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TASK IDENTIFICATION AND EVALUATION SYSTEM (TIES)

Submitted To:

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13. ABSTRACT (Maximum 200 words)

Five maintenance task data systems in the Air Force provide a variety of task information. Each was developed for different purposes, but only two of these systems use any of the data from the others. The five systems are the Occupational Survey Method, the Maintenance Data Collection System, the Logistics Composite Model, the Logistic Support Analysis Records, and Instructional Systems Development data. Each of these task data systems and their uses are described in detail. Data elements which would permit their linking in a Task Identification and Evaluation System (TIES) are identified. While the different systems can be linked, considerable subject matter specialist assistance will be required to automate the system. Nevertheless, the potential importance to manpower, personnel, and training integration makes development of a TIES highly desirable.

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Small Unit Maintenance Manpower Analysis (SUMMA)
Task Identification and Evaluation System (TIES)
Training (MPT)

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Preface

This report of a Task Identification and Evaluation System (TIES) describes five data systems that provide one or more of the manpower, personnel, and training (MPT) functions with data relevant to their purposes. The array of data provided by the five systems is varied, yet in aggregate, this array is never used by a MPT function. A TIES would provide a universal data base consisting of all of the variety of task information. Availability of such a data base should be a first step in the integration of MPT. Since each of the MPT functions are impacted differently by occupational classification structure, a TIES would provide much of the data needed to optimize structure decisions.

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SUMMARY

Five task data systems supporting key Air Force manpower, personnel, and training (MPT) analyses were reviewed in depth to show their origins, implementation, and uses. These five systems were the Occupational Survey Method (OSM), Maintenance Data Collection System (MDCS), Logistics Composite Model (LCOM) data, Logistic Support Analysis Records (LSAR), and Instructional Systems Development data (ISD). The purpose was to determine if these varied systems could be integrated or reconciled to make MPT analyses more efficient, informed, and comprehensive. Also, each system was assessed in terms of its present purposes and how well it serves these purposes. The basic features of each data system are described in detail.

The conclusion was that while there are formidable barriers to cross-walking the data, task matching could be done. While much of this matching could be done automatically, considerable manual work by subject matter experts would still be required. In particular, new capabilities in the ASCII CODAP (Comprehensive Occupational Data Analysis Programs) system offer a rich potential for linking occupational analysis data with other data systems.

Further, no single system at present fully serves all MPT uses; hence, MPT analysis integration. A TIES would provide much of the MPT data needed for new weapons systems acquisition and for force management decisions, especially for aircraft maintenance specialty reorganization.

Quite apart from TIES, movement toward standardization of task terminology and greater discipline in the generation of task data is needed and should be implemented immediately.

TASK IDENTIFICATION AND EVALUATION SYSTEM (TIES)

I. INTRODUCTION

Five task identification data systems, each providing a variety of descriptive and analytic data useful for manpower, personnel, and training (MPT) decisions, co-exist in the U.S. Air Force. Since they each derive from work performed by job incumbents, it is not unexpected that they duplicate one another in some facets, while at the same time contributing unique information about the work domain. These five task identification data systems are the Maintenance Data Collection System (MDC) which supports LCOM, the Occupational Survey Method (OSM), the Instructional Systems Development model (ISD), the Logistics Composite Model (LCOM), and the Logistic Support Analysis System (LSA).

Three of these systems have no mechanism for interfacing of their data bases, while two of them derive data from the other systems. ISD has a basis in both the OSM and LSA, while data employed in LCOM are partially derived from MDC. For the remaining three systems (OSM, LSA, and MDC), the few efforts to relate data from one to another has involved considerable data transformation and use of subject matter specialists to provide linkages among tasks (Cronk, 1986; Monson, Wagner, & Eisenberg, 1985). That they do not easily interface, of course, is not surprising. Each developed for different reasons and at different times during the past two decades and, except for the few linkage efforts cited above, the systems have functioned independently, to the possible detriment of MPT integration.

Because they were developed independently--serving different purposes--they differ in structure, content, reliability, and computer analysis capabilities, storage, and retrieval. The single feature common to all is the identification of tasks performed, but even here there are wide differences of specificity, orientation, and scope. Since task identification is the primary prerequisite for many of the various manpower, personnel, and training (MPT) functions, each of the task identification systems regardless of its original purpose has been employed in one or more of these functions. Rarely, if ever, has a MPT function utilized data from more than one system for a single purpose. Yet, each of the systems may provide relevant information for that purpose, especially in the personnel and training functions. Consider, for example, the training function. OSM data provide information about task performance, difficulty, and training priority, each of which is essential for decisions about whom to train and when and where they should be trained. For training development, task analysis must be completed as a part of the instructional systems development process. These data, in many cases, are available in LSA data. There is no evidence, however, that these two sources have been employed in development of resident training courses.

There are two principal reasons why the several data bases are not employed. First, there is a widespread lack of knowledge of what the various task identification systems provide. Second, even if potential users knew of the systems, they would be faced with the very formidable task of accessing, interfacing, collating, and analyzing the massive amount of data available from the various systems. At present, the only option is to accomplish these actions manually, and even here there would be considerable problems to overcome.

A Task Identification and Evaluation System (TIES), which this report addresses, would at least alleviate the second problem. In a TIES, the various task identification and associated data systems would be interfaced so that relevant data could be readily accessible, collated, analyzed, and reported in a usable format. The Occupational Research Data Bank (ORDB) at the Air Force Human Resources Laboratory (AFHRL) represents an initial effort at providing a centrally located, user friendly data system (Ellingsworth et al. 1985). But the ORDB is restricted to OSM task data and information about the Air Force personnel who perform the tasks. Project FOOTPRINT at the Training Development and Analysis Center is another effort directed at assembling a data base of a variety of MPT information from each of the military services. In the Navy, HARDMAN is an aggregation of MPT data. TIES, for the Air Force, would not duplicate any of these initiatives. Instead, it would permit the aggregation of the various task data systems and the crossflow of these data for MPT use. At present little, if any crossflow occurs. Different MPT functions use different sources, although each of the sources originate in the tasks that Air Force personnel perform. The result is that a task, for example, is defined differently in manpower and personnel and training usage. TIES could be a first step in a closer integration of MPT by providing a system for interfacing and analyzing all of the task data. Each function could then operate from the same basis.

Given the present situation in which the different systems provide data about work accomplished in maintenance specialties and the lack of any means of interfacing the data among systems, several important questions emerge:

1. Is there overlap in the data they provide and, if so, are they justifiable?

2. Do the data from the various systems need to be interfaced?

3. Are the data adequate for the various MPT uses to which they are put?

4. What would it take to unify, crosswalk, or interface the data systems and reconcile the differences among them?

The remainder of this report addresses these four basic questions. Specifically, each system will be described, including the processes involved, data collection and analysis relevant to MPT issues, data uses and reliability, linkage mechanisms, and uses to which data resulting from interfacing the data systems might be useful.

But, first, some discussion of the differences in the way maintenance tasks are recorded in each of the systems is warranted. Task identification is provided at different levels of detail. These differences are the source not only of specific criticisms made of the various data but are the cause of some of the problems to be faced in interfacing the data systems. MDC tasks are very detailed, showing the action taken at the component level. This detail is essential for identifying reliability and maintainability of equipment and systems. LSA data, for the same reasons, are available at the same level of detail. In addition LSA can provide the component steps or elements of each action taken as well. LCOM uses MDC action taken data as an input for building task networks and estimating maintenance probabilities and manhours. As employed for manpower determinations, MDC actions taken are compressed. Thus, LCOM tasks are slightly broader than MDC or LSA tasks (actions taken). Occupational analysis tasks are more generic, infrequently providing any actions taken at the component level. These tasks are most frequently used for personnel and training purposes. ISD tasks take a variety of forms. Since they are directly used in developing training courses and materials, the level of description varies according to the particular situation. Sometimes they are broadly stated, incorporating several occupational analysis tasks. Other times, they are described in more detail than the MDC or LSA actions taken. In any case, ISD uses require that each task, however described, must be analyzed into its component steps. Table 1 briefly displays the levels of task identification by the five systems.

Table 1. Task Data Systems and Level of Task Coverage

	Equipment, Weapons System	System	SubSystem	Component	SubComponent
MDC	x	x	x	x	
LSA	x	x	x	x	x
LCOM	x	x	x	x	
OSR	x	x	x	*	*
ISD	x	x	x	x	x

* Infrequent

II. TASK DEFINITIONS

The word task and the terms task identification and task analysis have different meanings depending upon the user, as is the case in the five systems. Each is based on "task" performance but those actions referred to as a "task" are generic at best.

As Meister (1976) points out, a task is a construct. As a construct, it may have a variety of meanings depending upon the purposes of task description.

The problem for any task identification system is to employ a definition that is most powerful for producing the data desired of the system. As will be noted in the discussion of the systems that follow, that which may be identified as a "task" is consistent with the use to which data are employed. Perhaps it should be stated at this point that the concept task is not explicit in the MDC, LSA, or LCOM data. Rather, the term action taken is used.

While task definitions vary along two major dimensions (Fleishman & Quaintance, 1984), the tasks of the five systems fit under only one dimension. They state that "....task definitions vary greatly with respect to their breadth of coverage (p.48)." At one end of this dimension are definitions that view a task as an integral part and indistinguishable from the larger work situation. A task is the totality of the situation imposed upon the performer. Such a definition is consistent with the practice in ISD.

At the other end of this dimension is the definition that treats a task as a specific performance. MDC usage, in the form of action taken on a specific component, is consistent with this definition. LSA usage, which parallels MDC except that it is developed for new weapons systems, also is consistent with this definition.

Ranging between these two extremes are the definitions employed by the OSM and LCOM. These will be described in more detail later. Briefly, the OSM tasks are more generic (Driskill & Gentner, 1978), LCOM less so, but not so specific as MDC and LSA. LCOM tasks (actions taken) are derived from combinations of action taken entries in MDC (DPSS working paper, 1986). Each of the five systems is in fact a task identification system, not a task analysis system, except for LSA when task analysis is also procured.

The term task analysis, too, has a variety of definitions (Fleishman & Quaintance, 1984) and provides an even wider variety of information. In practice the term has sometimes referred to data that are more appropriately task identification, as in the frequent reference to OSM and LCOM data as task analysis. These data have never been purported to be task analysis. More correctly, the term applies to situations ranging from the analysis of tasks into their component steps to more detailed analysis of such items as knowledge and skill requirements and cognitive processes involved in task performance (Horton, 1985). The scope of task analysis information is extensive, Reed (1967), for example, cited 45 different types of such information.

In regard to task analysis, each of the five systems provides, first, the source of the analysis--task identification. Second, each provides information, such as equipment used, relevant to task analysis. Of the five systems, only the LSA may provide the component steps of a task. None provide all of the information needed for task analysis, however one might define the term.

The relevance of the above discussion to TIES is sixfold evident in the following:

1. Task statements in the five systems derive from different constructs, whether explicitly stated or not, because of their varying purposes.

2. Task identification data are thus at different levels of specificity.

3. Use of the data from any of the systems is limited by its level of specificity.

4. Linkage of data among systems becomes more difficult and once accomplished may be expected to have a hierarchical structure, ranging from a generic task to the more detailed tasks appropriate to it.

5. No single system, nor any combinations of them, can be expected to satisfy all of the purposes for which task identification or analysis data are useful, simply because the task construct of these users likely will differ.

6. Yet, singly and in combination these systems provide a wide variety of information essential to manpower, personnel, and training analysis and decisionmaking.

7. There is no such thing as a truly unified MPT analysis capability at present. Without such a capability, it is not surprising that MPT functions are not fully integrated. Personnel decisions directly impact manning and training requirements, yet they operate from different data sources and premises.

8. Despite their different purposes, the task identification methods overlap in some respects. For example, the LSA task analysis data, if it were available to trainers, would eliminate some of the needs assessment analysis required by the instructional development process. An interfacing of the task identification systems would, in part at least, eliminate duplication of effort.

9. A case in point is the Small Unit Maintenance Manpower Analysis (SUMMA) work which clearly shows that M and P should and must interact with respect to maintenance in dispersed small unit operations. How maintenance specialties are structured is an important determinant of the manpower requirements. Some modelling of manpower requirements reported in Moore and Boyle (1986) shows that different specialty structures require different manpower requirements. Also, Dunigan et al. (1985) reported the same result. They used the Theater Simulation of Airbase Resources (TSAR) and TSAR Inputs Using the Airbase Damage Assessment (TSARINA) models to simulate combat maintenance requirements. They concluded that reorganization of personnel into fewer, more broadly trained types could improve the number of combat sorties launched by 13 percent for the F-16 in their scenario. They also concluded that such reorganization could be implemented in peacetime, but they do not show how to do it.

III. OCCUPATIONAL ANALYSIS PROGRAM

The Occupational Analysis Program is conducted by the USAF Occupational Measurement Center (USAFOMC) under the provisions of AFR 35-2 and ATCR 52-22. The OSM has produced data that have been used for a variety of MPT purposes.

Background

Research conducted by the Air Force Human Resources Laboratory (AFHRL) led to the establishment of the OSM operationally. According to Christal (1985), research began as a result of an Air Staff requirement for a job analysis system that would provide detailed task data collected from a large number of job incumbents. Initial efforts were directed at devising methods for describing the tasks of an Air Force Specialty (AFS) and administering these task lists to job incumbents to collect job data. Later efforts developed the Comprehensive Occupational Data Analysis Programs (CODAP) to analyze data collected from the incumbents. Although the OSM was implemented in July 1967, research on job analysis methods and CODAP extensions have continued, extending the technology greatly. The present OSM is an outgrowth of this research and the application of the processes to most of the AFS and to more than one and one-half million Air Force enlisted, officer, and civilian job incumbents. In addition the procedures were adopted by the other U.S. Services and the Canadian Armed Forces as operational programs, as well as other allied nations and civilian businesses.

In the beginning, the objective of the OSM was to provide data for use in personnel classification, specifically for AFS structure and description in AFM 39-1. The importance of task data to training decisions soon became apparent, especially for use in ISD and was followed by the emergence of other applications. These added applications caused subtle but significant changes in task description methods and in CODAP. Still, the current program clearly and closely resembles the one originally implemented in 1967.

The OSM is an AFSC or personnel-oriented system and, in contrast to MDC, LSA, and LCOM, it is applied to most enlisted and officer AFS as well as some civilian series positions. OSM survey techniques normally are not applied to an AFS with a population smaller than 200, although there have been instances when AFSs with as few as 20-30 incumbents have been surveyed.

As previously implied, the OSM relies on a task survey technique. The technique involves five basic steps: development of a USAF Job Inventory (a task list and background information) for the AFS being surveyed; administration of the Job Inventory to a large sample (frequently, the population) of AFS incumbents; CODAP analysis; interpretation of results; and report writing and briefings of results.

While a wide array of computer-generated reports can be produced, these reports provide six basic types of information:

1. Tasks comprising the AFS.

2. Percentage of incumbents performing each task.

3. Relative percentage of time spent on each task.

4. Relative difficulty of each task.

5. Relative training emphasis recommended for each task.

6. Summaries of background information--such as equipment used or maintained, test or special equipment, and job satisfaction information.

The numbers and kinds of data reports available are almost unlimited and can be overwhelming. It must be clearly realized, however, that these reports provide the six kinds of information shown.

Initially AFSs were scheduled for survey on a periodic basis. Now, the schedule is the result of a priorities working group consisting of representatives of the Air Force Military Personnel Center (AFMPC), the Deputy Chief of Staff for Technical Training (ATC), the Air Force Human Resources Laboratory, the ATC Surgeon General, the Air Staff (DPMPT), and the USAFOMC. This group considers requests for surveys three times a year. It also reviews AFSs for which surveys are dated (four to five years old). Requirements are assigned priorities and scheduled in Section 8, Volume II, Program of Technical Training (PTT). The PTT provides for a three-year schedule.

The PTT is the source document to determine what AFSC are to be surveyed and when the completion dates are projected. In addition the PTT provides the date the last survey of an AFSC was completed.

Development and Administration of Occupational Surveys

The basis of data produced by the OSM is the USAF Job Inventory for an AFS being surveyed. A Job Inventory consists of two parts: a background information section and a list of duties and tasks comprising the AFSC. The Job Inventory task list is the instrument for collecting the percent members performing and relative ratings of time spent performing tasks, task difficulty, and task training emphasis. The background information section provides the data from which computer-generated job description reports are designed and the basis for summaries of work environment information. In addition, the background information contains items to capture job incumbent job satisfaction, sense of accomplishment, and reenlistment intentions (for enlisted personnel).

Inventory development specialists at the USAFOMC develop the USAF Job Inventory from research of previous job inventories for the AFS (if the AFS has been surveyed earlier), publications, technical orders, Career Development Courses (CDC), interviews with training specialists and 7-skill level technicians at the prime technical training center and Air Staff functional managers, and extensive interviews with 7-skill level technicians in the AFSC at various operational sites. The purpose of this effort is threefold. First, problem areas to which job data are applicable are sought so that the survey will provide useful data for their resolution. Second, the research and interviews provide the source of information for gathering items to include in the background information section. Finally, the research and, particularly, the interviews with technicians in operational organizations provide the list of tasks and duties. All tasks in a USAF Job Inventory are generated by the 7-skill level technicians in the AFSC being surveyed.

Background Information Section

Two examples of data-gathering items from job inventories are shown in Figures 1 and 2. Figure 1 represents standard demographic information collected, such as name, social security number, and duty AFSC. These data are collected in each survey and all items must be completed by an incumbent before the data are used. The second figure is an example of the kind of work-environment information collected. In this case, the examples are from the inventory for AFSC 423X0, Aircraft Electrical Systems. Each of the elements of each item may be used alone or in a combination with others to produce a job description for personnel working on the elements.

Data collected from the Background Information Section are essential for later analysis. These data serve as the basis for generating job descriptions. Inadequacies in the content of this section limit data analysis, because information essential for identifying job incumbents for whom job descriptions are desired is not available.

A review of the USAF Job Inventories maintained by the USAFOMC reveals that the Background Information Sections do not always include all the pertinent work environment information for surveys of maintenance AFSC. The inconsistency of coverage among surveys occurs for several reasons. Task inventory construction (to be discussed below) sometimes permits the writing of tasks at more specific levels so that equipment, for example, can be included in the task statement. This type of situation does not inhibit analysis, although a different set of computer programs must be employed than is normally used. Also, during the development stage, functional managers may indicate they have no need for certain kinds of information, because it is available through other sources. In this case, the items may be left out of the section. This situation further inhibits later analysis and use of the data for unique applications, such as the identification of specific weapons system or equipment for use in designing and computing job descriptions.

For analyzing the OSM data, a consistent policy of including work environment items is desirable. Particularly from the viewpoint of TIES, availability of this information to use for generating equipment or weapons system specific information is vital.

Duty-Task List Section

This section contains a comprehensive list of tasks comprising an AFS. These tasks are generated by 7-skill level technicians in the AFS being surveyed during interviews with the inventory development specialist. It is crucial that users understand that each task in a USAF Job Inventory is a product of an experienced technician in the AFSC and that each has been reviewed and verified by a number of other such skilled personnel.

Before discussing task writing rules and objectives, some description of the organization of the list of tasks is needed. The tasks are organized into groups, called Duties. The purpose of the Duties is to make responding to the survey easier, research (Christal, 1985) having shown this type organization to

BACKGROUND INFORMATION
(THIS FORM IS SUBJECT TO THE PRIVACY ACT OF 1974 - SEE SEPARATE PRIVACY ACT STATEMENT)

CASE CONTROL NUMBER

PRINT YOUR ANSWERS AND CHECK PROPER BOXES

NAME (Last, First, Middle Initial)

SOCIAL SECURITY ACCOUNT NUMBER

DATE (Use numbers only) Year Month Day

PRESENT GRADE

E1	E2	E3	E4	E5	E6	E7	E8	E9
☐	☐	☐	☐	☐	☐	☐	☐	☐
AB	AMN	A1C	Sgt	SSgt	TSgt	MSgt	SMSgt	CMSgt

☐ Male ☐ Female

DATE OF BIRTH Year Month Day

CIRCLE THE HIGHEST SCHOOL GRADE OR COLLEGE/UNIVERSITY YEAR YOU HAVE COMPLETED (Include equal level, like GED, but NOT special training, like vocational, outside regular school)

ELEMENTARY SCHOOL: 01 02 03 04 05 06 07 08

HIGH SCHOOL: 09 10 11 12

COLLEGE OR UNIVERSITY: 13 14 15 16 17 18

PRIMARY AFSC (Leave blank if none) PREFIX NUMBER SUFFIX

DUTY AFSC (Leave blank if none) PREFIX NUMBER SUFFIX

IF CONVERTED OR RETRAINED, WHAT AFSC DID YOU HAVE PREVIOUSLY? (Leave blank if none) PREFIX NUMBER SUFFIX

FOR HOW MANY AIRMEN AND CIVILIANS ARE YOU THE IMMEDIATE SUPERVISOR? (Include only those who report directly to you)

AUTOVON PREFIX

TELEPHONE (Duty extensio

ORGANIZATION TO WHICH ASSIGNED

BASE TO WHICH ASSIGNED

MAJOR COMMAND SEPARATE OPERATING AGENCIES (Check one box)

0A ☐ AAC	0B ☐ USAFA	0D ☐ USAFE	0F ☐ AFLC	0H ☐ AFSC	0J ☐ ATC	0N ☐ HQ USAF
0Q ☐ MAC	0R ☐ PACAF	0S ☐ SAC	0T ☐ TAC	0U ☐ ESC	0Y ☐ AFCC	09 ☐ AFMPC
1S ☐ SPACE CMD	1W ☐ AF ENG SER CTR	3G ☐ AF ELEMENTS EUROPE		3V ☐ AF ELEMENTS OTHER		

☐ OTHER UNIT OR ORGANIZATION (Please specify)

TITLE OF YOUR PRESENT JOB (Duty assignment). NOTE: Do not give just the title of your Air Force Specialty - UNLESS that is the only name your job has)

TIME IN PRESENT JOB	YEARS	MONTHS
TOTAL TIME IN CAREER FIELD	YEARS	MONTHS
TOTAL ACTIVE FEDERAL MILITARY SERVICE (TAFMS)	YEARS	MONTHS

Figure 1. Standard Background Page

AFS 423X0

BACKGROUND INFORMATION (CONTINUED)

BLACKEN CIRCLE (1) TO THE RIGHT OF EACH RESPONSE YOU WISH TO INDICATE

For questions 21 through 23 blacken circle (1) to the right of each response you wish to indicate. You may have numerous responses to some of the questions. For example, in question 21, if you have completed the 3ABR42330 and 3AZR42370 courses, you would blacken circle (1) to the right of responses 2 and 3.

21. Indicate below the applicable resident courses you have completed applicable to your career ladder. Blacken circle (1) to the right of each response you wish to indicate.

1. I have not completed any courses
2. 3ABR42330, Aircraft Electrical Specialist
3. 3AZR42370, Aircraft Electrical Systems Technician
4. Other (Please specify on blank pages at end of booklet.)

22. Indicate below any test equipment you use in your present assignment. Blacken circle (1) to the right of each response you wish to indicate.

1. AC System Analyzers
2. Aircraft Generator Test Stands (Vari-drive)
3. Ammeters
4. Anti-skid Testers
5. Basic Field Test Stands (MC-2)
6. Battery Analyzers
7. Control Panel Test Sets (T-35)
8. DC Control Panel Testers (T-31)
9. Fire Detector Testers
10. Frequency Counters
11. Growlers

Figure 2. Work-Related Background Page

BACKGROUND INFORMATION (CONTINUED)

BLACKEN CIRCLE (1) TO THE RIGHT OF EACH RESPONSE YOU WISH TO INDICATE

12.	High Voltage Insulation Testers
13.	Ignition Testers
14.	Inverter Test Stands
15.	Linear Actuator Test Stands
16.	Load Banks
17.	Multimeters
18.	Nosewheel Steering Testers
19.	Oscilloscopes
20.	Portable DC Rectifiers
21.	Reflectometers
22.	Resistance Decade Boxes
23.	Rotary Actuator Test Stands
24.	T-170 AC System Test S[illegible]
25.	Transistor Testers
26.	Tube Testers
27.	Universal Starter Test Stands
28.	Vacuum Tube Voltmeters
29.	Vibration Meters
30.	Wheatstone Bridges
31.	Windshield Control Testers
32.	Vibrating Reed Frequency Meters
33.	Stick-Grip Testers
34.	Other (Please specify on blank pages at end of booklet.)
35.	I <u>do not</u> use test equipment

Figure 2 (Continued)

BACKGROUND INFORMATION (CONTINUED)

BLACKEN CIRCLE (1) TO THE RIGHT OF EACH RESPONSE YOU WISH TO INDICATE

23. Indicate below any aircraft electrical systems you maintain in your present assignment. Blacken circle (1) to the right of each response you wish to indicate.

1. A-7D
2. A-10
3. AC-130A
4. AC-130E
5. AC-130H
6. B-52B/F
7. B-52D
8. B-52G/H
9. C-5A
10. C-7A
11. C-9
12. C-18A
13. C-54
14. C-130
15. C-135
16. C-137
17. C-140
18. C-141
19. C-H3
20. CH/HH-53C
21. CT-39
22. E-3A

CODE 01, TYPE 1-9-8

Figure 2 (Continued)

AFS 423X0

BACKGROUND INFORMATION (CONTINUED)

<u>BLACKEN CIRCLE (1) TO THE RIGHT OF EACH RESPONSE YOU WISH TO INDICATE</u>

23. E-4A	①②③④⑤⑥⑦⑧⑨
24. EC-135	①②③④⑤⑥⑦⑧⑨
25. F-4C	①②③④⑤⑥⑦⑧⑨
26. F-4D	①②③④⑤⑥⑦⑧⑨
27. F-4E	①②③④⑤⑥⑦⑧⑨
28. F-5	①②③④⑤⑥⑦⑧⑨
29. F-5A	①②③④⑤⑥⑦⑧⑨
30. F-5B	①②③④⑤⑥⑦⑧⑨
31. F-15	①②③④⑤⑥⑦⑧⑨
32. F-16	①②③④⑤⑥⑦⑧⑨
33. F-105	①②③④⑤⑥⑦⑧⑨
34. F-106	①②③④⑤⑥⑦⑧⑨
35. F-111	①②③④⑤⑥⑦⑧⑨
36. FB-111	①②③④⑤⑥⑦⑧⑨
37. HC-130	①②③④⑤⑥⑦⑧⑨
38. HH-3E	①②③④⑤⑥⑦⑧⑨
39. HH-53B	①②③④⑤⑥⑦⑧⑨
40. KC-10	①②③④⑤⑥⑦⑧⑨
41. KC-135	①②③④⑤⑥⑦⑧⑨
42. O-2A	①②③④⑤⑥⑦⑧⑨
43. OA-37B	①②③④⑤⑥⑦⑧⑨
44. OV-10	①②③④⑤⑥⑦⑧⑨
45. RC-135	①②③④⑤⑥⑦⑧⑨
46. RF-4C	①②③④⑤⑥⑦⑧⑨

CODE 99

Figure 2 (Continued)

AFS 423X0

BACKGROUND INFORMATION (CONTINUED)

BLACKEN CIRCLE (1) TO THE RIGHT OF EACH RESPONSE YOU WISH TO INDICATE

47. SR-71
48. T-33
49. T-37A/B
50. T-39B
51. T-41A
52. T-41C
53. T-43
54. TR-1
55. U-2
56. UH-1F
57. UH-1N
58. UH-1P
59. UH60
60. WC-130
61. WC-135
62. Other (Please specify on blank pages at end of booklet.)
63. I do not maintain aircraft electrical systems

CODE 01, TYPE 1-9-B

Figure 2 Continued)

BACKGROUND INFORMATION (CONTINUED)

CHOOSE ONLY ONE RESPONSE

For questions 18 thru 20 blacken circle (1) to the right of the response which best describes your present job assignment and duty position. For example, in question 18, blacken circle (1) beside the aircraft maintenance function which best describes your present job assignment. If the aircraft function that best describes your present job assignment is "Electrical Shop", the you would blacken circle (1) to the right of response 6. Choose only one response.

18. Indicate the aircraft maintenance function which best describes your present job assignment. Choose only one response.

1. I am not assigned to an aircraft maintenance function
2. Aerospace Ground Equipment Shop
3. Aircraft Repair and Reclamation (AAR) Shop
4. Avionics Maintenance Shop
5. Battery Shop
6. Depot Maintenance
7. Electrical Shop
8. Engine Buildup Shop
9. Environmental Shop
10. Flightline Maintenance (Non-POMO)
11. Flightline Maintenance (POMO)
12. Jet Shop
13. Maintenance Control
14. Maintenance Scheduling
15. Maintenance Standardization
16. Phase Maintenance
17. Quality Control
18. Records and Reports

CODE 99

Figure 2 (Concluded)

be most effective. Tasks are listed alphabetically within a duty, research again revealing this organization to be most effective.

The guideline for organizing duties is to align or group tasks in the combination that workers are most likely to perform them. This decision is also made by AFS technicians. Three generic structures are usually found: geographic, functional, and a combination of the two. In the geographic structure, tasks are organized by the location in which they are performed--e.g., flightline, shop, test cell. Functional structure occurs when tasks are performed by functions--e.g., reclamation and repair, troubleshooting, general tasks. Many maintenance AFSs fit one or the other of these two structures, but occasionally tasks are organized in a combination of the two. In any of the three, the structure of the work performed as described by technicians in the AFS determines the USAF Job Inventory Duties.

Developing the list of tasks is also a crucial aspect of the survey process. While there are some very specific rules that apply to task writing, some other factors, primarily two, operate to affect the level of specificity of the tasks. First, more than one AFS may be included in the survey, by decision of the Priority Working Group and based on a request from a user, For example, a request to determine the similarity of work performed among two or more AFS. Second, the work of an AFS may be very heterogeneous, comprised of numerous jobs. In either the first or second case, the number of tasks to describe the work of the AFS becomes so long that some compromises about task specificity must be made. As the number of AFSs surveyed jointly increase, or when there is a very broad AFS, tasks must be more general. Otherwise, the task list is too long.

In regard to task specificity, OSM survey tasks tend to be more general than MDC, LSA, or LCOM tasks. That is, the tasks infrequently describe work performed at the component level. The principal purpose of survey tasks is to provide information useful for decisionmaking for training and job classification. The tasks are purposely written at a more general level than are those in MDC. For such use, more general tasks are adequate--for classification it has been generally considered sufficient to determine who is doing what tasks. There is growing evidence, however, that personnel decisions need to be based on more specific tasks (e.g., SUMMA). The same is generally true for deciding what tasks are trained where, although over time, the policy has been to write tasks as specific as possible. Such ancillary uses of the data as the benchmarking of tasks for learning difficulty and determination of walk through performance measures would be facilitated if more specific tasks were available. As Driskill and Gentner (1978) pointed out in a discussion of the criteria for describing tasks, "Theoretically, each occupational specialty should be described at the lowest level of work activity (p.205)."

Within the parameters of number of jobs surveyed, the capabilities of respondents to answer long task lists, and computer capacity limitations, the occupational analyst is charged with writing tasks that meet the criteria listed below. For a further discussion of them, see Driskill and Gentner (1978).

a. Each task should be time-ratable--that is, the job incumbent can reasonably estimate the relative amount of time he or she spends on each task. This criterion normally eliminates tasks that begin with such words as "insure", "have responsibility for" and "understand", which make it difficult or impossible to determine the relative time devoted to this activity.

b. Each task should communicate in the language of the specialty. The task statement must be clear so that it is easily understood by career field incumbents, the people who must answer the questionnaire. Terminology consistent with current usage in the career field reduces the chance for error or differing interpretations of task statements.

c. Each task should be mutually exclusive or independent of other tasks in the inventory; that is, whether a job incumbent indicates that he or she performs a task must be independent of his or her performance of all other tasks in the inventory.

d. Each task should differentiate among workers where actual task performance differs because of such factors as differences of jobs, experience level (apprentice, journeyman, technician), organizational level (command, staff, base, flightline, or shop), and whether or not the person is a supervisor.

Examples of tasks differing in specificity are shown in Figure 3a and 3b. The tasks in Figure 3a are from USAF Job Inventory, AFPT 90-326-428A, for AFSC 326X0C and D, Avions Aerospace Ground Equipment. In this survey, the tasks could be developed for the A-7D, C-5A, and F-4/RF-4 avionics aerospace ground equipment. Tasks are at a much greater detail than those shown in Figure 3b, the tasks in this figure being taken from USAF Job Inventory, AFPT 90-423-501, for AFSC 423X0, Aircraft Electrical Systems. Since this career ladder was not shredded, that is, not subdivided as is the AFSC 326X0 C and D, the tasks had to be written for electrical systems on all aircraft. The generality of the AFSC 423X0 tasks, however, does not inhibit analysis, since persons working on each aircraft (see Figure 2) can be identified from their background information responses. Job descriptions can then be computed by aircraft worked on.

Interviewing of technicians continues at operational units until no more tasks are being added. After extensive quality control reviews for coverage and compliance with task writing rules, the background and task sections are printed as a USAF Job Inventory.

While the development process is intended to provide comprehensive coverage, the final product should not invariably be considered an exhaustive listing of tasks that may be performed by personnel in the AFSC. The key word is comprehensive, and most inventories achieve this quality. In so doing, USAF Job Inventories include tasks, at a more general level, captured by MDC, LSA, and LCOM, and equally important, many tasks that are not captured by the other systems. These other tasks include supervisory, supply, administrative, training, and extra duty tasks as well as tasks that may not appropriately belong to the AFS. An occupational survey task list is intended to describe

1. Check tasks you perform now (✓).
2. If you don't do it - Don't check it.
3. In the "Time Spent" column, rate all checked (✓) tasks on time spent in present job. If you checked it - Rate it.

AFS 326X0C/D

PENCIL ONLY—PLEASE

NOTE: If any task you perform under this duty is not listed, please specify on blank pages at end of booklet.

CHECK: ✓ IF DONE NOW. Keep ✓ Within Block

TIME SPENT Present Job — RATE:
1. Very small amount.
2. Much below avg.
3. Below avg.
4. Slightly below avg.
5. About avg.
6. Slightly above avg.
7. Above avg.
8. Much above avg.
9. Very large amount.

Task	Check	Time Spent
117. Review base self-sufficiency reports		
118. Review MDC reports		
F. MAINTAINING A-7D SEMIAUTOMATIC TEST SETS		
119. Align AN/ASM-375 inertial measurement set (IMS) test sets		
120. Align AN/ASM-403 navigation weapons delivery computer (NWDC) test sets		
121. Align AN/AVM-11A heads-up display (HUD) test sets		
122. Align AN/AWM-55 armament station control unit (ASCU) test sets		
123. Align 500RM tally punched tape readers		
124. Calibrate AN/ASM-375 IMS test sets		
125. Calibrate AN/ASM-403 NWDC test sets		
126. Calibrate AN/AVM-11A HUD test sets		
127. Calibrate AN/AWM-55 ASCU test sets		
128. Calibrate 500RM tally punched tape readers		
129. Perform fault isolation of AN/ASM-375 IMS test sets		
130. Perform fault isolation of AN/ASM-403 NWDC test sets		
131. Perform fault isolation of AN/AVM-11A HUD test sets		
132. Perform fault isolation of AN/AWM-55 ASCU test sets		
133. Perform fault isolation of 500 RM tally punched tape readers		
134. Perform self-tests of AN/ASM-375 IMS test sets		
135. Perform self-tests of AN/ASM-403 NWDC test sets		
136. Perform self-tests of AN/AVM-11A HUD test sets		
137. Perform self-tests of AN/AWM-55 ASCU test sets		
G. MAINTAINING A-7D MANUAL TEST SETS		
138. Adjust SM-661/ASM-388 air data computer (ADC) simulators		

CODE 99

Figure 3a. Job Inventory Task List, AFS 326X0C/D

1. Check tasks you perform now (✓).
2. If you don't do it - Don't check it.
3. In the "Time Spent" column, rate all checked (✓) tasks on time spent in present job. If you checked it - Rate it.

AFS 423X0

#2 PENCIL ONLY—PLEASE

NOTE: If any task you perform under this duty is not listed, please specify on blank pages at end of booklet.

CHECK: ✓ IF DONE NOW — Keep ✓ Within Block

TIME SPENT Present Job — RATE

1. Very small amount.
2. Much below avg.
3. Below avg.
4. Slightly below avg.
5. About avg.
6. Slightly above avg.
7. Above avg.
8. Much above avg.
9. Very large amount.

