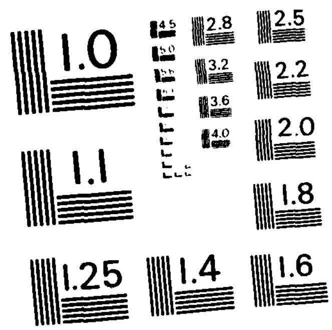
AD-A131 611 FORECASTING MANPOWER REQUIREMENTS FOR A NEW WEAPON SYSTEM(U) NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER SAN DIEGO CA T A BLANCO ET AL. JUN 79 1/1

UNCLASSIFIED SBI-AD-F630 023 F/G 5/9 NL

END
DATE
FILMED
9-83
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-F630022

(2)

Forecasting Manpower Requirements
for a New Weapon System*

Thomas A. Blanco
Navy Personnel Research and Development Center
San Diego, California 92152

and

George Chernowitz
American Power Jet Company
Ridgefield, New Jersey 07657

Presented at the
The Institute of Management Sciences
XXIV International Meeting
18-22 June 1979
Honolulu, Hawaii

*The opinions and assertions contained herein are those of the authors and are not to be construed as official or reflecting the views of the Navy Department.

FORECASTING MANPOWER REQUIREMENTS
FOR A NEW WEAPON SYSTEM[1]

ABSTRACT

Shortages in Navy fleet manning have been attributed in part to lack of information concerning manpower requirements during the acquisition of higher technology weapon systems. Manpower shortages in critical skill areas and increased training costs due to shorter lead times have also resulted. To avoid these pitfalls in the future, the Navy has embarked in a program to identify and evaluate the technological and operational factors of a new weapon system during the conceptual and developmental stages to determine their impact on manpower requirements.

This paper presents a methodology for forecasting the effects of technology operating tempo, and performance capability on the maintenance-manpower requirements of new aircraft systems. Application of the methodology to the new F-18 fighter aircraft is addressed.

---

[1]The authors wish to acknowledge and express gratitude to Manfred Smith of the Navy Personnel Research and Development Center and James Ciccotti of the American Power Jet Company who assisted in the preparation of portions of this paper.

The Navy has had problems in assessing manpower and training requirements for new weapon systems due to uncertainties in advancing technology and the lack of quantitative methods to determine total manpower requirements. Manpower shortages and lack of adequate skills for new systems have been attributed to insufficient assessment of manpower and training requirements. This is especially true for support-maintenance manpower, both military and civilian, which is usually estimated as a percentage of operational manpower. Manpower shortages in critical skill areas and increased training costs due to shorter lead times have resulted.

The need to place greater emphasis on controlling and forecasting the effects of new weapon system acquisitions on manpower requirements is not unique to the Navy. The Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics), in a memorandum for the Secretaries of all the Military Departments, has stated the need to conduct earlier and more comprehensive tradeoffs among manpower, system characteristics, and support concepts for major systems in development (White [10]). Manpower requirements considerations are fast becoming an integral part of the Defense Acquisition Review Council (DSARC) process. More emphasis must be put on controlling the hardware characteristics which impact workload demands and on translating these demands into effective support (White [11]).

A Military Manpower versus Hardware Procurement (HARDMAN) Project Office has been established by the Chief of Naval Operations for the function of monitoring and assessing manpower, personnel, and training requirements of new equipment and weapon systems, as well as exercising joint responsibility of the Deputy Chief of Naval Operations for Manpower, Personnel, and Training (OP-01) with the Warfare Sponsors for ensuring the validity and feasibility of such requirements (HARDMAN Project Master Plan [4]). A major HARDMAN objective is to develop and exercise analytical tools to determine manpower requirements for major new weapon systems. The Navy Personnel Research and Development Center (NPRDC) is performing research in direct support of accomplishing the above objective.

This paper addresses a major research effort to develop, test, and evaluate quantitative techniques to forecast maintenance manhour and skill requirements for a new aircraft. The technology breakthrough that this effort is attempting is in the area of forecasting reliability (failure rates) and maintainability (mean time to repair) for new aircraft equipments at very early stages of the DSARC process.

SYSTEM DEFINITION

It is important to remember that when an aircraft is in the conceptual stage of the weapon system acquisition process (WSAP), detailed data on equipment configurations are limited. Therefore, it is essential to define the physical, functional, and environmental boundaries of the aircraft system to be developed. Physical design and performance characteristics must be related to maintenance manhour requirements at the total aircraft level to set some bounds on total support implications and to get a truer picture of life-cycle costs (acquisition, operating, and support).

Much has been documented in the literature that supports the feasibility of relating support costs and/or system reliability to aircraft physical characteristics. Gates [5] states that for avionics systems, "both cost and reliability are functions of equipment complexity". He goes on to state that "as complexity increases, cost increases and reliability as measured by mean flight hours between failures (MFHBF), decreases. Figure 1 (adopted from Gates [5]) shows the strong relationship between unit production cost and field reliability for a diverse mix of Air Force avionics equipment.

In a recent Navy report, the Naval Weapons Engineering Support Activity [8] showed that overall system reliability of a particular aircraft type is inversely proportional to its maximum takeoff weight. Figure 2 shows how they used this relationship to predict an MFHBF of 1.25 for the F-18, or about one-third of the manufacturer's estimated 3.63 MFHBF.

Using aircraft empty weight as a surrogate for system complexity, it can be shown that there is a significant correlation between total military maintenance requirements and the empty weight of an aircraft. For the analysis, total organizational (squadron) and intermediate (O&I) maintenance manhours per flying hour

