AIR FORCE VEHICLE INTEGRATED MANAGEMENT SYSTEM (VIMS) DATA HANDLING STUDY

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Vehicle Integrated Management System (VIMS) is a base level management system that processes data related to vehicle maintenance. Vehicle maintenance data is collected and processed daily on the B3500 computer. This paper reports on a brief study and evaluation of VIMS that explored possible alternative techniques for improving the handling of vehicle maintenance management data. VIMS strengths and weaknesses are discussed, several near term improvements are suggested, and pursuit of a restructuring of VIMS to operate on-line is recommended.

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INTRODUCTION

BACKGROUND

The Air Force currently has more than 100,000 vehicles being maintained by over 20,000 personnel. These vehicles are maintained at approximately 150 sites having anywhere from 5 to 2500 vehicles per site. Most of the sites are Air Force bases.

An estimated 75% of all vehicles are brought to maintenance facilities at least once per month, either for routine preventive maintenance or for unscheduled repair. Maintenance operations are controlled and coordinated by 4 to 7 people in Maintenance Control. This area is responsible for analyzing and classifying problems which need correction, preparation of work orders for maintenance actions, workload scheduling and control, acquisition and issuance of parts, and quality control of repair work. Maintenance is accomplished in a number of work centers under the direction of work center supervisors.

Data related to the maintenance activities flows daily from Maintenance Control to Reports and Analysis (R&A). R&A prepares this data, together with data from other sources, for daily submission to Data Automation, where it is processed on the B3500 computer by a set of programs called the Vehicle Integrated Management System (VIMS). VIMS is a batch system, performing the daily transaction processing in a computer run of about 45 minutes. VIMS maintains several files of data, including historical and in-process vehicle inventory and maintenance status information, data on individuals who perform maintenance, and a record of parts and fuel used by each vehicle. The daily, weekly and monthly reports generated by VIMS provide the necessary data to support vehicle maintenance management at all levels, including daily operations, squadron level and higher headquarters management of the fleet.

OBJECTIVES

The Directorate of Logistics Systems at the Data Systems Design Center (DSDC) is responsible for the implementation and maintenance of the VIMS software and for the establishment of operational procedures for its use. In March, 1974 ESD/MITRE undertook a four month study for the DSDC, to explore possible alternative techniques for improving handling of vehicle maintenance management data.

Specifically, the study was to consider possible modifications to existing procedures, data forms and data flow, possible addition of new data capture devices, and possible use of on-line support. The latter consideration was stimulated largely by the imminence of AFOLDS (Air Force On Line Data System). AFOLDS is a generalized data base management system being developed by another activity within the DSDC, and current plans call for VIMS to be one of the first Air Force systems to become operational under AFOLDS.

APPROACH

After an initial study of vehicle maintenance and VIMS documentation, a team of people from ESD, MITRE and DSDC made a two week tour of three bases in order to gain a better understanding of actual maintenance procedures, especially those related to the generation and flow of data processed by VIMS. The three bases visited, selected to be representative of a large, medium and small base, were Ellsworth AFB (SAC), Nellis AFB (TAC) and Duluth AFB (ADC) respectively. The knowledge gained from this tour, as supplemented and amplified by documented procedure and discussions with DSDC personnel, forms the basis from which the findings in this report were developed.

SCOPE

Section II of this report presents a baseline description of vehicle maintenance procedures, concentrating on those transactions that are involved with the generation, reporting or use of VIMS data. Having been validated by DSDC, it serves as an agreed-upon description of the current system.

Section III presents some perceived strengths and weaknesses of VIMS.

Section IV contains a number of suggested near term improvements to VIMS. "Near term improvements" is used rather loosely to mean improvements that might be made to VIMS as it is presently structured.

Section V discusses possible long term improvements to VIMS, based on a restructuring of the system that would have it operate in an on-line, interactive mode as opposed to the current batch mode.

Section VI gives study conclusions.

SECTION II

BASELINE DESCRIPTION

VEHICLE MAINTENANCE ORGANIZATION

The standard base level maintenance organization is shown in Figure 1. This section gives a brief overview of the major responsibilities of each area within the maintenance organization.

Base Transportation Officer

The transportation officer manages the maintenance and operations activities of the base vehicle fleet. He assures that his program provides performance in keeping with Air Force standards. In addition, he provides budget reports of the maintenance and operations programs.

Reports and Analysis

The reports and analysis function is under the direct control of the base transportation officer. This work center does most of the data collection and preprocessing, and all of the analysis and formal reporting for the vehicle maintenance and operations activities.

Normally, reports and analysis:

1. Collects work order, parts, gasoline, and manhour data from maintenance control, the work centers and supply.

2. Provides the keypunching services for the vehicle maintenance system.

3. Processes data from maintenance to data automation.

4. Monitors and distributes computer generated status listings and summaries flowing from data automation to the transportation activities.

5. Maintains maintenance data records on the B3500.

6. Maintains a vehicle serv-o-plate master file.

7. Analyzes data to determine performance levels and to identify problems and trends.

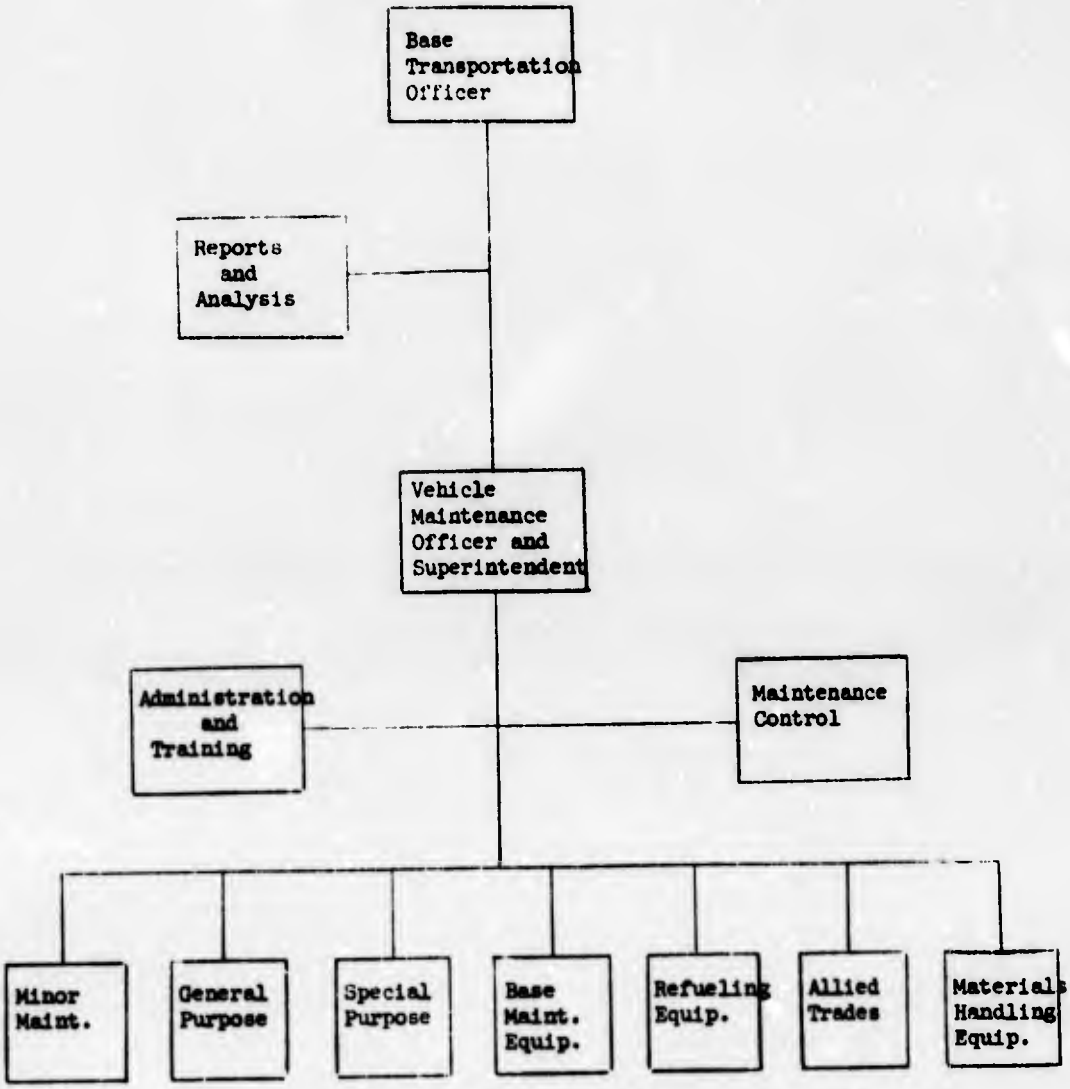


Figure 1. Vehicle Maintenance Organization

8. Provides the transportation officer and selected transportation personnel reports including performance factors, problem areas, trends, and expenditures along with comments and recommendations of possible corrective actions.