Task	Check	Time Spent
233. Inspect weight and balance system control circuit components		
I. ISOLATING MALFUNCTIONS ON AIRCRAFT ELECTRICAL SYSTEMS		
234. Isolate malfunctions on AC generator systems		
235. Isolate malfunctions on Aerospace Ground Equipment (AGE) electrical equipment circuits		
236. Isolate malfunctions on air recovery system circuits		
237. Isolate malfunctions on air refueling circuits		
238. Isolate malfunctions on air sampling circuits		
239. Isolate malfunctions on aircraft AC power distribution circuits		
240. Isolate malfunctions on aircraft DC power distribution circuits		
241. Isolate malfunctions on aircraft flight control circuits		
242. Isolate malfunctions on anti-ice or deice electrical control and warning circuits		
243. Isolate malfunctions on anti-skid circuits		
244. Isolate malfunctions on Auxiliary Power Unit (APU) components		
245. Isolate malfunctions on bail-out or ejection system circuits		
246. Isolate malfunctions on battery charger system circuits		
247. Isolate malfunctions on battery distribution circuits		
248. Isolate malfunctions on battery heater system circuits		
249. Isolate malfunctions on Blade Inspection Method (BIM) circuits		
250. Isolate malfunctions on bomb door system circuits		
251. Isolate malfunctions on cabin heater circuits		
252. Isolate malfunctions on camera circuits		
253. Isolate malfunctions on canopy control circuits		
254. Isolate malfunctions on cargo door control and warning circuits		
255. Isolate malfunctions on cargo hoist circuits		

CODE 01 TYPE 1-9-B

Figure 3b. Job Inventory Task List, AFS 423X0 comprehensively all of the work and tasks that comprise the jobs actively performed by personnel in the specialty. This characteristic sets the OSM product apart from the other systems as of considerable usefulness for training and classification purposes.

Administering USAF Job Inventories

Job Inventories are administered to a large sample of incumbents of an AFS. For specialties with less than 3,000 total manning, a 100 percent sample is sought. For larger specialties, a stratified random sample based on number of jobs, using commands, and operating locations is used. The sample is drawn from the latest tape files of the Uniform Airman Records (for enlisted personnel) compiled by AFMPC.

Inventories are mailed to occupational survey control officers in Consolidated Base Personnel Offices. They administer the inventories by name to job incumbents, and return the completed inventories to the USAFOMC. It is in this administration process that a major criticism lies. Managers contend that personnel, for a variety of reasons, do not give accurate information. But consistency and stability analyses of survey data clearly show that this criticism is not valid.

Job incumbents in the AFSC being surveyed respond directly in the Job Inventory. They complete the standard background items and the work environment information appropriate to each of them. They then complete the duty-task list section. Each respondent, first, goes through the entire list, checking those tasks performed in the present job. Next, the respondent rates each task on a 9-point relative time spent scale indicating the relative amount of time spent performing each task. The scale and instructions to the respondent can be seen in Figures 3a and 3b. It should be noted that the relative time spent means relative to all other tasks; it is not an absolute task time estimate.

At the USAFOMC, an administrative specialist is designated as project officer for each AFSC surveyed. The duties include suspensing returns, confirming unit receipt, following-up to obtain returns, and personally reviewing each returned inventory. This review includes checking for completion and reasonableness of the tasks performed, checking for collusion among respondents, and returning inventories to incumbents for correction. With this process it is not unusual for the sample return for processing to exceed 90 percent. This return rate is extraordinarily high, even considering the non-voluntary nature of the survey. Mailed surveys generally have a return rate no higher than 50 percent.

Analyzing Occupational Survey Data

Background information section and task list data are entered into the AFHRL Sperry 1180 for processing. Initial processing provides further quality control of responses. Final input must be at least 99 percent of the initial input.

Of special relevance to TIES are several CODAP computer reports (briefly described in the Appendix. The first of these is a duty-task list (TASK XX, see Figure 4). This report is a complete listing of the tasks and duties in alphanumeric order as they appear in the inventory. As the figure shows, each task has a unique alphanumeric identifier (Q636, for example). This listing would appear to be the primary source of OSM tasks for linking with tasks of other systems.

Another important initial report is the dictionary of variables (DICTXX, Figure 5). This catalogues by number each of the background information section items. Those numbers preceded by V indicate items in the background section (for example, V0011, Duty AFSC, in Figure 5). Those numbers preceded by C are computed variables. In these computed variables, values of two or more sets of items may be combined, or may represent variables generated from the data. This report provides the format for each of the background variables, and is essential in designing subsequent analysis.

Also at this time, a job description for each survey respondent is computed and stored for later retrieval as a job description for a single individual, or for combination with other respondents to form group job descriptions. These combinations of individual job descriptions are based on combinations of variables selected from the background section items and represented in the dictionary of variables.

Computation of individual job descriptions is straightforward. The time ratings a worker provides for each of the tasks performed in his or her present job are summed, divided by the number of ratings, and multiplied by 100 to
yield a relative time spent rating for each task. The job description for any individual can be reported, along with the background section items to which the worker responded.

Computation of group job descriptions is also uncomplicated. For whatever job description is designed, based on one or more background or computed variables, the job descriptions for the individuals who responded to these variables are combined. The relative percentage of time of all in the group for each task is summed and divided by the number in the group to yield an average percent time spent for each task.

The time spent performing tasks is not only a relative figure, but it is expressed as a percentage. Since it is a relative figure, it is questionable that any attempt to convert to absolute or real time spent should be made. The purpose of the relative time spent totals is to rank order the tasks performed by any group from the most to least time-consuming. Since incumbents may work shifts of differing lengths, or may only be working part time on some or all of the tasks, conversion to real time spent is difficult.

There is, however, evidence that the ordinal relationship between relative time spent and actual time spent is high. Garcia (1984) reported a correlation of .81 between relative time spent on the 9-point scale used in OSM and actual observed time. Earlier, McFarland (1974), in a study of the use of occupational analysis data (OSM) by management engineering teams (MET)

Q 636	57	Remove or replace FB-111 SATCOM synchronizer power supply SRU's
Q 637	58	Remove or replace FB-111 SATCOM synchronizer power supply bits and pieces
Q 638	59	Remove or replace FB-111 SATCOM telegraph modem bits and pieces
Q 639	60	Remove or replace FB-111 SATCOM telegraph modem SRU's
Q 640	61	Remove or replace FB-111 SATCOM teleprinter bits and pieces
Q 641	62	Remove or replace FB-111 SATCOM teletypewriter set control bits and pieces
Q 642	63	Remove or replace FB-111 SATCOM test station bits and pieces
Q 643	64	Remove or replace FB-111 SATCOM test station TRU's

R Maintaining F-15 AN/GSM-228 antenna A and B test stations and assigned LRU's

R 644	1	Align F-15 radar system antennas
R 645	2	Align F-15 radar system transmitters
R 646	3	Assemble or disassemble F-15 radar system antennas
R 647	4	Benchcheck F-15 radar system antennas
R 648	5	Benchcheck F-15 radar system low voltage power supplies
R 649	6	Benchcheck F-15 radar system transmitters
R 650	7	Calibrate F-15 AN/GSM-228 test stations
R 651	8	Isolate malfunctions in F-15 radar system antennas
R 652	9	Isolate malfunctions in F-15 radar system low voltage power supplies
R 653	10	Isolate malfunctions in F-15 radar system transmitters
R 654	11	Service F-15 AN/GSM-228 test station coolant and conditioning units with refrigerant
R 655	12	Service F-15 AN/GSM-228 test station cooling and conditioning units with coolant oil
R 656	13	Service F-15 AN/GSM-228 test station flush and fill units
R 657	14	Service F-15 AN/GSM-228 test station hydraulic power supplies

S Maintaining F-15 AN/GSM-230 test stations and assigned LRU's

S 658	1	Align F-15 APX-101 radio-receiver transmitters
S 659	2	Align F-15 APX-76 radio-receiver transmitters
S 660	3	Align F-15 ARC-109 UHF radio receivers
S 661	4	Align F-15 ARC-109 UHF radio-receiver transmitters
S 662	5	Align F-15 ARC-164 UHF radio-receiver transmitters
S 663	6	Align F-15 ARN-118 tactical air navigation (TACAN) radio-receiver transmitters
S 664	7	Align F-15 ARN-84 TACAN radio-receiver transmitters
S 665	8	Align F-15 instrument landing system (ILS) radio receivers

Figure 4. Alphanumeric Task Listing

```
DICTXX     326XSB: Integrated Avionics Manual Test Station                    TECHNICAL SERVICES DIVISION
                                                                             AF HUMAN RESOURCES LABORATORY
                                                                              AIR FORCE SYSTEMS COMMAND

C0001 Case identification assigned by inpstd                                      I4
C0002 Number of non-zero responses to the questionaire                            I4
C0003 Reserved for Future Use
C0004 Reserved for Future Use
C0005 Reserved for Future Use
C0006 Reserved for Future Use
C0007 Number of non-zero responses to the questionnaire                           F5.0
C0008 Sum of raw task responses                                                   F6.0
C0009 KPath sequence number                                                       F6.0
C0010 Number of non-zero responses to the questionaire squared                    F11.0
V0001 Case control number                                                         1A4
V0002 Name                                                                        4A4,A2
V0003 Social security account number                                              2A4,A1
V0004 Grade                                                                       A1
V0005 Sex                                                                         A1
V0006 Date of birth                                                               1A4,A2
V0007 Education level                                                             A2
V0008 Primary AFSC Prefix                                                         A1
V0009 Primary AFSC                                                                1A4,A1
V0010 Primary AFSC suffix                                                         A1
V0011 Duty AFSC Prefix                                                            A1
V0012 Duty AFSC                                                                   1A4,A1
V0013 Duty AFSC suffix                                                            A1
V0014 Converted AFSC Prefix                                                       A1
V0015 Converted AFSC                                                              1A4,A1
V0016 Converted AFSC suffix                                                       A1
V0017 No. persons supervised                                                      A2
V0018 Autovon                                                                     1A4,A3
V0019 Major command                                                               A1
V0020 Organization                                                                3A4,A3
V0021 Base to which assigned                                                      3A4,A3
V0022 Title present Job                                                           6A4,A1
V0023 Time in present Job                                                         A3
V0024 Total time in career field                                                  A3
V0025 Total active federal military service                                       A3
V0026 You cmpltg inventory under direct supvn CBPO Survey Ctl Ofcr      (1=yes)   A1
V0027 You cmpltg inventory at home or barracks                          (1=yes)   A1
V0028 You cmpltg inventory at organization which you work               (1=yes)   A1
V0029 Have instructions for cmpltg survey been read/explained to you    (1=yes)   A1
V0030 You asgnd to base/installation located outside continental u.s.   (1=yes)   A1
V0031 Will you be eligible to reenlist at end of current enlistment     (1=yes)   A1
V0032 Will you be eligible for retirement at end current enlistment     (1=yes)   A1
V0033 Do you hold rank of senior airman                                 (1=yes)   A1
V0034 How do you find your job (scale 1-7)                                        A1
V0035 How does job utilize your talents (scale 1-7)                               A1
V0036 How does job utilize your training (scale 1-7)                              A1
V0037 How satisfied with sense of accomplishment gained from work (scale 1-7)     A1
V0038 Do you plan to reenlist (scale 1-5)                                         A1
V0039 How were you assigned to your present career ladder (scale 1-8)             A1
V0040 Title that best describes primary job - analysis mon, DCM level   (1=yes)   A1
V0041 Title that best describes primary job - analysis mon, SQ level    (1=yes)   A1
V0042 Title that best describes primary job - auto tst sta shop chief   (1=yes)   A1
V0043 Title that best describes promary job - bench stock monitor       (1=yes)   A1
V0044 Title that best describes primary job - branch administration NCO (1=yes)   A1
```

Figure 5. Dictionary of Variables

```
V0207 Av age tst sta/tst eq gp wk wth-ind/controls tst sta (AN/GSM-229) (1=yes)    A1
V0208 Av age tst sta/tst eq gp wk wth-instr ind sys tst sets            (1=yes)    A1
V0209 Av age tst sta/tst eq gp wk wth-MSN/TRF cntrl tst sta (12a16849)  (1=yes)    A1
V0210 Av age tst sta/tst eq gp wk wth-MSN/TRF cntrl tst sta (12a16879)  (1=yes)    A1
V0211 Av age tst sta/tst eq gp wk wth-radar test sets AN/UPM/137        (1=yes)    A1
V0212 Av age tst sta/tst eq gp wk wth-satellite comm tst sta            (1=yes)    A1
V0213 Av age tst sta/tst eq gp wk wth-signal/data convtr tst sta        (1=yes)    A1
V0214 Av age tst sta/tst eq gp wk wth-TACAN tst eq gp (AN/ARN084 HT-MCK)(1=yes)    A1
V0215 Av age tst sta/tst eq gp wk wth-TACAN tst eq gp (AN/ARN-118 HT-MC)(1=yes)    A1
V0216 Av age tst sta/tst eq gp wk wth-UHF tst eq gp (AN/ARC-164 HT-MCK) (1=yes)    A1
V0217 Av age tst sta/tst eq gp wk wth-other                             (1=yes)    A1
V0218 Spec tools/equip you wk wth - none                                (1=yes)    A1
V0219 Spec tools/equip you wk wth - audio oscillators                   (1=yes)    A1
V0220 Spec tools/equip you wk wth - capacitance bridges (meters)        (1=yes)    A1
V0221 Spec tools/equip you wk wth - capacitance decade/dividers         (1=yes)    A1
V0222 Spec tools/equip you wk wth - capacitor test sets (tf20-1)        (1=yes)    A1
V0223 Spec tools/equip you wk wth - compressed gas bottles              (1=yes)    A1
V0224 Spec tools/equip you wk wth - connector repair kits               (1=yes)    A1
V0225 Spec tools/equip you wk wth - control/monitor devices             (1=yes)    A1
V0226 Spec tools/equip you wk wth - differential voltmeters             (1=yes)    A1
V0227 Spec tools/equip you wk wth - diode checkers                      (1=yes)    A1
V0228 Spec tools/equip you wk wth - distortion analyzers                (1=yes)    A1
V0229 Spec tools/equip you wk wth - dummy loads                         (1=yes)    A1
V0230 Spec tools/equip you wk wth - environmental chambers              (1=yes)    A1
V0231 Spec tools/equip you wk wth - freq meas devices (off equip)       (1=yes)    A1
V0232 Spec tools/equip you wk wth - isolation breakdown tst sets        (1=yes)    A1
V0233 Spec tools/equip you wk wth - logic state analyzers               (1=yes)    A1
V0234 Spec tools/equip you wk wth - multimeters (psm-6, 410cs, dig mult)(1=yes)    A1
V0235 Spec tools/equip you wk wth - oscilloscopes                       (1=yes)    A1
V0236 Spec tools/equip you wk wth - phase sensitive voltmtrs (psvm/pvm) (1=yes)    A1
V0237 Spec tools/equip you wk wth - power measuring devices             (1=yes)    A1
V0238 Spec tools/equip you wk wth - pressure regulators                 (1=yes)    A1
V0239 Spec tools/equip you wk wth - pressure temp tst sets (TTU-205)    (1=yes)    A1
V0240 Spec tools/equip you wk wth - pressure tst sets for in repl units (1=yes)    A1
V0241 Spec tools/equip you wk wth - pulse generators                    (1=yes)    A1
V0242 Spec tools/equip you wk wth - radio freq power amplifiers         (1=yes)    A1
V0243 Spec tools/equip you wk wth - resistance decade/dividers          (1=yes)    A1
V0244 Spec tools/equip you wk wth - resistor bridges (meters)           (1=yes)    A1
V0245 Spec tools/equip you wk wth - RF crystal detectors                (1=yes)    A1
V0246 Spec tools/equip you wk wth - RF multimeters                      (1=yes)    A1
V0247 Spec tools/equip you wk wth - RF variable attenuators             (1=yes)    A1
V0248 Spec tools/equip you wk wth - signal generators                   (1=yes)    A1
V0249 Spec tools/equip you wk wth - soldering or desoldering tools      (1=yes)    A1
V0250 Spec tools/equip you wk wth - spectrum analyzers                  (1=yes)    A1
V0251 Spec tools/equip you wk wth - strobescopes                        (1=yes)    A1
V0252 Spec tools/equip you wk wth - synchro/resolver standards          (1=yes)    A1
V0253 Spec tools/equip you wk wth - tire pumps and gauges               (1=yes)    A1
V0254 Spec tools/equip you wk wth - torque wrenches or torque screwdrvrs(1=yes)    A1
V0255 Spec tools/equip you wk wth - transistor test sets                (1=yes)    A1
V0256 Spec tools/equip you wk wth - tube testors                        (1=yes)    A1
V0257 Spec tools/equip you wk wth - vector impedance meters             (1=yes)    A1
V0258 Spec tools/equip you wk wth - voltage and current std devices     (1=yes)    A1
V0259 Percent time spent in duty a                                                 A3
V0260 Percent time spent in duty b                                                 A3
```

Figure 5 (Concluded)

and the measured actual time provided by the MET. In the civilian community, Page (1976) found a similar relationship between relative and actual percent time spent. Since the ordinal relationship is quite good, it may be that some linear transformation of relative time spent to actual time spent is possible. If such a transformation is possible, use of OSM for manpower determinations could be valuable. The importance of a relative-actual time spent transformation method would be especially important for LCOM modelling of non-maintenance AFSs.

An example of a job description (PRTJOB) is shown in Figure 6. This job description is for the total sample of workers with duty AFSC 326X5B. It shows a listing of all the tasks (truncated in the example) performed by these workers, the percent of members performing each task, and percent time spent by those performing and averaged across all members, and, the last column, the cumulative sum of time spent by all members. Every job description computed by CODAP contains this basic information.

A duty description is also computed (see Figure 7). Percent performing in a duty is determined by counting all members who perform at least one task in a duty. Similarly, the amount of time spent on the tasks in a duty is summed to provide the percent time entries.

A fourth computation early in the data analysis effort is the hierarchical clustering (OVRLAP, GROUP) of job incumbents based on the percentage of time spent on tasks (Archer, 1966). The process is based on the amount of overlaps of time spent on tasks reflected in any two job descriptions. In the first step, the time-spent-on-tasks overlaps of each incumbent with every other incumbent is computed. The two most similar job descriptions are merged, a new 2-person job description computed, overlaps determined and the next two most alike merged. This process continues until there is only one job description representing the entire sample. This clustering process is printed in a diagram format for use by the occupational analyst.

The analyst determines, from the diagram and from actual job descriptions for groups selected from the diagram, the structure of the specialty. This structure is expressed by the job types--those people who are doing the same tasks--and job clusters, which are groups of highly related job types. These data are important for classification purposes--deciding whether a career ladder should be subdivided or merged with another--and for training decisions-whether to channelize or not. The data also are useful for multiple other purposes, such as in the benchmarking and performance measurement areas. Of considerable importance is the existence of different jobs in every specialty (Driskill & Mitchell, 1979). The similarity, or lack of similarity, dictates classification structure and training programs. A significant problem with the grouping process is the lack of an empirical basis for determining clusters and job types or for defining the level of homogeneity or sameness of the work performed by the members in a given group (for a discussion of this issue, see Harvey, 1986). The product of the hierarchical grouping process is provided in summary form in the occupational survey report prepared for each specialty.

PRTJOB All 326X5B Personnel with a Skill Level of 5

TECHNICAL SERVICES DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

Task Level Job Description

Task	Task Statement	Percent of Members Performing	Avg Pct Time Spent by Mbrs Performing	Sorted Avg Pct Time Spent by All Members	Cumulative Avg Pct Time Spent By All Members	Task Seq Num
R 647	Benchcheck F-15 radar system antennas	91.26	1.10	1.00	1.00	
R 646	Assemble or disassemble F-15 radar system antennas	87.38	1.11	.97	1.97	
R 644	Align F-15 radar system antennas	88.35	1.09	.97	2.94	
R 649	Benchcheck F-15 radar system transmitters	90.29	1.02	.92	3.85	
R 651	Isolate malfunctions in F-15 radar system antennas	90.29	1.01	.91	4.76	5
F 160	Order parts by telephone	83.50	1.09	.91	5.67	
R 645	Align F-15 radar system transmitters	88.35	1.03	.91	6.58	
F 167	Research microfiche for part information	85.44	1.05	.90	7.48	
R 648	Benchcheck F-15 radar system low voltage power supplies	90.29	.99	.89	8.37	
T 715	Benchcheck F-15 integrated communications control panels	91.26	.98	.89	9.26	10
R 653	Isolate malfunctions in F-15 radar system transmitters	89.32	.96	.85	10.12	
H 226	Visually inspect and clean test stations	89.32	.94	.84	10.96	
H 225	Visually inspect and clean LRUs	88.35	.95	.84	11.80	
F 166	Research manuals for part numbers	79.61	1.05	.84	12.63	
T 746	Isolate malfunctions in F-15 integrated communications control panels	89.32	.93	.83	13.46	15
197	Install caps, plugs, or dust covers on test stations, test equipment, or LRU's	92.23	.89	.82	14.28	
S 682	Isolate malfunctions in F-15 APX-76 radio-receiver transmitters	85.44	.95	.81	15.09	
H 208	Perform periodic inspections of test stations	87.38	.92	.80	15.89	
R 652	Isolate malfunctions in F-15 radar system low voltage power supplies	89.32	.89	.80	16.69	
S 669	Benchcheck F-15 APX-76 radio-receiver transmitters	86.41	.92	.79	17.48	20
T 722	Benchcheck F-15 motion picture cameras	87.38	.91	.79	18.28	
E 124	Annotate maintenance data collection record forms (AFTO Form 349)	73.79	1.07	.79	19.06	
T 694	Align F-15 integrated communications control panels	86.41	.91	.79	19.85	
S 659	Align F-15 APX-76 radio-receiver transmitters	84.47	.92	.78	20.63	
T 749	Isolate malfunctions in F-15 motion picture cameras	85.44	.89	.76	21.39	25
T 692	Adjust F-15 controller aircraft grip assemblies	88.35	.85	.75	22.14	
E 132	Annotate reparable item processing tag forms (AFTO Form 350)	73.79	1.02	.75	22.90	
R 650	Calibrate F-15 AN/GSM-228 test stations	87.38	.85	.75	23.64	
T 713	Benchcheck F-15 generator control units	89.32	.82	.73	24.37	
S 681	Isolate malfunctions in F-15 APX-101 radio-receiver transmitters	84.47	.86	.73	25.10	30
T 744	Isolate malfunctions in F-15 generator control units	84.47	.83	.71	25.81	
S 668	Benchcheck F-15 APX-101 radio-receiver transmitters	84.47	.83	.70	26.51	
H 199	Inventory test stations or rollaways	79.61	.88	.70	27.21	
T 721	Benchcheck F-15 main communications control panels	90.29	.76	.69	27.90	
H 204	Perform confidence checks of test stations	90.29	.76	.68	28.58	35

Figure 6. Computerized Job Description-Task Level

PRTJOB All 326X5B Personnel with a Skill Level of 5

TECHNICAL SERVICES DIVISION
AF HUMAN RESOURCES LABORATORY
AIR FORCE SYSTEMS COMMAND

Duty Level Job Description

Duty	Duty Statement	Percent of Members Performing	Avg Pct Time Spent by Mbrs Performing	Sorted Avg Pct Time Spent by All Members	Cumulative Avg Pct Time Spent By All Members
T	Maintaining F-15 indicators and controls assigned to the AN/GSM-229 test station	93.20	33.49	31.22	31.22
S	Maintaining F-15 AN/GSM-230 test stations and assigned LRU's	93.20	18.27	17.03	48.25
H	Performing general LRU, test station, and emergency radio maintenance	96.12	14.08	13.53	61.78
R	Maintaining F-15 AN/GSM-228 antenna A and B test stations and assigned LRUs	92.23	12.00	11.07	72.84
E	Annotating forms and records	87.38	8.24	7.20	80.05
F	Performing administrative and supply functions	96.12	6.61	6.36	86.40
D	Training	48.54	7.55	3.67	90.07
G	Performing general maintenance functions	93.20	3.57	3.32	93.39
C	Inspecting and evaluating	61.17	4.35	2.66	96.06
A	Organizing and planning	47.57	4.29	2.04	98.10
B	Directing and implementing	58.25	3.14	1.83	99.93
I	Maintaining F/FB-111 simulators and mockups	.97	1.16	.01	99.94

Figure 7. Computerized Duty Description

In addition to the job descriptions and background data for each of the job groups (described above), a number of other analyses are available. Typically, job descriptions for each skill level, for each using command, and CONUS-overseas group are reported. Each of these is accompanied by a summary of the background information section variables for each group.

Computation of these job descriptions is based on the variables listed in the Dictionary. A job description can be computed for any of these variables or a combination of them. Thus, if a user wanted a description for 5-skill level airmen who worked in a shop area for a particular weapons system, the combination of the appropriate variables from the Dictionary will produce the description. It is this feature that makes development of the background section so important. The job descriptions produced show the tasks performed by the selected group, the percentage of the group performing them, and the relative percentage of time spent on each task (see Figure 6).

When the background section may not include appropriate items for computing a desired description another option exists if the task list is equipment specific. One or more tasks can be combined into a computed variable to use to identify persons performing the key tasks. This computed variable then can be used to print a job description for those personnel.

Task Difficulty Ratings

Using the USAF Job Inventory task list, the USAFOMC obtains responses from a small number of senior technicians (30 to 50) about the relative difficulty of each task, defined in terms of how long it takes a person to learn to do the task relative to all other tasks in the inventory. The raters use a 9-point relative difficulty scale. Results are averaged for each task across raters and summarized and an intraclass correlation of the responses to determine interrater agreement is computed. A .90 level of agreement is the criterion, and over the years few instances of agreement falling below .90 have occurred. The task difficulty ratings can be reported by each task alone, or along with other task data such as percentage performing. An important point to remember is that difficulty of tasks associated with specific items is not available if the task list specificity is not at the end item level.

Training Emphasis

The USAFOMC also administers the USAF Job Inventory to 30 to 50 senior technicians in the AFSC to obtain training emphasis for tasks. They rate on a 9-point scale the tasks they believe should be included in first-term training. The same .90 criterion is applied, but smaller values are much more often found. These data can be printed with each task, or be combined with other task data.

PRTMOD

While numerous data displays are available from CODAP, the most important for TIES may be the product of the program with the acronym PRTMOD. The run stream producing this display permits the matching of survey tasks and associated data items (such as percentage of incumbents performing and ratings of task difficulty and training emphasis) with data items from other sources. Most occupational survey reports include several of these displays--at least one matching tasks and Specialty Training Standard (STS) elements and another matching tasks to Plan of Instruction (POI) criterion objectives.

An example of a PRTMOD product is in Figure 8. This example is annotated, so that it is self-explanatory. Although truncated, it reflects several important features:

1. It shows how information and data from sources outside CODAP files can be matched and displayed with survey task data.

2. It displays how data from job descriptions for various groups of workers can be shown in summary format--as opposed to having to review the descriptions individually.

3. It shows how training emphasis and task difficulty data can be conveniently related to task statements as well as other data.

4. ASCII CODAP, developed by MAXIMA for the AFHRL, will permit various statistical analyses of data from the different sources and display of these analyses.

For TIES, the PRTMOD process will permit the display and, potentially, the analysis of data from the various task identification systems. These data would be grouped into modules that may be displayed individually or in combination with other modules.

CODAP is a comprehensive set of computer programs that provide a flexible means of analyzing job data. In ASCII CODAP, analytic and display capabilities are vastly extended. Explanations of these capabilities are presently being prepared. Implementation of ASCII CODAP is forecast for early 1987. Data analyzed by the present CODAP System can be transformed into ASCII CODAP structures.

Storage and Retrieval of OSM Data

OSM data are stored in four ways. Hardcopies of inventories, narrative reports, and data displays are maintained at the USAFOMC. Raw data tape files are retained at the AFHRL. Report data tapes, the source of the displays and the written reports maintained by the AFOMC, also are kept by the AFHRL. These tape files are readily accessible through the Occupational Research Data Bank (ORDB) at AFHRL or by request to the USAFOMC/OMY. No data analysis may be performed on the ORDB or report files. Any analyses that may be required must originate with the raw data tapes.

Reliability of Occupational Analysis Data

Reliability, especially for data from a survey technology, is a crucial question. For the OSM data, there are three specific examples of data consistency that are illustrative of the issue. First, Christal (1971) selected 10 previously surveyed career ladders. The cases in each skill level

PRTMOD STS Report - 326X5A: Integrated Avionics Manual Test Station

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AIR FORCE SYSTEMS COMMAND

Task Learn Diff.	Training Emphasis	Avg. Grade	STS Area Description / Task Statement		STS Codes	Percent Members Performing 3-Lvl	5-Lvl	7-Lvl
			047	15c(2) test & inspect IFF transponder	2b/3c			
5.43	7.22	4.0	S 668	Benchcheck F-15 APX-101 radio-receiver transmitters		69.2	84.5	50.0
			048	15c(3) test & inspect I'S receiver	2b/3c			
4.62	6.27	3.7	S 678	Benchcheck F-15 ILS radio receivers		76.9	87.4	50.0
5.73	7.06	4.1	S 680	Calibrate F-15 AN/GSM-230 test stations		53.8	83.5	50.0
			049	15c(4) test & inspect ILS test set	2b/3c			
5.74	6.39	3.7	S 679	Benchcheck F-15 ILS test sets		92.3	90.3	50.0
			050	15c(5) test & inspect UHF receiver transmitter	2b/3c			
4.90	6.63	3.9	S 670	Benchcheck F-15 ARC-109 UHF radio receivers		53.8	68.9	50.0
5.04	6.75	3.5	S 671	Benchcheck F-15 ARC-109 UHF radio-receiver transmitters		69.2	72.8	50.0
4.74	6.01	3.6	S 672	Benchcheck F-15 ARC-164 UHF radio-receiver transmitters		69.2	67.0	.0
			051	15c(6) test & inspect TACAN receiver transmitter	2b/3c			
4.77	6.44	4.0	H 206	Perform functional checks or test and inspection of LRUs issued from supply		61.5	74.8	.0
2.93	5.74	3.6	H 225	Visually inspect and clean LRUs		92.3	88.3	.0
4.60	7.00	3.6	S 674	Benchcheck F-15 ARN-118 TACAN radio-receiver transmitters		69.2	63.1	50.0
4.53	6.83	3.8	S 675	Benchcheck F-15 ARN-84 TACAN radio-receiver transmitters		38.5	49.5	50.0
			052	15c(7) test & inspect other LRU/SRU	2b/3c			
3.67	5.43	4.0	S 667	Benchcheck F-15 antenna selectors		53.8	59.2	50.0
4.21	7.00	3.5	S 673	Benchcheck F-15 ARN-118 digital-to-digital adapter converters		61.5	44.7	.0
3.27	5.64	4.0	S 676	Benchcheck F-15 automatic direction finding (ADF) antennas		38.5	59.2	50.0

Figure 8. STS-Task Matching (PRTMOD)

within each of these ladders were randomly divided in halves. Consolidated job descriptions were computed for each of these half samples. The percent performing and percent time spent values for each pair of job descriptions were correlated. Table 2 is reproduced from the Christal report. The correlations, as the table shows, are very high. In addition, Christal reported that the high values were applicable to job descriptions for as few as 15 members.

The second evidence of stability of the data over time is that reported by Driskill and Bower (1978). They reported that of 76 career ladders surveyed between 1 January 1977 and 30 June 1978, 71 of them represented resurveys. Of these 71, 59 remained stable over the time since the previous survey. They specifically cite two surveys as examples. No differences of structure were found for either the Dental Laboratory or Recruiter specialties. Further, for the Recruiter specialty, none of the participants in the second survey were the same as in the first: inventory development specialist, analyst, or respondents. Since specialty assignments are controlled tours, none of the personnel with the AFSC who were in the initial survey were still assigned the AFSC five years later when the resurvey ocurred. Yet, the two surveys yielded highly comparable results. Other evidence concerning the consistency and stability can be found in Christal (1969).

The third significant evidence is that reported by Garcia (1984) on the validation of the relative time spent rating scales. The criteria for the validation effort consisted of direct field observation of actual time spent and frequency of observed task performance. Computer programming specialists (AFSC 511X1) completed a job inventory for the specialty consisting of 577 tasks. In the second phase, actual task performance and time performance were observed and recorded. When the actual frequency and time-spent data were correlated with the same variables from the job inventory administration the correlations were .79 and .81, respectively. Stability was achieved with as few as 15 members.

Uses of Occupational Analysis Data

Over the past 19 years of existence, numerous uses of occupational analysis data have been made. The major uses and those with special relevance to a TIES are described below:

1. Occupational classification structure described in AFM 39-1 is based in large part on survey data. Several thrusts are evident. First, the data from the hierarchical grouping process, which reveals the job structure of a career ladder, are the basis for decisions of the division of a ladder into two or more ladders or shreds. Such decisions are made on the dissimilarity of the work performed by the job types. Where there is little similarity, some division of the career ladder, provided such criteria as promotion potential and overseas rotation are met, may be required to minimize training, both resident and on-the-job requirements, and facilitate work accomplishment. The difficulty in making these decisions lies in the fact that the survey data reflect only whether personnel in the job types are performing the same tasks or not. The data do not directly address the questions of similarity of

Table 2. Reliability of "Percent Performing" and "Percent Time Spent by Total Group" Vectors in Consolidated Job Descriptions (From Christal, 1971)

Air Force Specialty	1/2 N[a]	R_{11} Percent Performing	R_{11} Percent Time Spent by Total Group
Helicopter Mechanic			
43130	39	.965	.955
43150	256	.996	.986
43170	81	.961	.828
43190	26	.957	.965
Medical Administrative			
90630	76	.936	.894
90650	347	.985	.969
90670	189	.981	.951
90690	56	.968	.961
Management Engineering			
73331	42	.971	.958
73370	101	.984	.957
73371	180	.994	.973
73391	133	.952	.889
Outside Wire/Antenna			
36150	199	.987	.965
36170	92	.963	.919
36190	22	.958	.895
Electrical Power Production			
54330	70	.953	.952
54350	457	.987	.986
54370	143	.981	.970
Radiology			
90350	180	.997	.996
90370	78	.986	.975
Education and Training			
75132	146	.983	.972
75150	45	.974	.918
75170	30	.960	.935
75172	381	.995	.992
75190	28	.891	.895
Medical Materiel			
91530	63	.888	.813
91550	292	.978	.959
91570	137	.949	.908
91590	21	.931	.890
Preventive Medicine			
90750	113	.979	.955
90770	63	.966	.917
Jet Engine Mechanic			
43230	76	.979	.961
43250	473	.997	.992
43270	241	.985	.968
43290	35	.982	.974

[a]These values indicate the number of cases in each of the two subsamples. Total number of cases entering into computations reported in this table was 9,822.

Second, two or more career ladders are sometimes surveyed jointly to determine the degree to which members of one AFSC perform the tasks of another AFSC. These data impact decisions to merge career ladders. The same difficulty exists as for decisions for dividing an AFSC--the data do not address similarity of knowledge and skills involved in task performance. The question of whether members of one AFSC can effectively transfer to work in another AFSC is not normally addressed by survey data. There have been a few occasions when the question has been addressed in multi-ladder surveys by employing concurrent interviews with members of each of the AFSC being surveyed. During these interviews, each task for each AFSC is reviewed to determine similarity of knowledge and skills with the tasks of another AFSC. This process is much more time-consuming and resource intensive than the normal inventory development process. The process does, however, yield greater information on which to base AFS merger decisions.

A further use for classification has been to use task difficulty data to determine aptitude requirements for AFS (see, for example, Garcia, Ruck, & Weeks, 1985). As a result of research by the AFHRL, difficulty ratings for the tasks of a specialty are benchmarked so that they may be compared with the ratings of other specialties. Based on this benchmarked difficulty, aptitude requirements for an AFS are estimated. While the feasibility of operational implementation was established, such action has not occurred.

The importance of the technology lies in its being at present the best method of relating aptitude to work requirements. For TIES, it offers in combination with other data from the OSM, LSA, and MDC, a means of benchmarking difficulty of tasks for new equipment and estimating aptitude requirements for the tasks for this equipment.

Survey data also were the basis for categorizing career ladders according to their mechanical, administrative, general, and electronic requirements (MAGE) (Driskill, Keeth, & Gentner, 1981; Bell & Thomasson, 1984). Each of the four categories was broken down into smaller, more meaningful categories. For example, for the administrative area, three types of administrative tasks were discovered: clerical, computational, and office equipment operation. Subject matter specialists from various administrative fields then identified a set of tasks representative of each of these types.

