Some Thoughts on Logistic Planning Factors

By Commander Ralph E. Williams, Jr., Supply Corps, U.S. Navy

Editor’s Note: This article was originally published in 1954 in Naval Research Logistics Quarterly (NRL), which at the time was produced by the U.S. Navy’s Office of Naval Research. CDR Tom Gerstner, SC, USN recently discovered the article and was struck by its continued relevance. CDR Gerstner submitted it to be republished by The MOC Warfighter, along with the following foreword. NRL now operates independently from the U.S. Navy. It provided The MOC Warfighter with the high-quality electronic reproduction that is posted to this site. Recent NRL articles can be found at https://onlinelibrary.wiley.com/journal/15206750.

Foreword

Planning doctrine requires that Maritime Operations Center (MOC) staff sections develop and continually update their staff estimates. A major element of the Logistics Staff Estimate is the calculation of logistics requirements: how much fuel, food, ordnance, medical supplies and other supplies the fleet will need to perform the mission. Today, the basis of these estimates are logistics planning factors that were published in Naval Warfare Publication Sustainment at Sea, NWP 4-01.2, April, 2007. These factors, although published in 2007, are based upon 1979 studies.

As noted, estimates of logistics requirements form the basis of Logistics Staff Estimates. Once the requirements are estimates, the capabilities of the joint and naval logistics system are then applied to determine if the requirements can be met. If so, then the logistics problem is easy. If the estimated requirements cannot be met, then the operational level of war logistician must develop methods to overcome the shortages. However, the planning factors are not absolute. They are 39 years old – older than all but six active ships. Our current logistics planning factors were developed before the LM2500 gas turbine was fully implemented, before the V-22, before the F-35, and before the F-18 was operational. How do we use such factors to produce logistics staff estimates?

The following article, reprinted from the Naval Research Logistics Quarterly in 1954, outlines issues with developing logistics staff estimates based on “planning factors” and outlines how to manage uncertainties when developing logistics staff estimates and plans. Commander Williams’ article was written based upon lessons developed in World War II and the Korean War, and it provides insight that is used to train today’s logistics planners.

Enjoy the read.

Tom Gerstner
CDR Robert T. Gerstner, SC, USN
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SOME THOUGHTS ON LOGISTIC PLANNING FACTORS

Commander Ralph E. Williams, Jr.
Supply Corps, U. S. Navy

The singular feature about calculations for logistic support of military operations is that they are inevitable. No matter how difficult the process, or how long stalled, the requirement and capabilities for logistic support must sooner or later come down to hard, firm numbers expressed in meaningful categories of men, materials, and services. The tragedy of many an operation is that these numbers did not become known until it was too late to do anything about them. There is nothing chimerical about the realities of logistic support. They are always present, must always be dealt with, and will always affect the tactical and strategic operations of which they are an inseparable part.

Having accepted the thesis that some calculation is inevitable, the planner is then confronted with the problem of bringing the calculation process down to manageable proportions. This is the principal, indeed the only reason for planning factors. Planning factors are a sort of mathematical shorthand, a set of convenient abstractions of the mountainous detailed planning which would otherwise have to be done as part of the function of logistic planning. To this purpose, they are used, and misused, by planners all over the world in every phase of military activity. What follows here is an attempt to describe the nature of planning factors, to show what they are not, to attempt a description of what they are, and in general to advance some thoughts as to what can and what cannot be done with them.