Venicle Maintenance Officer

The Maintenance Officer is the manager of the vehicle maintenance system. He controls administration, training, quality control, maintenance control, and the work centers. In accordance with his duties, he:

1. Allocates and coordinates personnel and resources at the maintenance work centers.

2. Monitors the maintenance functions and activities.

3. Analyzes problems and implements necessary corrective procedures.

4. Maintains liaison with user activities.

Vehicle Maintenance Superintendent

The superintendent is the supervisor of all vehicle maintenance shops. He monitors workloads, schedules, and rosters. It is his responsibility to advise shop supervisors of maintenance problems and to advise solutions.

Maintenance Control

Maintenance control, the focal point of the maintenance activity, is under direct control of the maintenance officer. All vehicles arriving at the shop for repairs and/or maintenance are processed in and out by maintenance control. In the shop, all labor and material expended on a vehicle must be authorized by maintenance control. This center also monitors all contract and other government agency maintenance done on fleet vehicles. Four areas of responsibility are work scheduling, work load control, materiel control and quality control. Maintenance control is divided into two sections.

1. Work load control:

   a. Debriefs vehicle operator, inspects vehicle, and schedules vehicle into the shop deferring work when necessary.

   b. Initiates and controls all maintenance work orders.

   c. Conducts quality control inspections and returns vehicle to the using organizations.

   d. Collects parts, work order status, and time cards and forwards them to reports and analysis.

   e. Maintains a vehicle historical record for all vehicles and equipment.

   f. Maintains a contract and other government agency maintenance control file.

   g. Maintains a work load control board and a man-hour availability control board.

   h. Manages the scheduled maintenance program.

2. Materiel Control:

   a. Obtains the parts and tools required for the maintenance activity.

   b. Provides the interface between the maintenance and supply systems.

   c. Monitors the contractor operated parts store (COPARS) operation.

   d. Operates and manages bench stocks, tool cribs, and delayed maintenance parts bins.

Maintenance Shops

The shops are the work areas where the maintenance is actually performed. They are under the control of working shop supervisors whose job is to insure that all maintenance is being completed smoothly and correctly. Large bases have separate shops for general purpose vehicles, special purpose or heavy vehicles, firetrucks, and refueling vehicles. On smaller bases, one central shop handles all maintenance except refuelers which must be maintained in a separate shop because of the fire hazard involved with their fuel cargos. Most maintenance shops contain a minor maintenance berth where operator maintenance or work requiring less than one-half hour to complete is performed.

Mobile Maintenance

The mobile maintenance unit performs scheduled and unscheduled minor maintenance on those vehicles which can not be practically brought into the shops. Vehicles which are inspected and serviced in the field include bulldozers and cranes. Mobile maintenance will also perform emergency minor repairs on other fleet vehicles.

DESCRIPTION OF VIMS

The Vehicle Integrated Management System (VIMS) is a base level data management system which runs in the B3500 computer. R&A processes data into VIMS from the vehicle maintenance operation and VIMS maintains several files including vehicle and employee historical records, vehicle inventory and status records, and vehicle operating cost records. The system does its processing daily in batch mode, the entire process requiring about 45 minutes.

VIMS has been designed to interface the transportation activity with other base level organizations through the B3500 computer. Besides utilizing the maintenance data, VIMS accepts information from and provides it for the B3500 Accounting and Finance System and the base Supply U1050-II System. This interdependence eliminates the need for each organization to maintain duplicate records.

VIMS places particular emphasis on providing all levels of management with the information necessary to make informed managerial decisions. This data is in the form of periodic reports and summaries describing the status and the performance of various elements of the system. Some of these base level reports are utilized by the major command vehicle managers to control the entire vehicle fleet.

In addition to management information, VIMS provides daily and weekly listings for use in the normal operation of the transportation activities. Finally, VIMS supports the base level preventive maintenance system by supplying weekly scheduled maintenance reports.

TRANSACTIONAL DESCRIPTION

The following section describes for Maintenance Control, Materiel Control, the Work Centers and Reports and Analysis (R&A), the primary transactions that relate to the generation, reporting and use of VIMS data. It is not intended to be an exhaustive discussion of all of the transactions which can occur in each of the

control and work centers, but rather to provide a basis for understanding the origin and flow of VIMS data. While the details regarding the manner in which the transactions are performed will vary from site to site, the basic data that is generated remains essentially constant.

Maintenance Control

1. Incoming Vehicle Inspection

   a. Check the Operator Inspection Guide (AFTO Form 37X) for indicated maintenance.

   b. Personally inspect the vehicle.

   c. Read and record current mileage or operating hours.

   d. Note all work to be done on the 37X.

   e. Send the 37X together with the Vehicle Serv-O-Plate to Workload Control to initiate a work order.

2. Initiate Work Order

   a. Check VIMS Vehicle Master List (weekly list) for possible delayed maintenance. If any is indicated, check Delayed Maintenance List (VIMS daily output) to determine reason for deferring and to see if deferred work can now be done (e.g., are parts available). If work can be done, complete the previously initiated work order now being held in suspense file.

   b. Assign a number from the work order register. Record it on the Vehicle Equipment Work Order (AFTO Form 383) and emboss the Form 383 from the Vehicle Serv-O-Plate.

   c. Complete items 2 through 14 on the work order as required. Some of these items such as Registration Number, Management Code, Manufacturer and Model/Type do not have to be filled in if they appear on the Vehicle Serv-O-Plate. The priority assigned to maintenance of the vehicle is based upon the Force Activity Designator (FAD) code of the owning organization and the criticality of the vehicle to the mission.

d. Using the 37X, itemize jobs on the work order. The standard time for each job is entered on copies 1 and 2 but not on copy 3 (shop's copy) of the work order.

e. Check the VIMS Vehicle Master List for possible scheduled maintenance. If any is indicated, check the Scheduled Maintenance List (VIMS weekly list) for specifics, and enter them as separate jobs on the work order.

f. Check the one-time-repair limit on the Vehicle Master List. If it appears that the one-time limit may be exceeded, estimate the cost (materials, direct labor and indirect costs) for all jobs. If the repair estimate exceeds the limit, authorization for repair must be obtained.

g. Ascertain that required resources (space and manpower) are available.

h. Mark the Operator Inspection Guide to be returned to the Vehicle Control Officer (VCO) of the using organization.

i. Pull the Vehicle Historical Record (AFTO Form 271) and check for possible repetitive maintenance. If any is apparent, make note on the work order for the shop to check carefully to determine why.

j. Schedule the vehicle into a work center and update the resource availability data for the center.

k. If any of the assigned jobs were previously deferred, a status card (S-card) is completed and sent to R&A. This input to VIMS will remove the vehicle from the delayed maintenance file and daily list.

l. Send copy 3 of the work order to the work center.

m. Put copy 2 of the work order, together with the Form 271, in a slot on the status board for the selected work center.

n. Send copy 1 of the work order to R&A, where it will be used to create an "Open Work Order" transaction in VIMS. Data from copy 1 is also used by VIMS to update the appropriate record in the vehicle master file and to update data used to produce the weekly scheduled maintenance listing.

3. Add Jobs To Work Order

   a. When the shop discovers added work, they return to maintenance control for authorization.

   b. Maintenance control adds jobs to copies 2 and 3 of the work order.

   c. Check VIMS Vehicle Master List again to be sure that one-time-repair limit is not exceeded.

   d. Ascertain that added resources are available and update availability data to reflect added work.

   e. Return copy 3 of work order to shop.

