An Appraisal of Logistics Support Costs Used in the Air Force IROS Program

Marco Fiorello and Patricia Konoske Dey

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND
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PREFACE

An important objective of the Department of Defense is to improve acquisition policies so as to reduce the overall life-cycle costs of a weapon system. A major portion of these costs is the cost of ownership, which is strongly influenced by policy decisions made in the acquisition stage. An important step in determining how to improve the management of costs of ownership is to analyze historical data on operational weapon systems. Such analysis should provide a formal basis for tying various cost of ownership categories (such as logistics support costs) to acquisition policies, and the data should also help provide the basis for developing cost-estimating relationships.

The Air Force Increase Reliability of Operational Systems (IROS) Program considers detailed cost and capability data in an effort to increase the reliability of weapon systems and their subsystems. The program provides a powerful tool for management and analysis. Its principal purpose within the Air Force Logistics Command is to identify candidates for additional engineering, component improvement, modifications, or other reliability improvement and cost-reduction efforts by using data that rank the costs of subsystems and component logistics support. We believe, however, that IROS offers great promise to a wider array of cost-analysis purposes.

In the interest of improving the collection of data used for weapon system cost analysis, this study briefly evaluates the Air Force K051 Logistics Support Cost Ranking Reports used in the IROS program and recommends extensions to the original design. The study results are based on data for FY 1973, and it is possible that some of the disparities noted herein have been reduced in magnitude or even corrected. We have, however, made a sample comparison of IROS/K051 data and the Air Force Maintenance Collection System G001B base-level (66-1 data) for the A-7D, for the first half of FY 1974; in this sample analysis, IROS/K051 data seem even less complete than 1973 data comparisons showed. Therefore, we expect that the basic problems noted in this report are currently relevant.
This analysis was undertaken within and supports the R&D and Acquisition Studies Program and the cost analysis activity at Rand. It is part of the on-going Rand study of the life cycles of Air Force systems.* The report should be useful to a variety of Air Force managers and cost analysts--both to Air Force Logistics Command personnel who manage or use the IROS/K051 data, and to Air Staff personnel interested in data used to estimate the cost of owning a weapon system, in product improvement decisions, and in logistic support cost modeling.

SUMMARY

The Air Force Increase Reliability of Operational Systems (IROS) Program provides logistics support costs, and other data, on a set of current weapon systems. Logistics support costs dominate the overall cost of owning a weapon system and are of prime interest to cost analysts, product-improvement engineers, and reliability analysts. The KO51 Logistics Support Cost Ranking Reports used in the IROS program provide a unique cost profile of certain weapon systems and are potentially very valuable tools for analysis of weapon system support costs, the design and evaluation of new weapons, and the reduction of support costs for a given design.

This study assesses the performance of the IROS/KO51 Logistics Support Cost Ranking Reports and recommends extensions for use in support of cost visibility and life-cycle cost-management analyses. In the study approach taken, KO51 logistics support costs are determined for the Air Force A-7D Corsair II, as a case example; these costs are compared with reference costs from data-collection systems at the base and depot levels, for the same time period (FY 1973). The differences between the KO51 and reference costs are discussed, and, finally, ways to improve the data are recommended.

We found that with the current design of the cost ranking reports, certain pertinent support costs are not being collected. These include the cost of weapon system aerospace ground equipment, maintenance, modification hardware, and certain spares.

For those costs that the KO51 reports are designed to collect, only about 53 percent of the total relevant base-level costs for unscheduled maintenance and less than 7 percent of the total relevant depot-level costs for the A-7D are actually being gathered. Overall, the KO51 ranking reports appear to be reflecting between one-quarter

*The basic source of the logistics support cost rankings is the KO51 Weapon System Effectiveness Program and Models System.
and one-third of the total maintenance labor and material, transportation, and condemnation costs they are designed to collect.\* Also, logistics support costs that are reported at the subsystem and item level by the KO51 ranking reports are reflected in a disproportionate manner.

To determine if our findings were currently relevant, we carried out a partial comparison of KO51 costs with the reference systems for the A-7D for the first half of FY 1974. That comparison showed that the KO51 data reflect less than 50 percent of the base-level costs and less than 10 percent of the estimated depot support costs. These figures are consistent with our analysis based on FY 1973 data.

The principal reasons that the KO51 logistics support costs reflect lower than actual costs derive from design limitations, data system errors, and operational problems. To correct and extend the KO51 reports, we recommend the following changes.

**Design Improvements.** The KO51 ranking reports' design can be improved by fully capturing those logistics support cost items called for in its definition; in particular, costs for base material, planned depot maintenance, and engine repair. Extending the reports' design by adding costs for base-level and depot-level aerospace ground equipment maintenance, and, eventually, pipeline spares, modification hardware, technical training, and system management, could make the reports more useful in support of cost visibility analysis and in the evaluation of new weapon system designs. For those costs at the depot level that the ranking reports are currently not collecting, new formal interfaces with existing depot data systems should be implemented. Base identifiers should be added to the design to allow comparative analyses of similar items at different locations and to aid in the management of the logistics support cost reports. Finally, a new ranking report should be designed that ranks items by the difference between the average cost measured and the average expected costs, by federal stock number within work unit codes.

\* Note that in this analysis we have excluded the scheduled base-level maintenance estimates.
Data System Edits. Several data system edits are necessary to improve the quality of both the input data to the K051 ranking reports and the logistics support cost estimates. Specifically, base-level interrecord logic edits, base-level edit-total checks, depot-level input data edit checks, and partial IROS data edit checks are called for.

Operational Changes. To facilitate the use of existing base- and depot-level data systems, there is a need for a formal WUC:FSN:MDS directory. To perform the recommended planning, control, and evaluation activities, additional IROS staff analysis will be necessary. For certain weapon systems, a historical data base covering more than one year would be useful, and a means for preserving the data would be required. Formats for displaying K051 logistic support costs have been constantly evolving, and there is a need for a master format control source so that early and recent data can be correlated. Finally, until a single-thread data system is implemented, it will be necessary to allocate the maintenance cost of common items. Depending upon the nature of the subsystem or item (e.g., avionics, hydraulics), the appropriate prorationing surrogates may be different. An explicit task of establishing, monitoring, and evaluating the prorationing process should be undertaken.

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*Based on a previous Rand recommendation, this capability will be implemented throughout TAC in the near future.
†Work Unit Code: Federal Stock Number: Mission Design Series.
‡A single data system that provides detailed weapon system costs at both the base and depot levels.
ACKNOWLEDGMENTS

In preparing this report, we received assistance and many useful suggestions from various persons. In particular, we would like to thank Charles Feeley and Thelma Black at the Air Force Logistics Command, and Stanley Besen, Brent Bradley, John DeOlden, Jean Gebman, and Alvin Harman at Rand.
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I. INTRODUCTION

DESCRIPTION OF THE PROGRAM

The Air Force IROS (Increase Reliability of Operational Systems) Program was implemented and operates in accordance with Air Force Regulation 400-46, and Air Force Logistics Command Regulation 400-16.* It is a program that uses logistics support costs and data from the Air Force KO51 Weapon System Effectiveness Program and Models System, such as data on system effectiveness, availability and downtime history, and flight safety.† These are provided in a variety of quantitative displays, incorporating logistics support cost (LSC) rankings, for currently active Air Force aircraft and ground electronic systems.

The IROS program objective of increasing the reliability and effectiveness of weapon systems is approached by using two types of information provided by the KO51 system:

- data on cost, safety, and availability for product improvements, and
- a data base that allows the identification and cataloging of unreliable components so as to prevent their reentering the Air Force inventory as a part of new weapons.

The basic inputs to the IROS program are furnished by the Air Force GO01B Maintenance Data Collection (MDC) System, ** the Equipment Status

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*In addition to these regulations, various reference documents were used, some of which are listed in Appendix B.

†The KO51 Weapon System Effectiveness Program and Models System is the basic source of the logistics support cost ranking used in IROS. Throughout the report, this source will be referred to as the KO51 reports or the KO51 cost ranking reports, for convenience.

‡As of January 1974, more than 15 output displays were being produced. The four major segments of the IROS program and their associated display titles are listed in Appendix A.

**The GO01B data are commonly referred to as MDC 66-1 data for AFM 66-1 where the data and data-collection process are described.
Reports System 65-110, the K051 system, and several depot-level repair management systems (e.g., G072A/C). The IROS program also contains a cost model in which various data inputs are transformed into desired cost estimates.

The basic LSC management information that IROS produces is weapon system support costs associated with base labor, depot labor, depot material, cost of condemnation, and transportation and packing/shipping costs. In effect, the K051 reports are designed to collect and/or generate the dollar costs of supporting a weapon or its components identified by the work unit code (WUC) structure.* The K051 cost ranking reports can also be used to trace the maintenance cost back to the federal stock number (FSN) at the depot level. It is this combination of WUCs and FSNs within weapon systems and the separation of base-level and depot-level costs that makes the reports unique. With these data, IROS currently monitors the support costs for about 46 weapon systems and 46 ground communication, electronic, and meteorological systems.