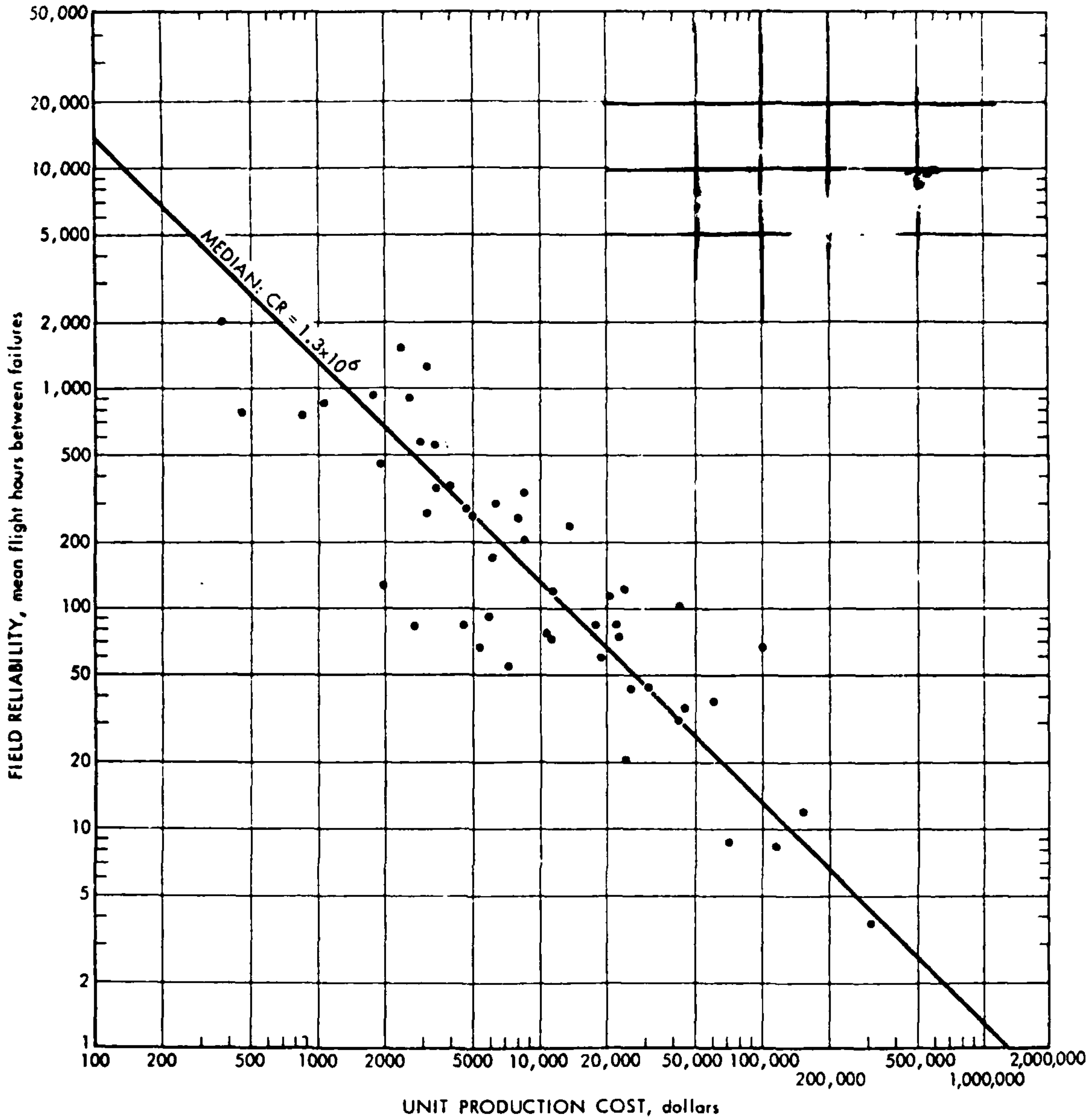
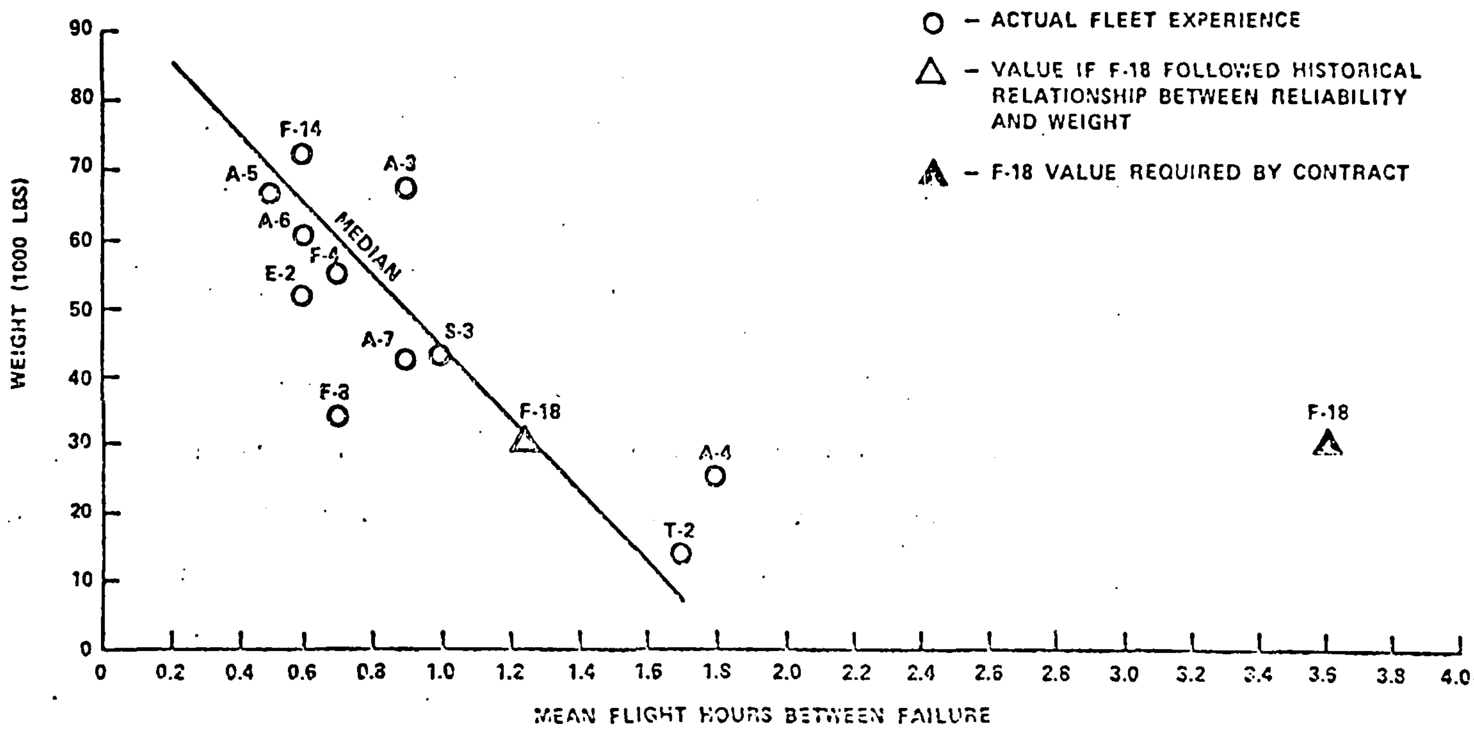


Figure 1. Avionics field reliability versus unit production cost for diverse equipments (from Gates).