4. Close Work Order (all jobs completed)

   a. When work is completed, copy 3 of the work order is returned to maintenance control.

   b. Maintenance control insures that necessary quality control inspections are complete, and notifies the user organization that the vehicle is ready.

   c. All work that was performed is posted on the Vehicle Historical Record (AFTO Form 271).

   d. The standard hour estimates for all jobs are transcribed from copy 2 to copy 3 of the work order.

   e. Copy 3 of the completed work order is sent to R&A, to create a "Close Work Order" VIMS transaction. The open entry in the current work order file is closed and the vehicle master file is updated. Information from copy 3 of the work order is reconciled by VIMS against data reported on Work Order Labor Cards (AFTO Form 380) submitted daily by shop personnel. VIMS uses data from both sources to produce a daily excessive labor report.

5. Close Work Order (with deferred maintenance)

   a. Copy 3 of the work order is returned from the shop to maintenance control.

   b. Maintenance control insures that all jobs that can possibly be done have been completed.

   c. Maintenance control insures that all necessary quality control inspections are complete.

d. Deferred maintenance is noted on Form 37X to be carried in the vehicle, and the user is notified that the vehicle is ready.

e. All work performed thus far is posted to the Vehicle Historical Record (AFTO Form 271).

f. The standard hour estimates for all jobs are transcribed from copy 2 to copy 3 of the work order.

g. Deferred jobs are copied onto a new work order. A work order number is not assigned at this time, but the old work order number is marked at the top. The new work order is filed with the 271 form on the delayed maintenance board. If parts are ordered for delayed maintenance, copy 3 of the new work order is given to materiel control.

h. Copy 3 of the original work order is sent to R&A to create a "Close Work Order" VIMS transaction. The open entry in the current work order file is closed, and the vehicle master file is updated. The deferred jobs are noted and the delayed maintenance file and listing are updated accordingly. Work order job reporting is reconciled by VIMS against data reported on the Work Order Labor Cards. VIMS uses data from both sources to produce a daily excessive labor report.

6. Vehicle Down for Parts (VDP) Procedure

a. Shop personnel complete all work possible on the vehicle.

b. When materiel control determines that required parts are not available from COPARS or base supply, the parts are back ordered, the vehicle is posted as VDP on materiel control's status board and maintenance control is notified that the vehicle is being placed on VDP.

c. If maintenance control concurs, the vehicle is declared VDP (for critical vehicles, maintenance control may try to avoid VDP through cannibalization of parts).

d. Copy 2 of the work order is filed with the Vehicle Historical Record in a slot on the VDP status board.

e. Copy 3 of the work order goes to materiel control while awaiting delivery of parts.

f. Maintenance control completes and forwards to R&A a Work Order Status Card (AFTO Form 384), recording the vehicle as VDP. R&A inputs this to VIMS, and the VDP status is subsequently reflected on the delayed maintenance file and listing.

7. Removal of Vehicle From VDP Status

a. When the necessary parts arrive at materiel control, materiel control immediately notifies maintenance control, and returns copy 3 of the work order with bin location of the parts noted.

b. Materiel control completes and forwards to R&A a Work Order Status Card (AFTO Form 384) identifying the bin location of the accumulated parts. This card is input to the daily VIMS run to update the delayed maintenance file and listing.

c. As soon as possible, maintenance control removes their copy of the work order from the VDP status board and assigns the work to the appropriate work center. The work center resource availability status board is updated accordingly.

d. Copy 3 of the work order goes to the shop.

e. Maintenance control completes and forwards to R&A a Work Order Status Card (AFTO Form 384) which R&A inputs to VIMS, removing the vehicle from VDP status.

8. Report New Vehicle

a. Maintenance control initiates an AFTO Form 271, Vehicle Historical Record, for each new vehicle.

b. Maintenance control prepares forms and forwards them to R&A, to be keypunched as A, B, and C cards. When entered into VIMS, A, B and C transactions form the basis for a new entry in the vehicle master file. Note: if the vehicle arrives as a transfer from another site, it is accompanied by a Form 271 and A, B, and C cards for direct entry into VIMS.

Materiel Control

1. Issue Low Cost Bench Stock

   a. A mechanic or supervisor comes to materiel control with a work order and/or parts request for controlled bench stock items costing less than $5.00.

   b. Materiel control issues the part. No costing against the vehicle is required. (At the time the low cost bench stock is replenished from supply or COPARS it is charged to an indirect account that is spread over all vehicles in the fleet).

2. Issue High Cost Bench Stock

   a. A mechanic or supervisor comes to materiel control with a work order and/or parts request for a bench stock item costing more than $5.00 (for some items, the request is to a separate shop, e.g. tire shop, battery shop).

   b. The requested part is issued if available.

   c. A prepunched Q-card for the issued item is completed and forwarded to R&A for input to VIMS. This is a cost accounting transaction, charging the item against a specific vehicle (when high cost bench stock items are replenished from base supply or COPARS, they are charged to a high cost bench stock holding account pending allocation to a specific vehicle).

3. Obtain Parts (in stock) From COPARS (includes parts under $5.00)

   a. A mechanic or supervisor comes to materiel control with a work order and/or parts request for an item from COPARS.

   b. A mechanic or supervisor obtains the required item from COPARS. The COPARS manager completes a COPARS sales slip.

   c. The item is issued to the requestor, and a copy of the COPARS sales slip is sent to A&F. A&F enters data from the sales slip as a transaction in the A&F program on the B3500. A resultant P-transaction output tape is used as input to the daily VIMS run. VIMS uses the P-transaction data to charge COPARS-supplied parts to specific vehicles.

4. Order Parts From COPARS

a. For general purpose vehicles, a mechanic or supervisor will place an order directly with COPARS as required. However, since the central source of parts supply for other vehicles is the servicing Base Supply, the maintenance control section must insure parts are unavailable through Base Supply prior to their requesting any parts for the non-general purpose vehicles from COPARS.

b. After determining that the part is not in stock, materiel control places an order with COPARS.

c. If the vehicle cannot be returned to the fleet without the part it is declared VDP (otherwise, the installation of the part will be considered as delayed maintenance).

d. A copy of the COPAR sales slip is sent to A&F after certification by materiel control, where it is entered by A&F to the required files it maintains on the B3500 and the proper payment is made. The A&F program outputs a P-transaction on tape which is input to the daily VIMS run. When VIMS receives P-transactions it uses them to charge parts to specific vehicles. In the case of delayed maintenance, VIMS finds the work order already closed and rejects the P-transaction. R&A punches a P-card (minus a work order number) and sends it to materiel control to save until the ordered part has been received and issued to a mechanic for installation. The P-card is then completed (the new work order number is entered) and sent to R&A for input to VIMS where it will cause the proper vehicle to be charged for the part.

5. Obtain Parts (in stock) From Supply

a. A mechanic or supervisor comes to materiel control with a work order and/or parts request.

b. Materiel control determines that the appropriate source for the part is supply and that the part is available.

c. The part is ordered from supply and is picked up during the day.

d. Supply generates an input transaction to the U1050-II computer. A VIM card, output from the 1050, is sent to R&A where it becomes an input to the daily VIMS run. The effect is to charge the cost of the part against the specific vehicle for which it was obtained.

6. Order Parts From Supply

a. A mechanic or supervisor comes to materiel control with a work order and/or parts request.

b. Materiel control determines that the appropriate source for the part is supply, finds that the part is not in stock and orders the part. Materiel control must research the part to determine proper part identification, including Federal Stock Number, manufacturer's part number and manufacturer's code.

c. If the vehicle cannot be returned to the fleet without the new part it is declared VDP (for critical vehicles, cannibalization may be authorized). Otherwise, the installation of the part will be considered as delayed maintenance.

d. Supply eventually charges the ordered part against the work order on which it was requested. This transaction on the supply computer (1050-II) generates a VIM card to reflect this charge. The VIM card is sent to R&A where it becomes an input to the daily VIMS run. VIMS recognizes the fact that the part being charged is for delayed maintenance, charges the part to a holding account and produces an H-card. The H-card is returned to materiel control where it is retained until the ordered part has arrived and has been issued to a mechanic for installation. The H-card is then completed and returned to R&A for input to VIMS, where it will remove the part from the holding account and charge it to a specific vehicle.