USES OF IROS

The focus of this study is on only one of the IROS products, namely, LSCs from the Air Force K051 Weapon Systems Effectiveness Program and Models System. Also, we consider using these LSC reports in applications for which they were not expressly designed. Thus, where we identify shortcomings and make recommendations to improve the IROS program, these qualifications must be kept in mind.

A major component of a weapon system’s life-cycle costs (LCCs) is its LSC, which is estimated by the K051 ranking reports for those weapon systems IROS monitors. Therefore, we are interested in the quality and completeness of the K051-generated costs and in the limitations that the current LSC reports may impose on weapon system support cost analysis, in, for example, decisions to design and evaluate new weapons, and in decisions for reducing or minimizing support costs for a given design.

*WUCs consist of five alphanumeric characters and are used to identify the system, subsystem, and component that required maintenance. Basic references for the WUC system are AFM 66-1 and T.O. - 00-20.2 series technical orders. (For example, 73FA0 is used for recording the base-level maintenance work on the A-7D inertial measurement system.)
Data from the KO51 reports can provide relevant operational experience on certain equipment currently in use, such as whether or not the equipment's past cost and reliability performance warrants its inclusion in a new design. Also, the IROS data base can help identify potential substitutes with a functional similarity to proposed parts—substitutes that have proven low support costs. In addition, LSC data from the KO51 reports are a potentially valuable source for item and support costs needed in predicting LCCs of future weapon systems. These data can also be used as a reference source for evaluating logistic parameters, such as base-level support costs, and in developing support-cost-estimating relationships.

IROS LSCs and reliability data could potentially be used to help minimize support costs for a given weapon system design. For example, future support costs could be reduced by improving the reliability of certain items that consume more support resources than they should. The KO51 LSC reports are designed to provide data that can be used to identify high support cost items—potential candidates for reliability improvements. These data can also be useful in comparing alternative maintenance support policies.

STUDY OBJECTIVE

The overall objective of this study was to analyze the potential use of IROS/KO51 LSC data for weapon systems support cost visibility analyses and for the management of current and forthcoming weapon systems. More specifically, we wanted to investigate and answer the following questions relating to extended applications of the present KO51 reports:

1. How complete is the IROS definition of weapon (sub)system logistics support costs?
2. What proportion of a weapon system's LSCs do the KO51 reports capture?
3. In what way might the KO51 LSC reports be incomplete?
4. What specific steps can be taken, in the short run, to improve the IROS LSC program?
In our approach, we first identified the KO51 LSCs for a specific contemporary weapon system, the A-7D Corsair II. The KO51 LSC estimate was then compared with "actual" costs as reflected in extant base- and depot-level data systems. We used the MDC 66-1 data* and the Depot Purchased Equipment Maintenance (DPEM) reports as the primary reference sources to determine the actual cost data. As part of the comparative analysis we noted various limitations in the KO51 data and laid a foundation for our subsequent recommendations for improvements.

In almost any cost analysis, comparative or otherwise, there are limitations imposed by the lack of adequate data, and this study is no exception. The basic data systems that we relied on for our reference costs are not perfect. These data products contain ambiguities and in some instances are possibly incomplete. However, they do reflect direct recordings of the maintenance and material resources consumed to support the weapon system of interest.

The remainder of this report is presented in two sections and two appendixes. In Sec. II we present a description of KO51 LSCs and evaluate the KO51 LSC product for the A-7D in terms of its completeness, relative cost rankings, and proportionate presentation of costs across subsystems. Last, we discuss the specific limitations of the current ranking reports and in several instances provide a quantitative measure of the magnitude of the limitations. Section III contains suggestions that can improve the KO51 LSC products, so as to make them a more reliable and effective tool for the cost-analysis applications considered in this report. The appendixes include backup descriptions and reference material.

*More specifically we used the MDC 66-1 data from the GO01B system for the A-7D fleet prepared at AFLC. It is our understanding that the base maintenance MDC 66-1 data we used are the same as the input data to the AFLC Product Performance System (D056), described in AFLCM 171-45.
II. IROS LOGISTICS SUPPORT COSTS: DEFINITIONS, COMPARATIVE ANALYSIS, AND PROBLEMS

DEFINITIONS

Weapon system LSCs, as defined in the IROS program, can be represented in equation form:

\[ \text{IROS Logistics Support Costs} = \text{Field maintenance} + \text{Specialized repair activity (SRA)} + \text{Packing and shipping} + \text{Condemnations} + \text{Base material} \]

in which

\[ \text{Field maintenance} = \$9 \times \text{field maintenance hours} \]

\[ \text{SRA} = \text{cost/unit} \times (1 - \% \text{condemned at depot}) \times \text{no. NRTS}^\dagger \]

\[ \text{Packing and shipping} = \text{units shipped} \times 2 \times \text{weight/unit} \times \text{cost/lb} \]

\[ \text{Condemnations} = \text{unit price} \times (\text{no. condemned at base} + \text{no. NRTS} \times \% \text{condemned at depot}) \]

\[ \text{Base material} = \text{cost/unit} \times \text{no. RTS}^\ddagger \]

The Air Force Logistics Command Director of Logistics Management (AFLC/MMO) LSC model, which we use as a convenient reference, has the general cost categories shown in Fig. 1. We see that the IROS

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*This information is adapted from briefing materials prepared by Charles Feeley at AFLC/MMO.

† Not reparable this station.

‡ Repair this station.
LOGISTICS SUPPORT COST MODEL

1. Initial and replacement spares
2. On-equipment maintenance
3. Off-equipment maintenance
4. Inventory entry and supply management
5. Support equipment
6. Personnel training and training equipment
7. Management and technical data
8. New facilities
9. Fuel
10. Spare engines

Fig. 1--Definition of logistics support costs from the AFLC/MMOA model

definition of logistics support costs does not include the following items: the recurring support costs for spares, management personnel, technical training, and documentation, and the investment costs for training and for support equipment. We also note that neither of these includes costs for modification hardware or the maintenance of support equipment. An overview of the LSC categories whose costs are included in IROS and those that are not is given in Fig. 2.

These omissions in the IROS definition naturally cause an understatement of the actual weapon system support costs. In a later section we note ways to incorporate several of these omitted costs. However, for the purposes of this analysis of the A-7D costs, we will compare the IROS LSCs with only the base and depot manpower and material costs in our reference systems.
COSTS INCLUDED
1. Field and organizational maintenance
2. Specialized repair activity
3. Packaging and shipping
4. Condemnation costs
5. Base material

COSTS NOT INCLUDED
1. AGE maintenance
2. POL
3. TC2T\(\text{a}\) hardware
4. Pipeline spares
5. Technical training
6. Systems management
7. Initial spares

\(\text{a}\) Time compliance technical order.

Fig. 2—Overview of IROS logistics support cost coverage

Before proceeding with the analysis we need to clearly identify the costs and the reference data used. We are concerned with field and organizational maintenance (labor and material) costs, hereafter referred to as base maintenance costs, and SRA costs, hereafter referred to as depot maintenance costs. We ignore packaging and shipping and condemnation costs, since they are largely omitted in the KO51 LSC reports. For the base maintenance costs we include only the unscheduled maintenance portion in our comparative analysis, as our interest is in the cardinal rankings of the subsystem and component support costs. The scheduled preflight and postflight activities are the largest consumers of base maintenance resources, but they are more appropriately charged against the entire weapon system.

We use MDC 66-1 data as the reference source for base maintenance data, as does IROS. The base-level maintenance labor hours recorded by
the MDC 66-1 system* are the direct manhours charged, by WUC activity. In the preparation of the IROS LSCs, the base maintenance costs are determined by multiplying the reported maintenance manhours by $9; this is the standard cost per manhour and "includes both direct labor and overhead."†

At the depot level, our reference cost data are from the DPEM‡ reports, which reflect the charges to item managers aggregated to the weapon system. The particular DPEM cost data we use are prepared in the Directorate of Management and Cost Analysis in AFLC. These costs include the charges for labor and expense material for all direct depot-level repair (Air Force and contractor) plus some overhead. In the IROS program the depot-level maintenance costs are projected by item (see p. 5) as a function of the base-level NRTS rate, less the number of condemnations multiplied by the depot standard cost of repair from the Depot Production Management System (GO72A). Those standard unit repair costs are compatible with those used in the DPEM reports.

COST COMPARISONS

Fundamental to all K051 LSC displays are cost rankings by various levels of WUCs in descending order of logistics resource consumption.