RELIABILITY PREDICTION BY WEIGHT



DATA SOURCE: NAVAIR RELIABILITY MAINTAINABILITY BRANCH

Figure 2. Reliability vs. maximum takeoff weight.

were extracted from Readiness Utilization Monthly (RUM) Summary Reports for three years for the Navy's four first-line fighter/attack aircraft: F-14A, F-4J, A-6E, and A-7E. First, the average O&I maintenance manhours per flying hour (MMH/FH) over the three-year period for each of the four aircraft were regressed against the respective aircraft's empty weight. A very high R^2 of .98 was obtained. Next, average MMH/FH for each year were regressed against aircraft empty weight to get an idea of the yearly variance of the established relationship. Using the twelve annual data points rather than the four three-year average data points, the R^2 was still .94. Furthermore, the same equation (within two significant digits) was chosen which gave the best least squares estimate. The relationship found (see Figure 3) was:

$$Y = 2.415 + 1.37X$$

where,

Y = average O&I maintenance manhours per flying hour,

X = aircraft empty weight in thousands of pounds.

The empty weight of the F-18 is reported to be 20,146 pounds. Using the above relationship derived from empirical data for the A-7E, A-6E, F-4J, and F-14A, the average O&I MMH/FH is estimated to be 30. The contractor developed MMH/FH is only 18 (Morgan and Fuller [7]). The discrepancy between the contractor estimated MMH/FH and the MMH/FH estimate derived from empirical data is not surprising. Figure 4 from Gates [5] shows specified and actual mean-time-between-failures (MTBFs) of tactical airborne radars. According to Gates, "the real military operating environment, including quality of maintenance, is rarely, if ever, anticipated by the [manufacturer]", and that "test plans are usually

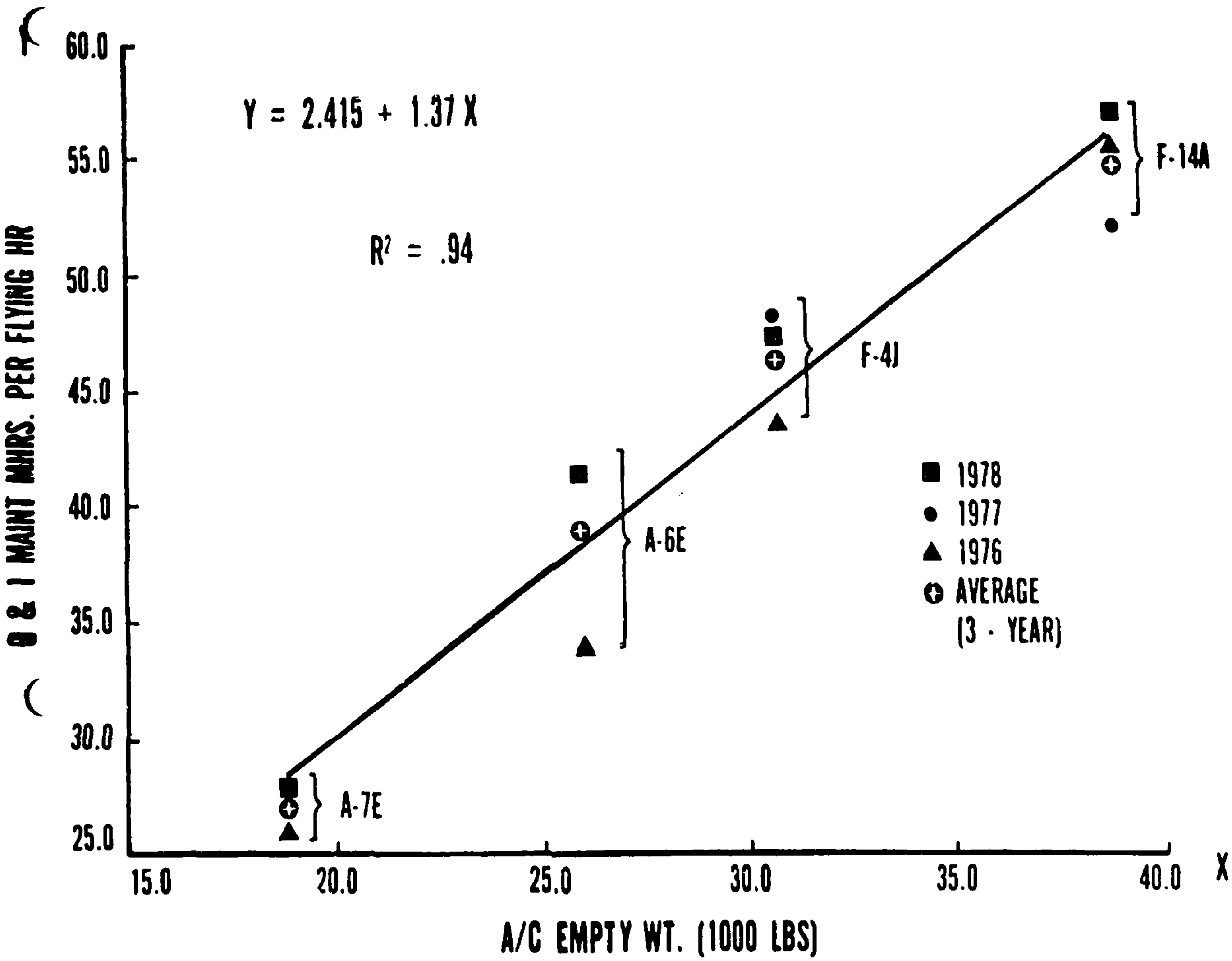


Figure 3. Total military maintenance manhours vs. aircraft empty weight.

