Economic Considerations in the Use of Carrier-Onboard-Delivery Aircraft

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The cost of any logistic supply system must be related to its ability to perform its mission—supporting combat forces. The cost of a logistic supply system supporting carrier tactical aircraft can be expressed in terms of aircraft availability (or readiness) on the carrier and inventory savings within the supply system itself. Aircraft availability significantly improves when delivery time to the carrier of repairable spare parts is improved. Associated with this improvement in delivery time are the savings gained through smaller inventories of repairable spare parts, particularly aircraft engines and avionic components. A cost-effectiveness methodology for determining the net value of increased effectiveness per aircraft carrier receiving high-speed logistic support by Carrier-Onboard-Delivery (COD) aircraft is presented herein. This net value, the gross value of a given improvement minus the cost of obtaining that improvement, is shown to be many times the cost per carrier of the COD system itself, and represents the potential savings per aircraft carrier made possible by improving delivery time to the carrier of critical, repairable spare parts.

Introduction

In selecting an optimum system or course of action from among several alternatives, cost-effectiveness and related analyses are tools designed to generate a succinct body of information from which decisions can be made with greater confidence. The thoroughness with which these tools are used is of paramount importance in fixing the level of confidence in the results achieved. In cases where the alternatives are similar, e.g., aircraft vs aircraft, a rather rigorous investigation of the differences between them is required. However, when competing systems are diverse, e.g., aircraft vs ships, a gross analysis of procurement and operating costs may indicate the proper choice. But, when an improvement to part of an existing system is suggested by the use of a new vehicle, the magnitude of the system's improvement, measured in terms of increased effectiveness or system savings over and above the cost of the modification, may justify procurement of the new vehicle. Such is the situation in this case.

Operational or cost-effectiveness analysis is an attempt to predict the results expected from a given course of action, taking into account all the significant factors involved. Although cost-effectiveness analyses play an important role in the choice of a system, the system itself must be well-designed. A poor design will invariably result in effectiveness far below that predicted in a theoretical analysis. Cost-effectiveness criteria, then, constitute a supplement and not a replacement for the evaluation techniques normally used in selecting an optimum system for the job. In this paper, not all the factors involved are examined in detail because the paper is limited to an analysis of the COD role in the last segment of the overall pipeline; that is, from the oversea supply points to the fleets. Therefore, we are only concerned with those factors affecting the last segment of the pipeline and their influence on the cost-effectiveness portion of the COD evaluation.

The fleet is currently supplied by shipping from continental United States (CONUS) to oversea naval supply depots via air and surface transport. Supplies are then hauled by air, rail, truck, or some other means to ports nearest fleet locations. Generally, supplies must be delivered to the ships while they are at dockside, necessitating frequent port calls. At sea, delivery is by underway replenishment groups (URG). The alternative resupply system considered in this paper utilizes COD aircraft for delivering high-priority, repairable items directly from the naval supply points to carriers at sea, the last link in a world-wide pipeline. The analysis is restricted to a comparison of these alternatives. Navy supply and support philosophy is based on Refs. 1–13.

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Basic Parameters

The approach used to analyze the cost-effectiveness of the present carrier supply system and of the COD supply system is based on the following parameters:

1) Cost: Net value of increased effectiveness—value of the increased effectiveness of carrier aircraft complement, plus inventory savings, minus COD system cost. The value of the increased effectiveness of carrier aircraft complement is a function of aircraft availability which varies with probability of no parts delay, probability of aircraft being fully equipped, and delivery time. Inventory savings vary with accumulated part operating time, carrier cruise time, and delivery time. COD system cost varies with the number of COD aircraft required (a function of operating range) and includes procurement cost, direct operating cost, spares, and support cost.

2) Effectiveness: a) Increased carrier aircraft availability, a function of delivery time, and b) increased number of sorties, a function of delivery time.

Based on these parameters, the following analysis attempts to select the most important factors, determine their value, and equate the parameters to give a meaningful comparison of the competing systems.

Inventory Savings

High-speed carrier resupply by COD aircraft should indicate significant gains, the first of which is a reduction in inventories or better use of current spare levels. On carriers there is a never-ending battle for space. Our advancing, ever-changing technology continues to create shortcomings in the availability of support and maintenance equipment and the attendant space requirements.

