toward cumulative conservative estimates on the things that are hardest. As a result, we may well underestimate our overall
capability. As analysts we need to get out and get our hands dirty so as to do a better job of predicting performance as a function of input resources.

Still, that won't solve all the problems. We need that overall framework evaluating the proper balance among force structure, modernization, readiness and sustainability. The classic solution of course, is to develop a theater air battle model and use it to perform the tradeoffs. And we have done that. Many here have worked with large scale simulations, or perhaps simple models of high aggregation, which attempt to tell you what the outcome of theater battle is or will be. Most of us who have dabbled in that business have concluded early on that there is a very, very big problem here. That is, there is a big variation in the outcome as a function of how one chooses to employ the forces at his disposal. That happens to be true both in simulation and in real warfare. The classic solution to that problem is to simply consult with the intelligence community on how your opponent is likely to use his forces in wartime. Then, go ask some operator how he thinks our forces will be used to counter the threat. There are two problems with that: (1) there is no uniformity of opinion on how the forces are to be used on either side; (2) even if there were, the proper use of the forces is something that can and probably will change in wartime, perhaps with no more than the stroke of a pen. That might not be terribly distressing, if the outcomes were not very sensitive to the range of variation in opinion of how the forces should be used. Unfortunately, that is not the case. Quite the contrary has been found to be true. It has been found that within the range of expert opinion on the matter, practically any result can be had. Now we've made considerable progress in solving this classic game theory problem, which over an extended period of time also has dynamic programming characteristics. The work that has recently been done at Rand on TAC SAGE for example has been extremely useful. We in Systems Analysis are reinventing,
after a number of years, the same kind of methodology and are running hard to catch up, but we're all still a long way from home. We are going to work hard on this problem of balancing the four pillars of combat capability. It is our number one problem. But this is one problem with plenty of room for lots of creative thought. It is a problem which demands that we get into the details of the concepts of operations, making sure we know what the time lines are and how to control them. It demands that we account for creative adjustments by smart commanders. It demands that we get our hands dirty. I urge the community of analysts to pitch in and help with it.