7. Report Receipt of Delayed Maintenance Parts

a. As parts for delayed maintenance are received, materiel control bins them and notes their location on their copy of the work order.

b. When all parts necessary to satisfy a particular work order have been received, materiel control returns the annotated copy of the work order to maintenance control.

c. Materiel control completes and forwards to R&A a Work Order Status Card (AFTO Form 384) identifying the bin location of the accumulated parts. This card is input to the daily VIMS run, where it is used to update the delayed maintenance file and daily listing.

Work Centers

1. Perform Maintenance

   a. Personnel assigned to work centers perform maintenance on vehicles as described and authorized on work orders.

   b. Work performed, including add-on jobs, is coordinated through supervisors with maintenance control.

2. Man Hour Reporting

   a. Personnel assigned to work centers account for at least 8 hours each day on a Work Order Labor Card (AFTO Form 380).

   b. Prepunched Work Order Labor Cards are supplied by R&A. Personnel record direct labor time by individual job and work order number, and indirect time by labor code.

   c. Work Order Labor Cards are submitted daily to R&A, to become inputs in the daily VIMS run. Several files are updated. Data from Labor Cards is also used in reconciling job reporting on work order close transactions. Data from both sources is used to produce the daily excessive labor report.

Reports and Analysis

1. Prepare and Submit Daily Inputs to VIMS

   a. Vehicle Master Records. Using data supplied by maintenance control, R&A keypunches A, B and C-cards to generate/update records in the Vehicle Master file. In the case of vehicles acquired by transfer, prepunched A, B and C-cards are supplied directly to R&A.

   b. Employee Master Records. Using data supplied by maintenance control, R&A keypunches D-cards to generate/update records in the Employee Master file.

   c. High Cost Bench Stock Master Records. Using data supplied by materiel control, R&A keypunches E-cards to place specified parts in the High Cost Bench Stock Master file.

d. Work Order Open Transaction. Maintenance control will forward to R&A copy 1 of AFTO Form 383 for each work order initiated. R&A will keypunch an F-transaction from the 383 to be used by VIMS to establish a record in the current work order file and to update the scheduled maintenance listing.

e. Work Order Labor Card. Each employee in the manhour accounting system submits a daily record of his time on AFTO Form 380. R&A duplicates the prepunched data on the 380 and keypunches the employee-supplied data. The resulting G-card transactions are part of the daily VIMS input.

f. Delayed Maintenance Parts Cards. When materiel control issues a part obtained from base supply that it has been holding for delayed maintenance, a VIMS-supplied H-card is completed and forwarded to R&A. R&A keypunches the added data and inputs the card to VIMS, where the part is charged to the specified vehicle.

g. Contract and Other Government Agency Maintenance Transactions

(1) Work Order. Maintenance control initiates a work order (AFTO Form 383) for each vehicle to be repaired by contract or other Government Agency maintenance. R&A processes copy 1 of this work order as described in item 'd' above to create an entry in the "Open Work Order" file. After repair, the contractor's invoice is marked with the work order number and forwarded to A&F. A&F inputs cost data into the general A&F system on the B3500, a byproduct of which is a J-transaction on tape for subsequent input to VIMS. VIMS uses the J-transaction to charge the incurred maintenance costs to the specific vehicle.

(2) AF Form 15. When a vehicle is distant from a base and normal contract procedures cannot be accomplished, maintenance performed by a commercial vendor is reported on a USAF Invoice (AF Form 15). The Form 15 is forwarded to A&F and processed through the A&F system on the B3500. The resultant J-transaction tape is input to VIMS, and by association of the vehicle registration number the repair costs are charged to the proper vehicle.

(3) SF Form 149. SF Form 149 (Credit Card) is used for off base purchase of fuel and oil, and for emergency roadside repairs. Where emergency repairs by a commercial vendor are so charged, the SF Form 149 invoice is forwarded to A&F. The costs will be reported to VIMS via a J-transaction in the same manner as described for processing of AF Form 15.

h. Fuel/Oil Issue

(1) AF Form 1251. All fuel and oil issued to vehicles by a base supply agent is recorded on AF Form 1251 (unless issued by automatic fuel dispensing and recording equipment). Base supply forwards daily to R&A the second copy of AF Form 1251 for every accountable fuel/oil transaction (for transient vehicles, the copy of the 1251 is given to the driver to turn in at his home base). R&A punches an M-card from each 1251 to indicate to VIMS the quantity of fuel and oil dispensed to specific vehicles.

(2) SF Form 149 Invoice. The SF Form 149 is used for credit card purchases of fuel and oil from commercial vendors. The vehicle driver returns all 149 invoices to vehicle operations. The dispatcher insures that the invoices are properly completed and sends them to R&A for processing. R&A keypunches M-cards for input to VIMS in the same manner as described for AF Form 1251.

(3) Automatic Fuel Dispensing. Where automatic fuel dispensing equipment is used, a punched paper tape accumulates the transaction data. The paper tape is processed on the U1050-II supply computer, and the 1050 produces VIM cards which R&A inputs directly into VIMS. VIMS internally reformats them to look like M-cards and processes them as in (1) above, to reflect the quantity of fuel and oil dispensed to specific vehicles (for transient vehicles, VIMS outputs a Fuel Return Card which R&A sends to the vehicle's home base).

i. Vehicle Return Transaction. Vehicles assigned to the fleet that receive maintenance at another site are reported to R&A from the other site on an N-card transaction. R&A inputs the N-cards to cause VIMS to update its files to reflect the maintenance performed on transient vehicles. (R&A also punches N-cards as a method of updating scheduled maintenance data for vehicles that have scheduled services accomplished using an AF Form 15 or SF Form 149.)

j. COPARS P-transactions. Parts issued by COPARS are invoiced to A&F. A&F inputs cost data into their general accounting system on the B3500. An output is P-transactions on tape which are input to VIMS in order to charge the parts against specific vehicles within the VIMS system. Where parts are for delayed maintenance, R&A may have to punch P-cards to forward to materiel control (see Materiel Control Transaction for details).

k. High Cost Bench Stock Issue. Materiel control and the tire/battery shop complete and submit to R&A a prepunched Q-card for each high cost bench stock item, tire or battery that they issue. R&A punches the added information and inputs the Q-cards to VIMS, to charge the parts to the specified vehicles.

l. Work Order Status Cards. Maintenance control and/or materiel control submits S-cards to R&A to report on receipt and location of parts for delayed maintenance, to report vehicles on and off of VDP status, to report completion of delayed maintenance and to adjust the reported backlog of manhours for delayed maintenance. R&A punches the S-cards and inputs them daily to VIMS.

m. VIM Material Cost Card. The supply computer will generate a VIM card for parts issued by (or turned in to) supply against a given work order number. R&A inputs VIM cards in the daily run, where VIMS matches the work order number against the Open Work Order file in order to charge the part to a specific vehicle. If work order numbers H8888 or L9999 are used, parts will be charged to the High Cost Bench Stock or Low Cost Bench Stock accounts, respectively.

n. Work Order Close Transaction. Maintenance control forwards to R&A copy 3 of AFTO Form 383 for each completed work order. R&A keypunches W-cards from the completed 383's and includes them in the daily VIMS run. Information from this transaction is used to update several files. Validity checking and cross correlation is performed, including a reconciliation of jobs reported on the work order with jobs reported on the Work Order Labor Cards. If possible, the open work order is closed.

2. Monitor VIMS Input/Output

a. R&A monitors all inputs to VIMS, checking them for completeness and accuracy. R&A prepares inputs for submission to data automation.

b. R&A receives all VIMS output products, checks them for accuracy, resolves errors and discrepancies and attends to error correction. R&A distributes copies of VIMS products as required.

3. Analysis and Report Preparation

a. R&A collects data into tables and charts, monitoring and comparing various performance indicators against recommended standards.

b. Where unfavorable performance or trends are noted, R&A performs further analysis to determine the underlying cause.

c. R&A prepares and submits to the Squadron Commander a monthly report summarizing vehicle maintenance performance, together with an analysis and recommendations for action as necessary.

SECTION III

VIMS STRENGTHS AND WEAKNESSES

STRENGTHS

1. VIMS appears to be quite complete and well thought out in terms of the data being collected and the procedures established for doing so.

2. The system is well documented. The documentation seems complete, thorough and provides clear guidance to system participants.

3. VIMS provides useful information to all levels of management, from higher headquarters to those responsible for daily operations. The feedback of useful products at the level where most of the data is collected and reported is important to the success of any such system.