The categorization was accomplished by subject matter specialists for each AFS. These specialists each reviewed a sample of tasks from their AFSC. These tasks were selected on the basis of a range of percent performing and difficulty and training emphasis rating values. The specialists determined the kinds of MAGE requirements in each of the tasks by comparing the AFSC tasks with the benchmark tasks. As a result of the study, each AFSC was categorized according to the primary requirements of the sample of tasks.

2. Occupational analysis data have been an important source for making training decisions. In the early years of the OSM, training courses (POI and STS) were compared against the percentage of airmen in their first Air Force job performing the tasks of the specialty. Adjustments of course coverage were made from this comparison. Later, ATCR 52-22 formalized this practice and provided guidelines for making decisions.

More recently, the data have been a primary source for Utilization and Training (U&T) Workshops. Representatives from the Air Staff, using commands, and the training community review the job data to determine how the workforce is being utilized. Once utilization issues are resolved, they then sort the tasks, using ATCR 52-22 guidelines and task difficulty and training emphasis ratings, into those tasks to be trained in the initial resident training courses and those tasks to be trained on-the-job or in advanced and lateral courses. This process is being modeled in some current research to develop a Training Decision System (TDS), which will be addressed briefly below.

As a data base for making training decisions, the occupational analysis data have provided significant input to the Instructional Systems Development (ISD) model. This model is generally well known and need not be repeated here (see AFR 50-8 and AFP 50-58). What is important is that survey data help satisfy the requirements of steps 1 and 2 of the 5-step model:

a. Analyze system requirements

b. Define education and training requirements

c. Develop objectives and tests

d. Plan, develop, and validate instruction

e. Conduct and evaluate instruction

It is important to note here that the data are employed for decisionmaking. Interviews with training development personnel reveal that the task data (percent performing, difficulty, and training emphasis) are the initial source for ISD. They indicate that for actual development of training, task specificity is an issue. In some cases, tasks are combined to represent what more appropriately might be entitled jobs. In others, tasks are further defined. In every case, detailed task analysis is required.

Nevertheless, in the computer-assisted task analysis program developed by the Training Development Service, a division of the USAFOMC, the survey task is the reference point. All task analysis data are keyed to appropriate survey tasks and associated data.

Also, in the training area, occupational data have been the basis for forecasting requirements for training for developing systems for which real data are not yet available. In one instance, a scenario-based approach was used (Tartell, 1979). Highly qualified personnel were presented an extensive list of tasks and equipment that might be employed to accomplish an accompanying scenario. These personnel indicated which of the tasks and equipment they believed would be involved. Interrater agreement was exceedingly high (in excess of .90) and the results were used to establish training.

In the second, the approach used a form of comparability analysis. After an analysis of a new weapon system, analysts were able to find existing weapons systems with similar mission capabilities and configurations. Using tasks that described the comparable systems, subject matter specialists for the newer system indicated tasks they believed appropriate for the newer system. Again, agreement among the specialists was quite high, and their estimates of requirements were used to develop training programs. While the accuracy of their estimates could not be assessed, their high level of agreement provided the best basis for training decisions in the absence of any other source.

Partially as an outgrowth of these two forecasting efforts, the Occupational Analysis Division of the USAFOMC created a branch to provide task information and data for new weapons systems or for new functions to be incorporated in non-maintenance AFSC. This organization is a prime candidate user of TIES.

3. While a variety of research studies have employed occupational analysis data, three important current research efforts utilize these data and would, it seems obvious, benefit from a TIES. The first of these is research to develop a Training Decision System (TDS). The objectives are to identify utilization patterns, model alternate patterns, determine the costs (probably relative) of resident and on-the-job training, develop task training modules, and provide data for decisions about where and when these modules should be trained.

The task modules are developed initially from occupational analysis data by hierarchical clustering of the tasks to show how they are co-performed--that is, tasks that tend to be performed together by the same job incumbents. These modules are modified by subject matter specialist judgments. Since the USAF Job Inventory tasks are the basis of the clustering, there are instances (see, for example, the tasks in Figure 3b) when the tasks are very generic. The array of systems or equipment on which job incumbents work are not enumerated. Addition of MDC data, which is weapon system and even end item specific, would add a level of detail that can be expected to enhance decisions about the task modules.

A second current research initiative is directed at building an Automated On-The-Job Training System. This research calls for the development of a master task list (MTL) for each AFSC. In addition there is to be a local task list for each unit. Interviews with the members of the research team indicate the master task list would contain these kinds of items:

1. Task statements that describe the AFS knowledge and performance requirements

2. Task identification numbers

3. Source identifications from which tasks were taken

4. Specialty Training Standard (STS) identifications containing corresponding task statements

5. MTL user identification codes

6. Training material identifications and locations

7. Task certification-before-performance requirement codes

8. Task recertification requirement codes and frequencies

9. Common subtask requirement codes

10. Position task requirement codes

11. Task factors (percent members performing tasks, task difficulty, training emphasis, etc.)

12. Weapon system or equipment that AFS supports

13. Support equipment required to perform tasks

14. Training/evaluation/development priority codes

15. Mandatory task training and performance requirement codes

16. Subtasks (identification codes)/performance sequence

17. Task steps/performance sequence

Occupational analysis data are a source for some of this information, particularly item 4 (from PRTMOD) and 11. Many of the master task lists, however, would consist of generic tasks and would not, for maintenance AFSC, reflect the many different weapon systems and kinds of equipment for which task performance is required.

Local tasks are tasks that supervisors identify as required in specified duty positions but which are not contained on MTLs or previously listed as new task requirements. New tasks are knowledge and performance requirements identified during reviews of new and revised technical references. Local AFS task lists consist of the following data elements:

1. Task statements

2. Subtasks (identification codes)/performance sequence

3. Task identification numbers

4. Follow-up requirement statements (statements generated and displayed within the AOTS that indicate local or new tasks have been identified and that they must a) be matched against the MTL file, b) be coded if unmatched and added to the appropriate MTL, c) have task-related data identified, cross-referenced, and stored, d) be assessed to determine if they should be added to the appropriate MTLs [based on the numbers and locations of users], e) have sources of performance and proficiency data identified, cross-referenced and stored and f) be deleted if found to duplicate entries on the MTL file)

5. Source identification from which tasks were taken

6. User identification codes

7. Training materials identification and locations

8. Task certification-before-performance requirement codes

9. Recertification requirement codes and frequencies

10. Common task requirement codes

11. Position task requirement codes

12. Task factors

13. Weapon system or equipment that AFS supports

14. Support equipment required to perform tasks

15. Training/evaluation/development priority codes

16. Task steps/performance sequence

Survey tasks, since they are not limited to AFSC specific tasks, can provide some of these data. Depending upon the comprehensiveness of the inventory, tasks may not be included. Thus, additional local task development effort can be anticipated. Availability of MDC and LSA in a system that would permit aggregation of similar task items could materially improve the development and quality of the master and local task lists.

A third effort, Small Unit Maintenance Manpower Analysis (SUMMA), is developing an F-16 data base oriented toward job specialty restructure. This data base will permit redefinition of specialties without regard to existing specialty structure (Moore & Boyle, 1986). Special purpose task analysis efforts have been required (e.g. to assess similarity of knowledge and skill requirements). OSM data tend to be general (in most cases), and not always directly relatable to specific equipment, making cross-AFS and cross Mission Design Series analysis difficult. Specific equipment tasks can be identified, however, in OSM by using combinations of background items to generate job descriptions. The inability of existing task identification methods and data bases to handle this urgent MPT problem (Boyle, Goralski, & Meyer, 1985) was one of the reasons for the development of a TIES (Ruck & Boyle, 1983).

Critique of The Occupational Analysis Program

Occupational analysis data have several important features that need summarizing:

1. The survey program extends to all AFS, providing data for a variety of personnel, training, and research uses. In contrast to LSA, MDC, and LCOM, which are maintenance oriented, the data are AFS oriented.

2. Tasks in the survey data are at the highest level of generality of the four data systems. While they have been extremely useful for classification and training decisions, development of training materials depends on further task analysis. All uses of the data could be enhanced if task description were more consistently and specifically related to equipment maintained or operated. In the LSA and MDC systems, a limited set of actions are related to equipment items (by work unit codes).

3. Tasks are written in the language of the worker and are intended to differentiate among workers. Thus, in the maintenance AFSC, there is not a close relationship among the action verbs with those used in MDC, LCOM, and LSA. Where task writing guidelines permit, closer correspondence of survey task language and MDC, LCOM, and LSA tasks or actions taken is desirable.

4. Especially when task lists are more generic, complete background information to facilitate processing of job descriptions is essential. More consistency of coverage is desirable.

5. Data analysis using CODAP is highly flexible and provides a wide array of powerful analysis strategies.

6. Data that have been analyzed as well as the raw data are fairly easily accessed. Since the raw data tapes are maintained by the AFHRL, further analysis can be made.

7. The CODAP capability to display and analyze data from other sources along with task data is an important asset directly usable in a TIES.

8. Data reproducibility has been repeatedly shown to be high in vigorous tests.

9. Several points of controversy and misconceptions about survey data exist.

a. The narrative reports prepared by the USAFOMC provide only a limited part of the data available from occupational surveys. Many other kinds of information are available, but, unfortunately, what this information may be and how to retrieve and analyze the raw data requires an analyst expert in CODAP. For this reason, many applications of the data may have been overlooked by potential users.

b. Data many times are said to be out-of-date. While most specialties are surveyed on an approximate 4-year cycle, the data remain stable over time, except for some highly volatile AFSs. The USAFOMC has installed a unit to investigate currency of data. In most cases, most of the data from older surveys are stable. Certainly, if these data could be augmented by MDC and LSA data, the currency question would be largely resolved. On the whole, AFSs have been shown to change slowly over time.

c. The generic nature of the task statements also poses problems for some applications. Foley (1980), while recognizing the power of the occupational analysis methodology, nevertheless criticized the task statements for their lack of hardware specificity and for their use of nonstandard action verbs and functions.

d. Survey data, since they are collected from individual job incumbents, provide no information about crew size or team performance requirements.

e. Although there is a high ordinal relationship, the relative time spent data for tasks cannot at present be equated with task time; that is, the actual clock time it takes to do a task. This lack of comparability of relative and actual times is unfortunate, since task time is an important driver of manpower in maintenance analysis in LCOM. In addition, the applicability of LCOM modelling to non-maintenance AFSs would be facilitated if the relative task times could be used to estimate or determine actual time.

10. All the same, survey data, besides the task difficulty and training emphasis information, provide information not available in other systems and which is exceedingly important for MPT. First, tasks can be related to skill level. Second, the job typing analysis provides work structure information. The power of these data would be enhanced if they could be related to MDC and LSA data. It would be particularly attractive if job types could be assessed with regard to the detailed MDC or LSA actions taken tasks comprising them. The advantage would lie in the ability to assess whether common knowledge and skill requirements exist--or whether there are sufficient differences to warrant different training or classification and assignment vehicles.

IV. MAINTENANCE DATA COLLECTION SYSTEM

The MDC is the oldest of the task identification and data systems discussed in this report. It is an equipment or weapons system oriented data base that does not easily lend itself to analyses of task performance by AFS. No data for nonmaintenance AFS work performed is recorded. Data are collected for aircraft, missiles, and communications equipment.

Origin of MDC

Prior to 1958, there was no formal reporting system except for an unsatisfactory reporting system for identifying equipment with low reliability. No formal records of manhours, actions taken, or items maintained were utilized. In 1958, the Technical Failure Reporting System was initiated. In the mid 1960's AFTO Form 349 became the vehicle for reporting maintenance manhours and actions taken. MMICS was implemented worldwide in 1974 to augment maintenance personnel, manpower, and training accounting and management. At present, the Core Automated Maintenance Data System (CAMS) is being implemented. While CAMS does not alter the kinds of data reported, it does provide for the automation of key input items--as opposed to the manual input presently employed in the MDC.

MDC is described in AFR 66-1, TO-00-20-2, and AFM 66-267. Its purpose is to collect at base level detailed maintenance data, including work center, work unit code, action taken, how malfunctioned, maintenance time, crew size, and worker identification. From these data, a variety of analyses providing information about manhours, the reliability and maintainability of equipment and weapons systems, product performance, weapons system readiness, product improvement, and support requirements and costs may be obtained (Quick Reference Guide, undated).

Development of MDC Data Base

The MDC data base consists of detailed data about on-equipment, off-equipment, and depot maintenance work. The data originate at base level (or depot), the input originating on AFTO Form 349 (Figure 9) with the input flow depending upon whether the maintenance is scheduled, unscheduled, or phase. Unscheduled maintenance is a term used to indicate that something is broken or malfunctioning. At that time a AFTO 349 is prepared for the reported failure, and designated for flightline action in the case of an aircraft. If the failure can be corrected on-aircraft, the work is accomplished. If off-equipment maintenance is required, an AFTO Form 350 (Figure 10) is prepared and routed along with the item to the appropriate shop. In some cases, the maintenance work requires activity of more than one shop, in which case the receiving shop prepares another AFTO Form 350 to route the item to the other shops. The flow for scheduled and phase maintenance is essentially the same, except the initial AFTO Form 349 does not result from a reported failure.

In every case that work is performed, an AFTO Form 349 is completed by the workers doing the work. Under systems like CAMS and the F-16 Centralized Data System, the AFTO Form 349 will be initially produced automatically and workers will make entries on a terminal. Under the present manual system, the AFTO Form 349 is completed by the worker and the data entered into the system by keypunching the AFTO 349 entries.

Figure 9 shows an AFTO Form 349. All data elements are supposed to be completed. The source for the entries are AFR 66-1, AFR 66-267, and the 00-20 series technical orders. Many of the codes to be entered are standard, but there are subsystem and component entries required that must be obtained from the 00-20 series technical order for the aircraft or appropriate technical order series for missiles or communications equipment on which work is being performed. The standard codes significant for a TIES are shown in Table 3. Each of them can be related to the item number of the AFTO Form 349:

Inspection of these codes reveals that very detailed information is provided on maintenance, including these important items: manhours, employee identification, base identification, command, complete designation for aircraft, missiles, and communications-electronic equipment, the work center and work unit codes, and action taken to the component level. From this array of information, plus the other collected by the AFTO Form 349, a variety of information can be summarized.

MAINTENANCE DATA COLLECTION RECORD

OMB NO. 21-R0227

1. JOB CONTROL NO.	2. WORKCENTER	3. I.D. NO./SERIAL NO.	4. MDS	5. SRD	6. TIME	7. PRI	8. SORTIE NO.	9. LOCATION

10. ENG. TIME	11. ENGINE I.D.	12. INST ENG TIME	13. INST. ENG. I.D.	14.	15.	16.	17. TIME SPC OPN	18. JOB STD.

19. FSC	20. PART NUMBER	21. SER. NO./OPER. TIME	22. TAG NO.	23. INST. ITEM PART NO.	24. SERIAL NUMBER	25. OPER. TIME

ACT. LINE	A TYPE MAINT	B COMP POS	C WORK UNIT CODE	D ACTION TAKEN	E WHEN DISC	F HOW MAL	G UNITS	H START HOUR	I STOP DAY	I STOP HOUR	J CREW SIZE	K CAT LAB	L CMD ACT ID	M SCH CODE	N AFSC/EMPLOYEE NUMBER
1															
2															
3															
4															
5															

26. DISCREPANCY

27. CORRECTIVE ACTION

28. RECORDS ACTION

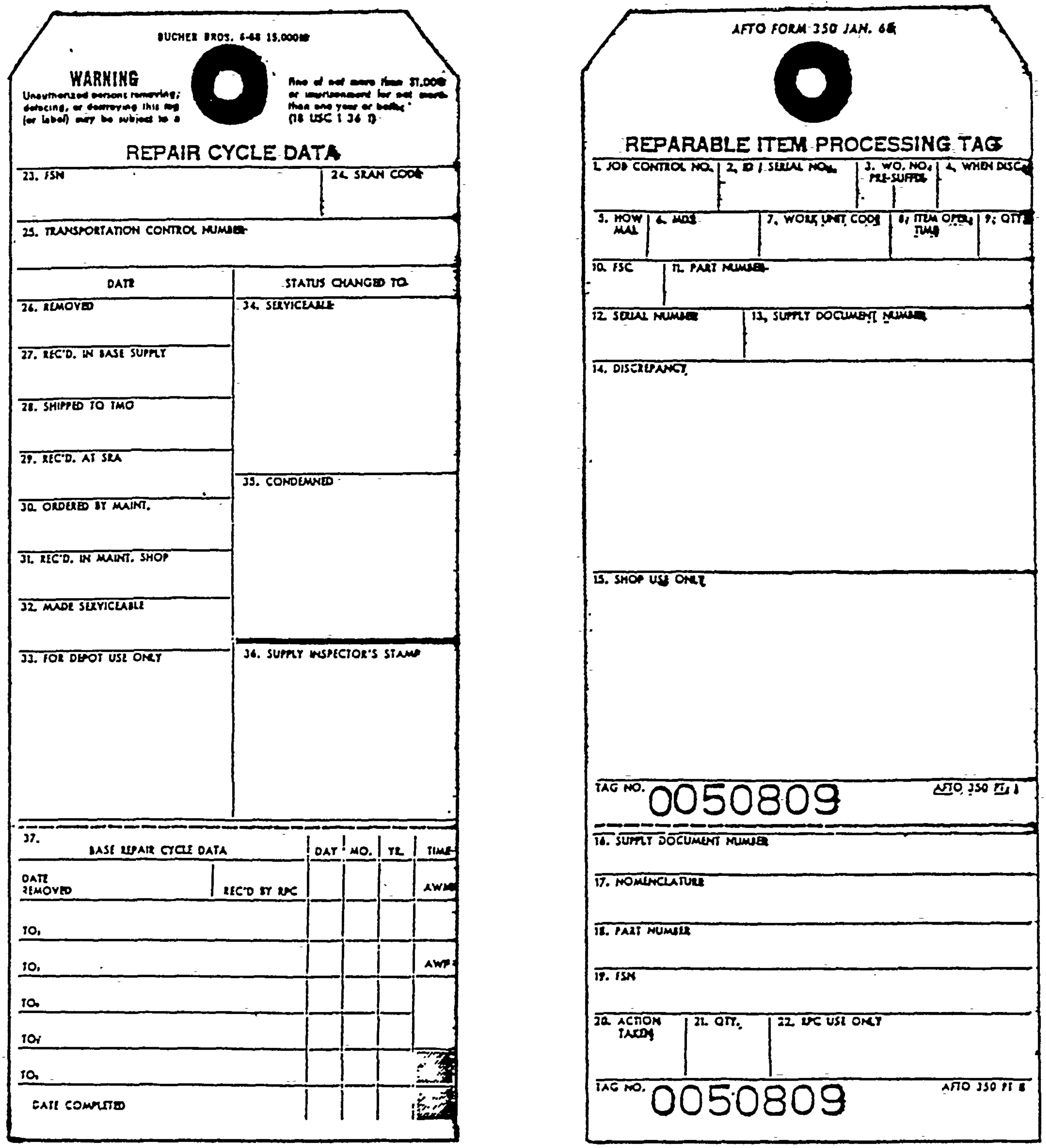
AFTO FORM JAN 81 349 PREVIOUS EDITION WILL BE USED.

29. PARTS REPLACED DURING REPAIR (SUBASSEMBLIES REPAIRED/REPLACED)

LINE NO.	A FSC	B PART NUMBER	C WORK UNIT CODE	D REF. SYMBOL	E HOW MAL	F QTY.

30. CONTINUATION FROM BLOCK ....

Figure 9. AFTO Form 349



BUCHER BROS. 6-68 15,000

WARNING
Unauthorized persons removing, defacing, or destroying this tag (or label) may be subject to a fine of not more than $1,000 or imprisonment for not more than one year or both. (18 USC 1361)

REPAIR CYCLE DATA

23. FSN
24. SRAN CODE
25. TRANSPORTATION CONTROL NUMBER

DATE	STATUS CHANGED TO
26. REMOVED	34. SERVICEABLE
27. REC'D. IN BASE SUPPLY	
28. SHIPPED TO TMO	
29. REC'D. AT SRA	35. CONDEMNED
30. ORDERED BY MAINT.	
31. REC'D. IN MAINT. SHOP	
32. MADE SERVICEABLE	
33. FOR DEPOT USE ONLY	36. SUPPLY INSPECTOR'S STAMP

37. BASE REPAIR CYCLE DATA		DAY	MO.	YR.	TIME
DATE REMOVED	REC'D BY RPC				AWM
TO,					
TO,					AWP
TO,					
TO,					
TO,					
DATE COMPLETED					

AFTO FORM 350 JAN. 68

REPARABLE ITEM PROCESSING TAG

1. JOB CONTROL NO. | 2. ID / SERIAL NO. | 3. WO. NO./PRE-SUFFIX | 4. WHEN DISC.
5. HOW MAL | 6. MDS | 7. WORK UNIT CODE | 8. ITEM OPER. TIME | 9. QTY.
10. FSC | 11. PART NUMBER
12. SERIAL NUMBER | 13. SUPPLY DOCUMENT NUMBER
14. DISCREPANCY
15. SHOP USE ONLY

TAG NO. 0050809 AFTO 350 PT I

16. SUPPLY DOCUMENT NUMBER
17. NOMENCLATURE
18. PART NUMBER
19. FSN
20. ACTION TAKEN | 21. QTY. | 22. RPC USE ONLY

TAG NO. 0050809 AFTO 350 PT II

Figure 10. AFTO Form 350

Table 3. Data Elements Utilized in the Maintenance Data Collection System

DATA ELEMENTS UTILIZED IN THE MAINTENANCE DATA COLLECTION SYSTEM
SOURCE: AFR 66-1, AFR 66-267, AND 00-20 SERIES TECHNICAL ORDERS.

JOB CONTROL NUMBER (JCN) - A UNIQUE SEVEN CHARACTER NUMBER USED TO CONTROL AND IDENTIFY MAINTENANCE JOBS, AS WELL AS TO IMPROVE ANALYSIS CAPABILITY. EXAMPLE: 0410001 ;041 IS THE JULIAN DATE AND 0001 IS THE FIRST JOB OF THE DAY.

PERFORMING WORKCENTER CODE (PWC) - A SPECIFIED FIVE CHARACTER CODE USED TO IDENTIFY THE WORKCENTER ACCOMPLISHING THE MAINTENANCE ACTION. EXAMPLE: U4500 ; THE FIRST POSITION IDENTIFIES DIVISIONS, WINGS, SEPARATE SQUADRONS, OR COMMANDS LOCATED ON A BASE. THE SECOND POSITION SIGNIFIES THE VARIOUS FUNCTIONS WITHIN THE MAINTENANCE COMPLEX. THE THIRD POSITION IN MOST CASES IS THE SUBFUNCTION WITHIN A SQUADRON. THE FORTH AND FIFTH POSITION IDENTIFIES A SPECIFIC BRANCH, SHOP OR SITE. THE ASSIGNMENT OF THE SECOND POSITION IS REQUIRED TO INSURE COMPUTER EDITS ARE CORRECT. THE ASSIGNED SECOND POSITION WORKCENTER CODES ARE:

(1) 1 - CHIEF OF MAINTENANCE
(2) 2 - ORGANIZATIONAL MAINTENANCE
(3) 3 - FIELD MAINTENANCE
(4) 4 - AVIONICS AND AIRBORNE MISSILE MAINTENANCE
(5) 5 - MUNITIONS MAINTENANCE
(6) 6 - GROUND COMMUNICATIONS - ELECTRONICS MAINTENANCE
(7) 7 - NOT ASSIGNED
(8) 8 - GROUND LAUNCHED MISSILE MAINTENANCE
(9) 9 - NONREPORTING WORKCENTERS
(10) 0 - AWAY FROM HOME STATION MAINTENANCE
(11) P - GROUND PHOTOGRAPHIC EQUIPMENT MAINTENANCE
(12) M - CIVIL ENGINEERING/ICBM MAINTENANCE
(13) S - GROUND LAUNCHED MISSILE NONREPORTING WORKCENTERS
(14) G - FIRST ACFT GENERATION SQUADRON
(15) H - SECOND ACFT GENERATION SQUADRON
(16) E - EQUIPMENT MAINTENANCE SQUADRON
(17) R - COMPONENT REPAIR SQUADRON
(18) ALL REMAINING A - Z IS AUTHORIZED DEPOT MAINTENANCE

IDENTIFICATION NUMBER (ID) - CONSISTS OF SIX CHARACTERS, AND IS USED TO IDENTIFY EQUIPMENT ON WHICH WORK WAS PERFORMED OR FROM WHICH AN ITEM WAS REMOVED. THE FIRST POSITION DESIGNATES WHO OWNS THE EQUIPMENT. THE SECOND POSITION IS THE FISRT CHARACTER OF THE STANDARD REPORTING DESIGNATOR CODE. THE LAST FOUR POSITIONS ARE NORMALLY THE LAST FOUR CHARACTERS OF THE EQUIPMENT SERIAL NUMBER.

STANDARD REPORTING DESIGNATOR (SRD) - CONSISTS OF THREE CHARACTERS AND ARE ASSIGNED TO IDENTIFY A SPECIFIC TYPE OR CATEGORY OF EQUIPMENT. THE FIRST POSITION OF THE SRD CODE IDENTIFIES THE GENERAL TYPE OF EQUIPMENT AS LISTED BELOW.

A - AIRCRAFT AND DRONES
B - GROUND RADIO EQUIPMENT
C - " " "
E - " " "
F - GROUND METEROLOGICAL EQUIPMENT
G - SUPPORT EQUIPMENT
H - PRECISION MEASUREMENT EQUIPMENT
J - GROUND SPECIAL ELECTRONICS
K - GROUND FIXED WIRE EQUIPMENT
L - MISCELLANEOUS GROUND COMMUNICATION EQUIPMENT

Table 3. (Continued)

M - GROUND LAUNCHED MISSILES
N - AIR LAUNCHED MISSILES AND GUIDED WEAPONS
Q - ELECTRONICS SECURITY COMMAND MISSION EQUIPMENT
R - REAL PROPERTY INSTALLED EQUIPMENT, SHOP WORK, ECM PODS/VEHICLES, GEARBOXES AND MODULES, SPECIAL PURPOSE PODS.
S - AGE GAS TURBINES, AUXILIARY POWER UNITS.
T - TRAINERS, MOBILE TRAINING SETS, AND RESIDENT TRAINING EQUIPMENT
U - COMMUNICATIONS SECURITY EQUIPMENT
X - ENGINES
Y - MUNITIONS
Z - MISCELLANEOUS LOCAL SUPPLIES
1 THROUGH 8 ARE NORAD COMBAT OPERATIONS CENTERS

TYPE MAINTENANCE CODES (TM) - A CHARACTER USED TO IDENTIFY THE TYPE OF WORK ACCOMPLISHED. TYPE MAINTENANCE CODES ARE OBTAINED FROM THE APPLICABLE WORK UNIT CODE MANUALS FOR THE TYPE OF EQUIPMENT WORK IS BEING PERFORMED ON. AIRCRAFT TYPE MAINTENANCE CODES ARE LISTED BELOW.

A - SERVICING
B - UNSCHEDULED MAINTENANCE
C - BASIC POST FLIGHT OR THRUFLIGHT INSPECTION
D - PREFLIGHT INSPECTION
E - HOURLY POSTFLIGHT OR MINOR INSPECTION
H - HOME STATION CHECK
J - CALIBRATION OF OPERATIONAL EQUIPMENT
M - INTERIOR REFURBISHMENT
P - PERIODIC, PHASE OR MAJOR INSPECTION
Q - FORWARD SUPPOT SPARES
R - DEPOT MAINTENANCE
S - SPECIAL INSPECTIONS
T - TIME COMPLIANCE TECHNICAL ORDERS
Y - AIRCRAFT TRANSIENT MAINTENANCE

COMPONENT POSITION (CP) - A SINGLE NUMERICAL CHARACTER TO SIGNIFY THE INSTALLED POSITION OF ENGINES AND ASSOCIATED COMPONENTS.

WORK UNIT CODE (WUC) - FIVE CHARACTERS USED TO IDENTIFY THE SYSTEM, SUBSYSTEM, AND COMPONENT ON WHICH WORK IS REQUIRED OR PERFORMED. THE FOLLOWING SHOWS THE BREAKDOWN OF A COMMON AIRCRAFT WUC:

EXAMPLE WUC : 72117 T-39A NAVIGATION RADAR DOPPLER DRIFT AMPLIFIER

72 = RADAR NAVIGATION SYSTEM
721 = AN/APN-131 DOPPLER SUBSYSTEM
72117 = DRIFT AMPLIFIER COMPONENT

LISTED BELOW ARE THE BASIC STANDARD AIRCRAFT SYSTEMS AS INDICATED BY THE FIRST TWO POSITIONS OF THE WUC

01 - GROUND HANDLING, SERVICING, AND RELATED TASKS
02 - ACFT CLEANING
03 - SCHEDULED INSPECTIONS
04 - SPECIAL INSPECTIONS
05 - STORAGE OF EQUIPMENT
06 - ARMING/DISARMING
07 - RECORDS PREPARATION
08 - NOT USED

Table 3. (Continued)

09 - SHOP SUPPORT
10 - NOT USED
11 - AIRFRAME
12 - COCKPIT AND FUSELAGE COMPARTMENTS
13 - LANDING GEAR
14 - FLIGHT CONTROLS
17 - AERIAL RECOVERY
22 - TURBOPROP POWER PLANT
23 - TURBO-JET ENGINE
24 - AUXILIARY POWER PLANT
32 - HYDRAULIC PROPELLER
41 - AIR CONDITIONING, PRESSURIZATION, AND SURFACE ICE CONTROL
42 - ELECTRICAL POWER SUPPLY
44 - LIGHTING
45 - HYDRAULIC AND PNEUMATIC POWER SUPPLY
46 - FUELS
47 - OXYGEN
49 - MISCELLANEOUS UTILITIES
51 - INSTRUMENTS
52 - AUTOPILOT
55 - MALFUNCTION ANALYSIS AND RECORDING EQUIPMENT
56 - AUTOMATIC ALL WEATHER LANDING
61 - HF COMMUNICATIONS
62 - VHF COMMUNICATIONS
63 - UHF COMMUNICATIONS
64 - INTERPHONE
65 - IDENTIFICATION FRIEND OR FOE
66 - EMERGENCY COMMUNICATIONS
68 - AIR FORCE SATELLITE COMMUNICATIONS
69 - MISCELLANEOUS COMMUNICATIONS EQUIPMENT
71 - RADIO NAVIGATION
72 - RADAR NAVIGATION
73 - BOMBING NAVIGATION
74 - FIRE CONTROL
75 - WEAPONS DELIVERY
76 - ELECTRONIC COUNTERMEASURE
77 - PHOTOGRAPHIC/RECONNISSANCE
82 - COMPUTER AND DATA DISPLAY
89 - AIRBORNE BATTLEFIELD COMMAND CONTROL CENTER
91 - EMERGENCY EQUIPMENT
94 - METEROLOGICAL EQUIPMENT
96 - PERSONNEL AND MISCELLANEOUS EQUIPMENT
97 - EXPLOSIVE DEVICES AND COMPONENTS
98 - ATMOSPHERIC RESEARCH EQUIPMENT

ACTION TAKEN (AT)- ONE CHARACTER USED TO IDENTIFY THE SPECIFIC MAINTENANCE ACTION TAKEN AS LISTED BELOW.

A - BENCH CHECKED AND REPAIRED
B - BENCH CHECKED SERVICEABLE
C - BENCH CHECKED REPAIR DEFERRED
D - BENCH CHECKED TRANSFERRED
E - INITIAL INSTALLATION
F - REPAIR
G - REPAIRS AND/OR REPLACEMENT OF MINOR PARTS, HARDWARE AND SOFTGOODS
H - EQUIPMENT CHECKED NO REPAIR REQUIRED
J - CALIBRATED NO ADJUSTMENT REQUIRED
K - CALIBRATED ADJUSTMENT REQUIRED
L - ADJUST

Table 3. (Continued)

M - DISASSEMBLE
N - ASSEMBLE
P - REMOVED
Q - INSTALLED
R - REMOVE AND REPLACE
S - REMOVE AND REINSTALL
T - REMOVED FOR CANNIBALIZATION
U - REPLACED AFTER CANNIBALIZATION
V - CLEAN
X - TEST-INSPECT-SERVICE
Y - TROUBLESHOOT
Z - CORROSION REPAIR

NOT REPAIRABLE THIS STATION CODES

1 - REPAIR NOT AUTHORIZED BY SHOP
2 - LACK OF EQUIPMENT, TOOLS, OR FACILITIES
3 - LACK OF TECHNICAL SKILLS
4 - LACK OF PARTS
5 - SHOP BACKLOG
6 - LACK OF TECHNICAL DATA
7 - LACK OF EQUIPMENT, TOOLS, FACILITIES, SKILLS, PARTS OR TECHNICAL DATA REPAIR IS AUTHORIZIED BUT THE ABOVE IS NOT AUTHORIZIED
8 - RETURNED TO DEPOT
9 - CONDEMNED

WHEN DISCOVERED (WD) - ONE CHARACTER USED TO IDENTIFY WHEN A DEFECT OR MAINTENANCE REQUIREMENT WAS DISCOVERED, CODES ARE LISTED BELOW.

A - BEFORE FLIGHT ABORT
B - BEFORE FLIGHT NO ABORT
C - IN-FLIGHT ABORT
D - IN-FLIGHT NO ABORT
E - AFTER FLIGHT
F - BETWEEN FLIGHTS BY GROUND CREW
H - THRUFLIGHT INSPECTION
J - PREFLIGHT INSPECTION
K - MINOR INSPECTION
L - DURING TRAINING
M - MAJOR INSPECTION
N - REFURBISH
P - FUNCTIONAL CHECK FLIGHT
Q - SPECIAL INSPECTION
R - QUALITY CONTROL CHECK
S - DEPOT LEVEL MAINTENANCE
T - DURING SCHEDULED CALIBRATION
U - NON-DESTRUCTIVE TESTING
W - IN-SHOP REPAIR AND/OR DISASSEMBLY FOR MAINTENANCE
X - ENGINE TEST STAND OPERATION
Y - UPON RECEIPT OR WITHDRAWAL FROM SUPPLY STOCKS
2 - DURING OPERATION OF MALFUNCTION ANALYSIS AND RECORDING EQUIPMENT
3 - HOME STATION CHECK
4 - BASIC POSTFLIGHT INSPECTION

HOW MALFUNCTION CODE (HM) THIS CODE CONSISTS OF THREE CHARACTERS AND IS USED TO IDENTIFY THE NATURE OF THE EQUIPMENT DEFECT, OR THE STATUS OF THE ACTION BEING ACCOMPLISHED. ONLY THOSE CODES THAT ARE APPLICABLE WILL BE LISTED IN EACH WORK UNIT CODE MANUAL. DUE TO THE NATURE OF SUPPORT GENERAL TYPE WORK, THE RECORDIN OF ACTION TAKEN, WHEN DISCOVERED, AND HOW MALFUNCTION CODES IS NOT REQUIRED WIT SUPPORT GENERAL WORK UNIT CODES. A COMPLETE LIST OF AUTHORIZED CODES IS

Table 3. (Continued)

CONTAINED IN AFM 300-4 IN BOTH DEFINITION AND NUMERICAL CODE SEQUENCE.

CATEGORY OF LABOR (CLB) - THIS DATA ELEMENT IS USED TO DIFFERENTIATE THE TYPE OF MAN-HOURS EXPENDED AS LISTED BELOW.