The problem of adequate space on a carrier is not new; it has been present since the advent of shipborne aircraft. With the introduction of jet aircraft, the tremendous growth of necessary support equipment far exceeds the ship alteration program intended to furnish the required facilities. Newer aircraft are generally larger, and many have two engines instead of one. The ramifications of an apparently simple logistic support problem become obvious. Since the newer engines have a rated installed life of roughly one-quarter of that of the older engines, it is necessary to carry an eight-for-one ratio in spares to maintain the same support level. Even though the jet engine has a much higher reliability, the overall support requirement is greater than that of its predecessor. In addition, the newer aircraft require larger maintenance crews to insure the availability mandatory for meeting squadron commitments.

The COD can be used to alleviate this space dilemma. By having a sufficient number of COD aircraft shuttling back and forth between the carrier and a resupply base, a significant number of high-priority items can be in the pipeline rather than stowed aboard the carrier, thus saving inventory. However, inventory savings, as considered in this study, do not necessarily mean a reduction in spare levels aboard a carrier. The total spares inventory required is distributed at three locations: aboard the carrier, in transit, and ashore at naval supply depots. Reducing the pipeline time with the COD will result in inventory savings, occurring, most probably, at the Naval Supply Depots (assuming that the main pipeline from CONUS is supported by high-speed transport or frequent deliveries).

Spares support levels required to achieve a given level of tactical aircraft effectiveness are a direct function of the number of aircraft being supported and their distribution in the fleets. As illustrated by Fig. 1, the quantity of "repairable" spares required increases in proportion to the buildup in the number of aircraft units (or squadrons). When these squadrons are phased out, there remains a significant quantity of useful spares which must be charged as a loss in investment since a need for them no longer exists. Some do wear out, and some are lost due to attrition, but the fact remains that many are left over. Speeding up the pipeline can reduce the number of spares required for a given level of effectiveness. Since the COD is a high-speed resupply vehicle, fewer repairable spares are required for a COD-supported carrier. The difference in the quantity of repairable spares between a self-sufficient carrier and a COD-supported carrier represents the "inventory" savings analyzed in this study.

Expendable spares are not considered an area for potential savings through use of the COD. Generally, the level of expendable spare support is in direct ratio to the number of squadrons; as the squadrons start phasing out, the expendable spares level is reduced. It is true that at any given time during the buildup of the squadrons, the quantity of expendable spares can be less for the COD-supported carrier than for the self-sufficient carrier. However, the true measure of savings is determined at the end of the squadron's life, and it is at this point that no significant saving is expected in expendable spares. Therefore, expendable spares are not considered in this paper.

The major elements in determining the number of repairable spare parts required to support a self-sufficient carrier and a COD-supported carrier are 1) mean time between replacements (MTBR) (repairables requiring transport off the carrier), 2) T_{oper}, part operating time (or accumulated hours), 3) T_{cycle}, replacement cycle time (removal from the vehicle, transit to replacement depot, and back to the carrier inventory), and 4) T_{cruise}, total cruise time or carrier operating period (total time carrier is on a cruise away from port). In the case of the self-sufficient carrier, the number of spares required (N_{ss}) is $N_{ss} = (T_{\text{oper}}/\text{MTBR}) + 1$. The plus one provides one spare for possible replacement near the beginning of the cruise, adequate spares during the cruise, and replacement near the end of the cruise.

In the case of the COD-supported carrier, the number of spares required N_{COD} is $N_{\text{COD}} = (U/\text{MTBR}) + 1$. The plus one provides for one spare on the carrier ready for replacement while another is in the pipeline or at a repair base. The accumulated utilization (U) on the part during a given part replacement cycle is $U = T_{\text{oper}}/T_{\text{cruise}}/T_{\text{cycle}}$. When considering all of the aircraft engines aboard the carrier, as well as other high-priority repairable items, it is easy to see that the COD will significantly reduce spares inventory without a reduction in fleet readiness. The alternative to this approach is either to stock the carrier with enough spares to satisfy its total "cruise" demands (which is not feasible in view of the shortage of space) or to decrease fleet readiness by URG (thus interrupting its primary combatant duties).