4. When procedures are followed carefully, VIMS gives uniformity to vehicle maintenance data being reported across many bases.

5. The documented procedures not only describe the data to be collected and the manner for doing so, but also give some useful guidance on how to analyze the data, what parameters to chart, what performance indicators to follow, and outlines further analysis to be carried out when established standards are exceeded.

WEAKNESSES

1. The success of VIMS at any given site is very much dependent upon the motivation and training of system participants, especially R&A and maintenance control. This is more in the way of an observation than a specific system weakness.

2. Some of the output listings from VIMS are formatted in such a way as to be confusing and hard to read. While R&A personnel may learn to accommodate to the formats, it is a more serious problem for products that are distributed outside of R&A. The Scheduled Maintenance Report (PCN N310021), which is distributed to VCO's, is a case in point (see Figure 4).

3. While there is a substantial amount of data being maintained in VIMS files, the only capability for R&A to specify any

additional computer-generated summaries, charts and so forth is through the use of "BLIS" inquiry. As this requires the development of a program deck, the data processing installation is required in most instances to assist in this effort. However, "BLIS" inquiries may not be used for recurring requirements. Such products, as mentioned above, might satisfy local reporting needs or otherwise assist R&A in its reporting and analysis functions.

4. Some key reports such as Manhour Utilization and Vehicle Maintenance Management are only produced monthly. Analysts in R&A indicated that it would be useful to be able to run a month-to-date on some of these reports before the end of the month.

5. Incorrect or incomplete data from work centers and control centers will result in inaccurate or late reports being generated. This problem is related to the first regarding motivation and training, and can become a circular problem. Late or inaccurate reports can reduce the credibility and usefulness of VIMS products to those who should be using them in day-to-day management. The result may be the institution of various local manual schemes, and a poor attitude toward data collection and reporting which ultimately further degrades the system.

6. The prescribed procedure by which maintenance control is supposed to keep track of the available manhours in each work center is weak. The present procedure calls for maintenance control to monitor available manhours for each work center, updating with grease pencil a status board for each center as jobs are scheduled in and completed. It appears that this procedure does not provide particularly useful scheduling data, since in our observation the procedure is seldom followed faithfully, if at all.

7. VIMS cross correlates job reporting on labor cards with job reporting on work orders. There is a built in delay of at least two days in discovering discrepancies, plus another day at least before the discrepancies can be fixed. That is, discrepancies found on today's edit list are from yesterday's run, with labor cards that report on employee's time from the day before yesterday. The longer the delay the more difficult it is to resolve discrepancies, and in the meantime the currency of reported data suffers.

8. Completed maintenance is recorded on the Vehicle Historical Record (AFTO Form 271), using a set of codes to indicate the vehicle subsystems repaired. This historical repair data is used to determine when repetitive maintenance is being performed. The set of codes now being used is not granular enough to accurately identify repetitive maintenance. Verification of what appears to be repetitive maintenance may require examination of narrative remarks or even referral to back work orders.

9. Shop personnel receive the second carbon copy (copy 3) of the work order. The legibility of this copy is often poor. Poor legibility is a contributing factor to the problem of incorrect work order numbers being entered by shop personnel on their labor time cards.

10. The Work Order Labor Card (AFTO Form 380) is a prepunched card, with space for shop personnel to write in the data showing the job-by-job allocation of their time. As the form is presently designed and used, one must write around the punched holes when entering data on the card.

11. The keypunching that R&A does from the Fuel/Oil Issue slips (AF Form 1251) is at least partially duplicated by supply.

SECTION IV

SUGGESTED NEAR TERM IMPROVEMENTS TO VIMS

1. Continue to emphasize the importance of training for personnel involved in VIMS data collection and reporting, especially in R&A and maintenance control. In order for the system to succeed, maintenance control must follow procedures faithfully and accurately, and R&A must have a good, working knowledge of VIMS to be sure that data input and system reporting proceeds smoothly and in timely fashion.

2. Improve the formatting of VIMS reports, especially those that are distributed outside of R&A. A report that is difficult to read and understand may not get used properly if at all, and can be the cause of some hostility toward VIMS and "computerized systems" in general.

   Reformatting examples are given for two reports, the Delayed Maintenance report (PCN N310015) and the Scheduled Maintenance report (PCN N310021).

   Figure 2 shows a page from the Delayed Maintenance report as it is now printed. This report is printed daily, and is used by the workload control section of maintenance control as an aid when scheduling vehicle maintenance. The interspersal of lines of text with the tabular data on the left hand side of the page makes the report hard to read. Also, it is not readily apparent that the line labeled MGT CODE BACKLOG HRS is a line of totals.

   Figure 3 shows a suggested reformatting of the Delayed Maintenance report. The two major problems mentioned above have been taken care of, the first by simply shifting the lines of text to the right hand side of the page, the second by using hyphens to show where totals are taken. Note the hyphen has also been used to clarify column headings, and the titling at the top of the page has been rearranged slightly to make the report title stand out more clearly.

   Figure 4 shows a page from the Scheduled Maintenance report as it is now printed. This report is printed weekly, and is used by workload control when processing vehicles in for maintenance. Copies of the appropriate section of the report are also sent to the Vehicle Control Officer (VCO) of each using organization.

PREPARED 24 APR 84 DELAYED MAINTENANCE REPORT SITE CODE 5 AS OF 24 APR 84 PCN M310015

MGT CODE	REGIST NUMBER	ADD WORK GRP	WORK CTR	W/C NUMBER	DATE DELAY	PARTS AVAIL	BIN LOC	BACKLOG MANHOURS BY DELAYED MAINTENANCE CODE A	B	C	E	E	F	G	H	J	M	L	N
0141	72000000	TA	17231	00904	24085	00000	0000	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	MGT CODE BACKLOG HRS							.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	TOTAL MGT CODE BACKLOG HRS							1.0											
	TOTAL WPCLES DEFERRED 30 DAYS OR MORE							0											
	TOTAL WPCLES DEFERRED LESS THAN 30 DAYS							1											
	TOTAL WPCLES DEFERRED THIS MGT CODE							1											
0225	66814313	TA	17231	40953	24081	00000	0000	.0	.0	7.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	MGT CODE BACKLOG HRS							.0	.0	7.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
	TOTAL MGT CODE BACKLOG HRS							7.0											
	TOTAL WPCLES DEFERRED 30 DAYS OR MORE							0											
	TOTAL WPCLES DEFERRED LESS THAN 30 DAYS							1											
	TOTAL WPCLES DEFERRED THIS MGT CODE							1											
0240	66812203	TA	17231	00907	24071	00000	0000	.0	.0	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
0240	66812403	TA	17232	00907	24087	00000	0000	.0	.0	.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0
	MGT CODE BACKLOG HRS							.0	.0	2.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0
	TOTAL MGT CODE BACKLOG HRS							6.0											
	TOTAL WPCLES DEFERRED 30 DAYS OR MORE							0											
	TOTAL WPCLES DEFERRED LESS THAN 30 DAYS							1											
	TOTAL WPCLES DEFERRED THIS MGT CODE							1											
0242	67887195	TA	17231	00903	24088	00000	0000	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
0242	68889418	TA	17231	00896	24086	00000	0000	.0	.0	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
0242	69881300	TA	17231	00975	24087	00000	0000	.0	.0	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

PCN M310015 PAGE 41 SITE CODE 5 PAGE 1

Figure 2. Sample Page of Delayed Maintenance Report

SITE CODE S
AS OF 04 APR 74
PREPARED 05 APR 74

DELAYED MAINTENANCE REPORT PCN B310015

MDT CODE	REGIST NUMBER	ASG ORG	WORK CTR	W/O NUMBER	DATE DELAY	PARTS AVAIL	BIN LOC	A	B	C	D	E	F	G	H	I	J	K	L	M
B550	66801290	TA	17231	B0830	74043	00000	0000	.0	.0	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
B550	66801290	TA	17233	B0842	74056	00000	0000	.0	.0	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
B550	69800883	TA	17233	B0976	74087	00000	0000	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
								.0	.0	2.5	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0

TOTAL MDT CODE BACKLOG HOURS --------------- 3.5
TOTAL VEHICLES DEFERRED 30 DAYS OR MORE ----- 1
TOTAL VEHICLES DEFERRED LESS THAN 30 DAYS --- 1
TOTAL VEHICLES DEFERRED THIS MDT CODE ------- 2