* The MDC 66-1 (see AFM 66-1) system is a production control system for use in maintenance management. The base-level maintenance system that provides the MDC 66-1 data in machine-readable form is the GO01B data system (see AFM 171-267 and AFM 66-1). However, the MDC 66-1 data used in this analysis and in IROS are from Hq. AFLC, which processes and edits the GO01B base data.

† Chapter 17, "Logistics Support Cost Ranking," AFLCM 66-18 (C6). In that chapter, AFM 66-18 is cited as the source of the $9 per hour cost factor. We were not able to clearly reconcile the current base maintenance airmen wages (under $4.50 per hour) with the $9 per hour figure. If a 100 percent overhead charge is used, the two figures can be made compatible, but the usual base-level overhead charge is under 15 percent. However, if we interpret $9 per hour as the rate to apply to the reported utilized manhours to reflect the worth of the total resources available and associated overhead, and if the ratio of available to utilized manhours is about 2:1, the two figure are reconciliable. We suspect this latter interpretation is appropriate. Nevertheless, to ensure that the desired base-level reference costs we use are consistent with the IROS costs we, too, multiplied the number of base labor hours reported by $9.

‡ See AFLCR 66-40 for a description of the DPEM reports.
These displays are designed to reflect the proportion of resources that each WUC consumes compared to the total logistics resources (as defined by IROS) consumed by the weapon system. Therefore, we have the option of comparing K051 LSCs at different levels of detail— at the aggregate system level, or, at the other extreme, at the item or shop repairable unit level. The level of detail that we choose to examine is dictated primarily by the detail reflected in the DPEM depot-level reference cost system, which allows comparisons only at the system and subsystem (two-digit WUC level) levels. We have chosen to compare costs in the categories of avionics, aircraft accessories, engines, and airframe.

To compare the costs shown by the K051 LSC reports and our two reference systems within the selected categories, we had to ensure that we had grouped the costs correctly. This was a problem, since our base-level reference data provided resource consumption by WUC, and our depot-level reference data gave costs by repair-group categories or Federal Stock Classes (FSC). The K051 LSC reports, however, provided costs by WUC and matching FSN within weapon systems. Starting with the greatest detail allowable in the DPEM data, we grouped the FSCs and associated repair costs within the four categories noted above.† Given the group of FSCs, within each category, we next identified the corresponding FSNs in the K051 listings. Of course, we also checked for logical consistency. This provided the link between the K051 and DPEM data for the depot-level comparisons. We next identified the set of WUCs corresponding to the FSCs and FSNs in the K051 reports. That list of WUCs provided the link between our MDC 66-1 reference base maintenance data (from AFLC) and the IROS base-level LSCs. We then multiplied the number of base labor hours by $9 to get the base reference costs to compare with the IROS base-level LSCs within the four categories of interest.

ANALYSIS AND FINDINGS

In the remainder of this section we make comparisons among the K051 totals, the rankings of the two-digit WUC levels, and the reference cost systems at the base and depot level.

*The first four digits of the eleven-digit FSN is the FSC.
†The grouping of FSCs used was prepared with the aid of Thelma Black of AFLC/ACMC.
Table 1 compares K051 maintenance and manhour costs with the MDC 66-1 and DPEM data for the A-7D fleet for all of FY 1973.

Table 1
MAINTENANCE MATERIAL AND LABOR COST COMPARISON
FOR THE A-7D FLEET (FY 1973)

<table>
<thead>
<tr>
<th>Data System</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC 66-1</td>
<td>$37,640,510</td>
</tr>
<tr>
<td>DPEM</td>
<td></td>
</tr>
<tr>
<td>K051</td>
<td>$11,605,000</td>
</tr>
<tr>
<td>Difference</td>
<td>$26,035,510</td>
</tr>
</tbody>
</table>

If the MDC 66-1 and DPEM total of $37.6 million is representative, then it follows that the K051 ranking reports in this instance are recording approximately 31 percent of the actual costs.

Given this total difference for the entire year of approximately $26 million, we next determined how this difference was distributed between the general categories of base-level and depot-level costs. Table 2 shows this breakout for the first half of FY 1973 for the A-7D

Table 2
COMPARISON OF K051 LSCs WITH MDC 66-1 AND DPEM
COSTS FOR THE A-7D FLEET (1ST HALF FY 1973)

<table>
<thead>
<tr>
<th>Data System</th>
<th>Base Level</th>
<th>Depot Level</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC 66-1</td>
<td>$6,975,910</td>
<td>---</td>
<td>$18,060,018</td>
</tr>
<tr>
<td>DPEM</td>
<td>---</td>
<td>$11,084,108</td>
<td></td>
</tr>
<tr>
<td>K051</td>
<td>$4,061,417</td>
<td>$727,669</td>
<td>$4,789,086</td>
</tr>
<tr>
<td>Difference</td>
<td>$2,914,493</td>
<td>$10,356,439</td>
<td>$13,270,932</td>
</tr>
</tbody>
</table>

*Unscheduled maintenance.*
fleet. (We used only the first half of FY 1973, because we had the more detailed KO51 LSC data for only that part of the fiscal year.)

The KO51 reports, in this example, appear to be collecting about 58 percent of the base-level maintenance labor and material costs and only about 6-1/2 percent of the depot-level costs. Clearly, those estimates of depot maintenance costs are incomplete.

Next, we determined, at the next lower level of weapon system detail, what the cost distributions were in both dollars and percents. For convenience, we used the KO51 rank order at the two-digit WUC subsystem level.

Table 3 shows, at the two-digit WUC level, the base-level and depot-level costs reflected by the KO51 reports and by the reference data systems. Again, the costs are for the first half of FY 1973 for the A-7D fleet. At the base level, the KO51 and MDC 66-1 costs are distributed over the four subsystems in basically the same proportions. Also, the cost rankings for the two systems are the same. However, at the depot level, neither the rankings nor the proportionate distribution of the costs are the same. In the lower third of Table 3, we have combined the base- and depot-level costs for all four subsystems. For these combined totals, the cost rankings are the same, but the distribution of costs over the categories is quite different. For example, the KO51 reports show that 52 percent of the total LSCs for the A-7D (excluding all scheduled inspections and shipping and condemnation costs) are for repair to the avionics subsystems. Compared with the actual costs represented by the sum of the MDC 66-1 and DPEM costs, the KO51 reports show that avionics costs account for a higher percentage of the total, even though the relative ranking for avionics is the same. Thus, when KO51 LSC data are used to determine which systems consume a greater than expected share of logistics resources, and which systems should receive corrective management actions, we always find that avionics costs dominate for the A-7D. This is not to say that the A-7D avionics should not be scrutinized to effect maintenance and reliability improvements, but just that this subsystem is disproportionately represented in the KO51 data.

To estimate how well the KO51 ranking reports gathered actual costs for the four subsystems, we took the ratio of KO51 costs to the MDC 66-1
Table 3

COMPARISON OF KO51, MDC 66-1, AND DPEM MAINTENANCE LABOR AND MATERIAL COSTS FOR THE A-7D FLEET (1ST HALF FY 1973)

<table>
<thead>
<tr>
<th></th>
<th>Data System</th>
<th>Avionics</th>
<th>Aircraft Accessories</th>
<th>Engine</th>
<th>Airframe</th>
<th>Totala</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subsystem</strong></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Base-Level Costsb</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDC 66-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td>6.98</td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>3.14</td>
<td>2.58</td>
<td>0.72</td>
<td>0.54</td>
<td></td>
<td>6.98</td>
</tr>
<tr>
<td>Percent</td>
<td>45.2</td>
<td>37.3</td>
<td>10.4</td>
<td>7.8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>KO51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td>4.06</td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>1.88</td>
<td>1.60</td>
<td>0.31</td>
<td>0.27</td>
<td>100</td>
<td>4.06</td>
</tr>
<tr>
<td>Percent</td>
<td>46.3</td>
<td>39.5</td>
<td>7.5</td>
<td>6.7</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td><strong>Depot-Level Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DPEM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>--</td>
<td>11.09</td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>2.34</td>
<td>2.10</td>
<td>3.89</td>
<td>2.76</td>
<td>100</td>
<td>11.09</td>
</tr>
<tr>
<td>Percent</td>
<td>20.7</td>
<td>18.9</td>
<td>35.2</td>
<td>25.2</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>KO51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>Rank</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td>4</td>
</tr>
<tr>
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<td>0.07</td>
<td>0.01</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Percent</td>
<td>88.5</td>
<td>10.2</td>
<td>1.01</td>
<td>0</td>
<td>100</td>
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<tr>
<td><strong>Total Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDC 66-1 and DPEM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td>18.06</td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>5.47</td>
<td>4.68</td>
<td>4.61</td>
<td>3.30</td>
<td>100</td>
<td>18.06</td>
</tr>
<tr>
<td>Percent</td>
<td>30.1</td>
<td>26.1</td>
<td>25.4</td>
<td>18.4</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>KO51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td>4.78</td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>2.52</td>
<td>1.67</td>
<td>0.28</td>
<td>0.31</td>
<td>100</td>
<td>4.78</td>
</tr>
<tr>
<td>Percent</td>
<td>52.0</td>
<td>35.3</td>
<td>6.6</td>
<td>6.1</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

aTotals may not add exactly because of rounding.

bUnscheduled maintenance only.
and DPEM costs separately and combined them by category of subsystem. These ratios, in percents, are shown in Table 4.