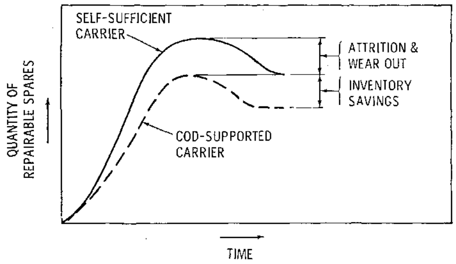

Fig. 1 Inventory savings.

A measure of inventory cost savings of high-priority items can be obtained by determining the number of spares required for a self-sufficient carrier and a COD-supported carrier. Given the cost of each item being considered, the net cost savings in inventory is the product of the unit cost and the difference in number of spares required for a self-sufficient carrier and a COD-supported carrier. Since high-value repairable items are the only inventory items considered in this paper, the net cost savings are one-time savings only.

For example, an aircraft complement for a typical CVA carrier is made up of 9 different aircraft types for a total of 90 aircraft. Let us assume that there are 134 engines installed in these aircraft and the carrier will be deployed for 90 days (T_{cruise}). The accumulated operating time T_{oper} on a particular type engine is determined by multiplying the number of installed engines in a given aircraft type aboard the carrier by the aircraft utilization (hr/month) and the carrier operating period (T_{cruise}). For the self-sufficient carrier the number of spare engines required (for the particular aircraft type considered) can now be determined assuming MTBR is equal to the planned time between overhaul (TBO) for the particular engine. Similarly, when considering a COD-supported carrier, the number of spare engines required for each aircraft engine type can be determined. In the case of a COD-supported carrier, it is assumed that the time to recycle a repaired engine is 30 days (T_{cycle}). For the aircraft complement assumed and the conditions previously stated, 51 engines of all types would be required on a self-sufficient carrier. On a COD-supported carrier only 27 would be required. Total value of the 24 engines saved is about $5,000,000.

The same 90-aircraft-carrier complement and similar complements discussed in this paper have been analyzed to generate the aircraft engine inventory savings vs engine cycle time T_{cycle} relationship shown in Fig. 2. Last-link delivery time from the naval supply depot to the carrier at sea is part of the engine cycle time, and any diminution in delivery time diminishes total engine cycle time by the same amount. Since the relationship of cycle-time to inventory-savings is linear, the implicit delivery-time to inventory-savings relationship is also linear. Savings increase as delivery time decreases. As shown in Fig. 3, more spares will be saved in wartime than in peacetime. The method used to determine savings is the same for both periods.

The value of high-priority avionic components can be similarly estimated. The avionic components considered in this paper are those classed as beyond capability of maintenance (BCM) on the carrier. Data pertaining to parts re-

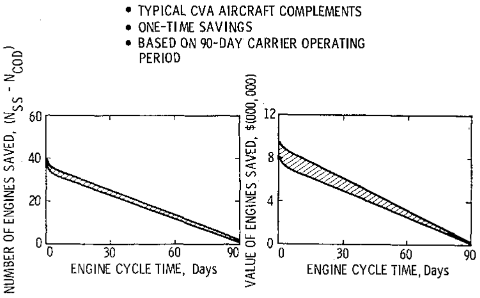

Fig. 2 Savings in aircraft engine inventory per carrier—peacetime.

placement can be obtained for each aircraft in the sample complement. Estimates of MTBR for each BCM item are determined from these data. On the basis of the MTBR estimated for each aircraft's avionic components that are BCM and the assumed 90-day carrier operating period, the difference in spares required between a self-sufficient carrier and a COD-supported carrier is obtained. The corresponding value of the BCM avionic components saved is shown in Fig. 4.

Aircraft Availability

The reduction in pipeline time resulting from the use of COD aircraft for delivery of critical spare parts and engines should improve the availability of fleet tactical aircraft. "Availability" is a function of "not-ready time" or the number of "not-ready aircraft." The measure of availability presented in this paper represents the average availability over a 24-hr day. The operating aircraft in a system are always distributed in some manner between maintenance, awaiting maintenance, equipment or part delays, flying, and awaiting flying. Thus, they operate in sequential states, categorized as ready time and not-ready time, which comprise cycles of operation. Therefore, "availability" is defined as the total possessed time (based on a 24-hr day) minus the total not-ready time, with the resulting time divided by the total possessed time.