MDT CODE	REGIST NUMBER	ASG ORG	WORK CTR	W/O NUMBER	DATE DELAY	PARTS AVAIL	BIN LOC	A	B	C	D	E	F	G	H	I	J	K	L	M
K302	[illegible]	TA	17232	B0857	74053	00000	0000	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
K302	[illegible]	TA	17232	B0934	74074	00000	0000	.0	.0	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0
								.0	.0	1.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0

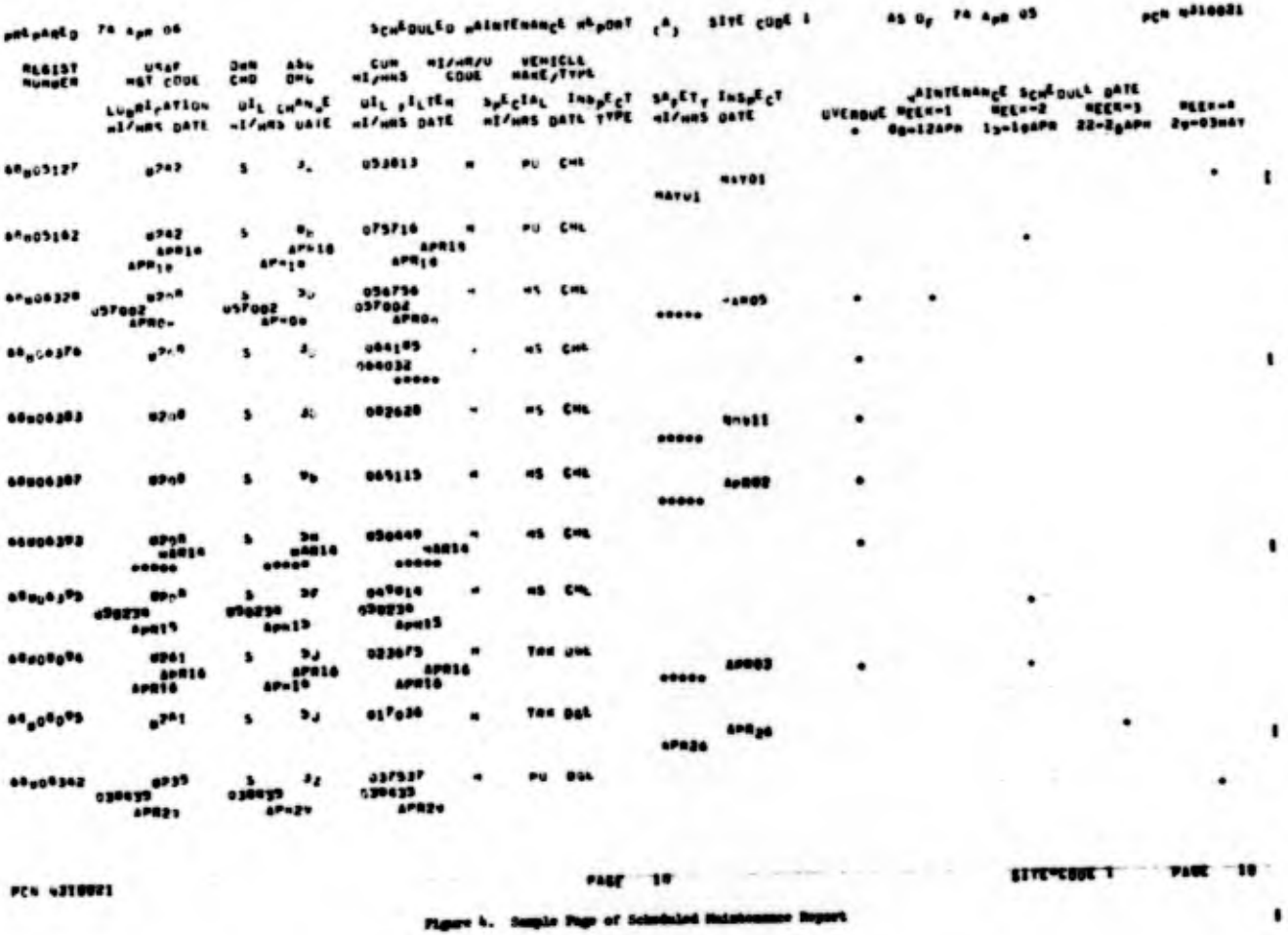
TOTAL MDT CODE BACKLOG HOURS --------------- 2.0
TOTAL VEHICLES DEFERRED 30 DAYS OR MORE ----- 1
TOTAL VEHICLES DEFERRED LESS THAN 30 DAYS --- 1
TOTAL VEHICLES DEFERRED THIS MDT CODE ------- 2

MDT CODE	REGIST NUMBER	ASG ORG	WORK CTR	W/O NUMBER	DATE DELAY	PARTS AVAIL	BIN LOC	A	B	C	D	E	F	G	H	I	J	K	L	M
L801	70L00805	TA	17231	F0890	73306	00000	0000	.0	.0	.0	.0	8.0	.0	.0	.0	.0	.0	.0	.0	.0
L801	70L00806	TA	17233	F0834	74044	00000	0000	.0	.0	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
								.0	.0	1.0	.0	8.0	.0	.0	.0	.0	.0	.0	.0	.0

TOTAL MDT CODE BACKLOG HOURS --------------- 9.0
TOTAL VEHICLES DEFERRED 30 DAYS OR MORE ----- 2
TOTAL VEHICLES DEFERRED LESS THAN 30 DAYS --- 0
TOTAL VEHICLES DEFERRED THIS MDT CODE ------- 2

SITE CODE S PAGE 38 PCN B310015

Figure 3. Delayed Maintenance Report - Reformatted



PCN 4310021 PAGE 10 SITE CODE 1 PAGE 10

Figure 4. Sample Page of Scheduled Maintenance Report

The difficulty in reading this confusing format is compounded in the specific example shown by the fact that the line printer on which the report was generated was out of adjustment, causing a rippling of the printing of some lines.

The primary problem with this report is the interleaving of information, necessitating a double line of headings. Thus the first line of data is associated with the first set of headings, and the next two lines are associated with the second set of headings. The column headings in some cases are confusing as to meaning and tend to run together. The net result is a report that is difficult to understand and to use.

Figure 5 shows a suggested reformatting of the Scheduled Mainteance report. The interleaved lines have been replaced by a split page image, with data pertaining to a given vehicle being continued in a second line in the lower half of the page. The registration number is repeated at the beginning of the second line. Spacing and underscoring with hyphens makes the column headings easier to identify and follow. The two line format under the second set of headings has been compressed to a single line. The item enclosed in parentheses is the due date for the scheduled maintenance, while the item preceding the parentheses is the mileage or hour meter reading at which the maintenance is considered due (five asterisks in parentheses means overdue maintenance). As in the Delayed Maintenance report, the titling at the top of the page has been rearranged to make the report title stand out.

Additional software would be required to accept line images as they are now generated, and accumulate them into page images in order to achieve the split page format. It is felt that the improvement in legibility of the report would be well worth the effort.