Table 4

PERCENTAGE RATIO OF KO51 LSCs TO MDC 66-1 AND DPEM COSTS FOR THE A-7D FLEET (1ST HALF FY 1973)

<table>
<thead>
<tr>
<th>Ratio of Costs</th>
<th>Subsystem</th>
<th>Overall Weighted Average</th>
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<tbody>
<tr>
<td></td>
<td>Avionics</td>
<td>Aircraft Accessories</td>
</tr>
<tr>
<td>Total KO51</td>
<td>46.2</td>
<td>36.1</td>
</tr>
<tr>
<td>(MDC 66-1)+(DPEM)</td>
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<td></td>
</tr>
<tr>
<td>Base KO51</td>
<td>61.2</td>
<td>61.5</td>
</tr>
<tr>
<td>MDC 66-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depot KO51</td>
<td>27.8</td>
<td>3.3</td>
</tr>
<tr>
<td>DPEM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Unscheduled maintenance only.

Thus, IROS is gathering between one-fourth (26 percent for the first half of FY 1973) and one-third (31 percent over the entire year) of the costs it is designed to monitor. The KO51 cost ranking reports do a much better job of estimating base-level than depot-level costs. At the base level, the proportions of actual costs reflected in the KO51 reports for avionics and aircraft accessories are both about 61 percent, but the reports capture only about 40 percent and 50 percent of the actual engine and airframes costs, respectively. As noted, the KO51 depot costs are quite incomplete; they reflect less than 7 percent of the actual depot-level costs for the A-7D for the first half of FY 1973. The magnitude of this data omission problem is increased when one recognizes that more than 60 percent of the A-7D costs IROS is designed to monitor occur at the depot level.
To determine if the above results, based on FY 1973 data, are currently relevant, we carried out a partial comparison of KO51 LSCs with data from the reference systems for the first half of FY 1974. (Our analysis was limited because of the unavailability of DPEM data for this period.) The comparison of KO51 LSCs and MDC 66-1 costs for the first half of 1974 are tabulated in Table 5. The overall percentage of costs gathered at the base level is lower in FY 1974 (45.8 percent) than in FY 1973 (58.3 percent). However, the KO51 report reflects the proportionate distribution of costs better in FY 1974—the distribution is nearly uniform. As a rough basis for comparison, we used the FY 1973 DPEM figures and derived an estimate of the FY 1974 depot support costs. This approximation will understate these costs, both because the A-7D fleet in FY 1974 was larger than in FY 1973 and because more of the depot maintenance costs for those aircraft deployed to Vietnam would show up in FY 1974 than in FY 1973. Therefore, the comparison of KO51 depot costs for FY 1974 with the DPEM costs for 1973 should overstate the percentage of actual depot costs that the KO51 reports.

Table 5

COMPARISON OF KO51 AND MDC 66-1 MAINTENANCE LABOR COSTS
FOR THE A-7D (1ST HALF FY 1974)

<table>
<thead>
<tr>
<th>Data System</th>
<th>Subsystem</th>
<th>Avionics</th>
<th>Aircraft Accessories</th>
<th>Engine</th>
<th>Airframe</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC 66-1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>4.04</td>
<td>3.52</td>
<td>0.83</td>
<td>0.67</td>
<td>9.06</td>
<td></td>
</tr>
<tr>
<td>Percent</td>
<td>44.6</td>
<td>38.8</td>
<td>9.2</td>
<td>7.4</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>KO51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rank</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Cost ($ millions)</td>
<td>1.78</td>
<td>1.54</td>
<td>0.46</td>
<td>0.37</td>
<td>4.15</td>
<td></td>
</tr>
<tr>
<td>Percent</td>
<td>43.0</td>
<td>37.1</td>
<td>11.0</td>
<td>8.9</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Ratio of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KO51: MDC 66-1</td>
<td>44.1</td>
<td>43.7</td>
<td>55.4</td>
<td>55.2</td>
<td>45.8</td>
<td></td>
</tr>
</tbody>
</table>
reflect. The total KO51 depot cost projection for the first half of FY 1974 is $0.91 million, which is approximately 8.2 percent of the DFEM costs for the first half of FY 1973. Clearly the FY 1974 approximation is compatible with the figures for FY 1973. We also note that the KO51 distributions and ranking of the costs across the four categories of interest are virtually the same for both FY 1973 and FY 1974.

To determine if the above percentages for the A-7D were representative or typical for KO51 aircraft LSCs, we looked at four other weapon systems being monitored. This brief comparison is shown in Table 6, which lists, for various weapon systems for the second quarter in 1973, the reported total KO51 LSCs, the percentage of the LSC total accounted for by the top ten high cost systems, at the three-digit WUC level, and the top three high cost items and their percentage of the total. All the equipment is of different design, yet we see a consistent pattern for two of the three high cost items at the three-digit WUC level, where all these aircraft have the same kind of avionics items—an inertial measurement system and a radar. The shortcomings of the information contained in Table 6 should be clearly understood. As we have shown for the A-7D, during the first half of FY 1973 the KO51 reports were capturing a greater proportion of avionics data relative to the other subsystem (e.g., propulsion). Consequently, the rankings in Table 6 are based on incomplete data and do not necessarily represent the actual or correct rankings. We use this partial data only to indicate that the KO51 ranking reports display similar patterns for different weapon systems, which tends to imply that our results for the A-7D are probably typical of KO51 LSC reports for other aircraft as well.

INCOMPLETENESS OF KO51 LSCs

There are three reasons why the KO51 report is capturing only one-quarter to one-third of the maintenance labor and material costs and even less of the actual weapon system LSCs:

Design Limitations. The IROS definition of LSCs, as described in Fig. 2, does not include all the logistics support resources
Table 6
COMPARISON AMONG K051 LSCs FOR SEVERAL WEAPON SYSTEMS (2ND QUARTER 1973)

<table>
<thead>
<tr>
<th>Weapon System</th>
<th>Cost ($ millions)</th>
<th>Percent of Total LSCs Spent on 10 Most Expensive Systems</th>
<th>3 Most Expensive Systems</th>
<th>Percent of Total LSCs Spent on 3 Most Expensive Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-7D</td>
<td>3.18</td>
<td>52.9</td>
<td>Inertial measurement</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attack radar</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Launch and racks</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>31.3</td>
</tr>
<tr>
<td>F-111A</td>
<td>3.60</td>
<td>50.5</td>
<td>Inertial measurement</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attack radar</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fuselage</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27.9</td>
</tr>
<tr>
<td>F-111D</td>
<td>5.76</td>
<td>82.7</td>
<td>Integrated display</td>
<td>46.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Attack radar</td>
<td>17.0</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Inertial measurement</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>69.8</td>
</tr>
<tr>
<td>F-4C</td>
<td>5.67</td>
<td>48.4</td>
<td>Inertial measurement</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Attack radar</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fuselage</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>23.9</td>
</tr>
<tr>
<td>F-4E</td>
<td>12.47</td>
<td>47.1</td>
<td>Attack radar</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inertial measurement</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fuselage</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27.4</td>
</tr>
</tbody>
</table>

NOTE: During this period the K051 reports were capturing for the A-7D a greater portion of avionics data relative to the other subsystems (such as propulsion). Consequently, the above rankings are based on incomplete data. We use this display to indicate that the K051 reports are displaying basically the same pattern for the A-7D as for other weapon systems.

consumed by a weapon system or subsystem. For example, costs for AGE maintenance, technical manuals, and technical training are not included. These costs were therefore deleted from the reference systems in the above comparison, so the above K051 LSC estimates, in fact, reflect a smaller percent of actual weapon system LSCs.

The K051 LSCs at the base level are defined as a function of the MDC 66-1 maintenance manhours and material accrued by WUC and by a cost
factor for direct manhours of approximately $9 per hour. This estimation process seems reasonable, yet not all the relevant MDC 66-1 hours chargeable to weapon systems are gathered. This is clearly shown in Tables 2 and 3.