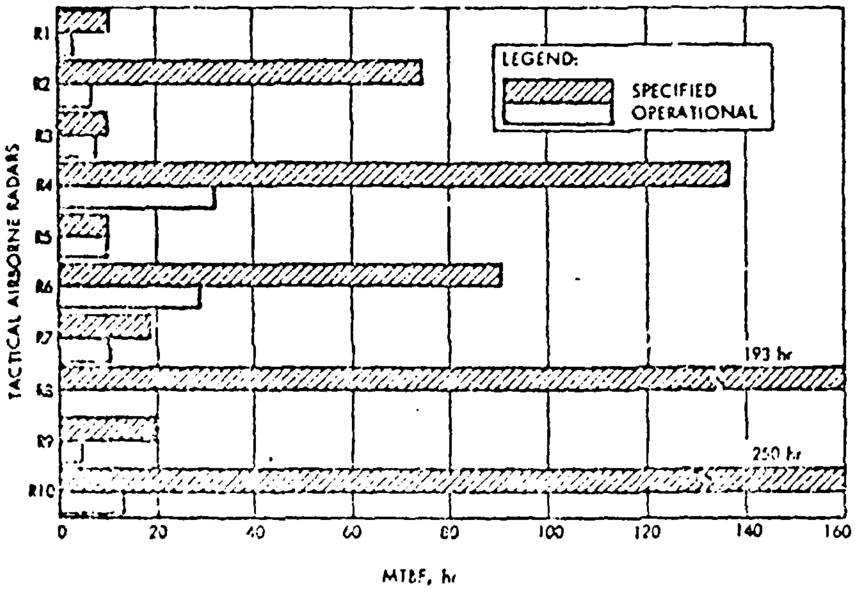


Figure 4. Specified and actual MTBFs of tactical airborne radars (from Gates).

drawn to demonstrate the performance of a system under standardized test conditions that resemble neither the operational environment nor the effects of operational maintenance on the system". He goes on to state that "20 to 50 percent of avionic equipments removed and recorded as failures are later found to be in satisfactory, well-functioning condition" and "the true field MTBF of avionics may be expected to be higher by a factor of 1.5 to 2 than the reported field MTBF because of no-fault removals". These human-induced "failures" must be accounted for.

Chernowitz and Bunker [2] were able to make rigorous comparisons of a fleet of helicopters in a military test environment, peacetime opeations, and active hostilities. They were able to show, Figure 5, that ev[illegible] well run tests tended to underestimate long term operational support requirem[illegible] by a factor approximating two, and moreover that, peacetime requirements [illegible] at least for the cases studied) a close approximator of those of active hostilities. However, the predictive quality of weapon system testing continues to receive intensive effort and this condition must be expected to improve.

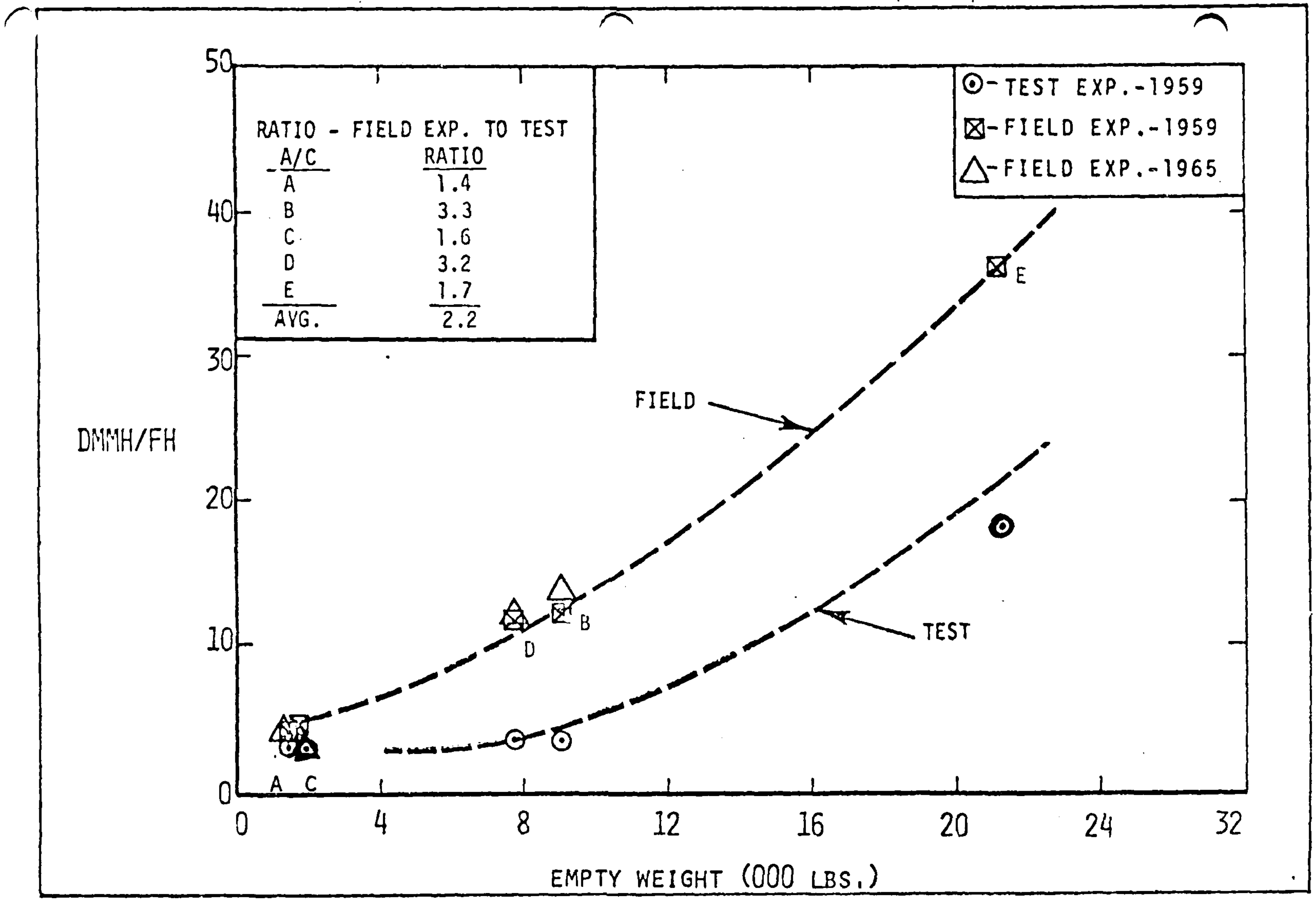


Figure 5. Test environment versus field experience (1959/1965).