REQUIREMENTS VS. CAPABILITIES

There is an important difference which is frequently missed between requirements factors and capabilities factors. So much of our work and discussion seems to focus upon the problem of determining requirements and we are perennially bogged down, it seems, on translating force tabs into tons of supplies and barrels of fuel and numbers of men. This is only half the field to be considered, however, since the limits of any logistic problem of any consequence are determined not by its requirements, but by its capabilities. This becomes even more important the higher up the planning ladder one goes, because in the last analysis we get just so much money, men, and material and they are not related, especially, to the job we may have to do. It is quite possible, in this shadowy, in-between, no-peace-no-war atmosphere that we are going to live in for the next five to fifty years that perhaps the most important element in our planning is the number of dollars we get and what we can buy with them; in other words, a dollar capability. Let it be repeated: the field of capabilities planning factors is separate from the field of requirements planning factors. It is just as big and complex, and just as important. Planning factors are just as much the rate at which airplanes and engines come off production lines, the ability of shipyards and repair ships to accomplish repairs, of seabee battalions to put up bases, of ports to handle cargo, or supply depots to store, receive and issue material, as they are the consumption of fuel by ships and planes, and like indices of requirements.
ITEMS VS. SYSTEMS

Secondly, it is of great importance that we learn to think in terms of the essential difference between items and systems, as they relate both to requirements and to capabilities. For example, take the difference between item requirements and system requirements. An operation will require so many thousands of barrels of oil, aviation gasoline, and jet fuel. It will chew up so many airplanes, pilots, bombs, rounds of 8" ammunition. The personnel concerned will eat up so many pounds of beef and flour and wear out so many pairs of shoes and use so many rolls of toilet paper. These are all item requirements. They represent a final expenditure of material and personnel at the point of use. But in order to get these items to the point of use, which may be thousands of miles away from their point of origin, we have to have a distribution system, and back of that a procurement system, and every single man, every barrel of oil, and every last bean and bullet makes a demand upon those systems for procurement, storage, movement and issue to the final consumer. So item requirements are irrevocably linked to system requirements, like two sides to the same coin.

Now it is out of this very matter of whether we are talking items or talking systems that so much confusion and misunderstanding have developed. When we talk about items we are talking about particular things—shoes, JP-5 fuel, boiler compound, 8" manila line, wiping rags. We are talking in terms of pairs, gallons, pounds, coils, and bales, depending on the issue unit of the items involved. The amounts by which these things are measured are non-additive, and would be even if the issue units were all the same. And there is implied the necessity for eventually computing, at some level, the requirements for literally millions of different kinds of things.

All this means that at the levels where people have to work out quick feasibility checks for specific operations (namely at the theater levels and below) there are going to be only a relatively few items that we can profitably use planning factors on. The people just are not available to sit down and work out separate factors on every item of supply they might need, in the first place, and it is not worthwhile, in the second place. There is a need to know at all times where one stands on fuel, major use items of ammunition, provisions, and a limited number of critical stores and repair parts; but generally speaking, the use of planning factors is limited to far less than one percent of the number of items in the Navy Supply System and that is generally about the level where we can expect it to stay.

When we talk about systems, however, we are talking about only a few broad categories of requirements, and we are concerned with only two basic units of measurement—weight and cube. The requirements of any one category are additive, so that we can add tonnages of dry provisions, repair parts, general stores and clothing and come up with a significant total requirement for the distribution system in terms of measurement tons of dry hold cargo demands upon the system. Moreover, there is great room for shifting overages and shortages between different items in the same shipping category, so that what we lose on the onions we can make up on the potatoes. So when we are considering systems, we do not have to concern ourselves with items as such, but only as they make a demand upon the system. We have to know what the items will displace in the following shipping categories:
Even here there is a certain amount of flexibility. Dry cargo can be loaded into refrigerated spaces, hold cargo can ride on deck, ammunition can be shipped in any dry cargo vessel if necessity demands.

It is in this business of estimating system requirements (and capabilities) that planning factors can be extremely useful. It should be emphasized that ocean shipping is only a part of the entire distribution system, and at times it is not even the critical part. Many readers may recall that at the very time when shipping on the West Coast was at its most critical point back in 1944 and 1945 there were anywhere from one to two hundred ships swinging around the hook in various Pacific Atolls—retentions—because at the terminal they could not be unloaded, either through lack of stevedore help, or lighterage, or beach-head handling equipment, or trucks to move the cargo off the beaches. Some of the ships were retained simply because there was no place to put the material ashore—forward area commanders were using the ships for floating storage in the forward area. Whatever the trouble was, it meant that somebody, perhaps in his preoccupation with items had missed his guess either on system requirements or system capabilities, or both. And it emphasizes the importance that any planning factor which describes the operation of a whole system must not exceed the capacity of the narrowest bottleneck in it.