At the depot level, the K051 LSC estimate is a projection determined by multiplying the base NRTS rate by the standard repair cost for the item. The NRTS rate is determined from MDC 66-1 data, and the cost of repair is determined from the GO72A/C Depot Production Cost System. Thus, any work for the A-7D not generated by a base NRTS will be missed by this procedure. These missed costs include those for Planned Depot Maintenance (PDM) on-equipment maintenance and the off-equipment repairs generated by PDM, support equipment, and engine overhauls and modifications. These costs are substantial, and in general amount to about two-thirds of the depot LSC for a typical weapon system.

Data System Errors. The MDC 66-1 system does not consistently record all relevant maintenance actions. In a recent Rand investigation it was found that base-level repair actions judged to have occurred were frequently lost or not indicated in the MDC 66-1 system. For example, within a job control number a common sequence of actions is a pull, a repair, and a replace. When one component of this sequence is missing in the MDC 66-1 report (e.g., if only a remove and replace were recorded), there is a logical error of omission. These data deficiencies in MDC 66-1 are seemingly passed on to the K051 reports, since there is no apparent input data logical sequence quality check. On the other hand, the MDC 66-1 system is a self-recording system and one has also to check for exaggerated numbers of maintenance hours reported—numbers incompatible with the resources available for maintenance.

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* See the discussion on p. 8.

† Our principal interest was in measuring the difference between K051 and MDC 66-1 data, not in finding the causes of the difference. However, we suspect that the problem lies in the processing of the base data, and that the computer programs involved should be analyzed to help solve this missing data problem.

IROS is not collecting all relevant costs that are available from the MDC 66-1 system. Important among these are the base material costs, AGE maintenance, costs, and the base engine repair manhours. An example of material cost omissions is illustrated in Table 7 which is a sample IROS PN4L display for one of the A-7D avionics subsystems. For the entire set of inertial measurement subsystems (WUC 73F) there are no base-level material costs indicated. In part, this omission may be due to a screening criterion that does not allow the accrual of material consumption costs per repair that are under a certain dollar value threshold. However, such a threshold would not exclude all material costs.

As already noted, the majority of a weapon system's costs at the depot level are not being collected by IROS. The principal depot-level data system used by IROS is the GO72A Depot Production Cost System, which provides standardized costs for the planned or projected work by FSN. Therefore, to correlate the depot item or FSN costs with the base-level WUC-generated NRTS action, a FSN:WUC mapping is required. This mapping is provided only implicitly by the MDC 66-1 and other IROS reference systems and often is not complete. Consequently, the symbol "p" is often found in the IROS printouts, which indicates that some cost element making up the cost for that particular WUC was missing at the time of the computation, meaning that the repair cost was missing or a FSN:WUC match could not be made, most likely the latter. Those costs preceded by a "p," which are at best lower-bound estimates, are quite prevalent as indicated in the sample printout in Table 7.

Another data system problem results from the inherent confounding of costs between the fourth- and fifth-digit WUC levels. This difficulty arises from the nature of the WUC structure, which allows line replaceable units to be defined at either the fourth or fifth levels.

*Operational Limitations.* IROS is dependent upon a WUC:FSN mapping to correlate costs from the base level and the depot level with one another. Currently there is no formal, regular procedure in the IROS program for checking, updating, and monitoring the WUC:FSN mapping by weapon system. The present procedure apparently consists of manual
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<th>WUC</th>
<th>NOUN</th>
<th>FIELD MAINT COST</th>
<th>SPEC REPAIR COST</th>
<th>PACK/SHIP COST</th>
<th>CONDEMNATION COST</th>
<th>BASE MATERIAL COST</th>
<th>TOTAL QTR</th>
</tr>
</thead>
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<td>73ECO</td>
<td>M.T ELECT EQUIPM</td>
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<td>73E00</td>
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<td>P</td>
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<td>$3</td>
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<td>P</td>
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<td>$28</td>
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aperiodic checks, which is inadequate. When one considers that the A-7D has approximately 3250 WUCs (at the fifth-digit level) and an even larger number of FSNs it is easy to appreciate the mapping complexity. This complexity is magnified by the frequent changes in the weapon subsystems and items made throughout a weapon system's life, and in particular during the earlier stages. These item changes often result from modifications or new replacement parts, which in general generate a new FSN. Consequently we find that the FSN for items frequently change, and in fact one item can be designated by several FSNs over time, depending upon the status of the modification or replacement actions. Hence, the mapping between FSNs and WUCs is dynamic. In Table 8 we illustrate this problem of multiple FSNs for several A-7D

<table>
<thead>
<tr>
<th>Component</th>
<th>WUC</th>
<th>FSN</th>
<th>MOD</th>
<th>Unit Price^a ($)</th>
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<tr>
<td>Antenna receiver</td>
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<td>5841 470 5164</td>
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<td>5841 001 7066</td>
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<td>5841 105 6686</td>
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<tr>
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<td></td>
<td>5841 601 7116</td>
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<td>34,629</td>
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</table>

^a The FSNs and unit prices are from IROS D041 (Recoverable Consumption Item Requirements System) and the relevant item manager.

^b The FSN and modification correlations are from the item manager's file for the above items. The FSNs for modifications 8 and 9 for the specific items only are shown.
avionics WUCs. For the same item we find that each modification causes an FSN change. One problem that this FSN change can cause is that if a base-level NRTS action is written up with reference to the FSN for an earlier modification, and the depot repair reflects the FSN for the latest modification, the depot and base actions will not have matching FSNs. This problem is compounded even more when there are several FSNs reflecting several modifications that are still in use; that is, previously modified parts that have not been remodified to meet the latest specification change.

A related problem occurs with respect to the unit price listed for the items in the K051 reports. Item price changes can occur for several reasons, such as modifications, quantity discount, and inflation. The avionics sample listing in Table 8 illustrates some price fluctuations. Also, regardless of whether the earlier purchase price is lower or higher, it is the latest price which is carried for the item. In those instances where there are no earlier items with a different FSN (e.g., those not yet modified), the entire item inventory has to be valued at the latest unit price listed.

Perhaps the most fundamental operational limitation in the IROS concept results from the absence of a review process that assesses how well IROS is performing. There are no explicit performance measures to gauge data input quality and quantity, or to evaluate the adequacy and effectiveness of the K051 reports. There is also a genuine need for a formal feedback mechanism to monitor corrective measures.

There is currently no provision to allow for weapon (sub)system IROS histories longer than one year. This limits those analyses concerned with tracking the reliability performance of one item over its life (i.e., longer than one year), or tracing the transitory phases in item maintenance support costs caused by product "seasoning" or modifications.

**IMPLICATIONS OF INCOMPLETE IROS LSC DATA**

The IROS K051 LSC reports are intended to be used as direct inputs to a number of weapon system, and recoverable item, management analyses.
Exemplary decisions deal with adjusting inventory levels, projecting future total system and item support costs, estimating reliability/cost tradeoffs, and identifying functional areas for applied research areas. At the very least, the IROS program's KO51 LSC ranking reports are intended as a means of informing management where the support cost dollars were spent and should provide a data base for use in LSC and LCC models.

To the extent that the KO51 LSC reports are incomplete (e.g., data are missing), and that the partial data are reflected in different than actual relative magnitudes, all the above decisions using IROS LSC data will at the very least be adversely affected or at the worst impossible to make. Based on our analysis at the two-digit WUC groupings, neither the absolute levels nor the correct proportions are determinable with confidence from the current KO51 LSC reports.*

*We note that the relative rankings of the IROS two-digit WUC groupings are the same as for the combined reference base and depot data systems.
III. RECOMMENDATIONS FOR IMPROVING THE KO51
LSC REPORTS USED IN THE IROS PROGRAM

In the previous section we reviewed a number of substantive deficiencies currently besetting the IROS LSC program. In this section we present recommendations that should, if implemented, correct many of these problems and provide a basis for improving the KO51 ranking reports in both the short run and the long run. However, since we have not carried out a thorough analysis on each suggestion, subsequent data system interface issues and resolution incompatibilities may preclude the use of some of these recommendations, particularly in the short run. In view of this possibility, we have deliberately listed several options where it appeared reasonable that more than one data source was available to IROS.

For convenience and to maintain consistency we will classify the recommendations by the topical headings used earlier to discuss the problem areas. Within each area we will distinguish, where possible, those recommendations for correcting existing deficiencies and those aimed at enhancing the KO51 LSC reports. We note that these latter recommendations are intended to extend the basic design of the KO51 reports, so that they will be more useful in weapon system management and support-cost analysis.