1 - MILITARY REGULAR DUTY HOURS
2 - MILITARY OVERTIME HOURS
3 - FEDERAL SERVICE EMPLOYEE-REGULAR DUTY HOURS
4 - FEDERAL SERVICE EMPLOYEE-OVERTIME HOURS
5 - LOCAL NATIONAL EMPLOYEE HOURS
6 - CONTRACTOR LABOR HOURS

COMMAND/ACTIVITY IDENTIFICATION (CMD/AI) - TWO CHARACTERS USED TO IDENTIFY THE OWNING COMMAND OR MAY BE USED BY THE UNIT TO IDENTIFY SPECIAL PROJECTS, TENANT SUPPORT, OR OTHER ACTIONS. OWNING COMMAND CODES ARE LISTED BELOW:

0A - ALASKAN AIR COMMAND
0B - U.S. AIR FORCE ACADEMY
0C - AEROSPACE DEFENSE COMMAND
0D - U.S. AIR FORCES IN EUROPE
0E - AIR FORCE ACCOUNTING AND FINANCE CENTER
0F - AIR FORCE LOGISTICS COMMAND
0H - AIR FORCE SYSTEMS COMMAND
0I - AIR RESERVE PERSONNEL CENTER
0J - AIR TRAINING COMMAND
0K - AIR UNIVERSITY
0L - USAF SOUTHERN COMMAND
0M - HQ AIR FORCE RESERVE
0N - HEADQUARTERS USAF
0O - AIR FORCE DATA AUTOMATION AGENCY
0P - HEADQUARTERS COMMAND, USAF
0Q - MILITARY AIRLIFT COMMAND
0R - PACIFIC AIR FORCES
0S - STRATEGIC AIR COMMAND
0T - TACTICAL AIR COMMAND
0U - ELECTRONIC SECURITY COMMAND
0Y - AIR FORCE COMMUNICATIONS COMMAND
02 - AIR FORCE INSPECTION AND SAFETY CENTER
03 - AIR FORCE TEST AND EVALUATION CENTER
05 - AIR FORCE INTELLIGENCE SERVICE
06 - AIR FORCE AUDIT AGENCY
07 - AIR FORCE OFFICE OF SPECAIAL INVESTIGATION
09 - AIR FORCE MANPOWER AND PERSONNEL CENTER
1W - AIR FORCE ENGINEERING AND SERVICES AGENCY
1X - AIR FORCE COMMISSARY SERVICE
40 - MILITARY ASSISTANCE COUNTRIES
41 - U.S. READINESS COMMAND
42 - ROYAL CANADIAN AIR FORCE
43 - ROYAL AIR FORCE, UNITED KINGDOM
44 - AIR FORCE TECHNICAL APPLICATIONS CENTER
45 - WEST GERMAN AIR FORCE
46 - OTHER FOREIGN GOVERNMENT
47 - COMMERCIAL AIRCRAFT
48 - SYSTEM SUPPORT MANAGER
49 - DEPARTMENT OF DEFENSE
4A - OTHER USAF ACTIVITIES
4B - FEDERAL AVIATION AGENCY
4C - OTHER U.S. GOVERNMENT

4D - BELGIAN AIR FORCE
4E - ROYAL DANISH AIR FORCE
4F - ROYAL NETHERLANDS AIR FORCE
4G - ROYAL NORWEGIAN AIR FORCE
4I - NATO AWACS PROGRAM
4J - EUROPEAN PARTICIPATING AIR FORCE
4W - MEDICAL MATERIEL FIELD OFFICE
4Z - AIR NATIONAL GUARD

MISSION DESIGN SERIES (MDS) - THIS 7 DIGIT ELEMENT IS THE COMPLETE DESIGNATION FOR AIRCRAFT, MISSILES AND C-E EQUIPMENT.
EXAMPLE: NKC135A

NKC = THE MISSION OF THE AIRCRAFT
135 = THE DESIGN OF THE AIRCRAFT
A = THE SERIES OF THE AIRCRAFT

SERIAL NUMBER (S/N) - THE 8 DIGIT SERIAL NUMBER ASSIGNED TO THE ITEM. FOR ENGINES AND RELATED PARTS THIS NUMBER IS CONTROLLED BY AFM 400-1.

ESTIMATED TIME IN COMMISSION (ETIC) - YEAR, DAY AND HOUR OF ESTIMATED TIME AN ITEM WILL BE RETURNED TO OPERATIONAL STATUS.

UNITS PRODUCED (UP) - PERMITS THE IDENTIFICATION OF COMPLETED MAINTENANCE ASCTIONS; ACTIONS THAT WERE IN PROGRESS BUT NOT COMPLETED; OR ACTIONS IN WHICH WORKCENTER PARTICIPATED BUT WAS NOT THE WORKCENTER ASSIGNED PRIMARY RESPONSIBILITY FOR THE COMPLETION OF THE ACTION.

DATE - YEAR AND DATE OF THE ACTION. EXAMPLE: 4099

STATION LOCATION CODE (SLC) - THIS IS A 4 DIGIT CODE LISTED WITHIN AFM 300-4 FOR THE BASE, OPERATING LOCATION, OR SITE AT WHICH THE WORK WAS PERFORMED.

TAG NUMBER (TAG) - THE LAST THREE DIGITS OF THE AFTO FORM 350 TAG NUMBER THAT IS PREPARED AND IS TO BE ATTACHED TO THE REMOVED ITEM WHICH WAS IDENTIFIED WITH AN ASTERISK IN THE WORK UNIT CODE MANUAL.

FEDERAL SUPPLY CLASS (FSC) - THE FIRST FOUR DIGITS OF THE NATIONAL STOCK NUMBER OF THE ITEM BEING REMOVED.

PART/LOT NUMBER (P/N) - THE PART NUMBER OF THE ITEM BEING MODIFIED OR REMOVED, INCLUDING SLASHES AND DASHES BETWEEN NUMERICS ONLY. FOR CONVENTIONAL MUNITIONS ITEMS THIS WILL BE THE LOT NUMBER OF THE ITEM. FOR ITEMS THAT DO NOT HAVE PART/LOT NUMBERS, ENTER THE NATIONAL ITEM IDENTIFICATION NUMBER (NIIN) WHICH IS THE LAST NINE CHARACTERS OF THE NATIONAL STOCK NUMBER (NSN).

REFERENCE SYMBOL - THE GRID LOCATION OF AN ITEM ON AN EQUIPMENT WIRING DIAGRAM OR ITS COMMON NAME.

Table 3. (Concluded)

OPERATING TIME - THE HOURS A PIECE OF EQUIPMENT HAS/WILL OPERATE.

FLYING HOURS (F/H) - THE TIME AN AIRCRAFT HAS FLOWN.

Several points should be made about some of the data items.

1. Column H, AFTO 349, provides for AFSC/Employee Number. Typically, employee number and <u>not</u> AFSC is entered in this column. Thus, there is typically no record of AFSC in the MDC. AFSC could be generated at base level by searching Maintenance Management Information and Control System (MMICS) files for employee number and AFSC and then extracting data based on employee number and matching to the employee's AFSC. This action is practical at base level but not at higher levels of aggregation, because of duplicate employee numbers among bases. Fortunately, there are other ways to identify AFSC in the aggregated data, through the use of work unit codes.

A further problem of identification of AFSC also exists. When more than one person performs work to be recorded on the AFTO 349, the number of only one worker is entered in column H. Usually this employee is the senior member of the crew, or in the case of Combat Oriented Maintenance Organization (COMO) organizations, the number of the employee with the prime AFSC for the work being accomplished is entered. While manhours are accounted for, as well as number of employees, distribution of work time by AFSC cannot be obtained.

No indication of the skill level of the personnel performing the work is provided. Thus, work performed cannot be differentiated as that which is appropriate for 3-skill, 5-skill, or 7-skill level employees.

2. Column J elicits crew size for the action reported. This information coupled with the work unit code and action reflects the number of personnel required to perform the work. This number, however, is subject to misinterpretation, because trainees are often included in the number of personnel performing a job.

3. Column C and D and item 5 are especially significant for a TIES. Column C is the work unit code (WUC), column D is the action taken, and item 5 is the mission design series (MDCs). Using the example cited under WUC above and relating this example to MDS and action taken, one can see a task statement not unlike that observed in other task identification systems--although often in greater detail and concreteness. For example, reading downward:

<u>English Translation</u>	<u>AFTO 349 Coding</u>
Remove and replace	Column D, Code R (action taken)
(the) drift amplifier component	Column C, 4th & 5th digit (WUC)
(on the) AN/APN-131 Doppler Subsystem	Column C, 3rd digit (WUC)
(on the) Radar Navigation System	Column C, 1st & 2nd digit (WUC)
(on the) T-39A	Item 5 (MDS)

The reader should recall that the information in the third through fifth digits of the WUC must be obtained from the 00-20 series technical order for the MDS. Codes, however, are accessible in the MDC B-4 master file.

The WUC along with the MDS are the sources of matching actions taken with AFS. Normally, a work center is manned by a single AFS. The exception is in COMO flightline maintenance, where the WUC would match up only to the lead worker.

The same process as described for aircraft also applies to communications-electronic equipment and missile maintenance.

Processing and Analyzing MDC Data

As indicated above, MDC data originate with the employee accomplishing the work. The raw data are either keypunched or entered via a terminal at base level. Data are aggregated at base level and listings appropriate to the base maintenance activity are provided daily.

Base level data are further aggregated at major command level. Each 30 days, major commands forward MDC data tapes to AFLC/MME-2 at Wright-Patterson AFB. There the tape files are added to the Maintenance and Operational Data Access System (MODAS) which is an interactive retrieval system for data for the past two years. Provision is made for operational units to have on-line access to MODAS.

The flow of the data from base level to AFLC is illustrated in Figure 11, which is reproduced from the Quick Reference Guide to Maintenance Data Collection (MDC). Notice that the data are aggregated in the D056A file, from which MODAS output is generated.

The input for MODAS, a G063 file, is the D056A file. MODAS design is shown in Figure 12. Notice that MMICS data also are input to the G063 file. MDC data are also maintained by the contractor who developed the weapon system.

MODAS is a menu-driven access system that provides reliability and maintainability, product performance, and product improvement data. Data are available by weapon system or equipment base, command, Air Logistics Center, and Air Force-wide. AFSC are not typically available. MODAS provides on-line trend plots, detailed reports, and user designed reports.

Examples of MODAS menus are reproduced in Figures 13-24. Some brief remarks about each of the figures:

Figure 13 - the array of data bases

Figure 14 - an example of option 1 from Figure 13 showing array of airborne data available

Figure 15 - menu for selecting aircraft system for display of data for option 1, Figure 14

MDC SYSTEM

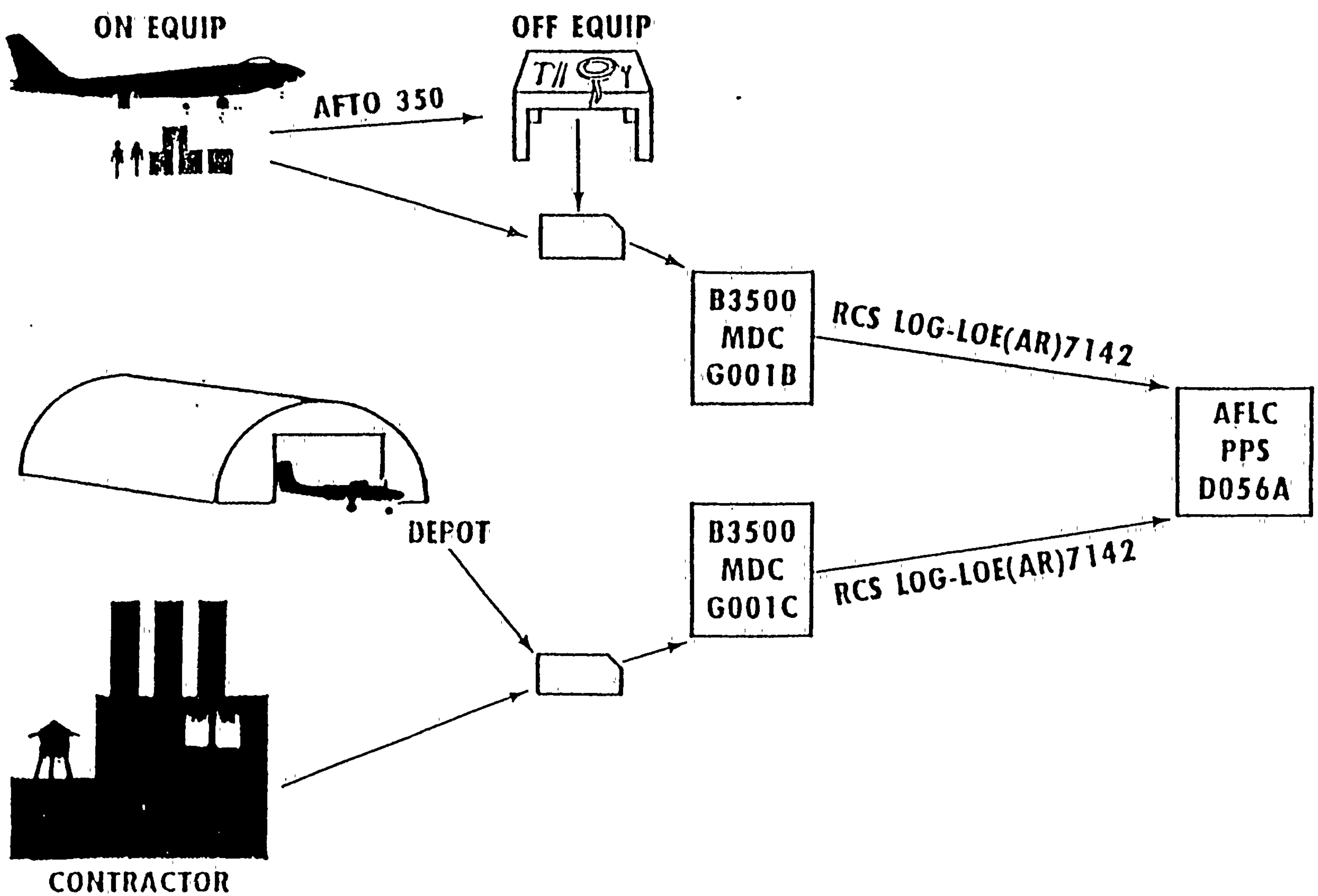


Figure 11. MDC Data Flow
(Source: Quick Reference Guide to MDC)

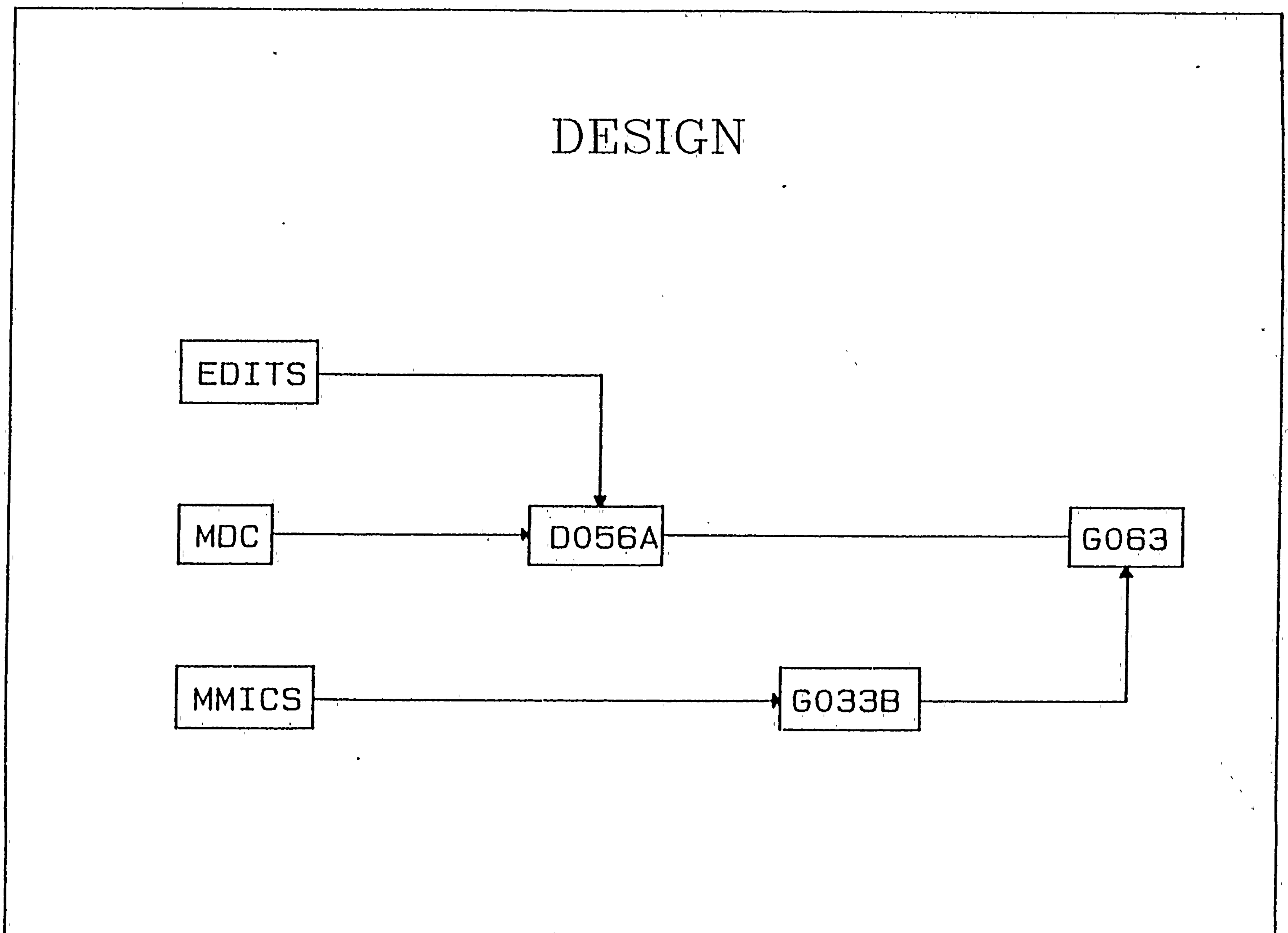


Figure 12. MDC, MMICS, and EDITS in MODAS
(Source: MODAS)

```
DSD G083                                              Version 1.01

                      *** M O D A S ***
                   MARCON INDUSTRIES, INC.

           --------------- Main Menu ---------------

                   1. Airborne Data Menu

                   2. Non-Airborne Data Menu

                   3. Operational Data Menu

                   4. Tables / Library Menu

                  99. Logout


ENTER YOUR SELECTION NUMBER (1-4 or 99) : 1
```

Figure 13. MODAS Main Menu
(Source: MODAS)

```
DSD G083                                              Version 1.01

                        *** M O D A S ***
                     MARCON INDUSTRIES, INC.

            ---------------- Airborne Data Menu ----------------

             1. Worst Case - Reliability & Maintainability Report
             2. Summary Failure Data Search
             3. Reliability Status Report/Displays
             4. Maintainability Status Report/Displays
             5. Detail Maintenance Data Search
             6. Return To Main Menu

ENTER YOUR SELECTION NUMBER (1-6) : 1
```

Figure 14. MODAS Airborne Menu
(Source: MODAS)

EAD MENU

1.	F004C	14.	NLF016A
2.	F004D	15.	NLF016B
3.	F004E	16.	NOF016A
4.	F004F	17.	NOF016B
5.	F004G	18.	GM025C
6.	F004T	19.	GM030B
7.	F016A	20.	GM065A
8.	F016B	21.	GM088A
9.	AF004C	22.	IR002A
10.	BEF016A	23.	BU015
11.	BEF016B	24.	S0212A
12.	DKF016A	25.	S0213B
13.	DKF016B		

SELECT NUMBER : 7

Figure 15. MODAS EAD Menu
(Source: MODAS)

Figure 16 - worst case menu for option 7, Figure 15

Figure 17 - reliability report for option 1, Figure 16; these data have implications for deciding where training emphasis may be required

Figure 18 - airborne data menu requesting option 5, detail maintenance data search

Figure 19 - menu for displaying detail maintenance data search, option 5 in Figure 18

Figure 20 - search options for detail maintenance data search. This display provides for some key searches: options 1, aircraft; 6, WUC; 7, action taken; 10, base; 11, command; 23, crew.

Figure 21 - a detail maintenance data report showing aircraft, type maintenance, WUC, and action taken. The English translation of the first line, based on MDC codes: unscheduled maintenance (B) to trouble shoot (Y) instruments (51000) on a given F-16A

Figure 22 - important menu for obtaining work unit codes; displays the master B4 file

Figure 23 - example of WUC 65XXX for F16A

Figure 24 - menu for identifying action taken and other codes.

These figures represent examples of the menus, searches, and reports provided by MODAS. Users may generate a variety of reports of these and other kinds.

Reliability of MDC Data

MDC are frequently maligned because of inaccuracies, but what is frequently overlooked is the fact that at least some parts of the data base are sufficiently reliable for many purposes. Much of the criticism levied pertains to the recording of manhours and the accuracy of action taken codes. The time criticism stems from two contentions, and, indeed, these criticisms were verified during interviews with maintenance technicians. First, units vary in their interpretation of what time is to be reported for a maintenance action. Some supervisors insist that an employee account for the time for his full shift. Others require actual maintenance times. The other criticism is that the MDC codes do not provide for accounting for such time consuming activities as travel, preparation, and set up. Interviews with members of a manpower shop employing the LCOM model revealed that they make operational audits of MDC data to derive the manhour parameters used in the model. While this audit will be described later, it is important to note that these specialists reported that they did not find a large disparity between the times determined by the operational audit and MDC data.

The assertion is sometimes heard that workers may not have ready access to the codes when they are completing the AFTO 349, and this situation reduces

```
                    WORST CASE MENU
        ----------------------------------------

      * Reliability *                    * Maintainability *
   ---------------------              -------------------------
1. Top 100 Wuc"s - by MTBM          5. Top 100 Wuc"s - by MH/FH
2. Top 100 Wuc"s - by Variance      6. Top 100 Wuc"s - by Variance
3. Top 50 Sub-Systems by MTBM       7. Top 50 Sub-Systems by MH/FH
4. All Systems - by MTBM            8. All Systems - by MH/FH

                   99. < END WORST CASE >


SELECT NUMBER  :   1
```

Figure 16. MODAS Worst Case Menu
(Source: MODAS)

Modas 16 APR 1985

F016A - Reliability Report #1
For Feb 85
* Top 100 Work Unit Codes *
Ranked by

Latest 3 Month MTBM (type 1 Failures)

Rank	Wuc	Noun	3 Month Failures	3 Month MTBM	Ranking Factor
1	65ADO	TRANSPONDER COMPUTER	266	145.42471	100.00
2	74DAO	INERTIAL NAVIG UNIT	255	151.69797	95.86
3	44AAE	LGHT WNGTIP NAV/FRM	223	173.46628	83.83
4	74ABO	RF UNIT LOW POWER	203	190.55655	76.32
5	23FBA	SEAL DIVRGNT NOZ SG	181	213.71814	68.05
6	63BAO	RCVR/XMITTER RADIO	180	214.90546	67.67
7	42GAA	BATTERY AIRCRAFT	171	226.21626	64.29
8	13DAB	TIRE MAIN LDG GEAR	169	228.89334	63.53
9	75CBO	LAUNCHER WING TIP	169	228.89334	63.53
10	13EAH	BRAKE ASSY	159	243.28915	59.77

Figure 17. MODAS Reliability Report
(Source: MODAS)

```
DSD G063                                                Version 1.01

                       *** M O D A S ***
                    MARCON INDUSTRIES, INC.

        --------------- Airborne Data Menu ---------------

         1. Worst Case - Reliability & Maintainability Report
         2. Summary Failure Data Search
         3. Reliability Status Report/Displays
         4. Maintainability Status Report/Displays
         5. Detail Maintenance Data Search
         6. Return To Main Menu

ENTER YOUR SELECTION NUMBER (1-6) : 5
```

Figure 18. MODAS Airborne Data Menu
(Source: MODAS)

```
                    RECORD TYPE MENU
                    ----------------

1.  "A"    ON EQUIPMENT AIRCRAFT

2.  "EF"   ON EQUIPMENT ENGINE

3.  "G"    ON EQUIPMENT NON-AIRBORNE

4.  "H"    OFF EQUIPMENT

5.  "P"    PARTS REPLACED DURING REPAIR

6.  "R"    R&R OF SERIALIZED COMPONENTS

7.  "S"    SUMMARIZED AIRCRAFT SUPPORT GENERAL

8.  "T"    R&R OF AIRCRAFT ENGINE


      SELECT NUMBER:   1
```

Figure 19. MODAS Record Type Menu (Source: MODAS)

```
EAD : F016A       DETAIL MAINTENANCE DATA REPORT      APR 16 1985

                        SEARCH INDEX MENU
                 ----------------------------------

 1.  AIRCRAFT                   14.  TYPE HOW MAL
 2.  SERIAL NO.                 15.  EAD OR MDS
 3.  WORK CENTER                16.  TIME
 4.  TYPE MAINT.                17.  YEAR
 5.  SRD                        18.  DAY
 6.  WUC                        19.  CPN
 7.  ACTION TAKEN               20.  UNITS
 8.  WHEN DISCOV                21.  START TIME
 9.  HOW MAL                    22.  STOP TIME
10.  BASE                       23.  CREW
11.  COMMAND                    24.  TAG NO.
12.  JCN                        25.  JCN2 (PART2)
13.  LAST 4 OF ID
--------------------------------------------------------------------

    SELECT NUMBER:  6
ENTER STRING:  65AD0
ENTER STRING:
    SELECT NUMBER:  10
ENTER STRING:  KRSM
ENTER STRING:
    SELECT NUMBER:

ARE SEARCH SELECTIONS SATISFACTORY < Y OR N > :  Y
```

Figure 20. MODAS Search Index Menu
(Source: MODAS)

DSDG063 *** MODAS *** PAGE 1
EAD : F016A DETAIL MAINTENANCE DATA REPORT APR 16 1985

AIRCRAFT	SERIAL NO	TYPE MAINT	WUC	ACTION TAKEN	WH
F016A	81000124	B	51000	Y	D
F016A	81000152	B	51000	L	D
F016A	81000152	B	51000	Y	D
F016A	81000154	B	51000	L	D
F016A	81000168	B	51000	P	F
F016A	81000168	B	51000	Q	D
"	"	"	"	"	"

Figure 21. MODAS Detail Maintenance Report
(Source: MODAS)

DSD G063 Version 1.01

*** M O D A S ***
MARCON INDUSTRIES, INC.

----------Tables/Library Menu----------

1. Work Unit Codes (B4 - Master)

2. Constant Tables (A1 - B3)

3. Return To Main Menu

ENTER YOUR SELECTION NUMBER (1-3) : 1

<u>Figure 22.</u> MODAS Tables and Libraries Menu
(Source: MODAS)

```
DSD G063                                                              Version 1.01
                              *** M O D A S ***

   B4 - MASTER DATA LIST                                         PREPARED 16 APR 1985
   END ART DESIG:  F016A
   WORK UNIT CODE:  65***

  ------------------------------------------------------------------------------------
  LI 100
  B4   AE    F016A650001FF SYSTEM       B000000100000    0000000100   7902 A
  B4   AE    F016A65A00AIR/GROUND IFF   B000000100000    0000000100   7902 A
  B4   AE    F016A65A99NOC              C000009900000    0000000100   7902 A
  B4   AE    F016A65AAFBIT RF           B000000100000    0000000100   7902 A
   .    .         .                           .               .          .  .
   .    .         .                           .               .          .
   .    .         .                           .               .          .  .
  B4   AE    F016A65AARCCA MODE 4       B000000100000    0000000100   7902 A
```

Figure 23. MODAS Master Data List
(Source: MODAS)

TABLES MENU

---

1. A1 - Action Taken Codes
2. A2 - When Discovered Codes
3. A3 - How Malfunctioned Codes
4. A4 - Base (Station) Codes
5. A5 - Federal Supply Class
6. A6 - SRD/MDS Cross Reference
7. A7 - Commands
8. A8 - Type Maintenance
9. A9 - EAD
10. B3 - EAD/MDS Cross Reference

SELECT NUMBER : 4

Figure 24. MODAS Tables Menu
(Source: MODAS)

accuracy of the data. Sometimes, interviews revealed, the worker logs the work against some code recalled, or logs the work against the vaguely defined "support-general" code. A large amount of support-general codes were reported during interviews, and at least one command is testing the deletion of the code.

Despite the possibility of incorrect WUC entries, the number of times it occurs should not affect the adequacy of a list of actions taken on a given subsystem or component. What may be affected is the time workers spend taking certain actions.

A legitimate criticism can be levied against the manual system in which raw data are keypunched by non-maintenance personnel. A review of MDC listings at base level often reveals obvious keypunch errors. Under CAMS, however, maintenance personnel believe these errors will be reduced, since maintenance personnel will be directly entering the data. Thus, readability and interpretation errors made by entry personnel will be eliminated. It should be noted also that all F-16 bases worldwide are using the Centralized Data System (CDS) to automate form generation and reduce paperwork. In addition the CDS links all F-16 bases to a host main frame computer in Boston which aggregates all F-16 maintenance data weekly.

There is provision for base level review of listings on a daily basis to determine errors and for correcting them. Visits at operational sites indicated that sometimes the listings are reviewed and sometimes they are not.

In summary, the question of how reliable are MDC data is best answered by stating that reliability is suspect in the minds of many maintenance personnel. No empirical evidence of its unreliability was discovered in this study. Perhaps the time has come to resolve the question once and for all. Such a study, for example, could determine variances in manhours among units and investigate the sources of any variance that was uncovered. But, there is considerable opportunity for AFTO 349 entries to be inaccurate, for the reasons cited above.

Uses of MDC Data

The primary uses of MDC data appear to be in the reliability and maintainability and product improvement areas. Clearly, the data are important for identifying components whose reliability is low, or for which maintenance is expensive in terms of maintenance manhours and resource replacement. Further, especially at base level, the data can be the basis for maintaining bench stock.

In the MPT arena, the data are typically used in base level maintenance shops to assess overall productivity, to track maintenance actions, and to determine manpower impacts of shifting workloads. They are especially important for maintenance managers to forecast manning requirements, according to interviews with these personnel. On-the-job training, through MMICS, is tracked by the experience that unit personnel acquire, and records of their training and certification are documented.

Above base level there is little evidence of the use of the data, except as a basis for input to the LCOM model, to be discussed below. In the 1977-78 time frame there was an abortive effort to use MDC data for designing resident training, especially in determining requirements for electronic principles training. The volume of material as well as the lack of a means of aggregating and analyzing the data made its use for training unsuccessful.

That MDC are not being used to any noticeable extent for training or classification and related personnel uses does not mean that the data cannot be used for such purposes. Indeed, a review of the MDC such as reported here reveals the data base to be a rich source of information for training and personnel decisions.

Critique of MDC

Several observations about MDC are apparent.

1. A massive amount of detailed data about the maintenance of weapons systems, communication-electronic equipment, and missiles is readily accessible, although for MPT uses some means of analyzing and displaying these data do not presently exist, except as employed in LCOM for manpower requirements.

2. MDC are weapons system specific. AFSC analysis is not possible with the present computer analysis capability--e.g., MODAS.

3. It is not possible to infer with any confidence who is doing the work, since neither skill level nor grade is reported on AFTO Form 349.

4. Accessibility of the data base is excellent through MODAS.

5. Reliability of the data is suspect in the opinion of most maintenance personnel. Task time is quite difficult to accept at face value, since there is no standard way of reporting job or task time. Does it include set up, clean up, and so on, or does it indicate just active repair time?

6. While MDC data are not presently being used for personnel or training purposes, the utility of the occupational analysis data (described in another section) that are presently used for decisionmaking in these areas could be considerably enhanced if MDC data were linked with the occupational analysis data. For example, data about reliability of specific subsystems or components could augment occupational analysis training emphasis data for making decisions about what to train in initial resident training courses. Also, in the personnel field the occupational analysis data are based on more generally defined tasks than MDC. If MDC tasks were linked with these more general tasks, a much clearer picture of the scope of work of an AFS would emerge, giving more substance on which to base decisions to merge or shred career ladders. In addition, programs that are now in the research stage that are discussed under the OSM section (i.e., the Training Decisions System, Advanced on-the-Job-Training System) would be facilitated by availability of a system for organizing and analyzing an exhaustive and detailed task identification and data system. Certainly, the efforts in SUMMA would be enhanced by a TIES.

V. LOGISTICS COMPOSITE MODEL DATA

As indicated in the previous section, MDC data are a primary input to the LCOM modelling process, either in the form of maintenance tasks and manhours for operational systems or in the form of comparability analysis for a new weapons system. One of the inputs to LCOM is a listing of tasks with associated manhours. These tasks are weapon system specific, but the tasks are identifiable with their appropriate AFS. While task identification data are an input of LCOM, it is not the modelling process that produces them. The tasks and associated data are produced from MDC and operational audits and task networking created for input into the LCOM model.

Origin of LCOM

Because the human resources required to support and maintain a weapons system are a major element in the total cost of the system, a need exists to identify and develop estimates of these resources early in the development of a new system. A pilot project was initiated in 1971 to develop, test, and employ a simulation model that would effectively predict manpower requirements for a new weapon system. The AX (now, A-10) Close Air Support Weapon System was selected as the simulation test bed (Maher & York, 1974). The intent was to transition the model to the operational command for use in determining manpower authorizations. The LCOM, developed earlier by RAND, was the model chosen for the pilot project. This transition occurred and at present several commands are employing LCOM to simulate manpower requirements.

In terms of task identification, an input to the LCOM process today yields tasks performed on operational systems as well as tasks to be required of new systems. The task identification and associated data are generated by the Data Preparation Subsystem (DPSS) for one input into LCOM. For the new systems, the tasks are the result of comparability analysis, although Cronk (1985) reported an instance in which Logistics Support Analysis data (see Section VI) were employed as input in LCOM modelling of a new system.

It should be reiterated that the LCOM model is a simulation process. The task identification data are simply input data, which serve as one of the parameters for modelling manpower and other factors.

The office of primary responsibility for the LCOM model for manpower is Hq, AFMEA/MEXL, Randolph AFB, Texas. Their brochure (AFMEA, 1986) describes LCOM as a multi-functional computer modelling system designed to determine through simulation the resource requirements of a system. The major uses of LCOM for modelling manpower is the Tactical Air Command. AFMEA and interviews with TAC personnel are principal sources of the information on LCOM in this report.

It should also be noted that LCOM simulation is not restricted to weapons systems or equipment or even aircraft maintenance, provided such parameters as the tasks performed and the time required to perform them can be described. There is nothing in the LCOM logic or software that limits its use to aircraft maintenance or manpower. The software is extremely flexible both in the amount of detail that can be input and in the range of resources and "systems" that can be studied. LCOM is merely a resource counter, and it runs on a queuing concept. At present, the Army Research Institute is evaluating LCOM, along with TSAR, for use in analyzing manpower and unit performance. The AFMEA Primer lists such uses as vehicle maintenance operations, space shuttle operations, and aerial port operations. Interviews at Tactical Air Command (TAC) headquarters in June, 1986, revealed that manpower requirements for supply and hospital operations were modelled in LCOM.

<u>Origin of LCOM Task Data</u>

For operational weapons systems, LCOM task data originate from historical data from the "...most current computerized maintenance records..." (AFMEA, 1986), i.e., MDC; and from operational audits of these data. The task data for emerging weapons systems, except for the instance cited by Cronk (1986), are derived from comparability analysis.

The Air Force Systems Program Office (SPO) determines the comparability of the hardware developed for the new system with other systems currently in the inventory. Engineers compare the designs of similar aircraft, drawing on the experience of associates who have worked on various programs, contractor data, and Air Force Technical Orders, as necessary. The results are then written up by subsystem work unit code, and include: identification of comparable aircraft and subsystem work unit code(s); any additional Line Replaceable Units (LRU) in the new subsystem or LRUs by work unit code in the comparable system that are not applicable; any factors that are applied to the comparable subsystem failure rates or task times in estimating for the new subsystem; and narrative analysis specifying the criteria used and supporting rationale for choosing the comparable subsystem and factors. Any scheduled maintenance considerations should also be mentioned. In some cases an item is so new or so changed that there is nothing reasonably comparable. In that case, the best source of data (e.g., contractor) should be identified, and appropriate factors and degree of confidence discussed. Study results should be reviewed in conjunction with experienced maintenance personnel to be sure no maintenance considerations are missed.

The next step is to obtain MDC data tapes on the aircraft with comparable subsystems. For operational systems, acquisition of the MDC data tapes is also one of the first steps. Data from these files are processed through the DPSS which alters the form of the tasks and generates task sequence networks. Processing of MDC are shown in Figure 25. This figure shows the input of MDC data and use of the B-4 master file WUC dictionary.

The alteration of form of the task consists of a compression of the MDC action codes into a smaller number of actions. The action taken conversion table is shown in Table 4 and their definitions in Table 5. It can be seen that MDC Action Taken Codes (ATC) A, F, G, J, K, L, and X convert for off-equipment ATC to LCOM Action Taken Code (LATC) W. For the reader's convenience, Table 6 gives the MDC ATC definitions so a comparison with the LATC can be made. The process reduces the number of tasks identified.