The methodology used for determining aircraft availability is based on a model which mathematically simulates a naval aircraft squadron's maintenance and support activity. It is based on a model developed originally by North American Aviation and modified extensively by Grumman's operations analysis group[14] to include additional missions and configurations so as to broaden its applicability to problems of availability prediction for developmental and proposed aircraft. A Monte Carlo technique with queuing is used to simulate mathematically a naval squadron's activity. By simulating "real world" maintenance, supply, and operational events, maintenance requirements and aircraft availability are predicted. The output of the model can be used to study the interactions of probability of no part delays (PNPD), probability of aircraft fully equipped (POAFE), and delivery time on aircraft availability.

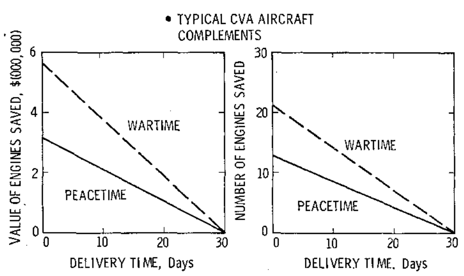

Fig. 3 Savings in aircraft engine inventory per CVA carrier.

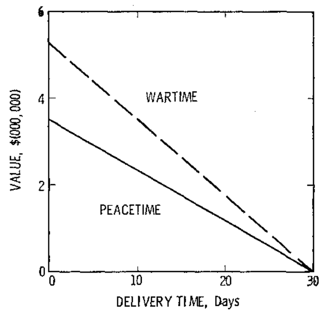

Fig. 4 Value of avionic components saved per carrier.

PNPD is the probability that a part is available to make an aircraft flyable. With respect to aircraft, PNPD is the probability that an aircraft can be made flyable. When an aircraft cannot be flown because it lacks a part, the aircraft is out of commission for parts (AOCP) and the part is called an AOCP part. When an aircraft is flyable but unable to perform its primary mission because it lacks a part, the aircraft is not fully equipped (ANFE) and the part is called an ANFE part. The probability of an aircraft being fully equipped (POAFE) is derived from the ANFE probability. Thus for a given period the aircraft status probabilities may be PNPD—0.75, AOCP—0.25; POAFE—0.65, ANFE—0.35. Aircraft carriers apparently have never been able to achieve 100% PNPD (all aircraft flyable) and 100% POAFE (all aircraft fully equipped) for two fundamental reasons: a never-ending battle for storage space and constant economic pressure to reduce spare parts.

The lack of spare parts when needed is only one factor that contributes to the unavailability of aircraft for combat mission requirements. Other factors are unscheduled and scheduled (routine) maintenance. Improving parts availability by a high-speed COD system for a given level of spares inventory improves carrier aircraft availability. This improvement is achieved by reducing the spare parts in the logistic pipeline as compared with the present techniques of resupplying the fleet by frequent port calls or URG.

The elements which comprise the major inputs for the program are 1) cumulative probabilities associated with parts and equipment, obtained from actual Navy statistical data consisting of AOCP, ANFE, and GSE occurrences as a function of delivery time; 2) cumulative probabilities associated with maintenance shops, obtained from actual Navy records of maintenance elapsed repair hours of discrepancies in several squadron maintenance shops; 3) delivery time, the measure of time in transit from a supply depot to the aircraft carrier; 4) tactical aircraft mission, a function of flight duration, number of sorties, and planned utilization.

Cumulative probabilities associated with parts and equipment are obtained from actual statistical data on all aircraft aboard CVA carriers during a given time period. The data consists of all AOCP/ANFE parts required during the cruise, the date each part is ordered, and the date each part is shipped to the consignee from CONUS. The summation of the parts shipped each day as a percentage of the total number of parts shipped yields the "cumulative probability of times between date ordered and date shipped" to the consignee of AOCP/ANFE parts. This is done for each aircraft type aboard the CVA carriers and a sample of the results is presented in Fig. 5. The missing element is the time from CONUS to the oversea supply points and then to the fleet and, in this paper, is identified as delivery time, allowing ½-day time in parts delivery by Military Airlift Command (MAC) from CONUS to the oversea supply points. The delivery time (from oversea supply points to the fleet) is a variable and depends on the mode of resupply in the last link of the pipeline.