DESIGN IMPROVEMENTS

Currently, IROS collects only that part of the weapon system LSCs that it is designed to monitor, and those costs are collected incompletely and are reflected in a disproportionate manner relative to the actual distributions. The KO51 ranking reports are designed to collect all direct maintenance labor and material, transportation, and condemnation costs for a specific set of weapon systems. For the purposes for which the IROS program uses the KO51 reports, it is not essential that all such maintenance, transportation, and condemnation costs be collected. That is, a partial set of data to provide relative rankings is adequate. It is crucial, however, that this partial set of
data be statistically significant and uniform across the functional or WUC categories. Given a statistical sample that proportionately reflects the resource consumption in the different categories, it should be possible to construct the total costs if needed. For example, for the base-level support cost data used in this analysis, the distribution of K051 LSCs and the costs based on MDC 66-1 data is very similar, and the ratio of the costs across the categories (avionics, aircraft accessories, engine and airframe) is approximately uniform; namely, 58 percent and 46 percent for FY 1973 and FY 1974, respectively. Thus as a rough rule of thumb, we could in this instance double the K051 costs and be reasonably close to the actual total MDC 66-1 costs reported. This hypothetical example is intended to illustrate that appropriate cost samples can be used and not to suggest a particular operational rule. We note that the various respective ratios of the sample costs to the total costs, as defined by the K051 reports, will most likely be different for the individual items that make up the two-digit WUC grouping and for the grouping itself. In the following recommendations, however, it is assumed that the K051 reports collect data on a continuous and complete basis and hence attempt to accrue the total IROS-defined weapon system LSCs.

There are several design changes that can improve the current K051 LSC reports.

Design Corrections for the Current K051 Reports

**Base Material.** Base material costs represent the purchase price of the parts used by maintenance to repair the weapon system, and a listing by FSN is recorded for input to the MDC 66-1 system. These costs are currently incorporated in the K051 reports' design but are not being collected; however, to the extent that they are reflected in the MDC 66-1 system, they can be recorded in the K051 reports system.

Without speculating on the reasons for this omission, we can suggest two ways that IROS can collect data on base material costs. The first approach is to use a combination of the MDC 66-1 record of
parts used in maintenance and the base supply 1050-II system, with or without a WUC:FSN:MDS directory, depending upon the number of aircraft at the base which use common items. This procedure would involve extracting the parts listed by FSN from the MDC 66-1 and then, for that set of FSNs, determining the actual volume of transactions and the prices from the base supply system. Presumably, the sample of FSNs from the MDC 66-1 system would reflect all the different parts, even though it may not reflect the total quantity of parts used. The supply system maintains a record of parts issued and prices and could also provide a reasonable estimate of the maintenance bench stock parts (those consumables issued in bulk). If several MDS used the same parts, an allocation of the common parts consumption would be necessary. If there were separate maintenance facilities for the different MDS, the allocation could be done as a function of the ratio of the frequency of occurrence of the maintenance actions which used the parts in question for the MDS. If the maintenance resources were shared by the MDS, as is often the case, those maintenance actions using the parts in question would have to be identified by MDS and then the above ratio applied. The identification of the base maintenance action to MDS can be determined from the MDC 66-1 system. To determine the set of parts that could be consumed by a maintenance action (WUC) within an MDS, the FSN:WUC:MDS directory could be applied.

The second approach is to estimate the consumption of these parts on a quarterly or some periodic basis by using the WUC:FSN:MDS directory, the base supply system, and a statement of the base maintenance capability status. In this procedure we would first determine from the base repair capability statement and the WUC:FSN:MDS directory the set of parts (FSNs) that could be used for base-level repairs by MDS at the base. For the single MDS base, we have only to input the list of FSNs to the base supply systems for a listing with prices of

* The base supply system has its own computer resource, the UNIVAC 1050-II, which has led to the current convention of referring to the base supply system as the 1050-II system.

† The Base Maintenance Repair Capability or AF 1996 system (see AFM 66-273) is one possible source for this information.
the issues for the past quarter.* In those cases where there are several MDS and a common parts problem, the total list of common parts transactions from the supply system would have to be allocated. One possible allocation rule is to allocate the parts in the proportion of the ratio of the maintenance actions by MDS that use the parts to the total of such maintenance actions. This latter information is determinable from the MDC 66-1 data (G001B system).

**Engine Support Costs.** These include all maintenance costs for repair, overhauls, and modifications and are only partially collected by IROS. At the base level, all engine maintenance actions are supposed to be reflected by WUC actions. In the case of the A-7D data for FY 1973, we found that less than 45 percent of the engine-related base-level data were reported by IROS; this percentage, of course, completely discounts any actions not collected by MDC 66-1. It is not clear why the MDC 66-1 and K051 base-level engine cost totals are different. A special edit check at the WUC level should be designed into the K051 reports data input process to determine where the relevant data are being lost, by WUC, and to provide information on why the engine maintenance cost totals for the two data systems are different.

At the depot level, the problem of missing costs of engine repair, modification, and overhaul is more complex than at the base level. We do know that the current IROS technique of projecting engine repairs is inadequate; very unacceptable provisions are made for engine repair requirements generated at other than the base level. The current K051 design should be changed to allow interfaces with one or more data systems. Any one of the data systems we will discuss appears to be an appropriate source for the required data, but at this point we are not sure which system would be most effective and practicable. Consequently we have identified several candidates.

Currently engine maintenance costs at the depot level are collected by several data systems, each with different cost detail or

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*The selection of a quarter as the time period is arbitrary. We could have used a week just as easily.*
degrees of resolution. The Management of Items Subject to Repair System (MISTR)(GO19C)*, the Depot Production Management System (GO72A/C),†, and the Mechanized-Engine Scheduling and Control System (GO20)‡ collect engine maintenance and piece-part costs at the FSN-item level. The DPEM system reflects costs at a more aggregate level than by FSN within MDS. Even though the DPEM cost categories are too aggregated for IROS requirements, they do provide a useful total budget check to compare K051 totals against at the two-digit WUC or major subsystem levels and the MDS level.

Engine component or piece-part maintenance is tracked or projected by both the MISTR and Depot Production Management Cost Systems. As these systems were initially designed, the specific engine identifications (by type) which required the repairs were not retained, making it very difficult to track the engine component repair costs back to the engine and then to the MDS of interest. With a FSN:WUC:MDS directory and a rational allocation scheme, maintenance costs for both common and specialized items could be distributed back to the engine and then MDS. However, this process is indirect and somewhat awkward. Recently, specific changes have been proposed and implemented to provide for engine identification by sequence number for piece-part repairs in both the GO72A and GO19C systems.+++ These changes allow the accumulation of piece-part maintenance costs by engine series; then all that remains is the mapping of the engine costs to the MDS of interest. For many contemporary weapon systems (such as the A-7D and the F-111) the engines are peculiar to a particular MDS and the engine

* See AFLCR 171-20, especially Appendixes 3, 5, 6, and 17, for a description of the MISTR (GO19C) System.
† See AFLCM 171-71; AFLCM 66-9, Part 3, Chapter 9; and AFLCR 170-20. See also AFLCR 66-29 for a specific discussion of the GO72C Depot Maintenance Program and Long Range Planning System, the MDS mapping product of which reflects the DODI 7229.29 requirements of a Uniform Depot Maintenance Cost and Production Reporting System.
‡ See AFLCM 171-173, and AFLCM 66-1, Part 2, Chapter 2A.
** See AFLCR 66-40 for a description of the DPEM System.
MDS mapping is straightforward. For those engines that are common to several aircraft (such as the J-57) it will be necessary to prorate the total engine costs over the common MDS. It is probably reasonable to assume that engine failures or occasions when repairs are needed are essentially random events across the set of MDS that uses that engine. If so, then one can prorate the costs as a function of flying hours and number of engines per aircraft type. We note also that the DPEM system data allow an aggregate mapping of engine depot maintenance costs to MDS, and the current G072A system data are used by AFLC/MAXP to prorate component repair workload back to the MDS levels. In particular, their workload and cost summary by MDS appears most useful.

In the long run, the changes proposed in Project Max* will provide engine piece-part or component variable maintenance costs by FSN and will allow weapon system visibility for accumulating costs by MDS.

**Depot Component Repair.** These are back-shop maintenance costs for other than engine components and are also only partially reflected in IROS. Candidate systems which could be used to fill this void for IROS are the MISTR (GO19C) and Depot Production Management Cost System (G072A/C). Neither of these systems, however, currently provides direct weapon system visibility. Consequently, it will be necessary to use a WUC:FSN:MDS mapping. For the FSNS that are common to several weapon systems, the problem of allocating piece-part maintenance costs to the respective MDS is more complex. The most practical solution in the short run is for IROS to use the basic prorationing methodology currently employed in the Depot Production Management Cost System workload by MDS product. In the long run, the proposed changes in the Project Max design will provide these backshop costs directly by MDS.

**Depot On-Equipment Maintenance.** This category includes such costs as those for PDM and are currently not even projected by IROS. At the depot level, all the on-equipment aircraft repairs are monitored by the Daily Automatic Rescheduling Technique (DART), † and directly reflect

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*Project Max, currently under test by the Air Force, is a maintenance management system developed for application to depot-level maintenance activities. See Project Max System Specifications for AFLC Depot Maintenance Workload Management and Accounting, Part 1, 00AMA/MA, 1 September 1973.