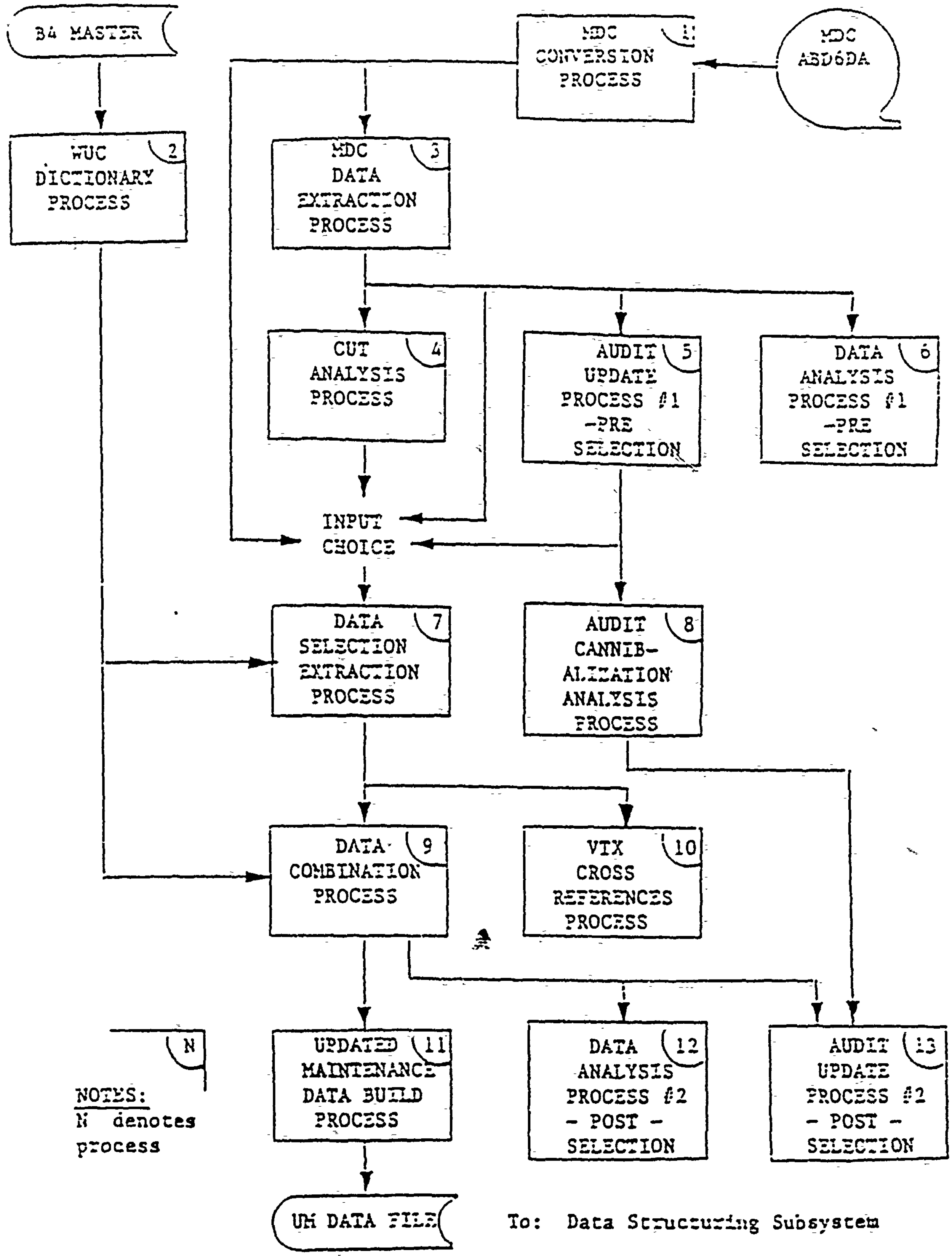


Figure 25. Data Preparation Subsystem Process Interfaces/Flow
(Source: DPSS Working Paper, 1986)

Table 4. MDC Action Taken Conversion to LCOM Action Taken Codes (Source: Form DPSS Manual)

MDC ATC (2)	MDC How-Mal (3)	LATC Conversions (4): for on-equipment MDC data	LATC Conversions (4): for off-equipment MDC data
A	any		W
B	"		K
C	"		C
D	"		N
E	not used by CDEP - inappropriate for LCOM modelling		
F	any	M	W
G	"	M	W
H	"	H	
J	"	M	W
K	"	M	W
L	"	M	W
M	"		D
N	"		D
P	799 800 803 804 805 other	X X RT X X R	
Q	same as MDC ATC "P"		
R	same as MDC ATC "P"		
S	any	X	
V	"	M	W
X	"	V	W (1)
Y	812 other	H T	
Z	any	M	K (1)
1	"		N
2	"		N
3	"		N
4	"		N
5	"		N
6	"		N
7	"		N
8	"		N
9	"		N

Notes:

(1) There is a bug in the off-equipment LATC conversion table: off-equipment work documented against MDC Action Taken codes X and Z have been reversed. The scope of this effect is not currently known, but the error will be corrected in the next CDEP system release.

(2) See Table 2 for definitions.

(3) See Table 3 for definitions.

(4) See Table 4 for definitions.

Table 5. Definitions Assumed for LCOM Action Codes (Source: DPSS Manual)

LATC	Definition
- - -	- - - - - - - - - - - - on-equipment work - - - - - - - - - - - - - - -
V	Verify (normally assumed to be a post-installation ops-check)
T	Troubleshoot
R	Unscheduled remove and replace (for failed parts)
RT	Scheduled remove and replace
M	Minor maintenance or repair in place (for failed parts)
H	Cannot-duplicate-malfunction troubleshoot
X	Remove and replace (of a good part to facilitate other maintenance
- - -	- - - - - - - - - - - - off-equipment work - - - - - - - - - - - - - - -
N	Bench checked, not reparable this station (NRTS)
K	Bench checked, no repair required
W	Bench checked and repaired
C	Bench checked, repair deferred
D	Dissassemble/reassemble

Table 6. MDC Action Taken Code Definitions
(from AFM 300-4, Vol. XI)

MDC ATC	Definition
A	Bench checked and repaired
B	Bench checked - serviceable (no repair required)
C	Bench checked - repair deferred
D	Bench checked - transferred to another base or unit
E	Initial Installation
F	Repair
G	Repair and/or replacement of minor parts
H	Equipment checked - no repair required
J	Calibrated - no adjustment required
K	Calibrated - adjustment required
L	Adjust
M	Disassemble
N	Assemble
P	Remove
Q	Install
R	Remove and replace
S	Remove and reinstall
T	Removed for cannibalization
U	Replaced after cannibalization
V	Clean
X	Test-inspect-service
Y	Troubleshoot
Z	Corrosion repair
1	Bench checked - NRTS (not repairable this station) - repair not authorized
2	Bench checked - NRTS - lack of equipment, tools, or facilities
3	Bench checked - NRTS - lack of technical skills
4	Bench checked - NRTS - lack of parts
5	Bench checked - NRTS - shop backlog
6	Bench checked - NRTS - lack of technical data
7	Bench checked - NRTS - excess of base requirements
8	Bench checked - return to depots
9	Bench checked - condemned

As a result of the conversion process, every maintenance task performed on the aircraft is identified. Accompanying data for each of them are crew size, AFSC, and task time. These items are a part of an output vital to a TIES.

The LCOM Model

The LCOM model is displayed in Figure 26. It consists of three primary modules:

1. The input module is used in the initialization process, in which the events and resource data are transformed into a format acceptable to the simulation module.

2. The main module accomplishes the simulation.

3. The postprocessor module provides summary data of the simulation output.

To build a model (AFMEA, 1986), the analyst, through the input module software, characterizes the operation being simulated. This activity includes the data and rules describing each aspect of the operation under study. Three kinds of data (Figure 27) are entered in the input module:

1. One input in building the model is the development of the operations scenario. The analyst describes the logic of the operation and any rules or constraints that will be used for the actual operation. Operations data describing the scenario would include, for a flight operation, such factors as the sortie rate, sortie type, takeoff time, sortie duration, number of aircraft, weapon configuration, weather factors, and rules for scheduled maintenance. A typical operations scenario for one aircraft sortie is shown in Figure 28. It describes the sequence of events to fly a sortie.

2. Another input used to build the model is specific data on maintenance. The analyst uses historical data from the most current computerized maintenance records and also gathers field measured work standards for each maintenance task. These standards are derived from an operational audit. Using MDC data as a strawman for work time, analysts interview personnel in operational units. They obtain from these specialists estimates of the time required to perform tasks. Also, these specialists provide input for the task networking process. One major LCOM user employs a sample of five specialists at one location to obtain the task time estimates.

Maintenance data identifies every maintenance task that is performed on the aircraft. The task sequence is described by networks including task durations, personnel and resource requirements, and test equipment requirements. Figure 29 shows a maintenance network for the repair of the VHF-FM radio. Note the sequence of subtasks, durations, probabilistic branching, and resource requirements.

3. Supply data are the final input used to build the model. Supply data identify resource type, cost, authorization, valid substitutes, failure rates, stock levels, and other factors.

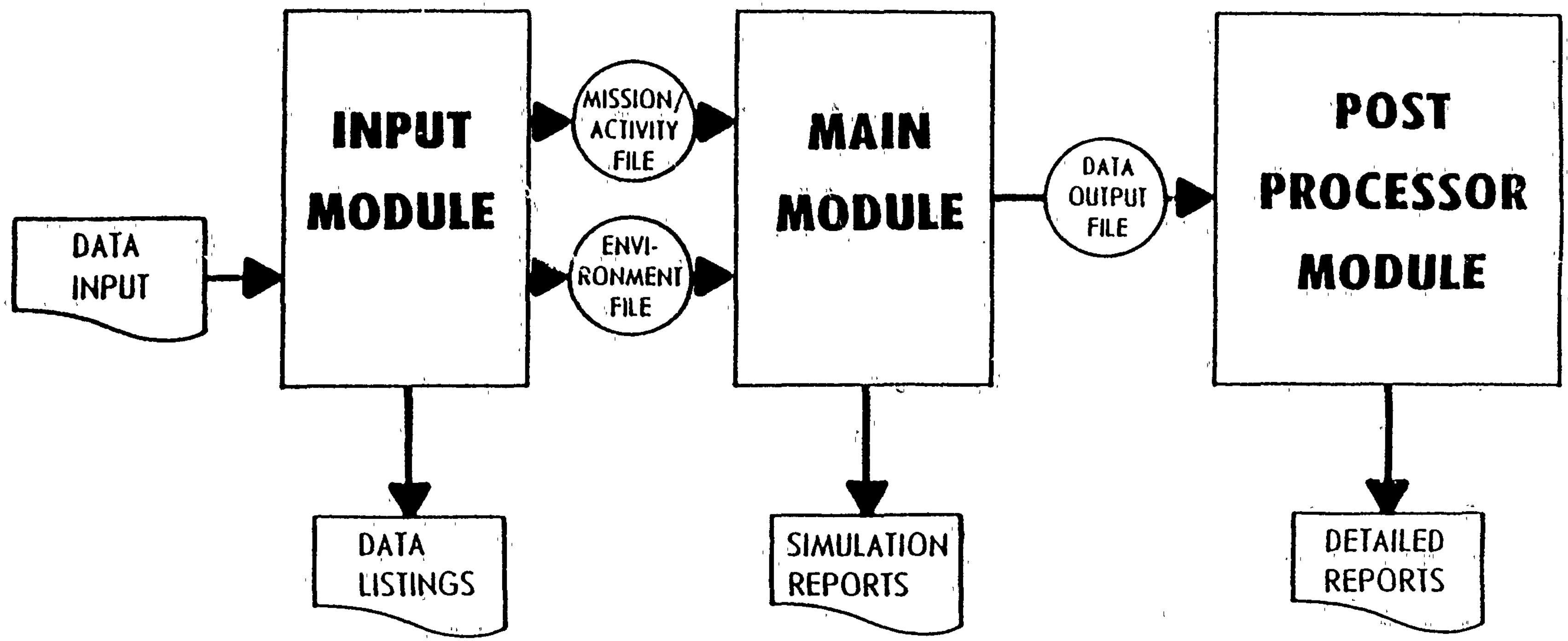


Figure 26. LCOM Simulation Subsystem Structure
(Source: LCOM Primer, 1986)

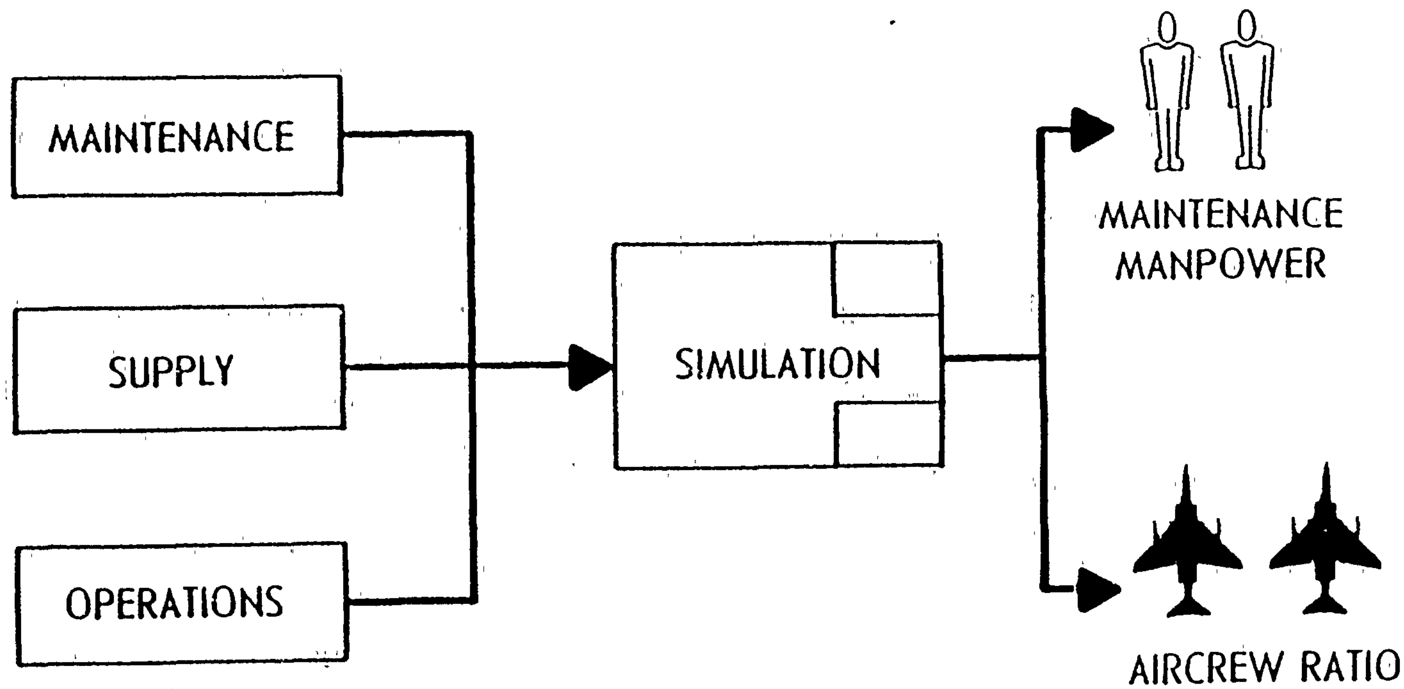


Figure 27. Logistics Composite Model
(Source: LCOM Primer, 1986)

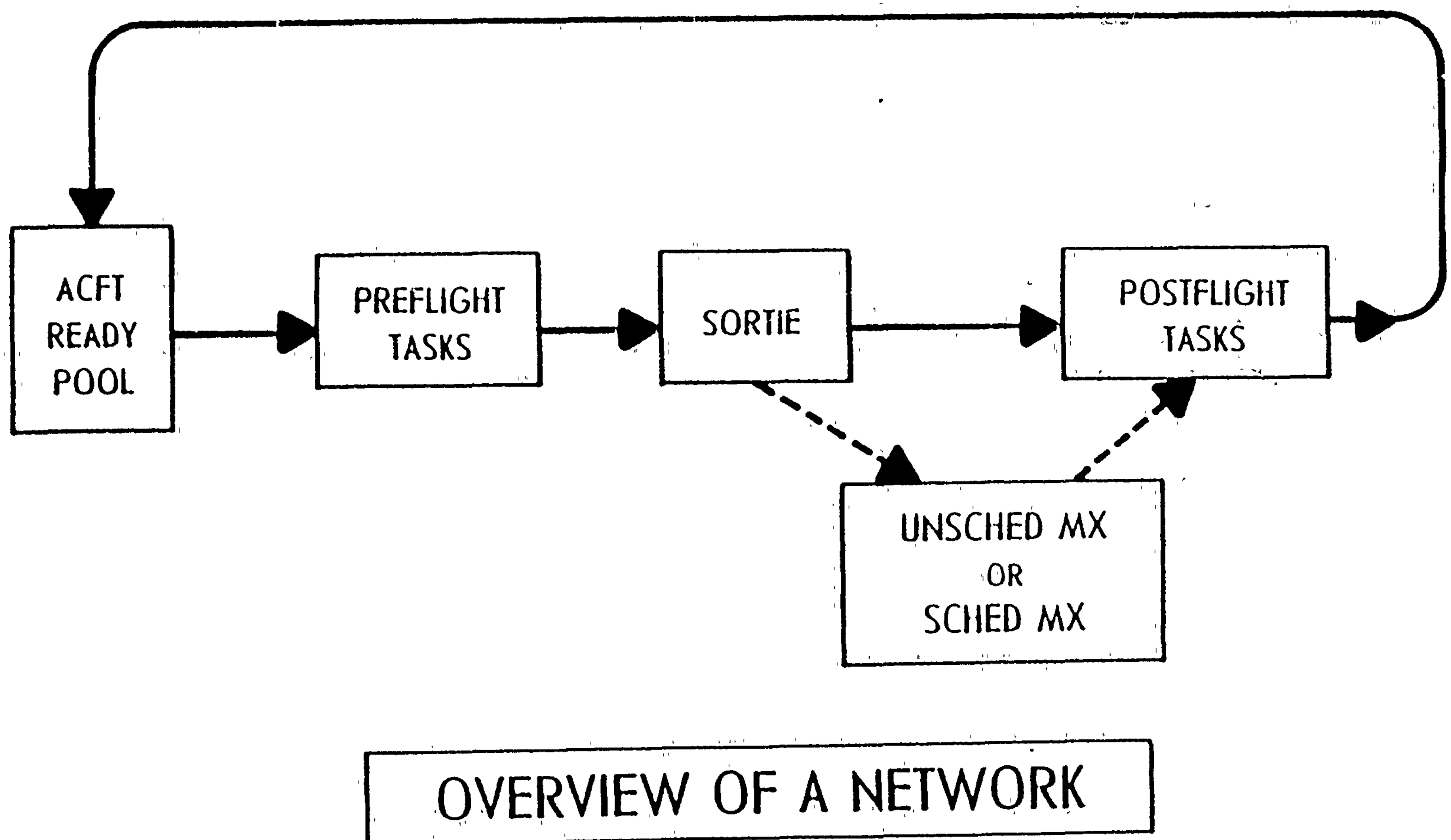


Figure 28. Overview of LCOM Network Logic
(Source: LCOM Primer, 1986)

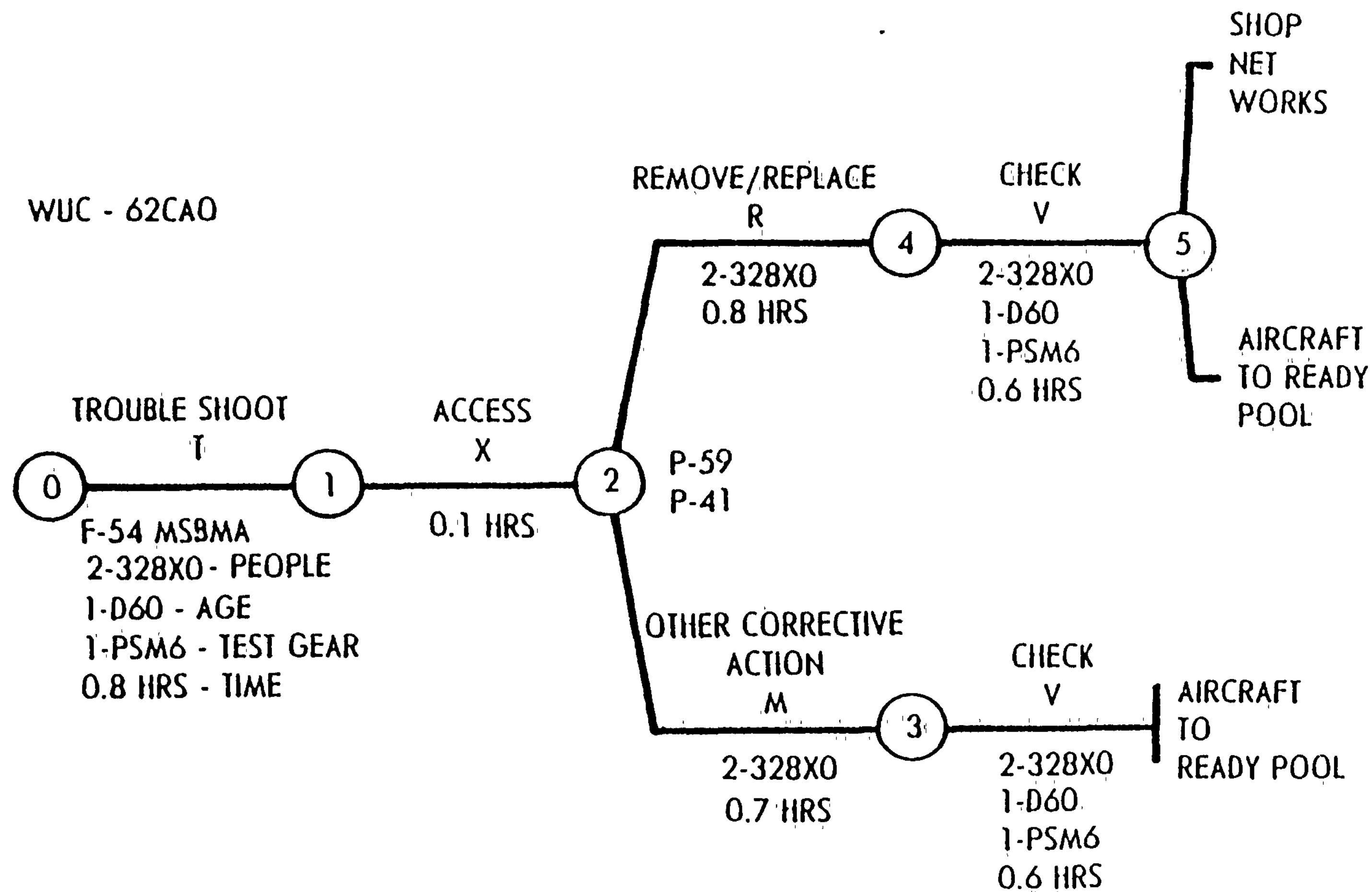


Figure 29. Example of a Task Network
(Source: LCOM Primer, 1986)

After the analyst has prepared the data using the Input Module software, the analyst builds a model which then is simulated in the Main Module of the program software (see Figure 27). The Main Module takes the model scenario and actually simulates the operation that was described. Individual aircraft are preflighted, loaded with munitions, taxied, flown, recovered, and maintained. Maintenance is divided into scheduled, unscheduled, and phase (periodic inspection). The simulation tracks the number of personnel and physical resources to run the operation, as each aircraft is flown and turned according to the operation scenario. With large simulation models with many maintenance tasks, the simulation can take hours of computer CPU time.

Depending on the requirements of the study, the analyst uses the Postprocessor Module to provide the output to analyze the system operations and resource interaction. Statistics describing the simulated operations are put in a format that can be used by the manager to make decisions. Specifically, the manpower manager uses manpower statistics, by work centers and maintenance skills requirements, as an important determinant of maintenance manning requirements. Output statistics for applications other than manning requirements can be generated. For example, supply requirements or operations factors can be output for analysis.

Analysis of LCOM Model Data

The output of a simulation includes a wide variety of data. First, resources must be constrained in various ways, or, for example, sortie requirements can be varied. For each such constraint or variation, output is available. Included are such items as manpower requirements by AFS, utilization rates, sortie capability, and supply requirements. One of the very important applications of LCOM is to answer "what if" questions. For example:

"If logistics or manpower resources are limited, how is sortie generation affected?"

"If a designated sortie rate is required, what are the manpower requirements for specific AFSC?"

"If a new weapons system is being designed with stated mission, logistic, and maintenance requirements, what are the life cycle costs?"

For a TIES, a key document is produced by the Data Preparation Subsystem. In the modelers terms, it is called an Extended Form 11. A truncated example is shown in Table 7. The first column is a line count number. The Prior Node column reflects the sequencing of the task in the network. In the third column are the crucial entries: for line number 32500, the code Q82CLF is made up of the LATC (the letter Q representing "install") and the WUC (82CLF, representing a subsystem--third digit--and component--fourth and fifth digits--of the computer and display system--82). In effect, task identification is established. In SUMMA, this combination of action taken and WUC was employed for identifying tasks. Obviously, the LATC-WUC combination produced a "task" looking very much like an MDC "task" and an OSM task.

Table 7. LCOM Extended Form 11 Listing

Line[1] Number	Prior Node	Task	Next Node	Selection Parameter	Sub-System	Time to Repair Mean	Time to Repair Variance	Crew Size Rqt	Crew Size AFSC
32500	IH200G	Q82CLF		28	82C**	5.6[2]	02	2	305X4
32510	IH200G	G82CLF	IH2COH		82C**				
32520	IH2COH	N82CLF			82C**	19	05	1	305X4
*		*	*	*	*	*	*	*	
32680	IH2COM	Q82CLU		37	82C**	56	02	2	305X4
32690	IH2COM	G82CLU	IH2COP		82C**				
*		*	*	*	*	*	*	*	

[1]Column titles were supplied by TAC LCOM specialists and data are extracted from a TAC generated Extended Form 11.
[2]In minutes

The subsystem column reflects the aircraft subsystem (82--computer and display). Under time to repair, the mean time for the install action on the component is 5.6 minutes, with a variance of 2 minutes. The last two columns reflect that two personnel with AFSC 304X4 are required. Contrary to the usual connection the X, the fourth character of the AFSC, does not stand for skill level. Rather, the X reflects that the task is performed on the flight line. Typically in the Extended Form 11 document, the fourth character is used to designate where the task is performed. For a TIES, the key data elements are the action taken, work unit code, and the AFS. A significant problem is the lack of a central data base.

At present, the most up-to-date LCOM analyses are available from the organization accomplishing the LCOM process. Mr. Charles Begin, ASD/ENSCC, Wright-Patterson AFB, indicates, however, he maintains a collection of LCOM data bases. The data are provided voluntarily, but Mr. Begin surveys LCOM users semiannually to obtain new data files.

Uses of LCOM

A major use of the LCOM model is to determine maintenance manpower requirements. At the LCOM model steering committee meeting at Randolph AFB in May, 1986, MAC, TAC, ATC, USAFE, and ASD, reported employing LCOM modelling of manpower requirements as follows.

MAC reported LCOM projects in progress on the C130EH, AC130/MC130, C5A, C-17, and for fleet services. The MAC representative stated that 50-55 percent of manpower forecasting is accomplished through LCOM. MAC also has employed LCOM to assess RIVET WORKFORCE impacts on manning. Future studies will be directed at the H53/1HC130 and C141 aircraft.

TAC reported that all major TAC weapons systems have had LCOM modelling: F15, F16, A10, F4E, RF4C, F111A, EF111A, T38, and A7. Studies of surge, sustained, peacetime, reserve, and guard have been completed. Studies are reaccomplished each 4 to 5 years.

ATC indicated simulation of sorties for flying training. Regression equations are derived to project manpower requirements. About 41 percent of ATC maintenance manning is determined by LCOM modelling. The ATC representative indicated that LCOM provides a better basis for determining manning requirements than standard methods. The ATC representative did, however, indicate problems of accuracy of the MDC used in the input module.

USAFE reported using LCOM for "traditional studies." At present, USAFE uses TAC produced F-15 staffing results.

Before addressing ASD use of LCOM, it should be pointed out that representatives at the conference indicated that LCOM is not just a manpower model. One of the LCOM's principal virtues is that the interactive impacts of manpower, supply, reliability, and maintainability, basing mode, etc. can be studied at once. The capability of relating these to unit performance, e.g., sortie generation, is a big advantage. Usage of the model was reported for alternate fighter engine analysis, system reliability, determining factors affecting manpower, reliability and maintainability needed in a component or subsystem, reallocation of tasks among work centers, utilization of personnel (which is a manpower, personnel, and user issue) and in an availability-readiness model.

Mr. Cronk, LCOM Group Leader for ASD/ENSCC, Wright-Patterson AFB, indicated ASD has accomplished some LCOM studies, for example, for the T-46 and for LANTIRN. In addition, ASD is investigating development of an LSA-LCOM interface program. More about this effort will be addresed in Section VI. It is sufficient to say at this point that LCOM modelling from an LSA data base has presented a number of problems.

Another significant use of LCOM is in the SUMMA project. Here the initiative is to optimize manpower and personnel requirements with respect to maintenance in dispersed small unit operations. LCOM has been used to model impacts of alternative maintenance occupational structures on manpower requirements for F-16 maintenance.

Critique

1. LCOM converts information about the tasks to be performed by maintainers into required manhours, hence numbers of people, to support a given weapon system at a given level of performance. Its principal advantage as an analysis tool is the ability to model the impact on unit performance (e.g., sortie rate) of changes in operational requirements, logistics support, and manpower. By varying any of these parameters, singly or in combination, their impacts on unit performance can be determined. It is a simple matter to illustrate, through LCOM or any other queuing technique, that total manning requirements are driven by workload (R&M) and by the way work is assigned to AFSs. Other things equal, if equipment did not break as often (R) or if it took less time to fix (M), the workload, and hence manpower, would decline. Also, if fewer separate specialties were defined, manpower would also decline, with no sacrifice of total unit performance. These two examples have in fact been studied extensively with LCOM over the years. The equipment R&M issue is readily dealt with by LCOM, as in the AFS or work center consolidation issue. What LCOM will not do, though, is tell you how or whether these changes can be accomplished. It can only provide an assessment of the payoffs or penalties that can be expected if they were implemented.

A common complaint against LCOM in this regard is that task performance is invariant, that a uniform "5-skill level" assumption is invoked. In fact, LCOM could be used to evaluate the impacts of different "skill levels" task-by-task if these data could be supplied in a form usable by LCOM; that is, in terms of differentiated task performance times. So far, credible data on this question have not been produced.

2. LCOM model usage is required in developing data about emerging weapons systems, usually through comparability analysis. Interfacing LSA and LCOM has been difficult.

3. As for the task identification data used in the modelling process, task statements resemble MDC tasks. There is compression of the MDC action

taken items, resulting in a more concise but less detailed listing of tasks. An important feature of the associated data that differs from available MDC output from MODAS is the indication of the AFS required to perform the actions taken and crew size.

4. The key data elements for a TIES are found on the listing of the "Extended Form 11" and consist of LATC, WUC, and AFSC.

VI. LOGISTIC SUPPORT ANALYSIS

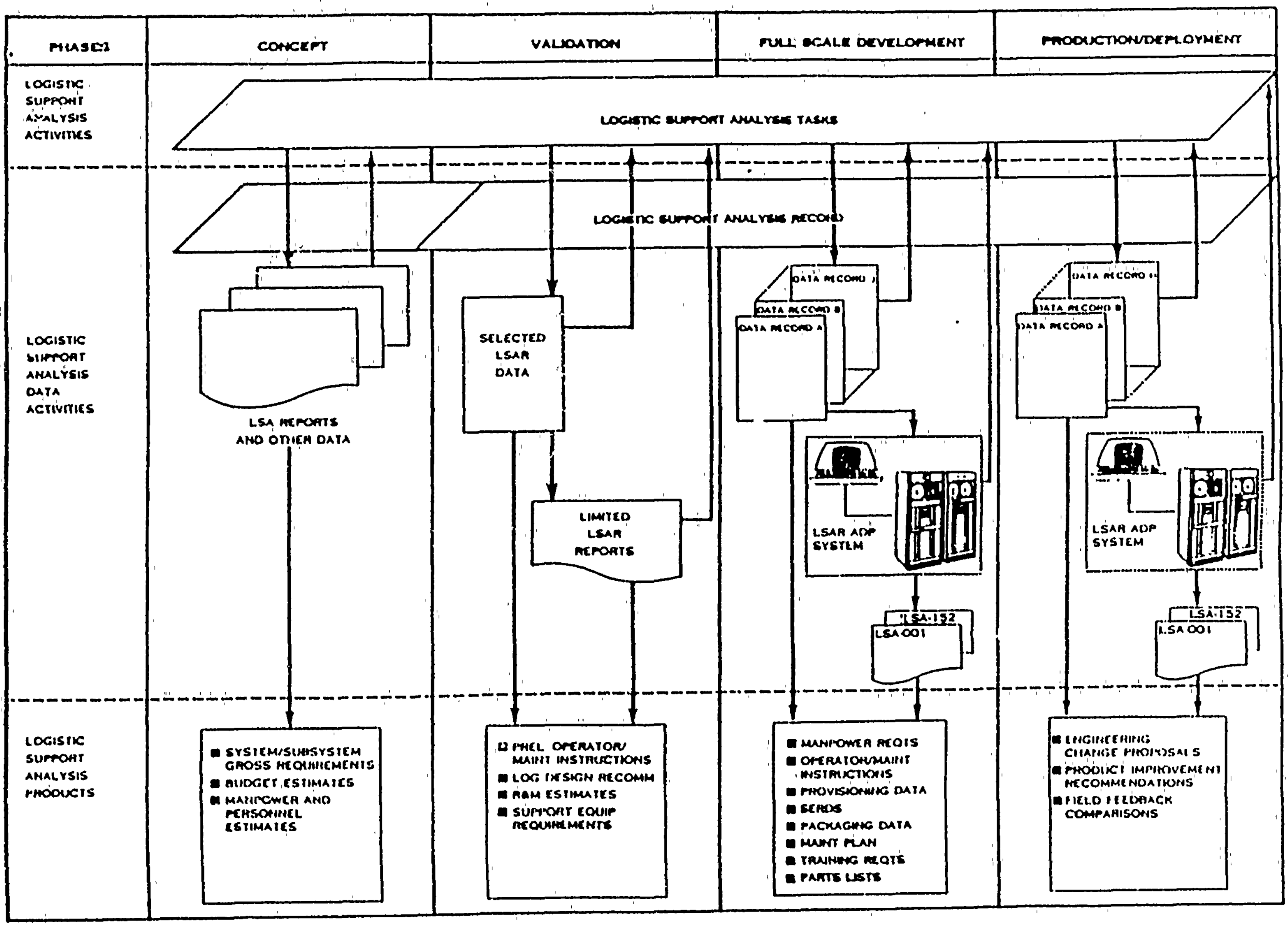
An elaborate system for regulating the collection and reporting the logistical requirements for new weapons system has been developed. For TIES, a key component is the LSA, the general requirements of which are contained in MIL-STD-1388-1A. This MIL-STD specifies 72 tasks that can be purchased from the contractor and which describe various aspects of the logistical support required for the new system. Mandatory procurement of some of these 72 tasks is required, others are optional. Unfortunately, some of the more useful tasks for MPT purposes are optional.

Origin

While data required for LSA have been developed over the past two decades, it was not until the publication of MIL-STD-1388-2A, DOD Requirements for a Logistics Support Analysis Record, 20 July 1984, that Department of Defense standard requirements, data element definitions, data field lengths, and data entry requirements for Logistic Support Analysis Record (LSAR) data were defined. The standard allows delivery of LSAR data in a manual, automated, or combination manual and automated format. The standard Joint-Service LSAR Automated Data Processing (ADP) software may be used, or industry developed LSAR ADP systems may be used. These industry ADP systems, however, must comply with minimum standards in MIL-STD-1388-2A.

MIL-STD-1388-2A applies to all system and equipment acquisition programs, major modification programs, and applicable research and development through all phases of the system or equipment life cycle. LSAR requirements are tailored by the requiring authority who establishes the LSA documentation requirements based upon the elements of those tasks procured.

The LSA process is intended to be conducted on an iterative basis through all phases of the life cycle. The LSA documentation process is illustrated in Figure 30, and the data flow and system engineering interface in Figure 31 (both extracted from MIL-STD-1388-2A). Figure 30 represents the general data record generation process. The flow should not be interpreted as meaning that one type of data record must be completed in its entirety before the next data record can be completed. Generation of some LSAR data, however, (particularly important to MPT uses) is dependent upon the design engineering process and the release of drawings, preliminary, development, and final. The LSAR data flow is required for every reparable item comprising a system or equipment end item.