For example, a distribution system for any one of the six general cargo categories must of necessity include all the following operations:

1. Continental storage and handling
2. Movement to tidewater
   Air, truck, rail
3. Loading out
   Labor capacity
   Berth capacity (including intransit storage)
4. Overseas movement
   Surface, air
5. Overseas terminal capacity
   Labor
   Berth and lighterage
   Port and beach clearance
   Storage and materials handling

**INITIAL MOVEMENT VS. RESUPPLY**

Thirdly, there is an important difference between planning factors for an initial movement and those for resupply. They are used differently and produce different results. Take the matter of item aggregation, that is, the control of a large number of different kinds of items by single planning factor. The Advanced Base Functional Component is a splendid example of item aggregation. A D-1 component means specifically so many quonset huts, so
many 6x6 trucks, jeeps, so many chief storekeepers, and if a fleet commander orders a D-1 he will get all these things and thousands more in the quantities prescribed in the outfitting list. The ASO allowance lists are another example of item aggregations.

Now item aggregations can be used freely in planning for an initial movement and by it the fleet commander can save a tremendous amount of detailed calculation. It is a one-shot proposition, and after the initial movement has been made the people concerned can gradually work down their overages and excesses and requisition shortages to bring their on-board supplies and personnel to a desired level. But we cannot use item aggregations for resupply, except in very special circumstances without borrowing trouble at compound interest. An example is the way in which we sometimes used the Basic Boxed Base Load (BBB) during World War II. This was a unit shipment consisting of about 7,500 items of GSM in "balanced" quantities for the initial stocking of an advanced base supply depot. After the first group of ships was serviced it was not balanced any more, and the depot's stocks never did get balanced until it was able to accumulate its own usage data and set up its resupply on a requisition basis. However, some depot commanders instead of going to an individual item requisition basis to resupply their needs, would merely send in a wire for another BBB, and out it would come, and then they would have ten years supply of what they only had five years of before it arrived—and their short supply items were still in short supply. They were using the BBB as a planning factor for item resupply, not for initial movement as it was always intended, and in the repetitive process of resupply the old errors were compounded every time a new shipment came in.

There are exceptions. Aggregations can be used for resupply if

1. There exists reliable usage data with a strong measure of central tendency on the items in the aggregation;

and

2. Usage can be rigidly controlled;

and

3. Liberal use can be made of substitute items.

Rations conform to these criteria, and to a less extent so do clothing and ship's store stock. We can, if we want to, put these three categories on an aggregate basis, and tie them up in neat packages of so many man-days supply and label them with a distinctive designator, and use them for planning factors. Up to a point, we can also substitute in certain categories of general stores items, but the possibilities for substitution in repair parts is practically nil. Machines are not nearly as accommodating as human beings in that respect. The possibilities for item aggregation on a resupply basis seem to find their practical limits in the three categories most closely related to human consumption: provisions, ship's store stock, and clothing.

DESCRIPTION OF LOGISTIC PLANNING FACTORS

Logistic planning factors are artificial values used to project, under specified conditions, the future requirements or capabilities of a given organizational unit in terms of men, material or services. They describe both systems and items, including aggregations of items. They may be employed for planning either initial movements or resupply. The ultimate purpose of logistic planning factors is to establish, with small effort and with good probability, the quantitative relationships between requirements and capabilities.

Good planning factors, correctly used, can perform a highly valuable service in helping to solve logistic problems. Their value lies in the fact that the planner using them can, with a minimum of time and effort arrive at approximately the numbers he would otherwise have to
obtain by an enormously complicated series of detailed calculations. And they perform this absolutely vital service: The planner can, with planning factors, determine reliably when a plan is definitely infeasible, so that he is permitted at the outset, before he has wasted his time and effort, to junk the plans that have no possibility of success. Then, having eliminated the courses of action that are definitely infeasible, the planners can further examine the retained courses of action to find out which of those promises to be the more rewarding, and which must be given further detailed treatment. Then, for each of the most rewarding courses of action, he is usually able to determine where the major deficiencies and trouble spots are which demand early corrective measures.