3. Provide more support to R&A's analysis and reporting function in the form of computer-generated summaries and graphs. Volume III of AFM 77-310, "Vehicle Integrated Management System" specifies some of the analysis and charting of VIMS data that is required of R&A. An example is the prescribed procedure for manhour analysis. Directions are given on charting direct (D), indirect productive (I) and non-productive (N) manhour percentages for each work center and for all work centers combined. The source for the data is specified as the monthly Manhour Utilization report (VIMS output product PCN N310028). In a case such as this where the data for charting is available to VIMS and the procedure for charting is well established, software could be provided that

SITE CODE 1
AS OF 05 APR 74
PREPARED 06 APR 74

SCHEDULED MAINTENANCE REPORT (A)

FCH H310021

REGIST NUMBER	USAF MDT CODE	OMS CMD	ASG CMD	CUM MI/HRS	MI/HR/U CODE	VEHICLE MAKE/TYPE	MAINTENANCE SCHEDULE DATE: OVERDUE	WEEK-1 08-12 APR	WEEK-2 15-19 APR	WEEK-3 22-26 APR	WEEK-4 29-03 MAY
68805127	BR42	S	3K	053813	M	FU CHE					•
68805162	BR42	S	8B	075716	M	FU CHE			•		
68806328	BR08	S	5D	056756	M	MB CHE	•	•			
68806376	BR08	S	3D	064185	M	MB CHE	•				
68806383	BR08	S	3D	082608	M	MB CHE	•				
68806387	BR08	S	9B	065115	M	MB CHE	•				
68806393	BR08	S	5M	050449	M	MB CHE	•				
68806395	BR08	S	5F	049814	M	MB CHE			•		
68808094	BR61	S	5J	023675	M	2BK BHE	•		•		
68808095	BR61	S	5J	017036	M	2BK BHE				•	
68808342	BR35	S	3E	037537	M	FU BHE					•

REGIST NUMBER	LUBRICATION DUE: MI/HRS	LUBRICATION DUE: DATE	OIL CHANGE DUE: MI/HRS	OIL CHANGE DUE: DATE	OIL FILTER DUE: MI/HRS	OIL FILTER DUE: DATE	SPECIAL INSPECTION MI/HRS	SPECIAL INSPECTION DATE	SPECIAL INSPECTION TYPE	SAFETY INSPECTION MI/HRS	SAFETY INSPECTION DATE
68805127		( )		( )		( )		( )		MAY01	(MAY01)
68805162	APR18	(APR18)	APR18	(APR18)	APR18	(APR18)		( )			( )
68806328	057002	(APR08)	057002	(APR08)	057002	(APR08)		( )		MAR05	(•••••)
68806376		( )		( )	069032	(•••••)		( )			( )
68806383		( )		( )		( )		( )		NOV11	(•••••)
68806387		( )		( )		( )		( )		APR02	(•••••)
68806393	MAR14	(•••••)	MAR14	(•••••)	MAR14	(•••••)		( )			( )
68806395	050234	(APR15)	050234	(APR15)	050234	(APR15)		( )			( )
68808094	APR16	(APR16)	APR16	(APR16)	APR16	(APR16)		( )		APR03	(•••••)
68808095		( )		( )		( )		( )		APR26	(APR26)
68808342	038435	(APR29)	038435	(APR29)	038435	(APR29)		( )			( )

SITE CODE 1

PAGE 10

FCH H310021

Figure 5. Scheduled Maintenance Report - Reformatted

would perform the charting automatically. Figure 6 shows an example of how a computer-generated chart of manhour utilization percentages might be presented on the line printer. A table of actual values from which the chart is derived could be printed beside the chart, and appropriate titling and labeling would be printed as required.

As shown in Figure 7, R&A would simply connect the points on the chart (color codes are presently used) and add any desired annotations such as the utilization goals for the particular command.

Such computer-generated charts could be included directly in the monthly analysis report prepared by R&A, and would help to expedite their end-of-month analysis and reporting.

4. VIMS should allow a month-to-date summary to be run on some of the reports such as Manhour Utilization that are presently available only on a monthly basis. This type of summary data could be useful to R&A during the month. It might also lighten tne end-of-month burden for R&A by allowing "trial balance" runs just before the end of the month. This would allow earlier detection of reporting errors and discrepancies and would allow R&A some time to fix such problems before the final end-of-month reports were run.

5. Eliminate the alphabetic prefix to the work order number. It appears to serve no useful purpose, and is a frequent source of error when hand transcribing the work order number.

6. The system codes now used on the Vehicle Historical Record (see Figure 8) to indicate the vehicle subsystem(s) that were repaired should be expanded beyond the present set of 40. Many of the present categories are so broad that it is difficult to identify true repetitive maintenance without referring to narrative comments or to back work orders for specific details. It is possible, for example, to have several items under the general heading of "08-ELEC. SYS/LIGHTS" that are unrelated in the sense that they do not indicate repetitive maintenance.

   An expansion of codes that would allow up to ten subcategories under each major subsystem might be adequate. This would mean adding another digit to the present two-digit code, e.g., 13.4 might represent BRAKES-MASTER CYLINDER. A disadvantage of expanding the codes would be the necessity for either redesigning the present Vehicle Historical Record (AFTO Form 271) and/or the use of an auxiliary list in order to determine the proper system code to assign.