<u>Figure 30</u>. LSA Data Documentation Process
(Source: MIL-STD-1388-2A, 1981)

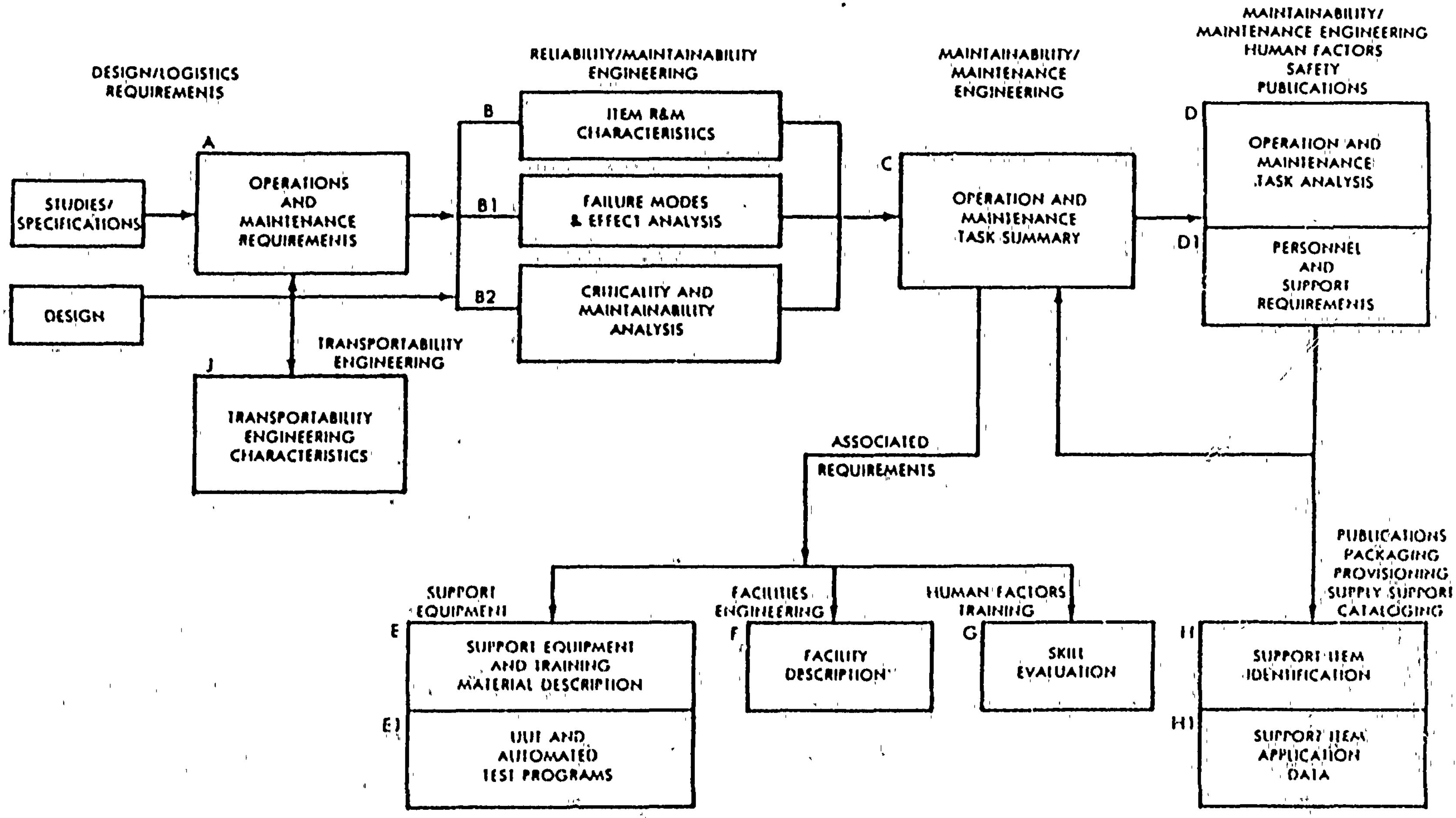


Figure 31. LSAR Data Flow and System Engineering Interface

Developing LSA

Some LSA products are developed by the requiring authority, usually a limited volume of data to define system level requirements. A large part of the data are procured. Data important for MPT uses are produced by contractors. Some LSAR result from reliability and maintainability of end items--e.g., manhour estimates, task identification while other LSAR are developed by engineers or technicians from these initial task identifications.

The requiring authority tailors the LSA data requirements by specifying the analyses tasks described in MIL-STD-1388-1A. Next, the engineering and Integrated Logistics Support functional element requirements which interface with the LSA and which generate LSAR data must be identified. Scheduling LSAR is then a complex process of determining when products of these elements will be available for development of the LSAR. Also involved is the establishment of the scheduled completion dates for data products that utilize LSAR data, specifically for the Data Item Description (DID) which are reports that the requiring authority may procure. For example, a DID that may be procured is DI-H-7068, Task Skill and Analysis Report. This report provides "timely and accurate" identification of technical tasks which will be performed by operator or maintenance personnel, job description, and manpower requirements. All of the data in this DID are obtained from various LSAR records and reports. Required delivery dates for the products specified by the DID should be established in conjunction with preparation of the solicitation package and should take into account the significant milestones of the development effort.

Since there are a number of DID that may be scheduled for delivery with relevance to MPT, a list of them with a short description of their purpose and LSAR application and record source are shown in Table 8. These DID are not available from LSA data tapes and are not automated.

LSA is initiated in the preconcept and concept exploration phase of the acquisition process. This effort is directed at establishing support related factors and constraints which must be used in developing design quidelines and trade study plans: reliability and maintainability, life cycle cost, logistics problems, and projection of logistic resource requirements and their costs. A limited volume of LSAR is produced from this effort.

In the demonstration and validation phase information about repair and support requirements for all levels down to major subsystems is developed. Of primary concern is the acquisition of data that would influence design guidelines and design characteristics and the refinement of logistic support planning data.

During full scale development, LSAR data records are completed to the hardware indenture level identified in Figure 32. The data are used to develop logistic support requirements for testing, operation, and deployment. The iterative nature of the LSAR process culminates at the end of this phase. A completed LSAR data base is now in place.

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
			istics which will provide medium confidence of nuclear survivability of the item. The C, D, and DI records document hardness critical procedures associated with operation and maintenance of a system/equipment or its constituent parts.	nuclear hardness and survivability design analysis.
MAINTENANCE PLANNING				
DI-L-7189, Maintenance Allocation Chart	The Maintenance Allocation Chart (MAC) is a management tool which assigns all authorized maintenance functions and repair operations to be performed by the lowest appropriate maintenance category, and delineates the tools and test equipment required to perform the operations. The MAC is a controlling influence in the preparation of equipment publications and in the selection of repair parts. The MAC is included as an appendix of the appropriate technical manual.	The LSAR provides all of the data requirements of this DID except for any explanatory remarks which may be required.	Use the LSAR input data records C, DI, and H and arrange the data in the MAC format.	Use the LSA-004 and LSA-020 reports with the reproducible option in order to completely satisfy the DID requirements.
DI-L-7190, Preliminary Maintenance Allocation Chart	The Preliminary Maintenance Allocation Chart (PMAC) is a list of all items, down to the lowest level of disassembly, recommending the category of maintenance, recoverability aspects, essentiality, tools required to perform specific maintenance operations, and remarks required to explain the maintenance operations. The PMAC includes additional data (over and above the required MAC data) and may be used to develop the MAC for the organizational technical manual.	The LSAR provides all of the data necessary to satisfy the requirements of this DID except for any explanatory remarks required.	Use LSAR input data records C, DI, H, and HI. Arrange the data in the PMAC format and generate Cover Sheet and Remarks page.	Use the LSA-016 and LSA-017 reports to satisfy the PMAC requirements.

TABLE 8. Data Item Description (DID) Relationships to the LSAR
(Source: MIL-STD-1388-2A, Appendix E)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
DI-L-2085A, Level of Repair (LOR) Analysis Report	To document and support the contractor's recommendations for most economical repair levels, repair versus discard at the operational sites and spare/repair part provisioning decisions. This data item describes the requirements specified by MIL-STD-1390, LOR Analysis Report.	The LSAR provides the reliability, maintainability, maintenance, manpower and personnel data required by this DID. Additional data such as personnel and training costs, supply pipeline times, and the density of equipment to be supported must be obtained separately from the LSAR.	LSAR data records A, B, B1, B2, C, D1, H, and H1 would be used to obtain the data required by this DID.	The LSA-060 and LSA-061 master file report listings would be used to obtain the source data required by this DID.
DI-R-3549A, Repair Level Analysis Report	To provide the government with the results of contractor performed system/equipment maintenance and logistics support level analysis, and to document and support recommendations regarding repair versus discard at failure maintenance and optimum repair level considerations.	The LSAR provides the reliability, maintainability, maintenance, manpower, and personnel data required by this DID. Additional data in the way of sensitivity analyses and decision logic must be developed separately.	LSAR data records A, B, B1, B2, C, D1, H, and H1 would be used to obtain the data required by this DID.	The LSA-060 and LSA-061 master file report listings would be used to obtain the source data required by this DID.
DI-H-7048, System Safety Hazard Analysis Report	To systematically identify, evaluate, and document hazards, both real and potential, for their elimination or control.	The LSAR contains data related to failure modes, effects and criticality. This data can be used as a source data for the evaluation of the system/equipment from a safety standpoint. The LSAR also identifies hazardous maintenance tasks.	The LSAR data records B, B1 and B2 can be used to obtain failure modes, effects, and criticality analysis (FMECA) data related to safety hazard severity codes for input to this DID report. The D and D1 records provide information related to any hazards associated with maintenance task performance.	The LSA-050, LSA-052, and LSA-054 can be obtained by safety hazard severity code and contain the FMECA data to support the development of this DID.

Table 8 (Continued)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
DI-S-61778, Summary, Calibration/Measurement Requirement	A summary of the technical requirements of a system, subsystem and/or equipment outlining the measurement parameters, specifying ranges, accuracy requirements, and calibration intervals for each echelon of measurement. The data is used to determine adequacy of support for systems/equipment requiring common, standard or peculiar test and measurement equipment. It also identifies/validates the need for calibration equipment/standards and shows traceable accuracy of measurement to the National Bureau of Standards (NBS).	The LSAR provides all of the data necessary to satisfy the requirements of this DID. However, some data element coding will require modification to satisfy DID requirement.	Use the LSAR data records D, DI, E, EI, and H and arrange data in the applicable format.	Use the LSAR data records E and EI and the LSA summaries LSA-005, LSA-019, and LSA-061 for subsequent arrangement of the data in the applicable format.
DI-L-7165, Maintenance Plan Report	To provide a concise narrative of the maintenance actions, source, maintenance and recoverability codes, and technical factors for each repairable item and the identification of the system/equipment maintenance requirements.	The LSAR provides all the data necessary to satisfy the requirements of this DID.	Use the LSAR data records B, C, DI, H, and HI and arrange data in the applicable format.	Use the LSAR summary LSA-024 to satisfy the requirements of this DID.
DI-S-6169, Optimum Repair Level Analysis (ORLA) Report	To advise the requiring activity of the results of the ORLA conducted by the contractor. The report documents and supports the contractor recommendations for optimum repair levels, repair versus discard at failure, use of Government furnished equipment, support equipment spares and spare/repair part provisioning.	The LSAR data base contains all of the reliability, maintainability, manpower and personnel, and maintenance data required to exercise a deterministic or stochastic model either manually or via computer routines for the accomplishment of an ORLA. Additional data pertaining to the cost of personnel and training, supply pipeline times, and density of equipment to be supported must be obtained separately to meet the requirements of this DID.	The LSAR data records B, BI, B2, DI, H, and HI contain the data required to support an ORLA report.	The LSA-060 and LSA-061 master file reports contain all of the data that would be necessary to support development of an ORLA report.

Table 8 (Continued)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
<u>MANPOWER AND PERSONNEL</u>				
DI-H-7057, Human Engineering Design Approach Document Maintainer	This document provides a source of data to evaluate the extent to which equipment having an interface with maintainers meet human performance requirements and human engineering design criteria.	The LSAR, in conjunction with applicable sketches, drawings, or photographs, provides all the date required to satisfy the requirement of this DID.	Use the LSAR data record B for evaluation of individual human engineering considerations such as equipment accessibility, ease of maintenance, safety, test points, skills, training, use of interconnective devices, labeling, and fault location procedures. Use the LSAR data records B1, B2, D, D1, E, E1, F, and G to obtain additional information required by this DID related to task performance descriptions, identification of critical tasks, task failure, information, personnel, skills and training impacts, and special tool and support equipment.	Use the LSAR 050, 051 052, 053, 054, 055, 001 through 015 reports to obtain supportive information.
DI-H-7068, Task and Skill Analysis Report	To provide timely and accurate identification of technical tasks which will be performed by operator and maintenance personnel, job description, and manpower requirements necessary for the operation, maintenance, and repair of systems and equipment.	The LSAR provides all the data required to satisfy the requirements of this DID.	Obtain data required from the LSAR data records A, B, B1, B2, C, D, D1, E, E1, F, and G.	The LSAR 001, 002, 003, 004, 005, 006, 007, 008, 009, 011, 012, 013, 014, 015, 019, and 023 automated outputs all provide data applicable to the requirements of this DID.

<u>Table 8</u> (Continued)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE: MANUAL	LSAR INTERFACE: AUTOMATED
DI-H-7090, Training Path System Documentation	The Training Path System is a structured approach to identify training requirements required by specific personnel to ensure the effective development of skills and knowledge necessary to coordinate, direct, and perform operation and maintenance of a system, subsystem, and equipment.	The LSAR provides a significant amount of data related to personnel requirements and training required to develop necessary knowledge and skills to operate and maintain system/equipment.	Use the C, D, DI, E, EI, and G data records to obtain required information. The G record is especially applicable as it documents new skill requirements, physical and mental requirements, educational qualifications and training requirements with narrative justification.	There are currently no automated reports utilizing data recorded on the G record, however, the LSA-001 through 015 do provide summaries related to personnel considerations.
DI-H-7091, Personnel Performance Profiles	Personnel Performance Profiles are complete listings of minimum knowledges and skills required for personnel to effectively operate and maintain a system, subsystem, or equipment. They are used as a basis for: a. Determining training requirements. b. Developing personnel evaluation criteria. c. Standardizing training materials among program participants. d. Developing course objectives in curricular and training materials. e. Minimizing duplication in coverage of knowledge and skills.	The LSAR provides all the data necessary to identify minimum knowledge and skill levels required.	Use the manpower and skill constraints data from the A data record, the sequential task information and skill specialty code data on the D data record, the personnel summary data on the DI data record, and the G data record to obtain required information.	Information on the G data record is currently not automated, however, the LSA 001, 002, 006, 007, 008, 011, 012, 014, 015, and 023 provide information related to the requirements of this DID.

Table 8 (Continued)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
TRAINING SUPPORT DATA				
DI-H-3258, Training Support Data	These data, required early in the acquisition of a system/equipment, are used to support training when it is not economically feasible to deliver technical orders/manuals in time for training.	The LSAR provides a significant amount of information suitable for use in establishing and supporting preliminary training requirements.	Use the LSAR data records B, D, DI, E, EI and G to obtain information relative to QQPRI, operation and maintenance instructions, equipment description and function data, and testing procedures.	Use the LSA-001, 002, 003, 005, 006, 007, 011, 012, 013, 014, and 023 reports to provide training support data.
DI-H-6135A, Reports, Facilities-Maintenance Training Equipment	To provide information for Maintenance Training Equipment (MTE) facilities.	The LSAR provides a significant degree of data related to the requirement for training equipment and facilities that is applicable to the requirements of this DID and supportive layout planning and design of required facilities.	Use the LSAR data records E, EI, and F to provide the detailed requirements of this DID.	There are currently no automated outputs generated from the LSAR data records E, EI, and F.
DI-H-1300, Personnel and Training Requirements	Qualitative and quantitative information developed by the contractor is used by responsible equipment management agencies to identify operator and maintenance personnel requirements by numbers, skills and other qualifications, and to plan for the conduct of necessary training programs in operation and maintenance.	The LSAR provides all of the data necessary to satisfy the requirements of the DID except in the area of a detailed New Equipment Training (NET) Requirements Report.	LSAR data records C, D, DI, and G would be used to obtain the data required by this DID.	The LSA-001, [illegible], [illegible], and 014 output summaries all [illegible] data applicable to the requirements of the DID. There are currently no automated reports utilizing data recorded [illegible] G record, [illegible] Evaluation and [illegible]fication.
DI-H-7067, Training Course Proposal	The proposal required by this DID is intended to provide technical and cost information required for the acquisition of training courses and instructor training services.	The LSAR provides training oriented information supportive of the requirements of this DID.	Use the LSAR data records D, DI, E, EI, and G to obtain required information.	Use the LSAR-[illegible] and 015 reports.

Table 8 (Continued)

DATA ITEM DESCRIPTION NUMBER AND TITLE	PURPOSE	LSAR APPLICATION	LSAR INTERFACE	
			MANUAL	AUTOMATED
DI-H-7069, Training Course Curriculum Outlines	The outlines of this DID are used to organize the course of instruction to ensure that all required topics are included and adequately covered within a course.	The LSAR provides training oriented considerations and rationale useful in satisfying the requirements of this DID.	Use the LSAR data records D, DI, E, EI, and G to obtain required training information.	Use the LSAR-014 and 015 reports.
SUPPORT AND TEST EQUIPMENT				
DI-S-3596A, Support Equipment Recommendations Data (SERD)	Represents the contractor's recommendations for maintenance level operational support equipment and the support equipment necessary for organization, intermediate and depot level maintenance.	Information will be accumulated using the LSAR to support and validate the recommendations for operating and maintenance support equipment.	The LSAR input data records E and EI contain all of the data necessary to satisfy the requirements of this DID. Transfer the information onto the SERD format.	The LSA-005 report can be combined with the nonautomated data records E and E1 to satisfy the requirements of this DID.
DI-L-1421A, Test Measurement and Diagnostic Equipment Data Sheets	This data item describes Department of Army Test, Measurement, and Diagnostic Equipment (TMDE) Program documentation requirements applicable to the procurement or development of TMDE.	The LSAR provides all the information required to satisfy this DID.	Use the data record E and EI to obtain the information required by this DID.	There are currently no automated outputs generated from the LSAR data record E and EI.
DI-T-3734A, Test Requirements Document (TRD)	Identifies performance and diagnostic test data. These data are used in the preparation of test packages (e.g., tapes, tape manuals, and interface items) or test procedures for automatic, semiautomatic, or manual test equipment. Specifies the test or test conditions required for performance testing and fault diagnosis.	LSAR data can be applied to newly designed or existing items selected for testing on automatic, semiautomatic or manual test equipment on which a TRD does not exist.	The LSAR provides the data necessary to satisfy the requirements of this DID. Transfer the information from input data records C, D, DI, E, and EI and complete the TRD.	There are no output reports which aid in development of this DID. Use the manual LSAR interface procedures.
DI-S-6176, Ground Support Equipment Recommendation Data (GSERD)	Reflects the contractor's recommendations for GSE to support the end article. Provides initial engineering data for review of the contractor's description of a function requiring support together with recommendations for development or procurement of a particular GSE item. Provides availability, logistic support and procurability type data for the GSE being recommended.	The LSAR can be used to support overall systems management action regarding GSE development, procurement, and optimum standardization.	The LSAR provides all of the data necessary to satisfy the requirements of this DID. Transfer the information from input data records E and EI onto the GSERD format	The LSA-005 report can be combined with the nonautomated data records E and EI to satisfy the requirements of this DID.

Table 8 (Concluded)

	HARDWARE BREAKDOWN \ LSAR INPUT DATA RECORDS	A	B	B1	B2	C	D	D1	E	E1	F	G	H	H1	J
LSAR	SYSTEM	A	A	A	A	A	A	A	O	O	A	A	A	A	A
	SUBSYSTEM	A	A	A	A	A	A	A	O	O	A	A	A	A	A
	LOWEST REPAIRABLE ASSEMBLY	N	A	A	A	A	A	A	O	O	O	O	A	A	N
	PART	N	N	N	N	N	N	N	N	N	N	N	A	A	N
	TOOLS/TMDE/ SUPPORT EQUIPMENT	N	N	N	N	N	N	N	O	O	N	N	A	A	N

A = Generally applicable
O = Dependent upon program requirements
N = Generally not applicable

Figure 32. LSAR data record utilization by hardware breakdown level (Source: MIL-STD-1388-2A, 1981, Appendix E)

LSAR data established during the development phase are retained for use during the production and deployment phase. They are used to support logistics analyses and as a basis for design change and requirements for succeeding generations of the materiel acquisition.

LSAR data of specific use by MPT are produced by hardware item. As a result data are produced by the prime contractor as well as by subcontractors who are developing subsystems or components.

Nine sets of standardized LSAR data records may be prepared, depending upon the options exercised by the requiring authority. As indicated above, some of the data records may not be procured. These nine sets are these:

1. Operations and Maintenance Requirements

2. Item Reliability (R) and Maintainability (M) Characteristics

3. Task Analysis Summary

4. Maintenance and Operator Task Analysis

5. Support and Test Equipment or Training Material Description and Justification

6. Facility Description and Justification

7. Skill Evaluation and Justification

8. Supply support Requirements

9. Transportability Engineering Characteristics

In the succeeding paragraphs data LSAR records significant for MPT are listed. Specific instructions for completing these records are in Appendix A, MIL-STD-1388-2A.

1. Data Record C, Operation and Maintenance Task Summary (Figure 33), is used to consolidate the operations and maintenance tasks identified for each reparable assembly. Detailed analyses of the tasks are provided on Data Record D.

2. Data Record D, Operation and Maintenance Task Analysis (Figure 34), provides a detailed step-by-step description of how tasks identified on the C record are to be performed, the specific skill specialty requirements, and task time (manhours and elapsed time). This record is initiated during the detailed design effort. It is not completed until the development stage.

3. Data Record D1, Personnel and Support Requirements (Figure 35), identifies training, personnel, support equipment, and supply support requirements for accomplishing the individual tasks. The D1 record is initiated and completed at the same time as the D record.

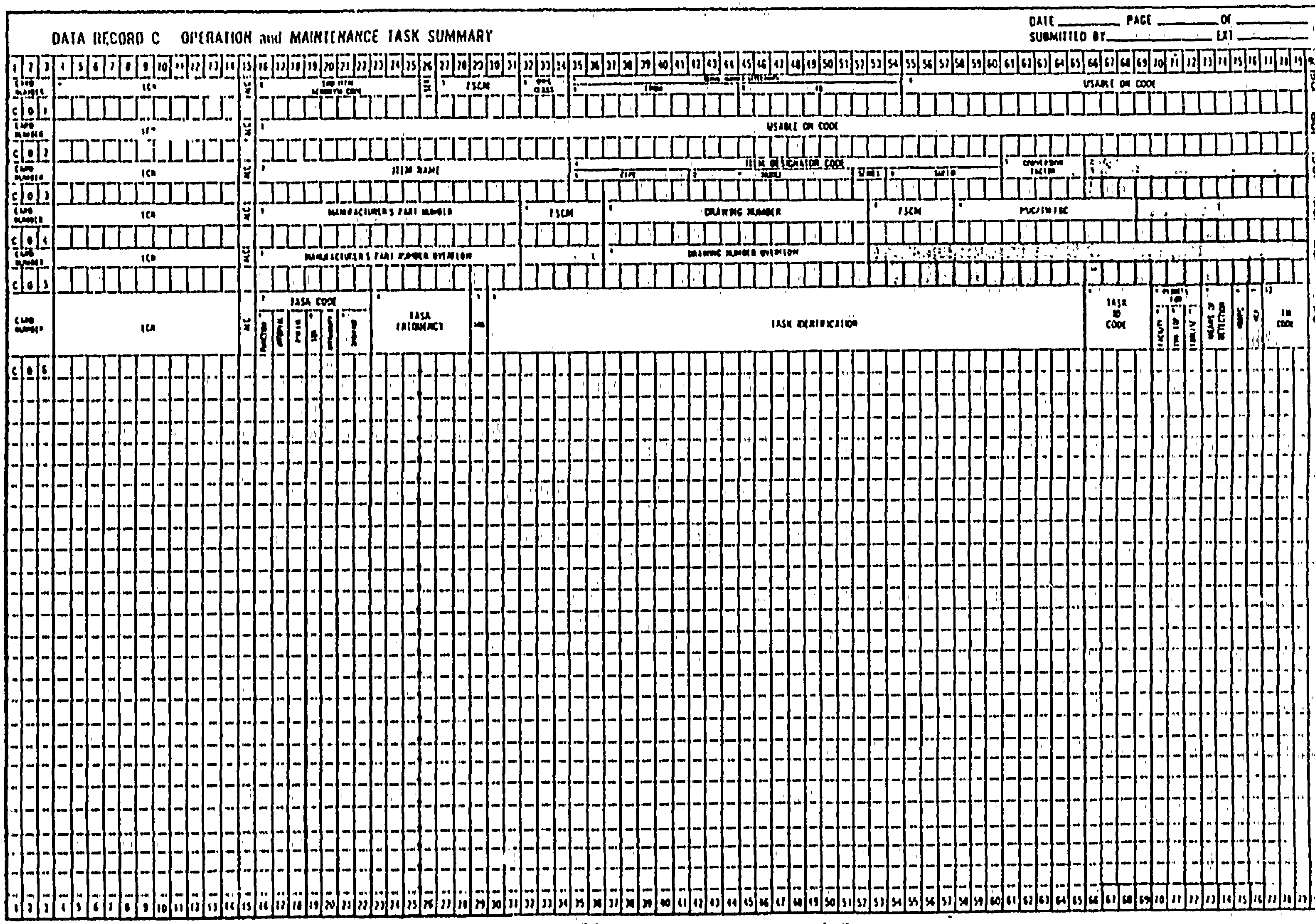


Figure 33. LSAR Data Record C.
(Source: MIL-STD-1388-2A, 1981, Appendix A)

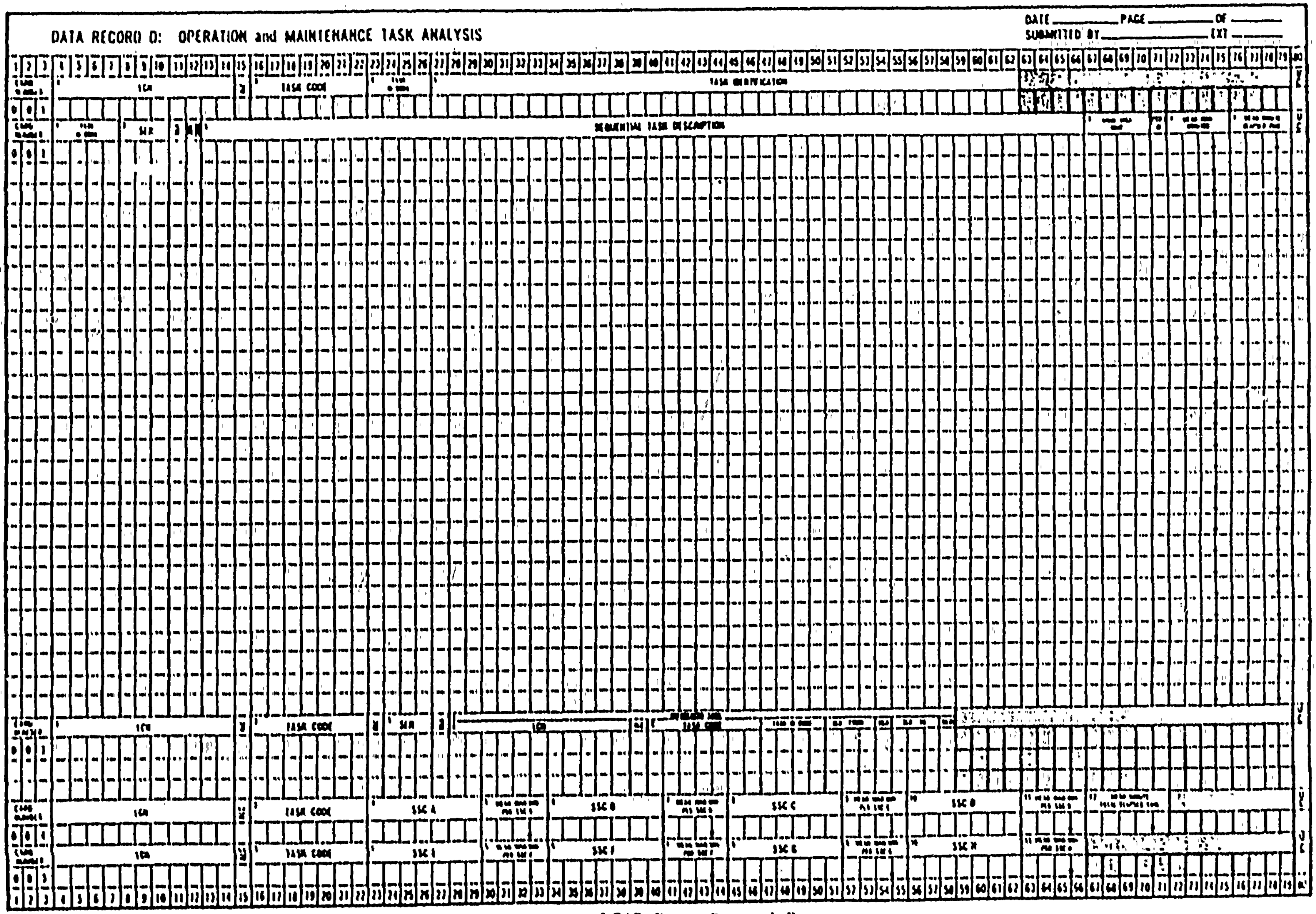


Figure 34. LSAR Data Record D.
(Source: MIL-STD-1388-2A, 1981, Appendix A)

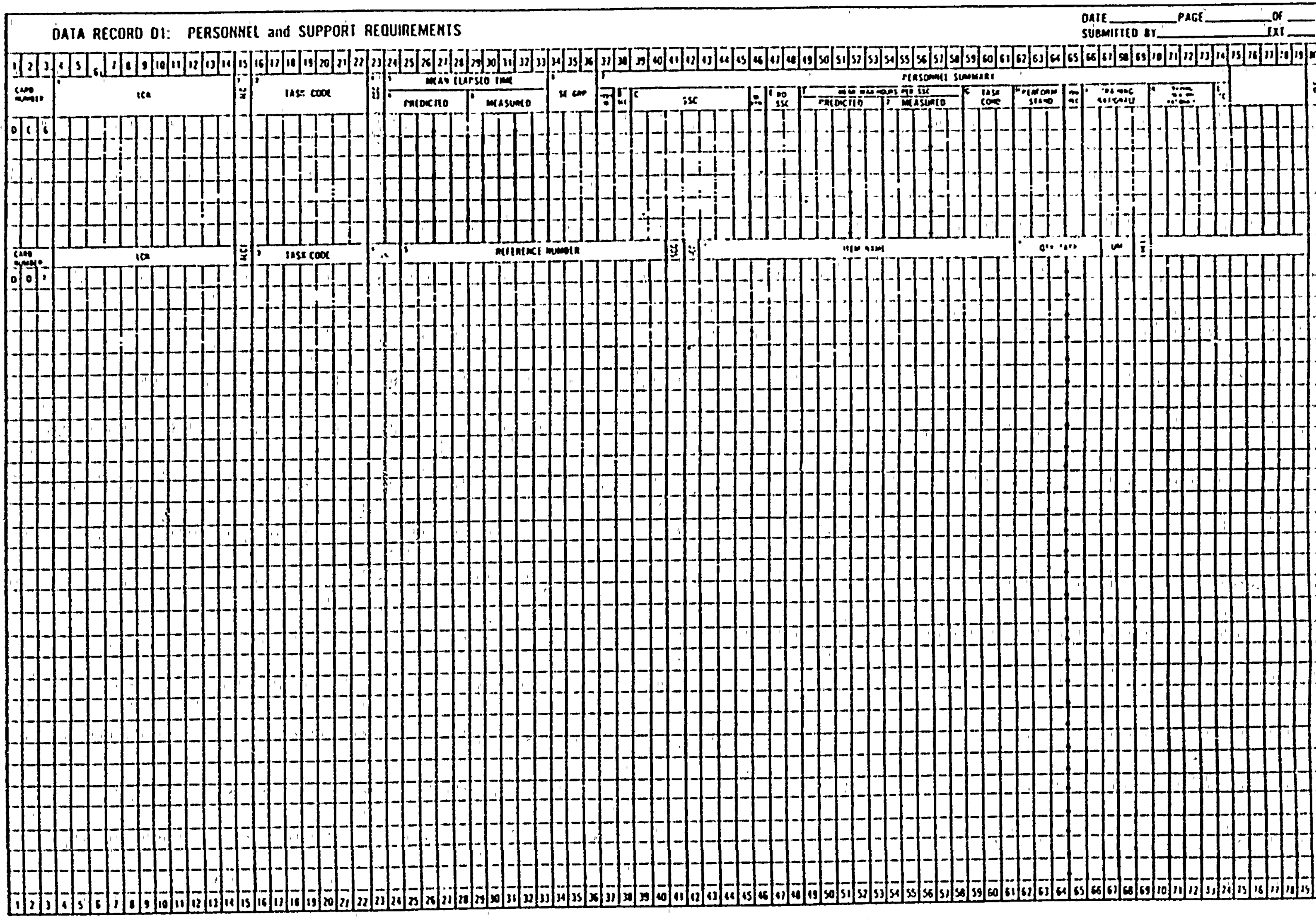


Figure 35. LSAR Data Record D1
(Source: MIL-STD-1388-2A, 1981, Appendix A)

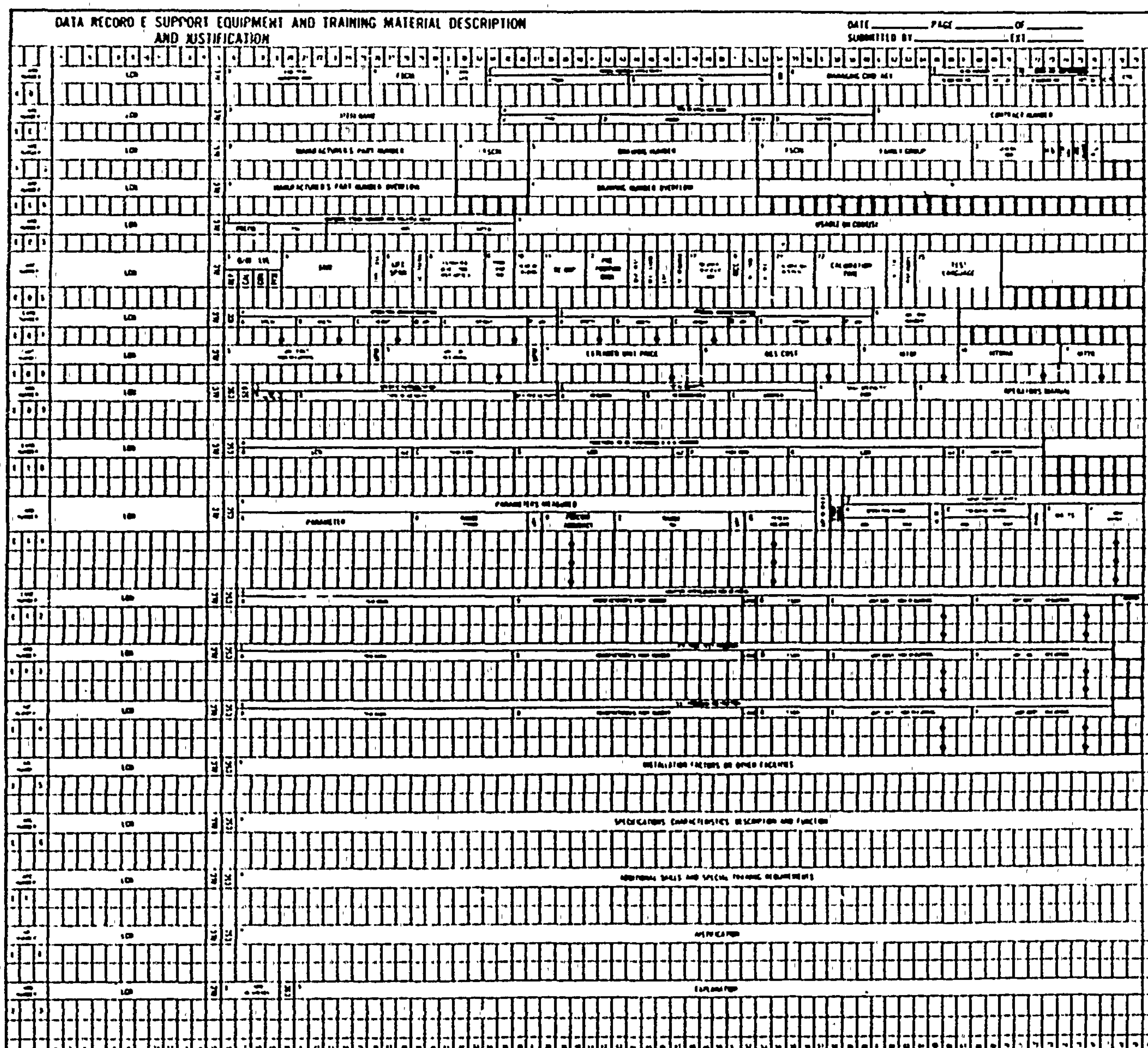


Figure 36. LSAR Data Record E
(Source: MIL-STD-1388-2A, 1981, Appendix A)

4. Data Record E, Support Equipment or Training Material Description and Justification (Figure 36), is structured to consolidate information related to new support or test equipment and training material.