To determine the effect on aircraft availability due to various delivery times, the cumulative probability data obtained (Fig. 5) was adjusted for 1½-day, 8-day, and 30-day delivery times by shifting the ordinate to the left by the

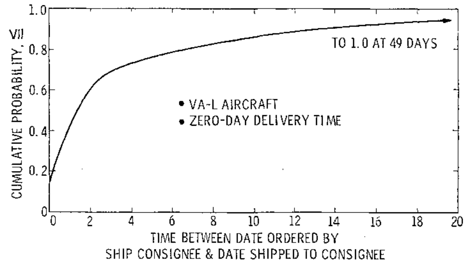

Fig. 5 Cumulative probability of times between date ordered and date shipped.

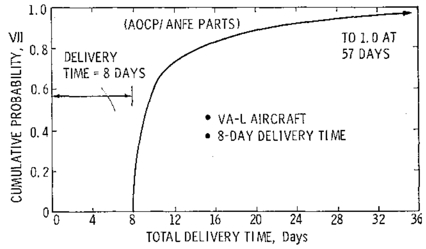

Fig. 6 Cumulative probability of times between date ordered and date received.

number of days to be considered as delivery time, as shown in Fig. 6. These data now present the "cumulative probability" of AOCP/ANFE parts delay from the time the order is placed to the time the part is received on the carrier as a function of "last link" delivery time. Figure 5 represents the cumulative probabilities of AOCP/ANFE parts delay for the hypothetical case of zero-day delivery time.

The cumulative probabilities associated with maintenance shops on the carriers were obtained from actual Navy records of maintenance elapsed repair hours of discrepancies for each of the squadron maintenance shops. The total number of maintenance actions and total elapsed hours of repair was obtained from each shop and the mean time to repair (MTR) and average number of discrepancies per flight were estimated. These actual statistics were converted to probabilities of occurrence by taking the event rate, discrepancy per flight (assuming an exponential distribution for the expected systems discrepancy rate) and obtaining the probability according to the equation $P = e^{-R_1}$, where P = probability of no discrepancy and R_1 = average number of discrepancies per flight.

An example of the probability of no discrepancies in each maintenance shop for VA-M aircraft is as follows: power plant = 0.606, airframe = 0.286, electronic = 0.603, ordnance = 0.169, electrical = 0.251, and others = 0.431. These probabilities indicate, for example, that there would be no discrepancies in the aircraft power plant system in 6 out of 10 flights. Similar data are obtained for other aircraft assumed to be in the typical carrier complement. The cumulative probability of no discrepancy is an important parameter for determining the unavailability of aircraft due to unscheduled and routine maintenance. The operational events simulated in the program for determining aircraft availability are typical aircraft missions for attack and combat air patrol (CAP)-type aircraft and are shown in Table 1 for peacetime operations.

The three parameters constituting the major inputs to the availability model are cumulative probabilities of part delay, cumulative probabilities associated with the maintenance shops, and aircraft mission definitions. The underlying assumption throughout the program is that aircraft malfunctions occur on a chance or random basis. To maintain the real world random nature of events, a Monte Carlo procedure is used in the model. This procedure utilizes random numbers to decide 1) the result or outcome of a decision point or event and 2) the extent or magnitude of the event. Twelve such decisions are made by this procedure. Nine of these are concerned with whether aircraft maintenance will be performed or delayed due to supply problems. The remaining three decide whether flying is permissible due to climate or other reasons and whether combat or noncombat attrition occurs.

Table 1 Operational events affecting A/C availability

Mission	Aircraft	NHPM[a]	NPFD[b]	NPS[c]	U_{AVG}[d]
Attack	VA-L	2	7	12	35
Attack	VA-M	2	7	9	47
CAP	VF	2	6	12	30

[a] NHPM, average number of flight hours per mission.
[b] NPFD, average number of aircraft required per day (sorties).
[c] NPS, number of aircraft in squadron.
[d] U_{AVG}, average monthly utilization (hr) per aircraft.