ORGANIZATIONAL BASES FOR PLANNING FACTORS

Planning factors rest upon two bases. One is organization; the other is the activities that organization carries on. If one disregards horses and mules, he can truthfully say that the final consumer of everything produced for the Armed Forces is either a man or a piece of equipment. Everything we get is either eaten up or worn out or used up maintaining a man, or it is burned up, shot up, installed in or on or otherwise used up maintaining a piece of equipment. Similarly the capabilities of the logistic support forces are ultimately based upon men and equipment. At its root, the organizational basis of all logistic computations, including logistic planning factors, is population—population of men and population of equipments.

Now obtaining good population figures of men is easy. We make an administrative habit of keeping track of our people and we always know pretty well where they are. So we take the organizational unit of man and make it the basic unit of measurement of all the supplies and services which are predominantly dependent upon population of men; i.e., consumption of clothing, provisions, and ship's store stock, medical supplies, hospital beds, so that we have requirements for and capabilities of these things expressed in terms of personnel spaces, man hours, man days, man years, etc.

But when we turn to the matter of trying to keep track of equipment populations we immediately run into all kinds of trouble because there are thousands of different kinds of equipments and in view of the mobility of our forces it would be impossible to keep track of them as individual pieces. Furthermore, when we consider item requirements for resupply, for example, we find that there are many kinds of general supplies, as well as repair parts, which are common to many different kinds of equipment. So it is not practicable except in the case of certain large and unusual pieces of equipment, to maintain population records of equipment types as such. And in lieu of basing our planning factors on individual types of equipment, we base them on aggregations of equipment, realizing that we are compromising, in the name of practicability, the principle that planning factors should be based upon population of the ultimate consuming or producing units.

As a result of this compromise, we in the Navy base our planning factors on the ship, the airplane, and the advanced base functional component as the most practical and logical aggregations of equipment. We even carry it one step farther and use them as the planning basis for aggregations of men as well, so that in logistics reference data one finds for example, the requirements for ship's store stock, clothing and small stores, and provisions stated in terms of tons per ship per month. This is entirely logical, and makes it easy to relate the strategic plan to the logistic plan, because our force tabs are all expressed in terms of ships, airplanes, and advanced base functional components. But we must never forget in our pre-occupation with these aggregations of equipment and men that a carrier consumes a certain
amount of fuel oil a day not because of the shape of its hull, but because installed in that hull there is a main propulsion plant of so many thousand horsepower that is operated at a certain average speed for a certain number of hours a day. One of the major problems of developing and maintaining logistic planning factors is the constant search for really relevant organizational bases which at the same time are readily accessible.

**ACTIVITY BASES OF PLANNING FACTORS**

Leaving the discussion of organizational bases of planning factors for a bit we may give some attention to the other basis, that is, the activities that the organizations perform. Requirements are created, and satisfied, by men and equipment engaging in certain activities, and since we have found it convenient to group equipment types into ships, planes and functional components we can say that requirements and capabilities are the product of the organizational units of men, ships, planes, and advanced base functional components carrying on certain activities. How much the requirements and capabilities amount to depends upon:

1. The number and type of organizational units involved,
2. The scope and intensity of their activities.

Now we have no trouble with the first element—that is, the organizational units. Their number is controlled by those who plan the operation, so that it is a known quantity. It is fixed, and it does not change unless we know about it. But of the second element—that of activity, we have under the best of conditions only a partial control and only a partial understanding—because our activity is conditioned not only by what we elect to do, but by what the enemy compels us to do, and by what he does to us. So we have two basic kinds of activity that the organizational units engage in which are largely independent of each other.