OPERATING TEMPO/UTILIZATION FACTOR

Besides relating physical design and performance characteristics to maintenance manhour requirements, the projected operating tempo or utilization of a new weapon system must be considered. In the case of new aircraft, utilization should be measured in flying hours per aircraft per month (FH/AC/MO) and sortie rate (number of missions flown).

Using F-14A squadron monthly maintenance manhour and flying hour data, a significant correlation was found between organizational (squadron) level direct maintenance manhours per flying hour (DMMH/FH) and flying hours per aircraft (FH/AC). Monthly DMMH/FH were regressed against monthly FH/AC for F-14A fighter squadrons VF-1 and VF-2. An R^2 of .87 was obtained for data for the period June 1977 to January 1979. The best relationship found was nonlinear (see Figure 6) and can be expressed as:

$$Y = 31.44 + 18.48e^{-.124(X-20.95)}$$

where,

Y = DMMH/FH;

X = FH/AC/MO; and

20.95 = $\overline{X}$ or mean FH/AC/MO for period.

These results are satisfying not only because of the good model fit but also because of the wide range of DMMH/FH (3.28 to 210.84) and FH/AC/MO (3.71 to 46.71) observed.

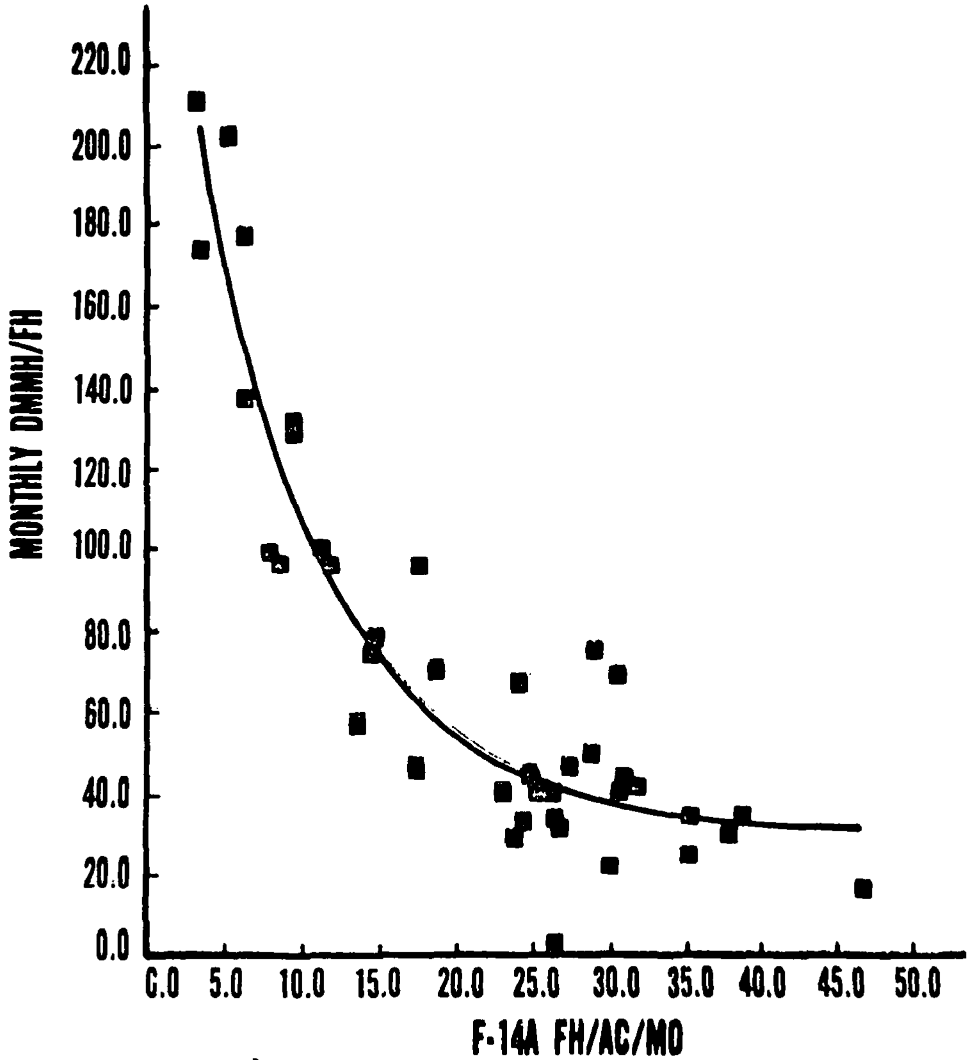


Figure 6. VF-1 and VF-2 pooled O-level maintenance.

FUNCTIONAL/SKILL DEFINITIONS

After bounds have been set for maintenance manhour requirements at the total aircraft level, it is important to establish general skill requirements for the proposed aircraft. Maintenance on an aircraft can be grouped into four major categories: airframe (sheet metal workers), engine, mission equipment (avionics and ordnance), and electrical. The level of performance (mission) capability desired determines the amount and complexity of equipments onboard and consequently, the distribution of maintenance skill requirements. A new Navy maintenance reporting system, Subsystem Capability and Impact Reporting (SCIR) System, was introduced to relate mission capability to mission essential equipments and also maintenance requirements.

SCIR defines for an aircraft a set of mission capability/functional levels to which mission essential equipments are assigned. This defines an unambiguous relationship between mission and manpower requirements. Table 1 gives mission descriptions for the A-7. Table 2 gives excerpts from the SCIR matrix for the A-7E/TA-7C aircrafts. Within this matrix, the alpha code at the top of the matrix corresponds to the possible levels of mission capability for the A-7 as described in Table 1, while the EOC codes identify the essential equipments that must be operative to attain each level. The mission capabilities are hierarchical, such that if an aircraft can perform a strike (B mission), it is also capable of performing a visual attack (D mission). Therefore, for an aircraft to be at optimum performance capability (A mission), all essential equipments having B, C, D, W, X, Y, and Z EOC codes must be operative. If an equipment with a B EOC code fails, such as the APN-154 Radar Beacon (B15), the aircraft falls from A to B capability, and so forth. If an equipment with a Z EOC code fails, such as the Landing Gear (Z38), the aircraft is not even safely flyable.

Table 1

Mission Descriptions
A-7

A. OPTIMUM PERFORMANCE CAPABILITY
Maximized capability for successful completion of all applicable missions through availability of all equipments.