The interaction of PNPD, POAFE, and delivery time on aircraft availability is examined in detail for the attack (VA) and fighter (VF) aircraft assumed to be part of the carrier's complement for the study time period In Fig. 7 is shown a sample of the results for VA-L aircraft for four delivery times and several PNPD and POAFE.

To ascertain the improvement in aircraft availability with decreasing delivery time, it is necessary to introduce the aircraft squadrons reporting PNPD and POAFE into these results. Because of the disparate maintenance and supply activities on each carrier, the PNPD and POAFE for a given-type aircraft varies to such an extent that no single value of PNPD and POAFE is truly representative of all the squadrons' activities. Therefore, a range of these probabilities was selected for analysis which would culminate in availabilities representative of all the squadrons on all of the carriers in the study time period. The resulting aircraft availabilities are those which are obtained as a result of selecting the practical range of probabilities (PNPD = POAFE = 0.90, and PNPD = POAFE = 0.95) which form the lower and upper boundaries of those reported "probabilities" from each squadron. A sample of the availability of the VA-L aircraft as a function of delivery time may be found in Fig. 8.

It should now be pointed out that in actual practice many ANFE aircraft do fly on missions. Although it may appear from the selection of POAFE equal to 0.90 to 0.95 that 5 to 10% of ANFE aircraft are not flown in the study model for determining aircraft availability, the boundaries selected do, in fact, cover the possibility that ANFE aircraft are performing in the defined missions. For example, when the upper boundary of PNPD = 0.95 and POAFE = 0.95, it results in an aircraft availability which is the same as the availability obtained at PNPD = 0.85 and a POAFE = 1.00. (A POAFE = 1.00 represents all ANFE aircraft capable of performing the mission, and a PNPD = 0.85 is not unusual according to AOCP records received from Navy squadrons.)

Referring to Fig. 8, it is apparent that aircraft availability can be significantly improved by reducing the delivery time of critical parts. This same approach was applied to the other VA and VF aircraft in the sample complement. The

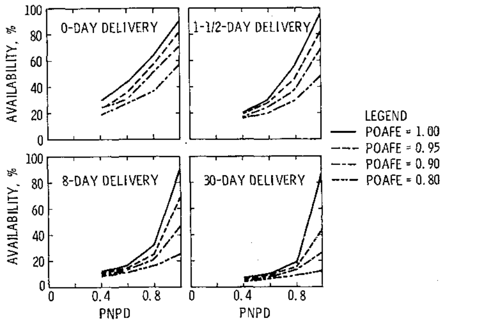

Fig. 7 VA-L availability for various delivery times.

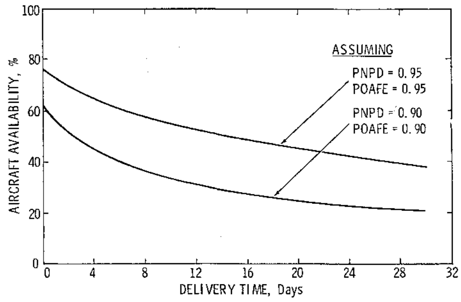

Fig. 8 VA-L aircraft availability, peacetime utiliaztion.

improvement in aircraft availability results in an increase in aircraft effectiveness measured in terms of the increased number of aircraft made available, and this number of aircraft is simply the difference in number of aircraft available at each delivery time.

In the sample aircraft complement of 90 aircraft, let us assume that there are six squadrons of VA-L, VA-M, and VF aircraft totaling 69 aircraft. From the availability analysis previously described, the number of aircraft available under the present resupply system, assuming a 30-day delivery time, is a maximum of 27 aircraft out of the 69 VA and VF aircraft aboard the CVA carrier. The increase in the number of aircraft made available with a decrease in delivery time is shown in Fig. 9. Note that the increase in the number of aircraft made available can be as high as 22 at the low delivery time (1 to 2 days) attainable with the COD-supported carrier.