† See AFLCM 171-128 and AFLCM 66-1, Part 2, Chapter 1A for a discussion of the DART (G037D) data system.
work scheduled by WUC within MDS. A possible alternative data source to the DART system is the Analytic Internal Determination for Depot Level Maintenance System (G090).*

Design Enhancements to the Current K051 Reports

Additional Costs. Currently the IROS LSC definition includes costs for base maintenance, labor and material, transportation, condemnation, and a projection for SRA (depot) maintenance, labor, and material. These costs do not reflect all LSCs for a weapon system, and adding certain potentially useful cost categories should be considered, such as costs for AGE maintenance, pipeline spares, modification hardware, technical training, and system management (see Fig. 3). The advantage of incorporating these costs is that the K051 reports alone would more nearly provide a complete data source for useful weapon system LSCs. However, each additional cost category should first be subjected to a cost/benefit assessment to the IROS program. We believe that it would be operationally feasible to include these costs in the K051 reports, and, as an example, we describe how AGE maintenance can be incorporated as part of the IROS LSC product. There is a set of special WUCs used in the MDC 66-1 production control system to manage and monitor base AGE maintenance. For those base locations where the AGE is peculiar to the weapon system of interest, all the AGE maintenance should be carried as an LSC component (according to the WUC breakdown) for that weapon. If the support equipment is shared by several weapon system types (e.g., different MDS), which is commonly the case, the total common AGE maintenance can be prorated. A candidate allocation function is the ratio of the maintenance manhours of the weapon system being costed, to the total maintenance manhours for all the aircraft at the base using the common AGE. While an LSC component derived this way would be only an estimate, it should be sufficiently accurate, since maintenance manhours are a reasonable surrogate for prorations of this type. It will probably be necessary to determine ratios for each set of homogeneous common AGE; that for avionics, propulsion, etc. Whether certain AGE is peculiar or common

*See AFLCM 171-141 for a discussion of G098.
to a weapon system and the location of the AGE can be determined from the DSDCO CO 13 Aerospace Ground Equipment Acquisitions Control System (AGEACS).* This data system monitors the AGE locations at the base levels only. For those AGE units located at depot Air Logistics Centers (ALCs)† or at a contractor, the specific repair facility management would have to be contacted. For the AGE located at other than a base, the AGE maintenance costs can be allocated in a manner similar to that described for the base AGE maintenance.

**Base Identification.** Base identification should be retained in the KO51 reports so that maintenance and reliability performance can be compared across bases for the same weapon where, for example, the weapon is the prime user in one setting and a tenant in the other. Also base identification could be useful as an aid in input data error control.

**Logistic Support Cost Ranking.** We have already noted that the incompleteness and disproportionate representation of the LSCs in the KO51 reports prevent that product from being very useful for LSC or LCC analysis. In that earlier discussion it was tacitly assumed that if the KO51 reports reflected all the costs they are designed to present, it would be possible to identify items consuming too much support resources. An item can be said to be consuming a disproportionate share of logistics resources only when it uses more support resources than it "should." We are interested in identifying the item or activity whose proportional excess of consumption over what it "should" consume is greater than for other items or activities, or if it is above a prespecified cost threshold. To make this identification, we

*See AFLCM 57-17 for a description of AGEACS.
†We include such special facilities as Aerospace Guidance and Metrology Center as an Air Logistics Center.
‡When MDC 66-1 data are forwarded to AFLC for use in the KO51 (IROS) and other data systems and programs, a base identification code is added. See AFM 300-4 for a listing of these codes. Much base-level logistics data editing and analysis results are presented in the Project Performance System (DO-56). See AFLCM 171-45, 21 April 1974.
**We thank Stanley Besen for his comments which led to the formulation of this argument.
must know what the logistics support costs should be for an item, or at least what the target or expected cost is,* and also the absolute costs and number repaired of each item. We can then make the item comparisons based on the average differences (between actual costs measured and expected costs) and the total support costs.

Currently, IROS is designed to provide only the total LSCs and not the average differences; target or expected costs are not part of the IROS program. To determine if an item is consuming more support resources than it should, we need an estimate of the costs it should consume and the difference between these and the actual costs it is consuming. Ideally, we would like a marginal cost comparison, but in general marginal costs are not collected. However, we can approximate the marginal costs from a history of average costs. The average cost differences between an item's expected costs and actual costs, coupled with the related total item support costs, would be sufficient to identify candidate items for LSC analysis. A ranking of the average cost difference by item and the total item LSC would probably be more relevant to the product improvement and logistics cost analysis decisions.

Given that we can identify appropriate candidates for reliability improvement and/or support cost reduction, there is still the problem of deciding whether it is cost effective to do so. We do not foresee a direct role for IROS in this aspect of the analysis.† These decisions are based on the marginal cost of reducing support cost or increasing reliability and the marginal benefit of doing so. The marginal benefit for doing so could in part be measured by the potential

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* Depending upon whether the weapon system or the component is old (operational) or new, different methods to establish "expected" costs can be used. Historical trends using simple averages, exponential smoothing, or moving averages can be used for mature components. In those instances where few or no historical data are available, a target LSC can be estimated by using the AFLC/MMOA LSC model, which is a function of logistics and policy parameters generally determined in the preproduction and testing stages.

savings in reducing current support costs of the item to its expected 
costs, or even in reducing expected costs if the total LSCs are too 
high.

DATA SYSTEM EDITS TO IMPROVE THE CURRENT KO51 REPORTS

In addition to the issue of design, there is a class of related 
problems dealing with data collection and data processing quality and 
completeness. These problems are an issue for both IROS and for the 
systems it depends upon for input data. It is virtually impossible 
to eliminate all errors of omission, syntax, and logic in complex data 
collection systems. Nonetheless, we feel that improved data quality 
can be attained for IROS with only a reasonable degree of additional 
effort. For these data-error-related problems, it is awkward to dis-
tinguish between a correction to achieve the intent of the IROS design 
and recommendations to enhance that design. Therefore our suggestions 
to improve the quality of IROS input data are presented in one group.

Base Interrecord Logic Edit

Currently the MDC 66-1 data are edited to detect data entry omis-
sions and to check on intrarecord syntax; e.g., whether the entry is 
properly alpha or numerically coded. However, there is no interrecord 
error edit check. For example, for a given WUC maintenance action 
initiated for a failure, a common logical sequence of records (actions) 
includes a remove, a repair, and a replace. In a recent Rand study on 
MDC 66-1 data, * missing data in the above logical sequence was fre-
quently observed. That is, if only a remove and a replace were indi-
cated for a WUC, within the same job control number, logically some 
repair action had to occur but was not entered into the data collec-
tion process. (Based on Rand recommendations, new edit programs will 
be implemented throughout TAC in the near future.) This interrecord 
logic check would impact principally on the MDC 66-1 data. Specifi-
cally, such a check would make the data more representative of the

* Working paper by Anders Sweetland, "A Maintenance Data Inter-
actual set of maintenance actions by identifying the missing data records and filling the "holes" with a statistically averaged time or cost. Since IROS is fundamentally dependent upon MDC 66-1 data for base-level maintenance histories, improving MDC 66-1 should also improve IROS.

**Base Edit-Total Check**

The above interrecord logical error edit check is aimed at improving the quality and completeness of input data for IROS. An additional problem is that IROS is currently not capturing all of the present MDC 66-1 data. One reason for this is due to the current IROS definition of LSCs, which explicitly omits certain data (such as AGE maintenance costs). However, for the set of MDC 66-1 data that IROS is designed to collect there are still large disparities between IROS and 66-1 totals. There is a need for an edit-total check to determine if IROS is collecting all the "IROS-design-relevant" data available in the MDC 66-1 system. This edit should statistically compare the totals at different levels within individual work unit codes, and should also compare the aggregate weapon system totals in the two data systems. Over time such total comparisons would indicate trends in the performance of IROS.

**Input Data Edits**

The present IROS projections of depot-level maintenance labor and material costs are inadequate. Until a "single thread" data system is designed that allows a logical derivation of depot maintenance actions as a function of base-level actions (e.g., maintenance, operations, deployment, mobility) and other weapon system characteristics (e.g., AGE, missions), IROS should interface with existing data systems for collecting depot data; candidate data systems are the G072A/C, G019C, G020, and DART.* Regardless of the data system selected for

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*In addition to these data systems, mention has been made of the Product Performance System--DO 56 (see AFLCM 171-45) as a possible source of useful data for IROS. However, we feel that the data systems noted in this discussion are more appropriate direct sources for the
source data, an interrecord logical error edit check should be implemented as part of the IROS input data collection process.