First, there is the activity of routine operations or functions. Everything goes according to the plan of the day. The ship steams at a controlled speed which is the free choice of the Captain or the Admiral; the sailors eat three square meals a day, and routinely wear out clothes, buy candy at the ship's store and routinely get sick. The guns are fired according to a carefully worked out training schedule.

Secondly, there is the activity that results from combat operations with the enemy. The ship steams at whatever speeds for whatever lengths of time necessary to catch, maintain contact, or get away from the enemy. Gunfire and strike plans set only a partial pattern for ammunition expenditure; enemy aircraft and submarines do the rest. And the factor of battle damage enters the problem as regards both equipment and personnel.

Now is there any way that we can relate these wild, erratic activity rates which are so far beyond our control to a definite set of numbers that can be used as planning factors? We can do it—to a degree. If we have access to enough reliable data to give us a truly representative sample, we can, by carefully noting—and recording—the conditions under which a given organizational unit consumed or produced a measured unit of logistic support, establish a planning factor which will be representative of that unit under those conditions. For example, let the black oil factor for CVA's be represented by the number 0177, based upon the assumption that the ship will be underway 63% of its time and will steam at an average of 18 knots. This says nothing about battle losses, or engagements with the enemy, or sustained operations, and in that alone lies its chief virtue. It admits that the planning factor is significant only under the standard conditions described—and it puts the commander on notice that he must, through exercise of judgment, modify the factor if the conditions under which he wants to use it are different from those given as standard. It is this recognition that planning factors are controlled
by a specific set of conditions, that they do not have universal application, and that professional judgment is always required that is the really significant contribution that the George Washington University Logistics Research Project has made to the philosophy of logistic planning factors, and it is the one thing fundamentally new and constructive that has happened in that field since the armed forces began to use planning factors. In other words, the notion is now established that planning factors can be set up for certain organizational units engaged in certain types of activity under a set of specified conditions. Then, as the commander's estimate of the situation discloses the differences between the standard conditions and those which are expected to exist in the proposed operation, the planning factors may be scaled up or down as dictated by his judgment.

RELIABILITY OF PLANNING FACTORS

This is easier said than done. We actually have to fulfill two separate conditions of reliability. First, the so-called "standard" planning factors have to be good or there is no use going further. But then, even assuming good standard factors, we have to have a reliable method of scaling those factors to adequately express the difference between the standard conditions and those which the estimate of the situation brings out. In other words, we have to have more judgment and less Jesus in the J-factor. Planning factors after all are predicted values, not actual values, and they are usually, but not always, based upon some sort of average of past performance. They do not produce results that can be predetermined on a strictly causal basis, and about the best that one can possibly hope for out of a planning factor is that it will give a reasonably good chance that the actual requirement or capability will not fall excessively above or below what it was predicted to be. Whether we are figuring requirements or capabilities, or systems or items, or initial movements or resupply, there is an element which bears directly upon the reliability of the planning factor: namely, the dispersion of the actual usage value about the predicted value of the planning factor. It goes without saying that the narrower the dispersion— that is, the closer the dots are to the norm— then the more reliable the planning factor X is. This is important because in planning we can never deal with the whole. We can only deal with infinitely small pieces of the whole— samples, in the language of the statistician. Planning factors are based on samples of past performance, and they are applied to predict the behavior of other samples of future performance. It is important for the future prognosis that the mean value taken as the factor of the past performance is truly representative of the sample.

Figure 1
For example, the chart at the top of Figure 1 shows good central tendency, and the probability that the planning factor \( X \) would be reliable even if it were derived from a sample of only half the number of dots shown here. The bottom chart shows a poor central tendency, with the commensurate poor possibility that any sort of decent planning factor can be gotten out of it. Of course, assuming each of these dots represent the consumption of a certain ship for a given item, the planner could conceivably wind up applying the factor \( X \) against the four dots on the high extreme end of the scale in the top chart. But the probability is overwhelming that he would by any random choice pick up four dots that were fairly close to the mean value, so that his planning factors would still be reasonably reliable. But in the case of the bottom chart, his chances of any four dots lying close to the mean would be pretty small.