Aircraft Sortie Rate

Increasing the availability of aircraft results in an increase in the potential number of sorties that can be flown with the present level of each squadron's aircraft. However, the number of potential sorties does not increase in proportion to the increase in aircraft availability because increasing the sorties imposes greater demands on maintenance and support activities. The dynamics of these interactions are such that an increase in the number of sorties imposes stringent demands on the carrier's resources. At some time when an aircraft requires maintenance, the proper personnel are then unavailable because they are working on other aircraft. This is evident from the aircraft availability analysis performed. For a given delivery time, actual aircraft availability decreases with an increase in sortie rate. If the carrier had unlimited resources, the variation of availability with sortie rate would be linear. However, in actual practice, availability diverges from the straight line, as shown in Fig. 10a.

Decreasing delivery time increases aircraft availability for a given sortie rate, as shown in Fig. 10b. The proportion of aircraft available as a function of delivery time increases nonlinearly as the sortie rate increases. In Fig. 10b, the availability ratios A/B and C/D are functions of delivery time. As the sortie rate increases (ΔSR) from E to F, the availability ratio increases from A/B to C/D.

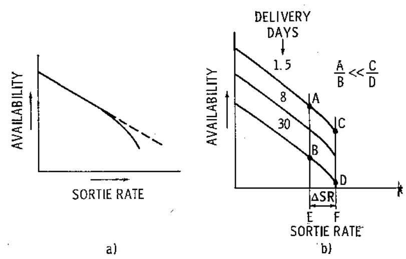

Fig. 10 Increase in availability vs sortie rate.

The increased number of sorties possible as a function of delivery time is shown in Fig. 11. From the 69 VA and VF aircraft onboard the typical carrier, a maximum of 40 sorties/day are possible under the present system of resupplying critical spare parts. An increase of 15 to 25 sorties/day or a maximum of 55 to 65 sorties can be performed if the carrier is supported by COD aircraft.

Value of Increased Effectiveness

The value of the increased number of tactical aircraft made available as a result of faster resupply by COD represents a savings, since without the COD it would be necessary to have additional tactical aircraft aboard the carrier to achieve the same level of availability. The value is a function of the increased number of aircraft available and includes their procurement cost (including special equipment), operation and maintenance cost, and personnel cost. This value is conservative because the alternative approach to obtaining these extra operationally available aircraft would require a larger complement and associated support since the number of operationally available aircraft is less than the total complement in proportion to the availability factor.

In this paper the gross dollar value of increased effectiveness of tactical aircraft in the sample complement was determined for a 5-yr program. The dollar value of the increased number of aircraft made available includes their procurement cost (which is a one-time savings), their operating and maintenance cost, and the personnel cost for 5 yr. This value is shown in Fig. 12 as a function of delivery time.

The net value of increased effectiveness is the gross value of a given improvement minus the cost of obtaining that improvement. The improvement sought in this analysis is increased fleet readiness. This can be accomplished by the COD aircraft which has the capability of delivering those high-priority items required on a daily basis by the carriers (and other ships of the fleet), thus satisfying the average daily demands of the fleet for critical parts necessary to keep aircraft in the air (and ships at sea) in a constant state of readiness.

The significant aspect of improved readiness is the effect of increasing the availability of carrier tactical aircraft by reducing pipeline time through the use of COD aircraft as the last link of the supply line. Associated with the reduction in pipeline time is the savings in required spare parts, particularly aircraft engines and high-value avionic components.

The dollar value of the increased number of carrier aircraft made available, including their operation, maintenance, and

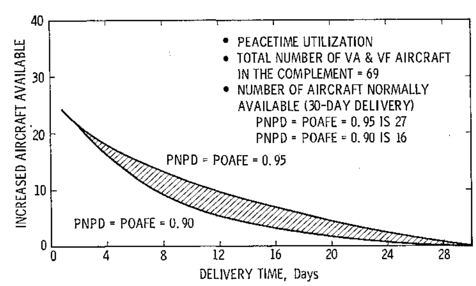

Fig. 9 Increased aircraft made available.

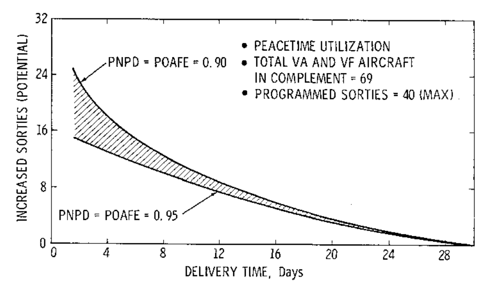

Fig. 11 Increased VA and VF aircraft possible sorties.