All of the depot-level production management systems employ a standard hour projection to reflect the depot workload. It is not clear what the inherent limitations on IROS analyses these projections might impose. We feel that these depot data system products can help IROS yield improved cost estimates. However, some appraisal is in order to assess the "estimated" error caused by the use of work standards to project a potentially very variable workload. It is quite possible that at the three-digit WUC and higher levels of aggregation, the depot workload variability will be sufficiently masked that no accuracy problems will be introduced.

Also, the base-level on-equipment maintenance costs as reflected by the multiplication of a cost factor times MDC 66-1 data are only partially captured by IROS. As with the engine base-level maintenance costs, the on-equipment maintenance actions are supposed to be monitored by the MDC 66-1 system. Clearly that system is the appropriate source for this information. What is not clear is why the MDC 66-1 and IROS data are so different. We feel that a specific edit check should be introduced to determine how and why the on-equipment maintenance data are not being captured by IROS. This editing process would be a logical extension of the edit called for above.

Partial Data Edit Check

The IROS program currently indicates by the symbol "p" in its LSC displays when some cost element making up the dollar cost equation was missing at the time of computation. Clearly the intent of this notation is to indicate that these partial costs are lower-bound estimates. However, we do not know just how "partial" these costs are, nor do we know which kinds of "errors" are causing this problem. For example, the occurrence of partial data could result from a mismatch between

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missing data. This does not mean that the DO 56 system cannot or should not be used. Certainly, the C-4 Master Files of FSC and WUC are important references.

* This point is a central argument in the Project Max analysis cited above.
WUC and FSN, or new FSNs, or in-process workloads. Even with different depot-level input data, partial costs could still occur and should be monitored by a specific edit check.

**OPERATIONAL CHANGES TO IMPROVE THE CURRENT IROS LSC REPORTS**

Our recommendations to correct and enhance the IROS LSC reports concern management and analysis. They follow logically from the design and edit error checks noted or from a need to improve the planning for and decisionmaking about the IROS LSC programs. Most of these operational recommendations concern enhancement to IROS.

**Operational Corrections to the Current IROS LSC Reports**

**WUC:FSN:MDS Directory.** The current design of IROS requires the matching of FSNs between the base and depot level in order to project, as a function of the base-level NRTS count, depot-level maintenance costs. Our design changes that recommend the formal linking of IROS with extant depot data systems also require a matching of FSNs within WUC and weapon systems (MDS). For either of these approaches to work well, an operational WUC:FSN:MDS directory must be established and maintained. This directory would provide either a way to directly identify and assign support costs to a WUC within a weapon system or a basis to indirectly allocate the costs. It is not clear who should have the responsibility for constructing this directory.* It is clear, however, that the IROS program will be a major user and should contribute to the maintenance and evaluation of it. This evaluation role should be coupled with formal feedback to the generators of the WUC:FSN directory.

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*The most straightforward development of this directory would be at the point where the Initial Spares and Support Lists (ISSL) are prepared at the provisioning conferences after DSARC III. At this time a master list of all repairable spares is prepared which correlates FSNs and contractor part numbers. (See AFM 67-1, Vol. 1, Part 1, AFLCM 65-3, and AFLCR 57-25.) The contractor, in the case of the A-7D, then prepares a WUC-contractor part number directly (see Consolidated A-7 Work Unit Code List, LTV Aerospace Company, Report No. 2-566 42/OR-5577, Dallas, Texas, 1 March 1973). Combining and maintaining these lists will provide the necessary WUC:FSN:MDS directory.
Operational Enhancement to the Current IROS LSC Reports

IROS Management. To implement the various recommendations in this study it will be necessary for the IROS supervisory staff to see that the additional planning and control evaluation activities are carried out. It is vital that specific performance measures be established as a basis for assessing how well the IROS LSC products are achieving this stated objective, or of how useful they are to decisionmakers involved in logistics analysis. Currently there are nine different IROS LSC reports,* and it is not clear just how useful they are to weapon system management and logistics analyses. As part of the IROS management tasks, at least the following set of issues should be investigated on a recurring basis:

- What impact have the IROS LSC ranking reports had on weapon system costs of ownership, for example, by identifying high-payoff modifications to lower LSCs and by providing useful reliability and LSC data to designers and managers of new weapon systems?
- Are total costs necessary for the IROS program or can statistical samples be used?
- How serious is the confounding of costs between the fourth- and fifth-digit WUC levels?
- From the point of view of IROS cost analysis, are the current WUC structures effective? If not, how can they be improved?
- What is the sensitivity of the IROS LSC relative rankings to the magnitude and nature of the partial data indicated in the output products?
- What modifications to existing IROS LSC reports are needed to make them more relevant and useful to weapon system management decisions? Our recommendation to use the difference between the average expected costs and the average actual costs by FSN within WUC is a case in point. Another has to

*Appendix A lists the different IROS LSC products that are currently produced.
do with making IROS a fundamental link in the development of life-cycle cost methodologies.

Cost Allocation Rules. Even with an operational WUC:FSN:MDS directory, it will still be necessary to allocate (i.e., aggregate back) the repair costs for FSN items common to several higher assemblies or weapon systems. Depending upon the nature of the part (e.g., avionics, hydraulics, or airframe) the appropriate prorationing surrogate can be different. In some instances, for example, the surrogate could be a ratio using flying hours or base-level maintenance manhours. The proration of costs should be an explicit, traceable function in the IROS management group. Also, the uncertainty introduced by any proration of costs should be assessed.

The following two recommendations are of secondary significance, from the viewpoint of enhancement to IROS LSC reports.

Format Control. The K051 report formats have been changed often. Data previously included have been deleted, and new data elements have been added. There is a need for a format control reference to coordinate early and recent data.

Historical Data Base. For certain equipment (weapon systems or items) it is often desirable to have LSC data for longer than a year. For example, an analysis dealing with impacts of modifications on support costs of an item would find data over the life of the item most useful. Of course, controls must be established over the selection of equipment for which extended historical data would be stored.

* * * * *

In sum, we feel that by introducing explicit editing checks, by devising a WUC:FSN:MDS directory to identify costs directly and to provide a basis for allocating common item costs, by using data products from existing depot-level data systems, and by expanding the IROS analysis and management function, the IROS LSC products can be improved. A general schematic of a plausible data flow which incorporates most of the recommended corrections and enhancements is depicted in Fig. 3.
Fig. 3—Elements of an improved IROS LSC report preparation
Appendix A

ELEMENTS OF THE IROS PROGRAM

This appendix contains a listing, by subject, of the major segments of the IROS program. It has been adapted from briefing materials prepared by Charles Feeley, AFLC/MMO.
The four major segments of the IROS program are:

**Logistic Support Cost Reports**

KO51.PN1L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Ranking Selected Items"
KO51.PN2L (RCS: LOG-MMO(Q)7214), "Equivalent Rate Ranking Selected Items"
KO51.PN3L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Ranking Work Unit Code Status"
KO51.PN4L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Breakdown Current Quarters Computations"
KO51.PN5L (RCS: LOG-MMO(Q)7214), "Equivalent Rate Ranking Work Unit Code Status"
KO51.PN8L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost File Maintenance Register"
KO51.PW2L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Ranking Item Manager Federal Stock Number Status"
KO51.PW3L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Ranking Rank of Ranks"
KO51.PW4L (RCS: LOG-MMO(Q)7213), "Logistic Support Cost Ranking Weapon System Correlation"

**Availability Ranking Reports**

KO51.30RA (RCS: LOG-MMO(Q)7216), "Rank Sequence by Aircraft Serial Number"
KO51.30RW (RCS: LOG-MMO(Q)7216), "Rank Sequence by Work Unit Code"
KO51.30RR (RCS: LOG-MMO(Q)7216), "High Degradation Work Unit Codes"
KO51.30FW (RCS: LOG-MMO(Q)7216), "System Degradation Work Unit Code Sequence"
KO51.30FA (RCS: LOG-MMO(Q)7216), "System Degradation Serial Number Sequence"

**Flight Safety Prediction Techniques**

This segment is under development in San Antonio Air Materiel Area, Processed in G095 Data Systems. Reports are not available.

**Feedback of Operational Performance and Logistics Support Histories**

Will be provided to new system design personnel by means of one-year reliability-maintainability summaries, report D056B5527 (RCS: LOG-MMO (AF)7220). These summaries are available for major subsystems (two-digit work unit code level), down to the lowest maintenance significant component (five-digit work unit code level), on an as-required basis. Processing of summaries will be concurrent with normal monthly processing frequencies of the D056 (AFM 66-1) data system.
Appendix B

IROS REFERENCES


AFLC Increase Reliability of Operational Systems IROS Program, AFLCR 400-16.

Logistics Support Cost Ranking, Chapter 17, AFLCM 66-18.