There are other statistical safeguards that need be mentioned. The sample used to base the planning factor on should be fully representative of the type of activity it is set up to describe. The Navy engages in a number of general types of war operations: carrier task force operations, amphibious assaults, convoy and escort, ASW operations, and underway logistic support force operations. Then, of course, there is the routine maintenance of naval forces in the theater which always accounts for a substantial portion of support. These different types of operations differ radically in the demands they make upon the logistic support system, and we should probably have a set of planning factors for each of them. The availability of ship types will have its effect on how good a sample is, which is why, generally speaking, that we are going to have much better planning factors for ship's parts of a Class 692 destroyer, of which we have some 150 in service than we ever will for the three Class 41 CVA's. There is simply more data available on destroyers because there are more of them.

So much for the standard factors. The difficult second part to the problem—that is, how one scales the standard factors to accommodate the difference in conditions between the standard and the particular, is one for which there are as yet no really good answers. Referring back to our factor of 0.177 for black oil consumption of a CVA on a 63% underway assumption at 18 knots, one can immediately see the difficulties involved in a situation where the commander wishes to run his force at 22 knots, to be underway continuously for a month. How to go about scaling the difference between the standard and the assumed ones? Fuel consumption produces some strange looking curves. The importance of this judgment factor, which deserves more attention perhaps than any other part of the factor, can scarcely be emphasized enough. An excellent set of standard factors can be absolutely ruined by a ham-handed application of the judgment factor in the same way a carefully drawn tactical plan may be ruined by an ill-considered judgment masquerading as a calculated risk. Like the risk, the judgment factor may be calculated, but unless the planner knows what he is doing, it may be nothing more than a blind, stupid, emotion-ridden guess.

A few generalizations remain to be made about the application of planning factors at different levels. One is that the higher the command level the more concerned the planner is with capabilities and the less he is with requirements. There are several reasons for this. At lower levels, the capabilities are better known than the requirements. They are easier to figure. The commander knows, within reason, what his logistic capabilities are—he knows how much oil he has and where it is, and how much he has coming. The same thing applies to ammunition, provisions, and critical spares—to a point. The things he requires are already in the distribution system, and the Navy has executive control of them. He may generally have some trouble calculating how much of these items an operation will require. But at departmental levels we are at the bitter end of our Navy distribution system and we are face to face
with that vast, nebulous jumble of capabilities, the American Economy. We do not have control of that, and there is no way in the world of determining with any degree of assurance the industrial feasibility of a war mobilization program in peacetime. The production complex is too big and complex to try to get down to cases, which fact contributes to the validity of the assertion that at the defense level it is much easier to figure the requirements than to determine the capabilities for meeting them.

Another generalization is that the usefulness of planning factors focuses upon the theater, fleet and service force levels, and tapers off rapidly in both directions. Perhaps the lowest point of usefulness of planning factors would be the task force level, and undoubtedly, many of the factors would not apply even then.

A third generalization, and this goes back to the samples discussed—planning factors have distinct applications at different levels. An Army division slice is 20,000 men at the division level, 40,000 men at the theater level, 60,000 at the defense level. A theater maintenance factor of so many tons of supplies per man per month is not a reliable factor at the station level.

Summing up, planning factors may be described as

... artificial values used to project, under specified conditions, the future requirements or capabilities of a given organizational unit in terms of men, material or services. They describe both systems and items, including aggregations of items. They may be employed for planning either initial movements or resupply. The ultimate purpose of logistic planning factors is to establish, with small effort and with good probability, the quantitative relationships between requirements and capabilities.

To which might be added:

Planning factors are most useful for planning at major field command levels.

Planning factors are based upon military organizations and the scope and activity those organizations carry on.

Planning factors are reliable to the extent that

1. The observations of the data on which they are based have been accurately recorded in accordance with recognized statistical methods.
2. The pattern of the observations shows good central tendency.
3. The conditions under which the planning factor is used can be quantitatively related to those under which it was developed.