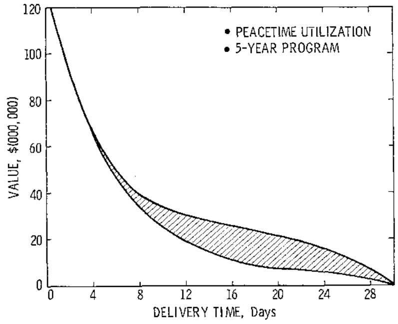

Fig. 12 Value of increased effectiveness of tactical aircraft per carrier.

personnel cost for 5 yr, plus the dollar value in aircraft engines and avionic components saved, represents the gross dollar value of increased effectiveness per aircraft carrier, as shown in Fig. 13. This gross dollar value of increased carrier effectiveness minus the COD aircraft cost per carrier results in the net value of increased effectiveness.

Of particular interest in Fig. 13 is the sensitivity of delivery time on the value of increased effectiveness. It is noted that reducing delivery times from 30 days to approximately 12 days has little effect on improving the value of increased effectiveness compared to delivery times less than 8 days. This points out the importance of a high-speed delivery system in the last link of the supply pipeline. Of course, as previously emphasized, this improvement in effectiveness is dependent on the capability of the main pipeline to satisfy the needs imposed upon it by the high-speed last-link delivery system.

The cost-effectiveness aspects of this study are based on inventory savings and the dollar value of aircraft made available to a typical aircraft complement on a CVA carrier, with due consideration to the costs of COD aircraft which make this possible. To arrive at the cost of the COD aircraft, it is necessary to determine the number of aircraft required to obtain the level of increased effectiveness suggested in this paper. The number of COD aircraft required is a function of fleet support requirements and the frequency of demands for this type logistic movement. However, this is a subject of separate study and is not analyzed herein. Several candidate transport aircraft were considered, each having the capability of taking off and landing on a carrier, carrying at least 10,000 lb of cargo a distance of 1400 naut miles, and delivering its payload once a day to the carrier. For purposes of illustration, the cost of the best COD aircraft system for a 5-yr program per aircraft carrier is shown in Fig. 13. The net value of increased effectiveness is the difference between the gross value of increased effectiveness and the COD aircraft cost, as shown in Fig. 14. Considering the possibility that the use of the COD aircraft results in 1- to 2-day delivery time, the

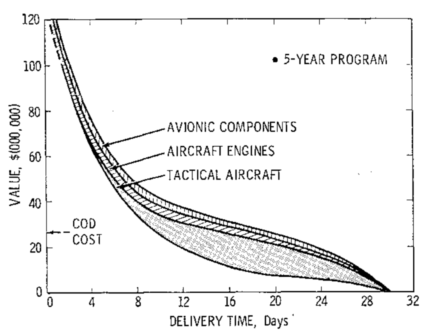

Fig. 13 Gross value of increased effectiveness per carrier—peacetime.

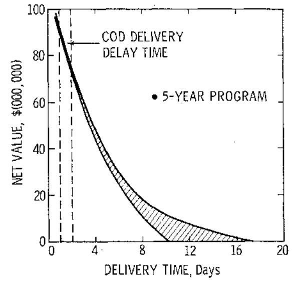

Fig. 14 Net value of increased effectiveness per carrier—peacetime.

potential net value of increased effectiveness can be 3 to 4 times the COD system cost per aircraft carrier.

Conclusions

Cost-effectiveness and related techniques used to analyze the economy of COD aircraft to supply the fleet indicate the following: Significant savings in terms of net value of increased effectiveness can be obtained by reducing the delivery time of critical high-value parts for an aircraft complement aboard a CVA carrier. COD aircraft offer the potential of reducing delivery time. The effectiveness of a logistic transport, such as the COD, is not only the measure of reduction in spare requirements (or better utilization of present spare levels), but the improvement in fleet readiness made possible by quick reaction in delivering spares when and where they are needed. The value of increased effectiveness can be several times the cost of the COD system required to achieve the improvement in fleet readiness.

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