5. Data Record G, Skill Evaluation and Justification (Figure 37), is used to describe and justify any new or modified personnel skills. A separate G record must be completed for each new or modified skill identified during the task analyses recorded on the D record.

LSAR reports with potential significance for MPT are given below:

1. LSA-001, Direct Annual Man-hours by Skill Specialty Code and Level of Maintenance (Figure 38), is a summary of manhour requirements. The manhour values are derived by multiplying the task frequency by the manhours involved and summing those values for each task performed by a particular specialty code.

2. LSA-002, Personnel and Skill Summary (Figure 39), reports the manhours by skill specialty code, expanded on each task.

3. LSA-006, Critical Maintenance Task Summary (Figure 40), reports a list of all tasks that exceed a specific value for task frequency, elapsed time, manhours, or annual manhours.

4. LSA-011, Requirements for Special Training Device (Figure 41), reports operator or maintenance tasks identified as requiring a special training location requirement.

5. LSA-014, Training Task List (Figure 42), provides the rationale for training requirements and training location requirements.

6. LSA-015, Sequential Task Description (Figure 43), provides a task analysis for each task. This summary may be requested to identify all task descriptions applicable to the total system, task identification level, a specific maintenance level, or a specific specialty skill code.

Each of these reports include significant data identification elements useful in a TIES. These elements include skill specialty code recommended for task performance, work unit code, and task identification.

LSA Data Storage and Retrieval

As indicated earlier, the LSA data are developed by the contractor. While MIL-STD-1138-2A requires specific formats, data may either be in a manual, automated, or a combined mode. Most large development efforts should be recorded in the automated mode.

Interviews revealed that most data are stored at contractor facilities. Further, for past development efforts, there are differences in the kinds of data recorded. When LSA data production and recording are complete, data tape files are forwarded to AFLC, but there is no means of accessing them at the

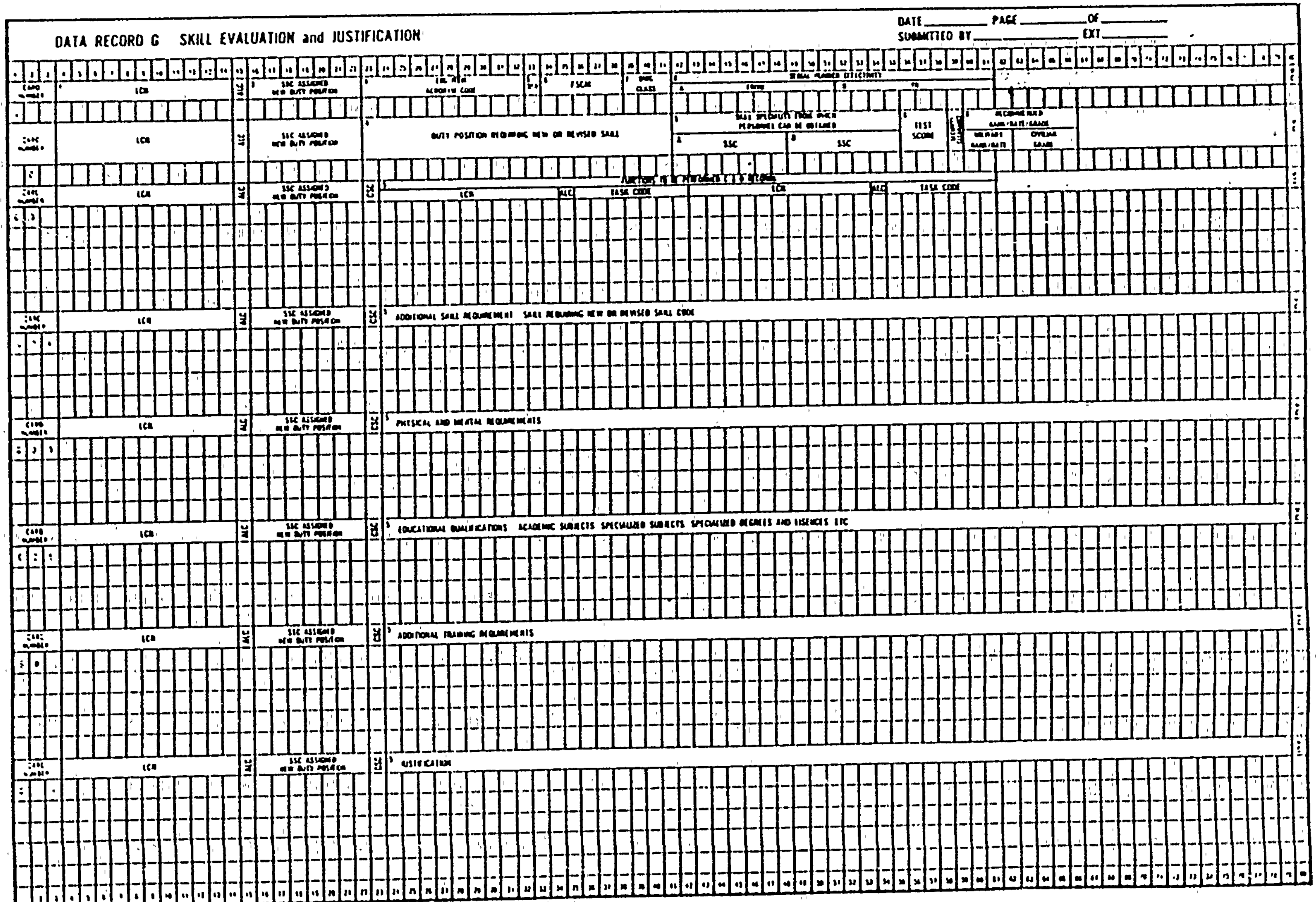


Figure 37. LSAR Data Record G
(Source: MIL-STD-1388-2A, 1981, Appendix A)

LSA-001 RCC A CYCLE 0002 LOGISTIC SUPPORT ANALYSIS RECORD 84/03/06

DIRECT ANNUAL MAINTENANCE MAN-HOURS BY SKILL SPECIALITY AND LEVEL OF MAINTENANCE

EIAC	ITEM NAME	START LCN	ALC	STOP LCN	UOC DCY	SERV DES	SSC
EIAC	REFRIGERATION UNIT	0				ARMY	

NUMBER OF SYSTEMS SUPPORTED BY MAINTENANCE LEVEL:

OPERATOR/CREW	1
ORGANIZATION/ON EQUIP	30
INTERMEDIATE: DS/AVIM/AFLOAT/OFF EQUIP	150
INTERMEDIATE: GS/ASHORE	1
INTERMEDIATE: ASHORE AND AFLOAT(NAVY)	300
SPECIALIZED REPAIR ACTIVITY	3000
DEPOT/SHIPYARDS	1

SSC	OPERATOR/ CREW	ORGANIZATIONAL/ ON EQUIP	INTERMEDIATE: DS/AVIM/AFL/ON EQP	INTERMEDIATE: GS/ASHORE	INTERMEDIATE: ASHOR+AFL (NAVY)	SPECIALIZED REPAIR ACT	DEPOT/ SHIPYARDS
35B20	.0000	.0000	.0000	.0000	.0000	.0000	.2340
35B30	.0000	.0000	.0000	.0000	.0000	.0000	.3460
44B10	.0000	.0000	13.5000	.0000	.0000	.0000	.0000
44E10	.0000	.0000	6.6000	.0000	.0000	.0000	.0000
52C10	.0000	24.5700	15.0000	.0000	.0000	.0000	.0000
52C20	.0000	624.3000	1219.2000	.0000	.0000	.0000	.0000
76J10	54.4964	2.2200	.0000	.0000	.0000	.0000	

TOTAL NUMBER OF MAINTENANCE TASK: 47

NUMBER OF TASK WITH PREDICTED MAN-HOURS: 16 34.0%

NUMBER OF TASK WITH MEASURED MAN-HOURS: 31 66.0%

Figure 38. LSA-001 Summary
(Source: MIL-STD-1388-2A, 1981, Appendix B)

LSA-002 ACC A CYCLE 0002 LOGISTIC SUPPORT ANALYSIS RECORD 03/06/84 PAGE

PERSONNEL AND SKILL SUMMARY

EIAC	ITEM NAME	START LCH	ALC	STOP LCH	UOC	SERV DES	SSC	SS EVAL	DISP OPT
EIAC		0			DCY	ARMY			

NUMBER OF SYSTEMS SUPPORTED BY MAINTENANCE LEVEL:

OPERATOR/CREW	1
ORGANIZATION/ON EQUIP	30
INTERMEDIATE: DS/AVIM/AFLOAT/OFF EQUIP	150
INTERMEDIATE: GS/ASHORE	300
INTERMEDIATE: ASHORE AND AFLOAT (NAVY)	1
SPECIALIZED REPAIR ACTIVITY	3000
DEPOT/SHIPYARDS	1

SSC	LCN ITEM NAME	ALC	TASK CD	TASK INDENTIFICATION	TASK FREQ	MB	SS EVAL	NO SSC	TRN EQP	M-H PER SSC	ANL M-H / ITEM	TOTAL ANL M-H	WIC/III FGC
35B20	002 WIRE HARNESS ASSY		CGDAG	INSTALL WIRE HARNESS ASSY	.200	0	A	01	H	.67 (M)	.13	.13	02
	002 WIRE HARNESS ASSY		RGDAG	REMOVE WIRE HARNESS ASSY	.200	0	A	01	H	.50 (M)	.10	.10	02
35B30	002 WIRE HARNESS ASSY		BGDAG	TEST WIRE HARNESS AS SY	.200	0	A	01	H	.37 (M)	.07	.07	02
	002 WIRE HARNESS ASSY		JGDAG	REPAIR WIRE HARNESS ASSY	.200	0	A	01	H	1.36 (P)	.27	.27	02
44B10	00102 DOOR SIDE LEFT		JGFAG	REPAIR DOOR	.272	0	A	01	H	.33 (M)	.08	13.47	0102
44E10	00102 DOOR SIDE LEFT		JGFAG	REPAIR DOOR	.272	0	A	01	H	.16 (M)	.04	6.52	0102
52C10	0 REFRIGERATION UNIT		HGOAA	REPLACE REFRIGERATIO N UNIT	4.054	0		01	H	.17 (M)	.68	20.67	00
	002 WIRE HARNESS ASSY		ABOAC	ORGANIZATIONAL INSP OF WIRES/CABLES	.300	0	A	01	H	.10 (P)	.03	.90	02
	005 COMPRESSOR ASSY		HGFAA	REPLACE COMPRESSOR A SSY	2.000	0		01	H	.05 (P)	.10	15.00	05
	006 ENGINE ASSY		HGOAA	REPLACE ENGINE ASSY	3.337	0		01	Y	.03 (M)	.10	3.00	06
52C20	0 REFRIGERATION UNIT		HGOAA	REPLACE REFRIGERATIO N UNIT	4.054	0	A	01	H	.46 (M)	1.86	55.94	00
	0 REFRIGERATION UNIT		JGOAA	MINOR REPAIR ACTION	5.405	0	A	01	H	.33 (P)	1.78	53.51	00
	0 REFRIGERATION UNIT		HGOAAAA	FAULT LOCATION - UNI T INOPERABLE	3.007	0	A	01	H	.23 (M)	.69	20.74	00
	0 REFRIGERATION UNIT		HGOAAAB	FAULT LOCATION - INS UFFICIENT COOLING	2.801	0	A	01	H	.25 (M)	.70	21.00	00
	0 REFRIGERATION UNIT		HGOAAAC	FAULT LOCATION - NOI SY OPERATION	5.105	0	A	01	H	.25 (P)	1.27	38.28	00
	00102 DOOR SIDE LEFT		HGOAB	REPLACE DOOR	.572	0	A	01	H	.18 (P)	.10	3.09	0102
	005 COMPRESSOR ASSY		ABOAC	INSPECT ASSY FOR LEA KAGE	6.790	0	A	01	H	.10 (M)	.67	20.37	05
	005 COMPRESSOR ASSY		HGFAA	REPLACE COMPRESSOR A SSY	2.000	0	A	01	H	.70 (P)	1.40	210.00	05
	005 COMPRESSOR ASSY		HGFAG	FAULT LOCATION - COM PRESSOR ASSY	1.800	0	A	01	H	.17 (M)	.30	45.90	05

Figure 39. LSA-002 Summary
(Source: MIL-STD-1388-2A, 1981, Appendix B)

LSA-006 RCC A CYCLE 0002 LOGISTIC SUPPORT ANALYSIS RECORD 03/07/84 PAGE

CRITICAL MAINTENANCE TASK SUMMARY

EIAC	ITEM NAME	START LCN	ALC	STOP LCN	UOC	SERV DES	DISP OPT
EIAC	REFRIGERATION UNIT	0			DCY	ARMY	

CRITICAL CRITERIA 1. THE FOLLOWING TASKS EXCEED 1.00 FOR ANNUAL MAN-HOURS.

2. THIS REPORT COVERS:CREW MAINTENANCE LEVEL(S).

3. THIS REPORT COVERS:SCHEDULED AND UNSCHEDULED TASKS.

LCN	ALC	ITEM NAME	REFERENCE NUMBER	FSCM	TASK CD	TASK IDENTIFICATION	TASK FREQ	MB.	ELAP TIME	M-H/TASK	ANNUAL MAN-HRS	WUC/TM FGC
006		ENGINE ASSY	CCKA-MS/3834J	44940	CBCAC	CHECK ENGINE OIL LEVEL	900.000	0	.06	.06	54.00	06
006		ENGINE ASSY	CCKA-MS/3834J	44940	HGOAA	REPLACE ENGINE ASSY	3.337	0	1.48	1.54	5.13	06
006		ENGINE ASSY	CCKA-MS/3834J	44940	CBOAA	CHANGE OIL AND OIL FILTER	72.000	0	.37	.05	3.60	06
006		ENGINE ASSY	CCKA-MS/3834J	44940	HGOAA	FAULT LOCATION - ENGINE ASSY	3.309	0	.78	.78	2.58	06
006		ENGINE ASSY	CCKA-MS/3834J	44940	BGFAG	TEST ENGINE ASSY AFTER REPAIR	3.337	0	.77	.77	2.56	06
0		REFRIGERATION UNIT	F10000RG-2	94833	HGOAA	REPLACE REFRIGERATION UNIT	4.054	0	.46	.63	2.55	00
0		REFRIGERATION UNIT	F10000RG-2	94833	HGCAAAC	FAULT LOCATION - NOISY OPERATION	5.405	0	.37	.37	1.99	00
0		REFRIGERATION UNIT	F10000RG-2	94833	JGOAH	MINOR REPAIR ACTION	5.405	0	.33	.33	1.78	00
00607		CARBURATOR ASSY	142-0431	44940	DGOAA	ADJUST CARBURETOR	3.336	0	.50	.50	1.66	0607
005		COMPRESSOR ASSY	5D43-139-A	10855	HGFAA	REPLACE COMPRESSOR ASSY.	2.000	0	.75	.75	1.50	05
0		REFRIGERATION UNIT	F10000RG-2	94833	HGOAAAC	FAULT LOCATION - NOISY OPERATION	5.105	0	.25	.25	1.27	00
0		REFRIGERATION UNIT	F10000RG-2	94833	HGCAAAB	FAULT LOCATION - INSUFFICIENT COOLING	3.041	0	.33	.33	1.00	00

Figure 40. LSA-006 Summary
(Source: MIL-STD-1388-2A, 1981, Appendix B)

LSA-011 RCC G CYCLE 0002

LOGISTIC SUPPORT ANALYSIS RECORD

84/06/12 PAGE

REQUIREMENTS FOR SPECIAL TRAINING DEVICE

EIAC	ITEM NAME	START LCN	ALC	STOP LCN	UOC	SERV DES
F16000R	ENGINE ASSY	006			DCY	ARMY

LCN	ALC	ITEM NAME	TASK CD	TASK IDENTIFICATION	TASK FREQ	MB	ELAPSED TIME	SSC	MAN-HOURS	UOC/TM FGC
006		ENGINE ASSY	BCFAG	TEST ENGINE ASSY AFTER REPAIR	3.337	0	.77(P)	52C20	.77(P)	06
		ENGINE ASSY	CBCAC	CHECK ENGINE OIL LEVEL	900.000	0	.06(M)	76J10	.04(M)	06
		ENGINE ASSY	CBOAA	CHANGE OIL AND OIL FILTER	72.000	0	.37(M)	[illegible]2C20	[illegible]	[illegible]
		ENGINE ASSY	HCOAA	REPLACE ENGINE ASSY	3.337	0	[illegible]	[illegible]2C20	[illegible]	06
		ENGINE ASSY	HCOAA	REPLACE ENGINE ASSY	3.337	0	.08(M)	32C10	.03(M)	36
		ENGINE ASSY	HCOAA	FAULT LOCATION - ENGINE ASSY	3.309	0	.78(M)	52C20	.78(M)	06
00614		STARTER ASSY	HCFAG	REPLACE STARTER ASSY	.333	0	.61(M)	52C20	.61(M)	0614
		STARTER ASSY	JQFAG	REPAIR STARTER ASSY	.333	0	.35(M)	52C20	.35(M)	0614

Figure 41. LSA-011 Summary
(Source: MIL-STD-1388-2A, 1981, Appendix B)

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LSA-014   RCC A   CYCLE 0002            LOGISTIC SUPPORT ANALYSIS RECORD                84/02/07  PAGE
                                              TRAINING TASK LIST

EIAC             ITEM NAME                START LCH        ALC      STOP LCH         UOC       SERV DES    SSC
EIAC             REFRIGERATION UNIT       0                                                    ARMY

SSC     LCH     ALC  ITEM NAME            TASK FREQ  MB   TASK CD  TASK IDENTIFICATION   TRN RECOMMENDATION   UUC/TM FGC

35B20   002          WIRE HARNESS ASSY      .200     0    CGDAG    INSTALL WIRE HARNESS  OJT                  02
                                                                    ASSY

TASK CONDITIONS:

PERFORMANCE STANDARD:  SUPERVISION REQUIRED

RATIONALE FOR TRNG:  PROBABLE CONSEQUENCE OF INADEQUATE PERFORMANCE
RECOMMENDATION

RATIONALE FOR TRNG:  TASK LEARNING DIFFICULTY
LOCATION

35B20   002          WIRE HARNESS ASSY      .200     0    RGDAG    REMOVE WIRE HARNESS   OJT                  02
                                                                   ASSY

TASK CONDITIONS:

PERFORMANCE STANDARD:  SUPERVISION REQUIRED

RATIONALE FOR TRNG:  PROBABLE CONSEQUENCE OF INADEQUATE PERFORMANCE
RECOMMENDATION

RATIONALE FOR TRNG:  TASK LEARNING DIFFICULTY
LOCATION

35B30   002          WIRE HARNESS ASSY      .200     0    BGDAG    TEST WIRE HARNESS AS  CLASS AND OJT        02
                                                                   SY

TASK CONDITIONS:  TMDE/ATE/BIT/BITE REQUIRED  SPECIAL TOOLS REQUIRED

PERFORMANCE STANDARD:  SUPERVISION REQUIRED

RATIONALE FOR TRNG:  PROBABLE CONSEQUENCE OF INADEQUATE PERFORMANCE
RECOMMENDATION

RATIONALE FOR TRNG:  THEORY, PRINCIPLES, OR VERBALIZED CONCEPTS REQUIRED
LOCATION
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Figure 42. LSA-014 Summary
(Source: MIL-STD-1388-2A, 1981, Appendix B)

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LSA-015   ACC A     CYCLE 0002              LOGISTIC SUPPORT ANALYSIS RECORD                          84/03/06  PAGE    1
                                              SEQUENTIAL TASK DESCRIPTION

   EIAC         ITEM NAME            START LCN   ALC  STOP LCN   UOC   SERVICE   TSK-CD  TSK-MRG-CD   SSC     MLS      SEQ
   EIAC         ENGINE ASSY          006                         DCY   ARMY

  MAINT   LCN          ALC  TASK TASK-CD  TASK IDENTIFICATION                    TASK   M  PRED ELAP   PRED  MAN    PID   SSC
  LEVEL                      ID                                                  FREQ   B  MEAS TIME   MEAS  HRS
  CREW    006               ABI  CBCAC    CHECK ENGINE OIL LEVEL              900.000  O  (M) 006.00  (M)  000.06  A   76J10

                      REFERENCED      SUB                                                  WORK  PERS MEAN MAN  MEAN ELAP
   TASK SLN INS       TASK SLN INS    TASK  SEQUENTIAL TASK DESCRIPTION                    AREA   ID    MIN        MIN
    ID                ID              CD

  AABI  AAA  A                               WARNING:  DO NOT REMOVE THE DIPSTICK WHILE THE ENGINE
        AAA  B                                  IS RUNNING. OIL MAY BLOW OUT THE OIL FILL
        AAA  C                                        TUBE CAUSING INJURY.
        AAA  D                         S    CHECK ENGINE OIL LEVEL BY OBSERVING THE OIL LINE ON THE         A    000.5      000.5
        AAB                                 ENGINE OIL LEVEL INDICATOR.
        AAC                            S    IF OIL LEVEL IS BENEATH THE 'F' MARK, ADD OIL (CHECK
        AAD                                 AMOUNT ADDED, BEING SURE NOT TO OVERFILL), UNTIL THE OIL            A    003.0      003.0
        AAE                                 REACHES THE 'F' MARK.
        AAF                                    NOTE:  THE OIL LEVEL SHOULD BE CHECKED EVERY 8 HRS.
        AAG                                           USE MIL-L-2104 OIL ONLY

  MAINT   LCN          ALC  TASK TASK-CD  TASK IDENTIFICATION                    TASK   M  PRED ELAP   PRED  MAN    PID   SSC
  LEVEL                      ID                                                  FREQ   B  MEAS TIME   MEAS  HRS
  DS      006               ABH  BGFAC    TEST ENGINE ASSY AFTER REPAIR       003.337  O  (P) 000.77  (P)  000.77  A   52C20

                      REFERENCED      SUB                                                  WORK  PERS MEAN MAN  MEAN ELAP
   TASK SLN INS       TASK SLN INS    TASK  SEQUENTIAL TASK DESCRIPTION                    AREA   ID    MIN        MIN
    ID                ID              CD

  AABH  AAA                                 REFERENCE LCN 006 TASK CODE HGOAA.

  MAINT   LCN          ALC  TASK TASK-CD  TASK IDENTIFICATION                    TASK   M  PRED ELAP   PRED  MAN    PID   SSC
  LEVEL                      ID                                                  FREQ   B  MEAS TIME   MEAS  HRS
  ORG     065               ABJ  CBOAA    CHANGE OIL AND OIL FILTER           072.000  O  (M) 037.00  (M)  000.05  A   52C20

                      REFERENCED      SUB                                                  WORK  PERS MEAN MAN  MEAN ELAP
   TASK SLN INS       TASK SLN INS    TASK  SEQUENTIAL TASK DESCRIPTION                    AREA   ID    MIN        MIN
    ID                ID              CD

  AABJ  AAA                                   NOTE:  ENGINE OIL SHOULD BE CHANGED EVERY 100 HRS.
        AAB                                      USE OIL WITH MIL-L-2104 DESIGNATION OEHDO ONLY.                A    008.2      010.0
        AAC                            S    DRAIN OIL WHILE ENGINE IS STILL WARM.
        AAD                            S    THE ENGINE OIL FILTER SHOULD BE REPLACED AT EACH OIL
        AAE                                 CHANGE.                                                             A    000.3      000.3
        AAF                            E    REMOVE AND RETAIN THE AIR SEAL.
        AAG                            E    REMOVE THE FILTER BY TURNING COUNTERCLOCKWISE, USING A              A    000.5      000.5
        AAH                                 FILTER WRENCH.
        AAI                            E    WHEN INSTALLING THE FILTER FIRST LUBRICATE THE GASKET               A    000.5      000.5
        AAJ                                 WITH ENGINE OIL.
        AAK                            E    SCREW THE FILTER IN UNTIL THE GASKET TOUCHES THE BASE.              A    000.5      000.5
                                            TIGHTEN 1/2 TURN - DO NOT OVERTIGHTEN.
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Figure 43. LSA-015 Summary

(Source: MIL-STD-1388-2A, 1981, Appendix B)

present time. The most readily available access at the present time is through accessing contractor records.

The Unified Data Base (UDB) project, programmed for completion in 1987, should provide easy access to LSAR. Plans call for the UDB to provide an on-line system featuring comprehensive editing and help capabilities, user defined function keys, narrative text editing, illustrated parts breakdown, and data indexing, among many other capabilities. The plan calls for a dial-up capability to access current and historical LSAR. Observation of a demonstration of the development efforts of the UDB to January, 1986, revealed that menu-driven access to the data should make LSAR data easily and quickly accessible.

Reliability and Validity of LSA Data

Two factors affect the stability and accuracy of LSA data. First, the data are supposed to be developed iteratively with provisions made for updating the various records as development indicates changes to be required. Second, estimates of such factors as skill specialty codes and manhours are merely subjective estimates. The technician supplying skill specialty codes may or may not for a variety of reasons select the appropriate code. Further, equipment reliability and maintainability entries have little basis in experience until late in the life cycle. Interviews revealed, for example, that reliability estimates for some equipment items were grossly incorrect. Also interviews indicated that the AFS codes frequently must be changed. In regard to the frequent changes reported as needed in AFS designation, it should be noted that AFS decisions for a new weapons system are the result of negotiations between the personnel classification functions in the Air Force Military Personnel Center (AFMPC) and the major command gaining the new system. The contractor has every incentive to minimize requirements for new MPT resources. On the other hand, the gaining command has incentives to capture resources by advocating new AFSs or shreds of existing AFSs. The AFMPC role is to reconcile the requirements consistent with such guidelines as similarity of task and job requirements, assignment equity, and promotion. While the contractor may be entirely correct in the designation of the AFS to perform a task, these major command and AFMPC considerations may change the designation.

Mulligan and Bird (1980) make this statement about LSAR data in their publication of guidelines for maintenance task identification and analysis, "Analysts may be aware that the quality and technical integrity of LSAR data varies considerably from one program to another (p.37)." Of most use are the LSAR data bases that are required in full by contract and are implemented completely by the contractor with a continuously updated data base. Many times, however, a limited LSA is procured. In some cases the LSA is performed during the conceptual and developmental phases, in which case the LSA data are limited and do not remain current. In other cases, LSA data relevant to the TIES problem are not procured. Also, data sheets E, F, and G are not usually entered into the computer data base.

Uses of LSA Data

Aside from use of the LSA data for design changes and as a basis for future design considerations and for development of technical manuals and publications, use of the data varies. There obviously is a wealth of data for manpower purposes. For each task identified, manhour and elapsed time estimates are provided. Summaries of these requirements by skill specialty code, organizational level, and annual maintenance manhour requirements are available. There have been efforts to utilize these data for LCOM modelling of manpower. Cronk (1986) reported that an LCOM conversion program for inputting data provided by the LSA preprocessor is being developed.

The Aeronautical Systems Division (ASD) of the Air Force Systems Command has accomplished LCOM manpower studies using LSAR for the T-46. Cronk's conclusion is that LSAR summary reports are inadequate for use for LCOM modelling. The C and D data records, however, contained approximately 90 percent of the data required by LCOM, at least for unscheduled maintenance. He stated that the LSA master file from the contractor if processed by the joint ADP system would probably satisfy all of the data requirements, in which case, an interface program could be developed.

Problems in using LSAR, aside from program language, in LCOM include:

1. Blank data fields

2. Data fields with zeros or dummy values

3. Data fields not in prescribed format, because of waivers granted to the contractor

4. Unexpected data entries, e.g., new LSA control numbers

5. Did not contain authorized work unit codes

6. Variable record lengths

7. Government furnished equipment data not in LSA data base

8. Difficulty in producing task networks

In the personnel community, data about recommended skill specialty codes can be useful. They should be used with caution, but they could be the starting point for making classification decisions.

Also, there is a considerable amount of data useful for training development, especially the rationale for requiring training on a task, the task analysis, and tasks requiring special training devices. Unfortunately, these data are available only if the training development personnel know where to obtain hardcopies of the data. Because of the volume of hardcopy data, use of them is difficult. At present a primary user are ISD specialists in the 3306th Test and Evaluation Squadron, Edwards AFB, California.

This organization is charged with developing training materials and providing the initial cadre of trainers who are assigned at the first site implementing a new system operationally. The training development process should begin at least three years before the implementation for such systems as the B-1. In every case, the development process must have a long lead time.

Using specialists from various AFSC who are T-prefix qualified, the 3306th builds course training standards, plans of instruction, and materials. The ISD process is employed, and requires detailed system analysis as its first step. The task analysis reported on LSA-015 satisfies much of the system analysis requirement. Other LSA reports also provide valuable input.

An interview with 3306th T and E Squadron personnel revealed that these data are frequently available too late for their ISD use. Instead, their team members spend time at the contractor site on temporary duty to obtain the same kind of information that later appears in the LSA reports.

While the data developed during this TDY are available for training development for initial resident technical training, its use for this purpose is uncertain. One inhibiting reason is the volume of the hardcopy data. Personnel in the Training Development Service, USAFOMC, were unaware of the scope and content of the data.

Because of their immediate need for the LSA data, the 3306th T and E Squadron is acquiring a terminal for access to the UDB. While data may not be complete, UDB access will provide these personnel with the data available, its updating, and relatively easy access for limited analysis. Any such analysis that could be accomplished appears to be limited to a given data record. Analysis across data records is not available.

Critique of the LSA

1. The LSA data base provides a wide variety of information highly relevant to developing MPT requirements for new and existing systems.

2. Caution in using these data is needed, because they may not be complete data. Also, since some of the data items usually are developed by a single person, they may not be entirely accurate.

3. Attempts to use LSA data in LCOM modelling have encountered problems that need resolving, but manpower modelling can certainly be done. In theory, about 90 percent of the data needed for LCOM simulation is provided by LSA.

4. MPT uses have been limited. Some agencies whose functions could be enhanced by usage of the data were unaware of data scope and content.

5. Criticisms have to do less with the LSA and LSAR _per se_ than with data availability, completeness, and awareness of the MPT community that they exist. Certainly, MIL-STD-138-2A provides the mechanism and guidance for generation and display of data relevant to MPT.

6. One may get a false sense of security about LSAR, because it has an "engineering" veneer. In fact, LSA data relevant to MPT are quite subjective and not dealt with as rigorously as in the case of OSM data or in the operational audits employed to develop input into LCOM.

7. LSAR figures importantly in front-end MPT analysis for new systems. HARDMAN, for example, depends upon the availability of LSAR, either for the new system, or from an older system using comparability analysis, to calculate manpower requirements and assorted training system trade-offs. In some respects, then, LSAR can be thought of as a prototype MPT data base. But obtaining the data in the first place, and updating the data as development progresses, present serious problems for the serious MPT analyst.

VII. INSTRUCTIONAL SYSTEMS DEVELOPMENT

The first step of the Air Force five step ISD process is to analyze system requirements. This analysis requires a needs assessment (Goldstein, 1978) which includes task analysis, organizational analysis, and person analysis. Results of these analyses are used in the second step of the model to define education and training requirements. It is in this step that decisions about what is to be trained are made. Thus, it seems apparent that prerequisite to the first two steps are the requirements to identify tasks that will be performed by those who are trained as well as information to decide the emphasis to be placed on training each of the tasks and how training should be developed.

Origin of ISD

AFR 50-8, AFMs 50-2 and 50-62, and AFP 50-58 specify the requirements and methods for developing instructional programs according to the five step ISD model. While policy requires the ISD process be used in developing training programs, the five step model is most frequently applied to new courses or programs. Interviews revealed that while most of the steps of the ISD model are applied to some degree in every development effort, there is no audit trail of the development efforts. In terms of the first two steps of the model, occupational analysis data as they are available serve as the task identification source. When these data are unavailable, training personnel must generate their own task identification data or find some other source. Information from the occupational analysis data base, such as task difficulty and training emphasis, are also extremely valuable for deciding which tasks are to be trained in resident courses. The OSM data are also useful for other technical training (e.g., advanced courses), but not nearly so much as for resident training for which ATCR 52-22 provides guidelines for applying the OSM data to decisions about initial resident technical training.

The use of Utilization and Training (U&T) Workshops grew out of a Hasty Grad initiative in 1977. U&T workshops are made up of users, trainers, personnel representatives, and occupational analysts. This group, using OSM data and subject matter expert guidance, define training requirements, satisfying the first two steps of the ISD model.

More recently, AFR 50-58 (6 Aug 1984) in paragraph 3b directs that "Anticipated training requirements for each stage in the life cycle of a weapon or support system or for Air Force personnel career qualification are defined by a multicommand Training Planning Team (TPT). The results of TPT efforts are documented in a Training Development Plan (TDP)." Members of a TPT include Hq ATC, using command, and AFMPC representatives.

A TPT can be initiated by the Air Staff (functional manager or other major staff element) through issuance of any of the normal change directives in the Planning, Programming, and Budgeting System (Driskill, Mitchell, & Ballentine, 1985). When such a directive is issued, Hq USAF/DPPT will direct Hq ATC to form a TPT to develop career ladder TDPs. A TPT can be required for a variety of reasons:

1. AFR 36-1 or 39-1 changes requiring significant revision of resident, correspondence, on-the-job, field, or unit level training.

2. U&T workshops or system acquisition plans which identify significant changes in existing training programs.

3. Internal or external evaluation data which identify a training need of a major training user.

The TPT is a highly formalized structure to accomplish ISD. Implementation of this initiative is the first instance in which the ISD model is to be applied to the development of training across a career ladder. Previous ISD applications were directed at segments of an AFS, i.e., initial resident training or command-sponsored training.

Development of ISD Data

As indicated above, personnel involved in application of ISD rely on OSM task identification data when they are available. Other data sources are also used, and when no sources are available, the ISD specialists must develop their own data. They use interviews with subject matter experts and questionnaires administered in person or by mail. In the case of the 3306th Test and Evaluation Squadron, development of tasks and associated data is accomplished at the contractor site or from LSAR if these data are available.

ISD Data

In conducting a systems analysis and determining training requirements, ISD specialists require a variety of information about the jobs that the trained personnel are expected to perform. This information includes:

1. Task identification

2. Task criticality

3. Percentage performing

4. Number performing

5. Frequency of performance

6. Learning difficu

7. Training development time

8. Task analysis (action taken, item acted on, steps of the task, knowledges, and skills)

Proficiency requirements of these items, task criticality, and frequency of performance, are difficult to capture either in interviews or by questionnaire. Criticality may have a variety of meanings to the respondents or interviewees. Unless a clear, precise definition is employed, the reliability of these data can be questioned. Frequency of performance presents two problems. First, frequency data must be captured in an equal interval format; otherwise the data cannot be analyzed arithmetically. Second, decisionmaking from frequency data is difficult. How is a decision rule developed? Should an infrequently performed task be trained in preference to a frequently performed task--or vice versa?

Storage and Retrieval of ISD Data

Data relevant to ISD are recorded on a variety of forms. These data are not automated. Furthermore, interviews revealed that documentation is inadequate. The one exception is the task analysis data being developed by the USAFOMC/OMT where the efforts are systematically documented and accessible through the USAFOMC IBM 4341 system. Data developed by the 3306th TES are available, but they must be manually accessed.