B. STRIKE
Capable of conducting single aircraft deep strike or war-at-sea missions employing all weapons and delivery modes compatible with the aircraft regardless of terrain, weather, or enemy defenses.

C. STRIKE SUPPORT
Capable of ocean surveillance.

D. VISUAL ATTACK
(1) Capable of conducting missions under visual meteorological conditions (VMC) employing system deliveries.
(2) Capable of conducting Arm Support Mission.
(3) Capable of conducting close air support of friendly forces under forward air controller (FAC) control.
(4) Capable of special warfare--tanking, photo and aircraft peculiar weapons.
(5) Capable of fleet support--anti air warfare exercise (AAWEX) and other exercises.

W. EXPANDED MOBILITY
(1) Capable of safe movement on and off the aircraft carrier/short airfield tactical support (OV/SATS) during day and nighttime and inclement weather conditions.
(2) Capable of independent navigation.
(3) Capable of inflight refueling (receive).

X. IMC FLYABLE
Capable of day or night instrument meteorological conditions (IMC) field flight operations with necessary communication, information friend or foe (IFF), navigation, flight and safety systems in accordance with applicable Naval Air Training and Operating Procedures Standardization (NATOPS) and Federal Aviation Administration (FAA) regulations.

Y. SAFELY FLYABLE
Capable of day, field flight operations under visual meteorological conditions (VMC) with two-way radio communication and necessary aircraft and crew safety provisions.

Table 2

A-7E/TA-7C SCIR Matrix

EOC Code	Equipment Description	Mission A	B	C	D	W	X	Y
B11	AUX UHF (ARR-69/ARC-159)	X						
B12	RADAR TF (APQ-126)	X						
B13	APC (ASN-54)	X						
B14	ANTI-SKID	X						
B15	RADAR BEACON (APN-154)	X						
B16	PRECISION APPROACH RECEIVER (ARA-63)	X						
B17	SIDS	X						
B18	TAXI LIGHT	X						
B19	RAIN REMOVAL SYSTEM	X						
B20	PARA BRAKE (TA-7C ONLY)	X						
C30	RADAR AGR/TA (APQ-126)	X	X					
C31	PMDS (ASN-99)	X	X					
C32	WALLEYE	X	X					
C33	ELECTRIC FUZING (ASW 2/4)	X	X					
C35	STATIONS 3 & 6 BRU-10 INSTALLED	X	X					
C36	THERMAL CLOSURE INSTALLED	X	X					
D60	AFCS (ALT HDG NAV) (ASW-26/30)	X	X	X				
W41		X	X	X				
W42	PECM (ALR-45/50)	X	X	X	X			
W43	DECM (ALQ-126)	X	X	X	X			
W44	CHAFF (ALE 29/39)							
W45	ASCU							
W46	ADC (CP 953)	X	X	X	X			
W47	EXTERNAL FUEL SYSTEM (WIRING AND PLUMBING)	X	X	X	X			
X60	DOPPLER (APN-190)	X	X	X	X	X		
X61	APPROACH LIGHTS	X	X	X	X	X		
X62	LAUNCH BAR	X	X	X	X	X		
Y11	AIR REFUELING PROBE	X	X	X	X	X	X	
Y12	ANTI COLLISION LIGHTS	X	X	X	X	X	X	
Y13	EXTERNAL LIGHTS	X	X	X	X	X	X	
Y14	INSTRUMENT LIGHTS	X	X	X	X	X	X	
		X	X	X	X	X	X	
Z33								
Z34	UHF (ARC-51A/159)							
Z35	AUDIO CONTROL SYSTEM (AIC-25)							
Z36	PITOT STATIC SYSTEM							
Z37	AIRFRAME STRUCTURE	X	X	X	X	X	X	[illegible]
Z38	LANDING GEAR	X	X	X	X	X	X	X
Z39	FLIGHT CONTROLS	X	X	X	X	X	X	X
Z40	HYDRAULIC/SYSTEMS	X	X	X	X	X	X	X
Z41	YAW STABILIZATION	X	X	X	X	X	X	X
Z42	OXYGEN SYSTEM	X	X	X	X	X	X	X
Z43	FIRE DETECTION SYSTEM	X	X	X	X	X	X	X
Z44	TRIM SYSTEM	X	X	X	X	X	X	X
Z45	ENGINE	X	X	X	X	X	X	X
Z46	INTERNAL FUEL SYSTEM (FUSELAGE AND WING)	X	X	X	X	X	X	X

This system of relating mission capability levels to mission essential equipments can be used to derive maintenance manhour estimates by major skill groupings for new aircraft. For example, for an aircraft to be safely flyable certain basic equipments or subsystems are necessary, such as an airframe structure, landing gear, and engine. The amount of mission equipment (avionics and ordnance) required depends on the level of mission capability desired. For example, if the airplane must be capable of day or night instrument meteorological conditions (IMC flyable) a radar altimeter is needed; for expanded mobility a doppler radar is needed; for visual attack a voice crypto is needed; for strike support an autopilot is needed; for strike a missile is needed; and for optimum performance capability, a radar beacon is needed.

FORECASTING RELIABILITY AND MAINTAINABILITY (R&M) BY SKILL AREA

The airframe skill grouping which contains the 11, 12, and 14 work unit codes (WUCs)[1] is perhaps the most straightforward to forecast. Physical characteristics such as airframe weight, type of construction, and type of material can be regressed against failure/maintenance manhour data for existing aircraft. These relationships can be used to obtain airframe skill grouping maintenance manhour estimates for the new aircraft, given its airframe physical characteristics.

The engine skill grouping (WUCs 23, 24, 25) MMH estimates can be obtained in much the same way. Physical characteristics (size and number of engines), performance characteristics (pounds of thrust/pounds of aircraft), and specific fuel consumption (pounds/pounds-thrust-hour) are the prime variables of interest. The electrical skill grouping (WUC 42) maintenance manhour requirements depends on the aircraft's power requirements and the number of subsystems to be supplied.

Of the four major maintenance skill groupings, the mission equipment skill grouping (WUCs 51-76), which includes avionics and ordnance equipment, is by far the most difficult to forecast for this is the area where technology is changing the fastest. Gates [5] put it clearly as early as January, 1974 stating,

> ..."the explosive technological growth in electronics has, in recent times, been far more rapid than the growth of any other branch of military technology. Efforts at taking advantage of this evolution in the context of system acquisition practices geared to more stable technologies have led to acquisition and maintenance cost excesses".

---

[1]Work unit codes (WUCs) are numerical alpha names used to identify naval aviation equipment for computer processing purposes. Work unit codes at the 2-digit level identify functions (e.g., 72, radar navigation).

Subsystem Commonality

Blanco et al [1] analyzed technology trends and maintenance workload requirements for the A-7, F-4, and F-14 aircraft. Avionics, mission, and support equipment were analyzed to determine commonality among the A-7B, A-7E, F-4J, F-4N, and F-14A aircraft. Results showed a high commonality of equipments. Even the newest and most technologically advanced aircraft, the F-14A, was found to have at least 52 percent of its items incorporated from existing technology onboard the A-7 and F-4 aircraft. Thus, in forecasting manpower requirements for new aircraft, attention must be paid to equipment similarities as well as differences from existing systems. To illustrate this phenomenon further, Table 3 lists five avionics equipments found on the new F-18 aircraft which can also be found on existing Navy aircraft. Certainly, the historical maintenance data of these equipments can be exploited.

Table 3

Five F-18 Avionics Equipments that Exist in the Fleet Today

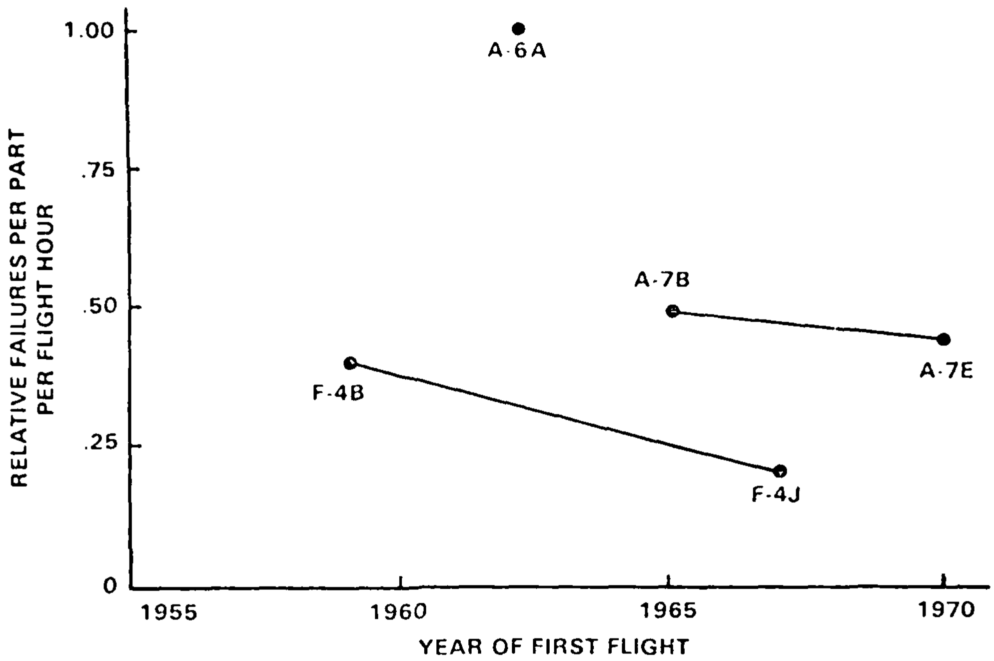
Equipment Nomenclature	Description	Other Aircraft Installed On
AN-ARA63	Receiving Decoding Group	A-6, A-7B/E, F-4J/N, RF-8G, F-14A, S-3A
AN-APN194	Electronic Altimeter Set	A-7E, F-4J/N, A-6, F-14A
AN-ALR45	CM Receiving Set	A-6, A-7B/E, RF-8G, F-4J/N, F-14A
AN-ASW25	Digital Data Communication Set	A-7B/E, F-4B/J/N, E-2C, S-3A
AN-ARC159	Radio Set	A-6, A-7E, C-2A, F-4J/N, F-14A

System Complexity

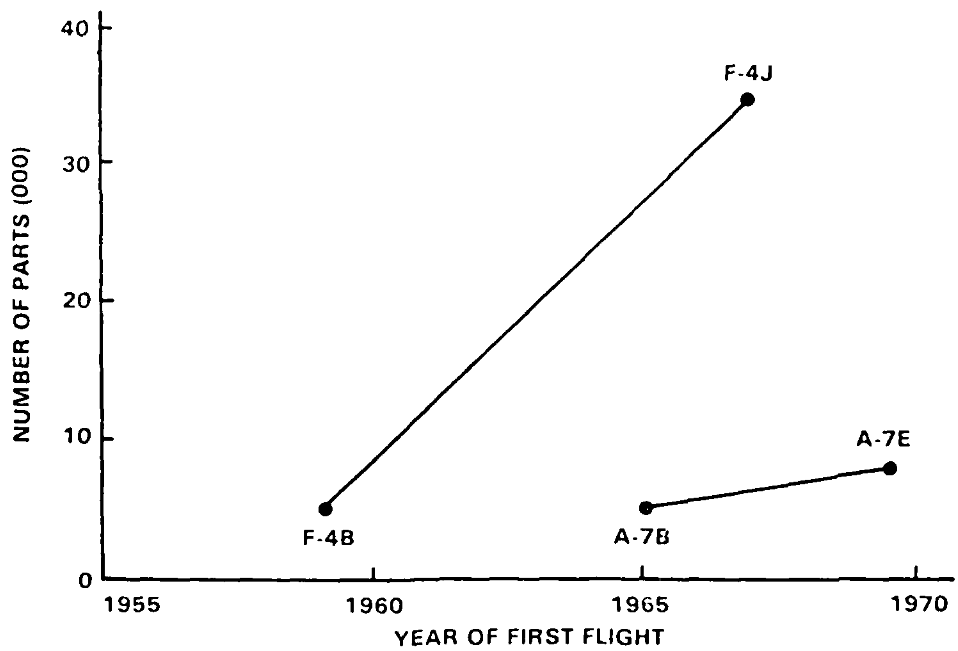
Recent developments in construction materials, electronics, optics, and other technical elements have increased potential component reliability and maintainability (R&M). In most instances, however, technological improvement has been accompanied by an increase in density of functions and capabilities. This point is illustrated by Figure 7 which shows how both component reliability and complexity of the radar subsystems of the F-4 and A-7 families of aircraft have increased (extracted from Comptroller General Report [3]). The increases in the number of components or parts associated with each radar subsystem (Figure 7b) is particularly dramatic. The F-4J and A-7E aircraft are much more technologically sophisticated and capable (can perform more functions) than their respective predecessors, the F-4B and A-7B.