Reliability of ISD Data

When data from the other task identification systems are employed, the reliability of the data of those systems applies. For ISD specialist-developed data, reliability is not assessed. Reliability would depend upon the replicability of the data through successive SME interviews or panels.

VIII. CAN TASK DATA BASES BE LINKED?

Across the various task data bases is a wide variety of information that, if a method of aggregation can be developed, could be highly useful for MPT purposes. Table 9 displays these various kinds of information, identifying each type of data and the task system or systems that produces them. For each information type, the table shows which MPT function can make use of the data. When a M, P, or T is underlined, the function is at least partially making use of the kind of data provided.

Given the variety of information and uses, can the task data systems be linked so that all of the information would be available? The answer is yes. Data elements and literal translations identifying tasks exist in each of the data bases that will permit linking tasks and associated data among systems.

Table 9. Illustration of Task Data Systems and Data Provided

	TASK IDENTIFICATION METHOD				
DATA PROVIDED	OSM	MDC	LCOM	LSA	ISD
Task Identification	MPT	MPT	MPT	MPT*	PT
AFSC	MPT		MPT	MPT*	T
Weapons System	MPT	MPT	MPT	MPT*	T
Sub System	MPT	MPT	MPT	MPT*	T
Component		M T	M T	M T*	T
Crew Size		M	M	M T*	T
Percent Performing	PT				T
Job Structure	MPT				T
Actual or Estimated Time		M	M	M *	
Relative Time	PT				T
Estimated Difficulty				PT*	
Relative Difficulty	PT				T
Consequences				PT*	T
Relative Training Emphasis	PT				T
Task Analysis				T*	PT
Support Equipment	T			T*	PT
Job Satisfaction	P				

* In the acquisition process

But, because of the different way tasks are described among the systems, some manual methods of linking will inevitably be required to supplement an automated linking methodology.

There are several precedents for linking data from different systems. The first of these precedents occurs in the linking of specialty training standard elements and plan of instruction criterion objectives with occupational analysis program tasks and related data. Using the PRTMOD option of CODAP, the USAFOMC provides a matching of survey tasks and the training documents in each survey report. The matching is accomplished by subject matter specialists in the career ladder to which the data apply. Recently an automated matching process based on the semantic content of the different sets of data to be matched was developed to enhance the task and training document matching activity. Subject matter specialist input to fine tune the matching is still required; it is not entirely automated.

A second example of matching data is reported by Monson, et al. (1985). Their purpose was (1) to produce performance-based position descriptions for AFSCs from actual records of maintenance actions; and (2) link these descriptions with occupational analysis tasks and specialty training standards. Extracting historical maintenance data from the F-16 Centralized Data System, Monson, et al. formatted these data into action verb-noun task statements by AFSC. They then obtained occupational analysis tasks performed on the F-16 on the flightline. The third step was to obtain specialty training standards for F-16 AFSCs.

The matching of the three task data sources consisted of three steps. First, subject matter specialists mapped the maintenance tasks onto occupational analysis tasks. Next, the specialists linked the occupational analysis tasks to training standard tasks. Finally, the results of the mapping procedure were validated by additional subject matter specialists.

Monson, et al. state that the mapping methodology "successfully linked maintenance tasks, OS tasks, and STS statements" (p.8). They reported some need, however, to discard occupational analysis tasks and specialty training standard elements. They eliminated from the occupational task list those tasks that had no correlates in the maintenance task data inventory. These tasks were those that would pertain to maintenance on other aircraft and the tasks that maintenance personnel perform in their job that are not recorded under the MDC. They also removed tasks that represent some of the power of the OSM. These were tasks that their subject matter specialists identified as not being performed on the F-16 or as being tasks personnel assigned to this aircraft do not perform. The evidence over the years in which the OSM program has functioned clearly shows that personnel do perform tasks not assigned to their AFSC or thought to be performed by some subset of members of the AFSC. For example, incumbents are sometimes called upon to work on transient aircraft, in which case the historical record of their work could only be found under that aircraft in MDC. Given present inabilities to identify this work in MDC, capturing these tasks in the Monson, et al. study was impossible. But eliminating these tasks is a mistake that must be avoided in a TIES. MDC tasks may not be linkable with all OSM tasks, but this does not mean that the unmatched tasks are not performed or important.

Specialty training standards contain elements that are not task specific, such as understanding of some principle of operation, or safety training. Monson, et al. eliminated this type of task. In the PRTMOD match of OSM tasks and training standard elements, however, the subject matter specialists link the non-task elements with task statements.

To identify the AFSC of incumbents who performed work on the F16, Monson, et al. established an identification code for each participant. Such a code is required if the data are extracted from AFTO 349, since AFSC is not recorded.

The result of the Monson, et al. study was the production of job description reports. These reports could be generated in terms of the maintenance, occupational analysis, or STS tasks. What is not clear in their report is whether there was a one-for-one matching of the tasks, or whether one OSM task or specialty training standard element was mapped to a single MDC task. Experience with PRTMOD matches and the differences of the level of detail of MDC as opposed to the OSM tasks suggest that a one-to-one match is unrealistic.

IX. USER TASK DATA REQUIREMENTS

While members of MPT organizations speak clearly about their missions and organizational objectives, they do not so clearly articulate the needs for data to support their decisions. Most of the organizations rely to varying degrees on data from one of the task data systems. Only one part of the MPT structure, however, has any written guidelines for applying data to the decisionmaking process. ATCR 52-22 establishes rules for applying occupational analysis data in making decisions about what tasks are to be trained and where they are to be trained. Other aspects of the training establishment as well as the manpower and personnel functions are free to use, or not to use, products of the OSM, MDC (except as it is required in LCOM), LCOM, and LSA in the manner they choose.

LCOM is used for determining some maintenance manpower requirements. Interviews with manpower personnel reveal their greatest concern to be inaccuracy of maintenance data. They use the operational audit as a means of obtaining more accurate assessment of task time and crew size. The operational audit is labor intensive and cannot be employed on as wide a scale as necessary to obtain the quality of data the manpower community desires. For the maintenance tasks, little use of occupational analysis or LSA data is conceived by manpower specialists in modelling maintenance manpower requirements. The manpower function requires, for current weapons systems, data on the time required to perform maintenance on a particular end item, and the frequency with which this maintenance must be performed. These data are readily available from MDC. At least two observations about the present manpower practices, however, seem appropriate. First, is a report (McFarland, 1974) of a study of the potential uses of occupational analysis (OSM) data by management engineering teams (MET). The study was requested by Hq, USAF, Manpower and Organization, since both the OSM and MET programs are concerned with task level descriptions of time spent to perform tasks required in the Air Force. The Computer Systems career field (AFSC 51XXX) was chosen as the objective of the study. A job inventory was administered to personnel in the AFSC 51XXX workcenters to obtain the relative time spent estimates. At the same time, the MET performed its time measurements. As noted earlier, the correlation between the two time measures was .79. More importantly for using OSM with LCOM for manpower determinations were these findings:

1. Hierarchical grouping of the OSM data became the basis for a MET recommendation to restructure workcenters.

2. The OSM job descriptions were "extremely useful in the development of workcenter descriptions (p.10)." McFarland indicated that it was felt that significant savings in manhours could be realized by MET during the preliminary phase by using current OSM job descriptions.

McFarland cautioned that OSM data are more useful for large workcenters and the more homogeneous AFSs than for smaller workcenters and heterogeneous AFSs.

A second observation is that manpower specialists occupy a unique position compared to personnel and training specialists. They view the work performed in workcenters first hand. While they are concerned with identifying the proper AFSC for the workcenter, they also are able to observe special qualification requirements. This information would be valuable information if it could be aggregated for personnel classification. In addition, the manpower specialists are a valuable source for mapping functional account codes to AFM 39-1 job descriptions and OSM data.

The McFarland findings have significant implications for integrating manpower and personnel issues. While M and P, as is noted in a subsequent section, operate from different task definitions, an application of OSM data in manpower studies would bring the two functions to a more common meaning. The significance of using OSM in maintenance specialties is probably not so great as its use for LCOM modelling of nonmaintenance specialties. Here there is no source like MDC to build a strawman for operational audit. Coupled with better defined tasks in the OSM and a linear transformation of relative time spent to clock time, LCOM modelling of nonmaintenance manpower needs could be greatly facilitated.

Personnel has responsibility for determining classification structure and defining the overall task, aptitude, educational, and strength and stamina requirements of AFSs. The most efficient classification structure is that which provides the broadest task coverage consistent with the similarity of task skill and knowledge requirements. Certain homogeneity of skill and knowledge requirements must exist within an AFS. As the disparity of knowledge and skill requirements (or lack of homogeneity) among jobs increases, so grows the inefficiency with which AFS incumbents move through assignments. Initial and on-the-job training increase; aptitude, educational, and strength and stamina requirements determinations may also be adversely affected.

The classification function has long relied on occupational analysis data and subject matter specialist input for making job structure decisions. Interviews revealed that classification policy makers would welcome any additional data, such as a TIES could provide, that would assist them in assigning tasks to AFS structure on the basis of similarity of knowledge and skills.

At least two weaknesses of present data sources for making classification determinations are apparent. First, OSM data provide only some of the information needed for classification decisions. The data provide the tasks performed and their work structure, but not the similarity of knowledge and skill requirements. Also, the generic nature of the tasks describing many AFSs frequently does not permit an assessment of the scope of the work required by a specific task, that is, the many different weapons system specific tasks represented by a general task. It is easy to assume, for example, that the knowledge and skills to "install starters on jet engines" are the same, if the number of different jet engines and types of starters are not obvious. In the performance measurement research to develop measures of hands-on performance, however, task analysis revealed the knowledge and skills to be sufficiently different so that separate hands-on measures of installing starters on J-57, J-79, and TF33, had to be developed.

This performance measurement incident also illustrates a second weakness of present data sources. A subject matter specialist conference prior to the task analysis effort had indicated the knowledge and skills involved in installing starters to be so similar that a single hands-on measure could be applied. Obviously, the task analysis revealed otherwise. The point is that subject matter specialists made an incorrect recommendation for the measurement of the generic task. What would have been their recommendation had they had the opportunity to assess the differences of task performance by engine type? One, unfortunately, can only hypothesize that such consideration would have improved their analysis of the task requirement and hence their recommendation. This instance calls into question the whole notion of subject matter expert judgments. Reliability and validity of their subjective judgments must somehow be determined.

Another weakness of subject matter specialist judgment, particularly those judgments based on more general circumstances, is the variation of judgments from one group to another. A case in point is a maintenance specialty (AFSC 326XX) created in 1970 that is undergoing its fourth reorganization under the present effort to combine work centers, which is employing the same methodology as the previous reorganizations.

The crux of the matter is that the personnel classification function is provided only some of the data sources useful to perpetuation of an efficient structure. Information from a TIES should enhance present use of occupational analysis data by providing very specific information about tasks.

Personnel in the various parts of the training function readily appreciated the potential of a TIES. Training personnel must provide the initial, specialized, and on-the-job training for the tasks of AFSs. Whether they are involved in developing training for new systems or equipment or on-the-job training for current systems, or members of staffs of technical training courses or major commands, training personnel require certain basic data about tasks:

1. A statement of each task.

2. A definition of who performs each task.

3. Information on which to base decisions about when and where each task should be trained.

4. Analysis of tasks to be trained into their component steps, knowledges, and skills.

For new equipment or systems, the ISD personnel in the 3306th Test and Evaluation Squadron use LSA data when they are available early enough in the development cycle. Otherwise, the 3306th personnel develop necessary information from other sources, usually through on-site interviews and observation with contractor personnel developing the new equipment. They need access to the LSA data as early as possible.

Trainers in the technical school as well as in the Training Development Service rely on OSM data and utilization and training workshops to decide content of initial training. Once decisions are made on the tasks to be trained, task analysis to define knowledge and skill and task steps is completed by subject matter experts.

Field Training Detachment (FTD) and on-the-job training are position-specific training efforts. FTD training is designed to provide specific instruction on a system or equipment at a given Air Force base. Decisions about what to train in FTD courses present little problem. A greater problem is the sketchy audit trail between initial resident training and FTD training. Accomplishing an audit trail could be easier by existence of TIES that would permit matching of equipment-specific tasks trained with related specialty training standard element and occupational analysis tasks.

On-the-job training is intended to be based on job qualification standards (JQS) developed for various positions of an AFS. These positions may represent job types and corresponding tasks from occupational analysis data. Tasks comprising the JQS are selected to be those on which persons who work in a position covered by the JQS should receive training. Completion of training for all of the tasks results in task certification of the incumbent. In many cases, this certification leads to the skill upgrading of the incumbent. Since survey tasks or an equally generic type of task comprise a JQS, any further definition of them would improve communication. For example, in the install starter case, it would be much more meaningful to know which starter an incumbent had been trained to install.

In summary, each of the MPT functions utilizes data from at least one of the task identification systems. They each need timely, accurate, and complete data at the most specific level possible.

X. TIES APPLICATIONS

While the development of a TIES presents many challenging issues, the benefits to be derived from the implementation of such a system are also many. In addition, there are some actions that can be taken that will facilitate TIES development.

The benefits to derive from a TIES originate in two related sources. First, a TIES will provide task identification from generic to specific levels of detail, including the analysis of tasks into component steps. Any MPT system whose decisionmaking function is based on task information would certainly be enhanced by the more detailed data from TIES. Second, a TIES would provide for a system of detailed audit trails of personnel and training activities and a mapping of their interrelationships.

More specific task information than is now available to MPT functions would be generally useful across the board. Some specific enhancement of MPT activities are listed below: decisions about content of resident technical training courses, specific task identification for FTD and major command training courses, and delineation of job qualification standards (JQS) in terms of specific equipment or systems for which training is provided for certification purposes. Of special importance is the fact that the content of the training delivery systems share no common mapping or interfacing technology. A TIES would provide the technology so that, for example, the tasks on a specific system trained in an FTD could be mapped to the specialty training standard or to tasks trained. A similar analogy also applies to development of a JQS for on-the-job training use.

AOTS and TDS would also be served by more detailed task information. AOTS especially stands to gain from a TIES, because of the requirement for master and local task lists. The first could be generated by a combination of OSM and MDC data as a first-cut master task list in maintenance AFSs. Local job descriptions could be the product of the base level generated MDC combined with other task identification processes at base level.

Development of the TDS technology is based on the creation of task training modules from hierarchical and non-hierarchical grouping of tasks of an occupational survey of an AFS. The scope of these modules would be revealed if MDC data were mapped onto the survey tasks. In fact, without the array of systems, subsystems, and components whose maintenance is reflected by the task training modules, one may be misled about the complexity of the training issue.

When classification is considered, the need for a TIES becomes important also. Classification should put together those activities that have similar knowledges and skills and separate those activities with unlike ones. At the level of occupational survey data and using subject matter opinion about what activities should go together, the issue of similarity of knowledges and skills can easily be lost. Survey data make no provision of the knowledge and skill data, while the interviews infrequently pay sufficient attention to the issue. The problem is that the judgments of senior experts in a field about the ease of performing certain tasks are tempered by their familiarity with the tasks and related knowledge and skills. Unfortunately, what may be easy for an experienced expert is not necessarily easy for someone who is just beginning to learn the work of a specialty. There is a need for a methodology of estimating the degree of difficulty of performing tasks of one kind when the job incumbent has experience with other kinds of tasks, or no experience at all.

A TIES would be especially useful in initiatives like Project SUMMA. The variety of data from TIES, especially if methods of determining the transferability of skills among AFS were fruitful, would provide a large data base showing job structure, job satisfaction, actions taken at the component level, and other data relevant to altering AFS structure to optimize requirements of each of the MPT segments.

For trainers, the idea of a TIES was exciting. The concept of an OSM task referenced to MDC tasks which in turn are referenced to LSA task analysis offers trainers the promise of a large amount of information that must be developed for each task trained. Equally as attractive is the idea that a clear audit trail from training standard to job requirements can be documented.

There also is considerable promise of a TIES for new weapons system MPT issues, especially where comparability analysis is used to arrive at manpower and reliability and maintainability estimates. If the MDC task data of the comparable systems have been mapped to OSM and LSA tasks, then job type, training emphasis, task difficulty, specialty training standard information, and the task analysis results are available for sorting out questions of AFS designations, and definitions of aptitude, educational, strength and stamina, and training requirements.

A significant question for a TIES relates to its potential contribution to MPT integration. The formal interactions of the three functions and the agencies involved were concisely reflected by Armstrong and Moore (1981). This interaction, displayed in Figure 44, is complex and illustrates clearly the variety of impacts that the action of one function has on the other two.

While Armstrong and Moore clearly illustrate the formal structure, the variety of perspectives each of the communities has on MPT issues is not shown. MPT integration will require accommodation of these perspectives. Specifically, each of the MPT functions views the issue of accomplishing work in different terms, and, indeed, there are other players, namely the user and the worker, who are crucial. The user generally will have three variations of the same perspective. At the highest level, the desire is to acquire and train personnel to perform whatever job must be accomplished in the shortest time possible (although the present initiative in SUMMA suggests some softening of this position). At intermediate levels, the perspective is more limited, incorporating the need for job incumbents who can accomplish the work required by the intermediate level and to retain them as long as possible. At the lowest level, the concern is much more specific - the training and retention of personnel to do the specific jobs to which they are assigned. This perspective, while varying in degrees, has strong implications for their view of occupational classification structures.

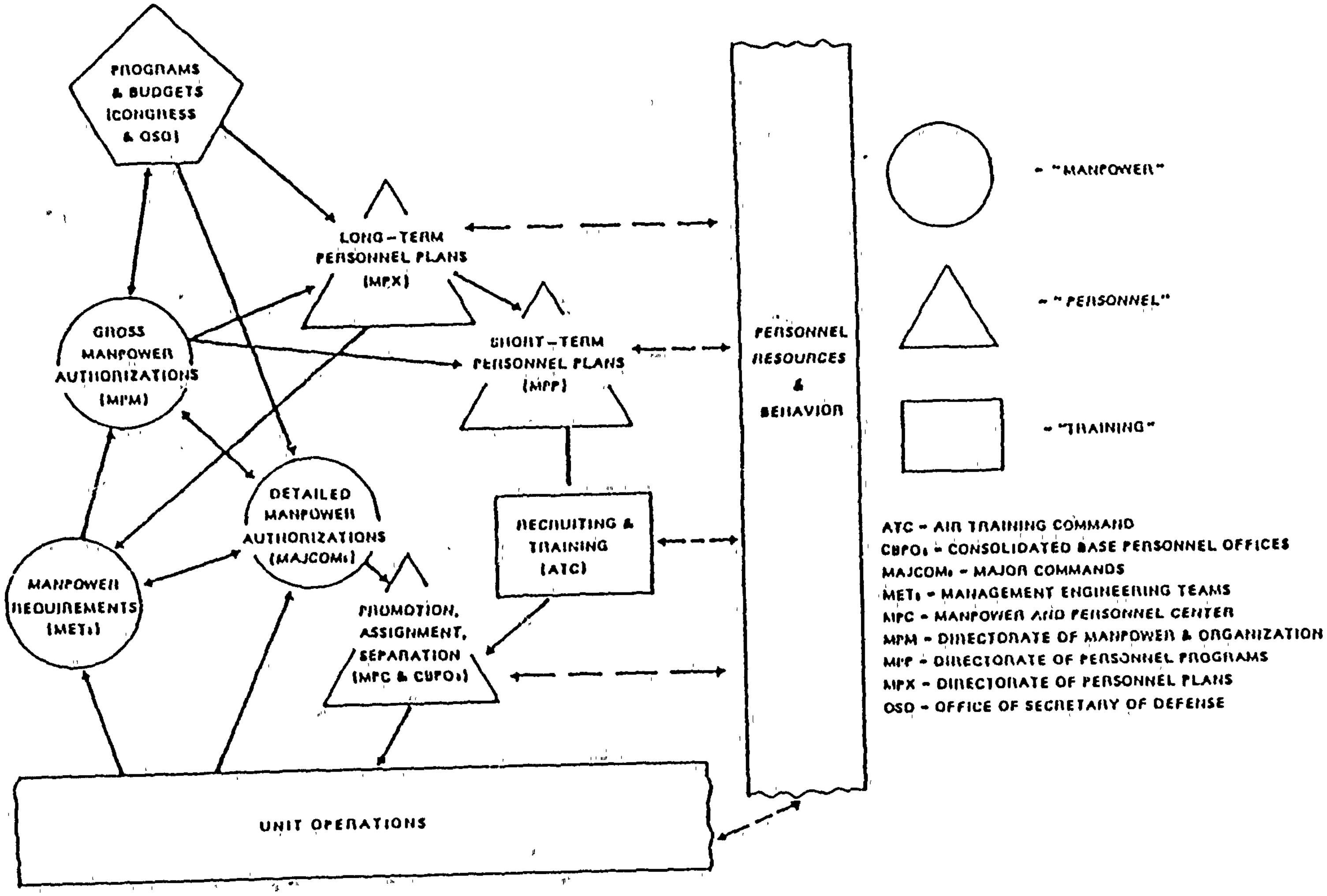

Figure 44. Summary: USAF enlisted manpower, personnel, and training system (From Armstrong & Moore, 1981, p. vi).

Workers have different perspectives. They are concerned with their sense of accomplishment and job satisfaction, the meaningfulness of the work they perform, promotion potential, career progression, and assignment desirability. For example, one has only to look at numerous occupational surveys of AFSs, especially in the maintenance specialties, to see how job incumbent satisfaction has varied within and among specialties as a function of changes in classification structure. This perspective, too, has strong occupational classification implications.

The manpower function must address two basic considerations. First, jobs must be identified and described so that they can be matched to an appropriate AFR 36-1 or 39-1 classification code. Second, the manpower resources necessary to accomplish workload must be determined. As SUMMA shows, as does the TSAR modelling of combat maintenance capabilities reported by Dunigan, et al. (1985), occupational classification structure has a major impact on manpower requirements.

From the personnel perspective, aside from the selection issue, there are several important criteria. Occupational classification optimally would combine into a single structure those jobs in which knowledges and skills are highly similar and where transfer of them from one job to another is at a maximum. . There are additional considerations, however, to structuring. Assignment equity, especially overseas rotation, career progression, promotion potential, and meaningfulness of work (all of essential concern of workers) must be accommodated in occupational classification.

Training is also impacted by the occupational structure. Broad classifications present a very difficult training problem. More narrowly defined classification structure reduces the problem. In a broad career ladder, it simply is cost prohibitive to train all who enter initial resident technical training on all aspects of the AFS. ATCR 52-22 came into existence because of this situation, specifying that training should be provided on the tasks for which the probability of a job incumbent performing them during the first assignment is high. Under this provision, many tasks, especially in broadly structured AFSs, are not trained initially. There is a consequent increased on-the-job training burden. In narrowly-defined AFSs, training can be more economically provided and reduce future training requirements. While the TDS, as do U&T workshops, is addressing this issue, the problem is unlikely to be significantly reduced with regard to initial training without concurrent changes in occupational structures.

It seems clear that occupational classification structure has highly significant MPT impacts. The problem is to optimize the issues or, better, the criteria that M, P, and T, as well as the user and worker, apply to the classification issue. As MPT have functioned, these criteria have not been optimized. In U&T workshops and in TPTs, manpower representation is not required. Summa is attempting to optimize M and P, but T is not a player. In the present effort to combine work centers under RIVET WORKFORCE, the major players are involved, but the efficiency of this effort may be inhibited because of the lack of necessary data about similarity of knowledges and skills.

But, what does this discussion have to do with a TIES? TIES will not solve the issue of MPT integration. A TIES will, however, bring into a single data base a number of sources of information that should facilitate integration. At present neither M, P, or T use more than one data base--and those data bases are different. A "task" to manpower, or to maintenance personnel, is not the same to personnel or to training in deciding what to train. A TIES would not necessarily change their respective definitions of a task, but it would match the different "tasks." Further, a TIES would aggregate a variety of information relevant to MPT issues in a single source, i.e., such factors as tasks, job satisfaction data, job structure, task difficulty, etc. It also is possible that over time the values of the various criteria can be developed, so that they can be weighted according to various situations. If these values and weights can be determined, modelling of occupational classification structure to optimize MPT, user, and worker criteria can become a reality.

Building a TIES is not the most difficult of the problems that lie ahead. Typically, MPT personnel are not data oriented, and time and effort will be necessary, first, to acquaint them with a TIES and, second, to equip them to make use of the data. It is not clear how the various factors should be weighted and integrated.

Interface Problems and Issues

The idea of a TIES for use in MPT is seductive, but its creation and implementation are not without problems and issues of some concern.

1. Historical data, i.e., data presently in the OSM, MDC, LCOM, LSA files, are difficult to access and were not originally developed to interface with any other data system. For these data, whose interfacing will be resource intensive, it is suggested that a TIES be developed on request only. A TIES initiative seems better directed at the actions necessary to align the different systems for interfacing than at the creation of new data.

2. Incorrect or missing WUC or other key identification data will limit the amount of initial automatic linking processes.

3. As with any new or expanded data system, initial use will be limited. Time and training will be required for potential users to become aware of the data system.

4. The variable schedules of occupational analysis surveys and LCOM modelling creates a problem of updating the matching of data. Also, there is the question of when LSA tasks should be matched--at the end of the development phase?

5. Differences of task specificity will require considerable subject matter specialist input to resolve task mapping questions.

Some actions that can be taken in the near term to facilitate future interface are suggested below:

1. Increase compatibility of USAF Job Inventory verb and noun task statements with MDC, LCOM and LSA tasks. This effort can be approached in two ways. First, actions taken statements from the MDC, LSA, and LCOM bases can be adapted to the survey tasks during the inventory development process. Here the USAFOMC may need research assistance to aggregate the different data sources and develop a methodology. Under the pressure to produce inventories and survey reports, the USAOMC has little resource for developmental efforts. Second, inventory format for data collection should be studied from a research perspective. Foley (1980) suggested a revised format that potentially could extend the range of equipment specific data collected in occupational surveys as well as resolve the incompatibility of action verbs. The importance of Foley's suggestion is that it illustrates an alternative approach to data collection format. What Foley's work is not is a job analysis system devised from research findings. It is a suggestion for another approach to collecting maintenance task data through surveys. As such it should not be employed operationally until it is subjected to the same kinds of tests of accuracy and stability of data as the present program underwent. For the success of a TIES, however, reduction of incompatibility of action taken verbs between the SM and the MDC, LSA, and LCOM must be achieved.

2. Increase consistency of task description from one job survey to another, especially between surveys of the same specialty.

3. Devise quality control procedures to assure consistency of coverage of background information items in USAF Job Inventories.

4. Explore feasibility of including workers' AFSC on the AFTO 349.

5. Improve discipline in completing LSA data records and MDC AFTO 349s to assure that correct data codes, especially WUC, are entered.

If data from the four primary systems are successfully related, output which displays the matched data will inevitably raise several crucial questions. First, given the array of equipment included under a certain occupational analysis task, a logical question is "How similar are the knowledges and skills involved in the maintenance action taken among the different equipment?" A related question concerns how a job incumbent, especially a first-termer, can effectively move from performing one set of tasks in an AFS to another set--on different equipment or at different locations. These two questions are at the very heart of the classification problem. They, unfortunately, are not easily resolved, but research which looks at the ability of subject matter specialists to estimate the similarity of knowledges and skills required of tasks among job types or specialties is urgently needed.

In some unreported efforts to obtain estimates known to the author, the thrust was to identify subject matter specialists expert in two or more specialties to provide the estimates. Unfortunately, the supply of such experts was too limited for the purposes. Given, however, a study conducted at the USAFOMC (reported by Falle & Knight, 1983) and the rather extensive work in developing task taxonomies (see for example, Fleischman & Quaintance, 1984), there is sufficient reason to suggest that a methodology could be developed for obtaining estimates useful for determining similarity of jobs.

In the USAFOMC study, senior technicians for three career ladders estimated the amount of training required for a job incumbent in one ladder to perform each of the tasks for the other two ladders. Agreement among raters exceeded .90, and the results revealed that the experts considered a merging of two specific AFSC much more appropriate than any other merger combination.

There also is available some evidence that subject matter experts can provide certain detailed information that, when aggregated, yield acceptable estimates of a factor about tasks. A case in point is a study reported by Rose, et al. (1984) in which the factor to be developed was the complexity of tasks. Rather than obtain estimates of the complexity of each task, Rose, et al. obtained specific kinds of information about the characteristics of the tasks from the subject matter specialists--e.g., the quality of the technical manual describing a task; the logical sequencing of steps of the tasks. An algorithm for combining these data into a single complexity rating was developed. As a result, Rose, et al. were able to rank a set of tasks from most to least complex.

The point to this detour is that there is evidence developing to show that indepth knowledge of two or more AFS may not be necessary to estimate how efficient movement of a worker from one job to another, consisting of different tasks, may be. If research could develop an estimation methodology, the importance of a TIES for MPT would multiply dramatically.

Still another question can arise from the interfacing of a occupational analysis task with its MDC, LSA, and LCOM counterparts. Does the task difficulty rating of the generic OSM task accurately represent the difficulties of the counterpart tasks? In short, using the earlier install starter task example, is the difficulty of installing starters (of different kinds) across all jet engine types the same? Since the task difficulty rating is an important element of aptitude determination for an AFS, resolution of the question is important. There may be differences of difficulty for a given generic task--as some unreported evidence known to the authors tentatively suggests--depending upon the specific equipment upon which the task is performed. In which case, aptitude determinations may be affected.

Since the OSM task statements tend to be fairly general, they provide a high level summary for cross-referencing MDC, LCOM, and LSA items across data systems. It is anticipated that many MDC, LCOM, and LSA data elements will map into each OSM task. Any mapping of MDC, LCOM, and LSA data to OSM task statements will have to be accomplished by a methodology to be developed.

The most obvious methodology is to have subject matter experts manually provide this matching or mapping among the elements in all systems. As this process is potentially very time consuming and costly, it is suggested that data element descriptions in each system be tentatively matched using an automated approach. Perhaps as much as 60 percent of the effort can be accomplished with automated support based on some recent related research. The remaining 40 percent of the effort will consist of subject matter specialist evaluation and correction of the automated matching and completion of mapping which requires substantive expertise. One method of obtaining a preliminary mapping is to require, for all future occupational surveys, inventory development specialists to obtain subject matter expert input about MDC actions taken as they relate to tasks during inventory development interviews. This requirement should be expected to improve task list consistency and coverage, as well as provide the initial and crucial step in interfacing the systems.

The first step in the process would be a cross-matching and mapping of task statements in occupational analysis inventories with each other. This process would raise the OSM tasks above the AFSC level, allowing the selection of tasks from across AFSCs by equipment or system and subsystem--corresponding at least to the MDS and first two levels of the work unit codes in MDC, LCOM, and LSA. A flexibility is created by this action to permit MPT users to access data at whatever level they desire, including the AFSC level. Then, for whatever level chosen, the user could generate a variety of tasks, combat or peacetime, for example, that could be aggregated on a wide variety of criteria, such as task difficulty, percentage performing equipment, mission criticality, crew requirements, training emphasis or training standard requirements, and aptitude requirements. What if questions could be answered, such as "What if a certain set of tasks are aligned to be performed along with another set of tasks?" Would aptitude requirements change; or would job difficulty increase or decrease? The only limit to the analysis potential is imagination.

The format of a TIES is conceptualized as resembling the product of the Specialty Training Standard--OSM data matching produced in occupational analysis reports (see Figure 8). In the OSM matching, the Specialty Training Standard element is more general than OSM tasks. The element, as a result, is the basis for the matching of the tasks. In a TIES, OSM tasks are usually more general than any of the actions taken in MDC, LCOM, or LSA. Because of their more general nature, OSM tasks would be the basis for the matching of the other task data.

Questions to be answered involve LCOM and ISD tasks. LCOM tasks, because action taken codes in MDC are aggregated in the DPSS, are more general than MDC tasks. This situation suggests that LCOM tasks would precede a listing of appropriate MDC actions taken at the component level. Also, in LCOM data preparation, the first three digits of the WUC are often used, the last two digits reflecting component level maintenance being omitted. A second issue is the placement of ISD tasks. They range from a consolidation of OSM tasks, making them very general in nature, to the MDC actions taken on components level.

These issues of format will need resolving. Nevertheless, the general guideline seems to be the arrangement of the tasks (or actions taken) in a hierarchical structure. They would be aligned from the most general to the most specific.

Since the individual task data systems address the pressing needs of their various users, what is the value of a TIES? TIES would integrate the separate systems into a full system capable of accommodating and summarizing very detailed information into more global descriptions and, when necessary, identify the specific sources contributing to each global description.

XI. SUMMARY AND CONCLUSIONS

Four of the five task identification systems, OSM, MDC, LCOM, and LSA provide the MPT community with availability of a variety of task data. These data vary in their content, currency, ease of access, accuracy, and reliability. While each system generally satisfies the uses for which it was designed, a combination of the data from two or more of the data systems would increase the decision data base for MPT issues.

Although tasks are identified in each of the systems at different levels of specificity, there are data elements from each of the systems that would permit development of a system for linking the data bases. There is sufficient task identification data in the individual systems to permit as much as an estimated 60 percent of the linking effort to be accomplished automatically. The remaining 40 percent of the effort would involve subject matter specialists to refine the product of the automatic linking and to map those data that cannot be automatically linked.

Because of the differences in data design, it is recommended that matching historical data be approached on a request basis. Beginning now, however, some actions could be implemented that would facilitate the future linking of the systems. These actions involve making occupational analysis task statements more compatible with MDC task statements, greater consistency of background information section items in occupational surveys, using AFSC on the AFTO 349 in MDC, and greater discipline in the completion of LSA data records to provide more timely and accurate data, particularly work unit codes. In addition, collaboration of OSM and LCOM manpower specialists on reconciling task performance and time issues would be an immediate step to increasing OSM usefulness for LCOM modelling.

The LSA is an excellent source of task analysis information for use in technical publication development and in designing training. Unfortunately, some trainers report that the data are completed too late in the life cycle to be useful for developing the training materials to be used at implementation of a new weapons system. Also, accessibility of the data has been a problem, although the development of the Unified Data Base (UDB) promises to relieve the accessibility issue. In this regard, the 3306 TES is presently embarked on a trial use of the UDB for ISD in concert with the AFHRL. Preliminary indications are that the data handling capabilities of the UDB can contribute greatly to ISD for new systems as practiced by the 3306 TES. Even so, the LSAR must still be bought and still be made available earlier than they usually are for the UDB (or in any other data base management system) to be useful in ISD for emerging weapons systems (or in any other MPT application of LSAR data).

While a linking of the task data systems can be expected to create a more comprehensive data base for MPT purposes, there will yet be missing information vital to these purposes. None of the systems provide for determining the similarity of the knowledges and skills requirements among tasks. This information is crucial to personnel and training activities, especially those like RIVET WORKFORCE (Boyle, 1985) and SUMMA (Boyle, 1986) in which structuring jobs into specialties is the issue.

A TIES is feasible and should be developed. It is a system that could be consistent with the FOOTPRINT and HARDMAN initiatives. It is also suggested that the system be based on the occupational analysis tasks as the highest level of linkage. Development should start with the development of a methodology which would result in raising the OSM data base above the AFSC level and provide accessibility to these data and the data with which they are linked from a variety of perspectives: e.g., weapons system, subsystem, AFSC, actions taken. Linking of MDC, LCOM, and LSA data with survey data would proceed by automatic and manual processes.

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THE APPENDIX

DESCRIPTIONS OF ASCII CODAP PROGRAMS

Descriptions of ASCII CODAP Programs

DICTXX: Lists a description for each computed or background variable currently available for use in the analysis of an AFSC. Background variables consist of information collected directly from the job incumbents and/or raters. Computed variables are created by interacting the background variables and/or task information.

GROUP: Interprets the information contained in a similarity matrix created by the OVRLAP program and produces a clustering solution. This solution may be used by other programs in the system to control the order in which the cases and tasks are reported.

OVRLAP: Creates a similarity matrix for either cases or tasks that can be used by the GROUP program to group together individuals into a totally nested hierarchical clustering solution.

PRTJOB: Prints a job description for any desired group of job incumbents. The job description is an ordered list of task or duty statements. These descriptions are referred to as either a task or duty job description, respectively. The percentage of the members in the group who perform each task or duty, and the average percentage of an incumbent's time that is spent performing the task or duty is listed with each statement.

PRTMOD: Reports task-level data along with summary values for identified sets of tasks called modules.

TASKXX: Lists the tasks contained in the job inventory for the AFSC specified. The tasks statements are grouped together in the listing into modules or duties.