Each new generation of aircraft, from the A-7 to the F-4 to the F-14, reflects enhanced performance capabilities, as well as increased system complexity. The additional complexity and parts count of weapon system electronics have resulted in decreasing system reliability in spite of increased reliability of each individual component.

For new avionics equipment, Morgan and Fuller [7] advocate establishing a data base containing physical data characteristics of analogous equipments--size, weight, number of parts, etc. The avionics equipment for the new aircraft is grouped into identifiable functions (2-digit WUCs). For each function equipments from the physical characteristics data base that are closest analogies to the new equipment are selected. Regressions are run using physical characteristics as independent variables and failure/maintenance manhour data as dependent variables (see also Tetmeyer [9]). For example, the KY58 avionics equipment is a secure voice that is unique to the F-18. An analogous equipment in the fleet today is the KY28 secure voice, which can be found on all fighter/attack Navy aircraft. To forecast the maintenance requirements of the KY58, KY28 maintenance data can be related to its physical characteristics, such as number and size of black boxes, number of parts within the black boxes, etc.



a. Reliability of radar subsystems.



b. Complexity of radar subsystems components.

Figure 7. Changes in reliability and complexity of radar subsystems of F-4 and A-7 aircraft. Modified from Comptroller General of the United States report LCD-77-429. Operating and Support Costs of New Weapon Systems Compared with their Predecessors. Washington, D. C., October 1977.

The APG65, flight and fire control computer, onboard the F-18, has no analogous equipment performing that function in the fleet today. In this case, it is better to analyze equipments similar in design (e.g. integrated circuits), rather than in function. Physical characteristics, such as the number of circuits, can be related to maintenance data for the similar-in-design equipments.

Tetmeyer [9] advocates using parametric estimating techniques in estimating corrective maintenance manhours for new equipment, also. He stresses that the level of detail of the estimates based on analogous equipments depends on the stage the new aircraft is in the acquisition process. During the conceptual stage comparability is usually not permitted beyond a two-digit WUC level. After the development stage, however, Tetmeyer states that comparability analysis should be expanded to cover significant line replacement units (LRUs) at the four-digit WUC level. The examples given above for the F-18 are all at the four-digit WUC level.

CONCLUSIONS/FUTURE DEVELOPMENTS

Preliminary results in the developing and testing of analytical techniques to forecast maintennace manhour/skill requirements have been very encouraging. The feasibility of providing Navy managers with early DSARC decision tools has already been established. Grumman [6], under contract with the Air Force, has successfully developed design-sensitive cost estimating relationships, at the subsystem level, for all life-cycle system acquisition cost categories (RDT&E, Production, Initial Support, and Operations and Support), for all fighter/attack and cargo/transport aircraft. Although these relationships were developed on a dollar per flight hour basis rather than on a manhour/skill per flying hour basis, the practicality of relating aircraft physical and performance design characteristics to maintenance demands has clearly been demonstrated.

The Navy Personnel Research and Development Center is currently applying similar techniques to develop comprehensive maintenance manhour/skill forecasts for the Navy's new F-18 aircraft. Future plans include applying these techniques to evaluate the maintenance manhour/skill requirements of alternative design proposals for the Navy's new trainer aircraft (VTX).

The process which we have described, i.e., that of relating technology and the operating tempo to establish trends and predictive relationships, provides a sound baseline for manpower prediction. Given this baseline as a "surprise-free" prediction, it is then possible to consider on an item-by-item basis technological and managerial innovations as well as the effects of changes in the operational enviroment. This process of successively placing bounds on manpower requirements also permits the host of other manpower-driven costs and resource requirements to be more realistically estimated early in the weapons system acquisition process; indeed at the very earliest stages of consideration.

REFERENCES

1. Blanco, T. A., Chernowitz, G., Ciccotti, J., and Lee, A., Technology Trends and Maintenance Workload Requirements for the A-7, F-4, and F-14 Aircraft, (NPRDC Technical Report No. 79-3). San Diego: Navy Personnel Research and Development Center, May 1979.

2. Chernowitz, G., "Helicopter Maintainability-Specification, Test and Evaluation, and Field Experience", paper presented at the Army Maintainability Symposium, Washington, D. C., September 1975.

3. Comptroller General of the United States, Operating and Support Costs of New Weapon Systems Compared with their Predecessors, (LCD-77-429). Washington, D. C.: October 1977.

4. Department of the Navy, Office of the Chief of Naval Operations, OP-112, HARDMAN Project Master Plan, Washington, D. C., November 1978.

5. Gates, Howard P., et al, Electronics-X: A Study of Military Electronics with Particular Reference to Cost and Reliability. Volume II: Complete Report, (Report R-195). Institute for Defense Analyses; Prepared for Advanced Research Projects Agency, Washington, D. C., January 1974.

6. Grumman Aerospace Corporation, Modular Life Cycle Cost Model for Advanced Systems Phase II, (AFFDL-TR-78-40). Wright-Patterson Air Force Base: Air Force Flight Dynamics Laboratory, April 1978.

7. Morgan, J. D. and Fuller, A. B., The Feasibility of Estimating Avionics Support Costs Early in the Acquisition Cycle, (Institute for Defense Analyses Paper P-1292). Prepared for the Office of the Director of Defense Research and Engineering, Washington, D. C.: September 1977.

8. Naval Weapons Engineering Support Activity, A Prediction of Aviation Logistics Requirements for the Decade 1985-1995, Washington, D. C.: June 1978.

9. Tetmeyer, D. C., LTCOL, USAF, "Planning Manpower to Maintain Aircraft in Combat", paper presented at the Joint National ORSA/TIMS Meeting, New York, 3 May 1978.

10. White, John P., Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics), Memorandum for Secretaries of the Military Departments, dated 17 August 1978, Subj: Manpower Analysis Requirements of System Acquisition.

11. White, John P., Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics), Memorandum for Secretaries of the Military Departments, dated 17 August 1978, Subj: Manpower and Logistic Concerns for New Major Systems.

END

DATE
FILMED

9 — 83

DTIC