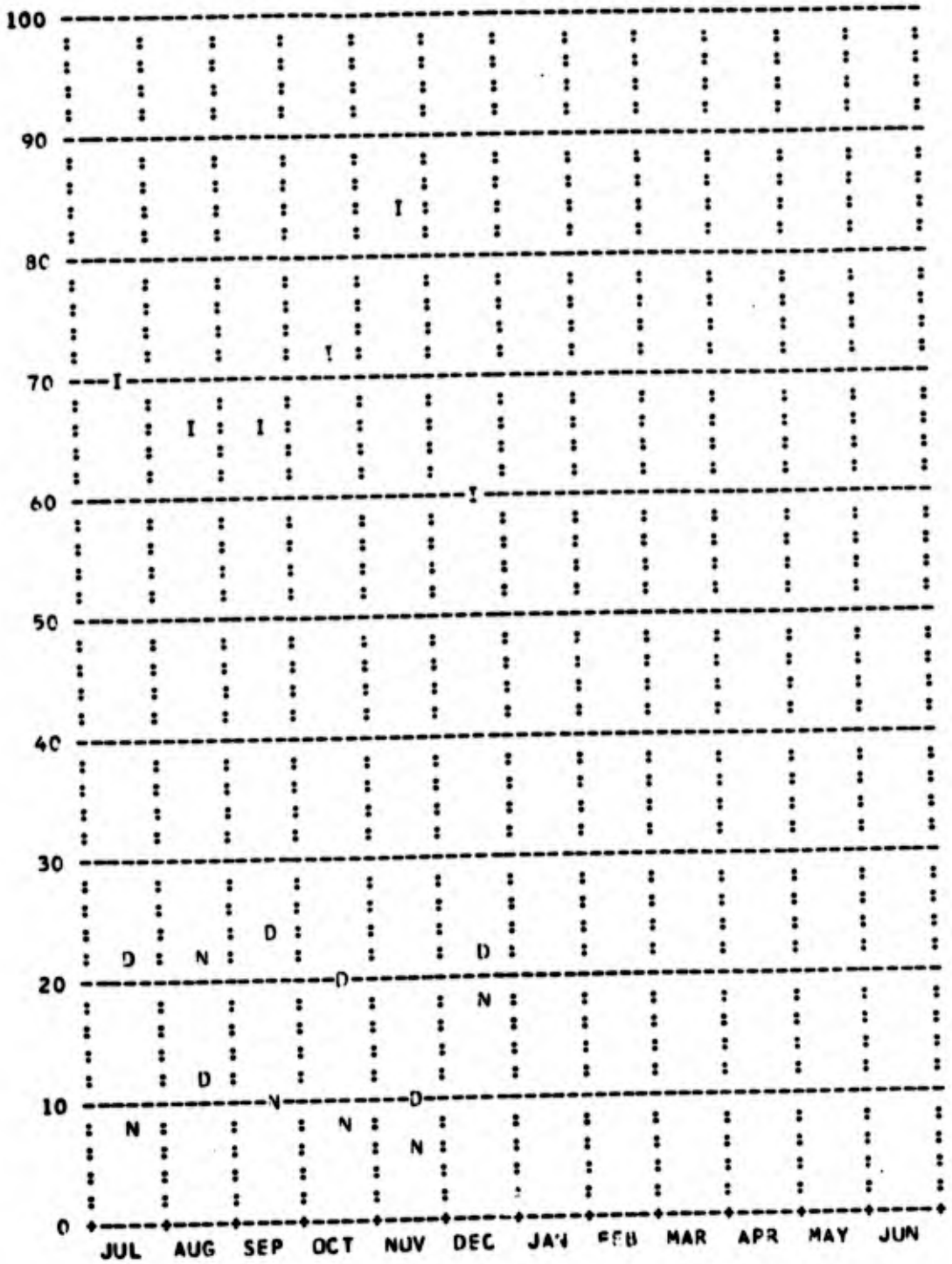


Figure 6. Computer-Generated Manhour Utilization Chart

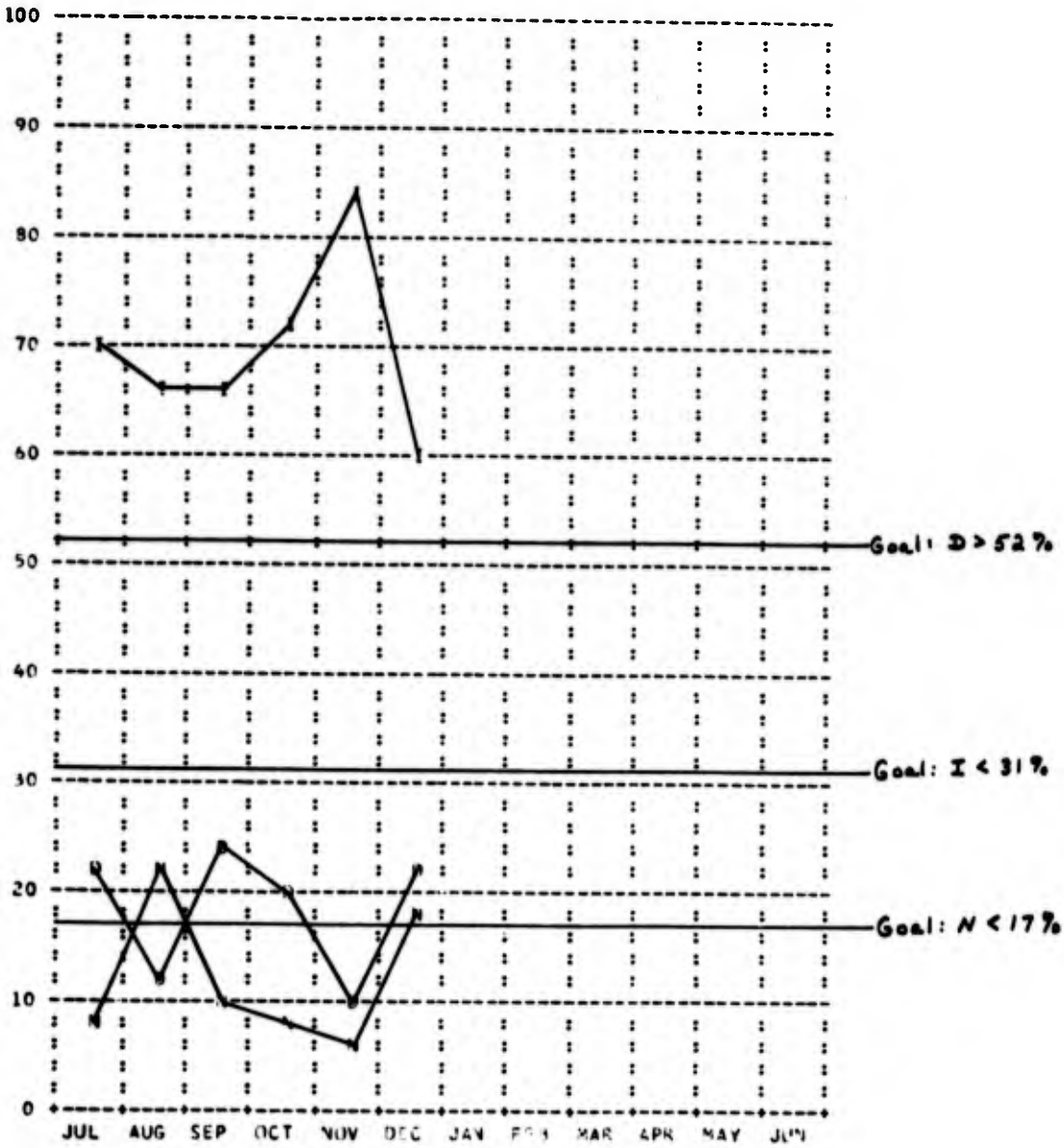


Figure 7. Computer-Generated Chart, Completed by R&A

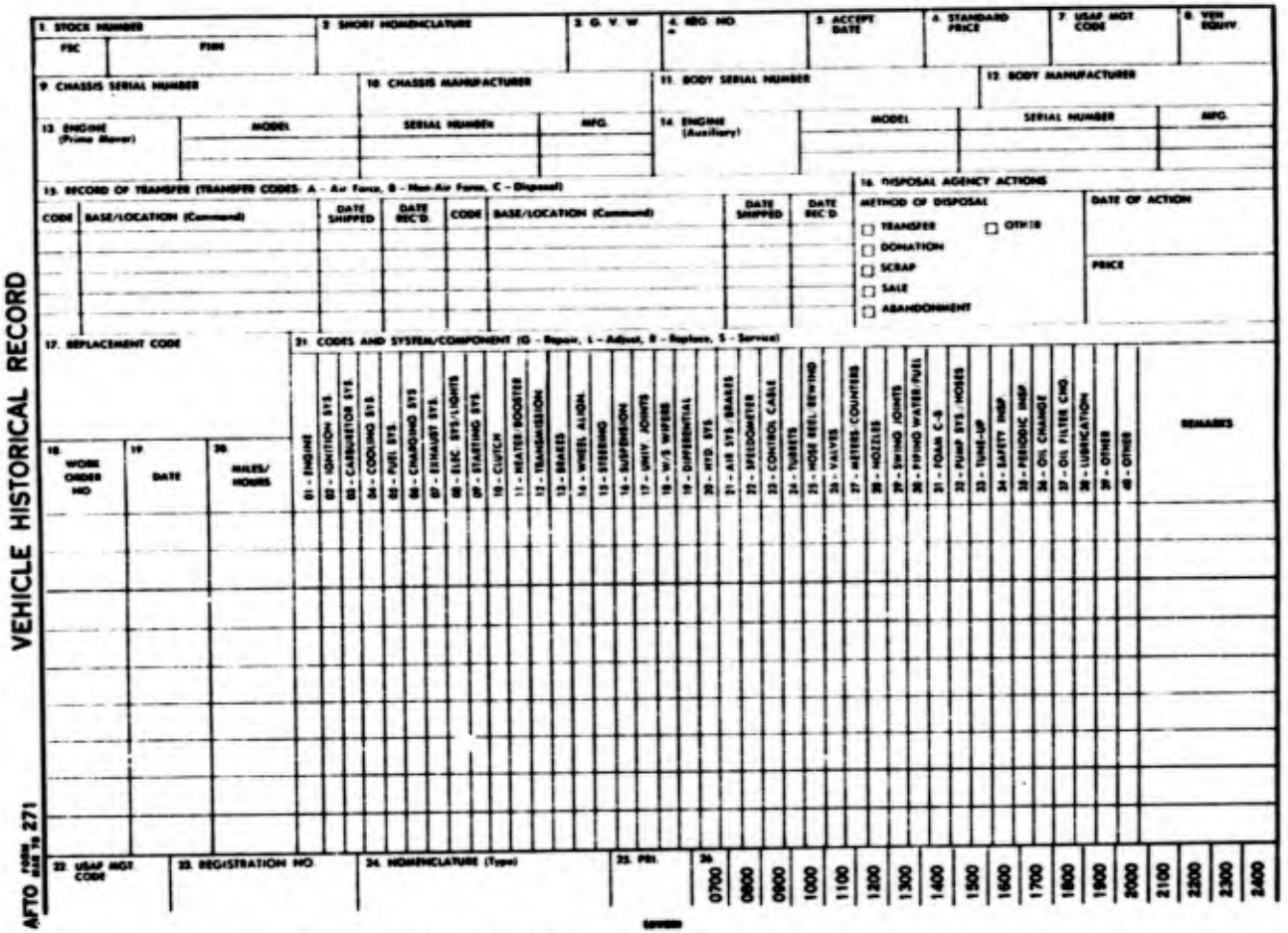


Figure 8. Vehicle Historical Record

7. The Work Order Labor Card (AFTO Form 380) should be redesigned so that maintenance personnel do not have to write around punched card holes when recording their time. Figure 9 illustrates the card as it is currently used.

8. R&A should reach an agreement with base supply that would eliminate the duplication of effort that presently exists in keypunching data from Fuel/Oil Issue transaction slips (AF Form 1251). Where automatic fuel dispensing equipment is used, supply already is providing R&A with punched cards that meet the requirements for input to VIMS. Where the automatic equipment is not available (which is generally the case), R&A punches one card for each slip while supply batches them and punches summary information. Supply should either punch all of the data and provide a copy to R&A, or should be provided with a copy of R&A's processed data.

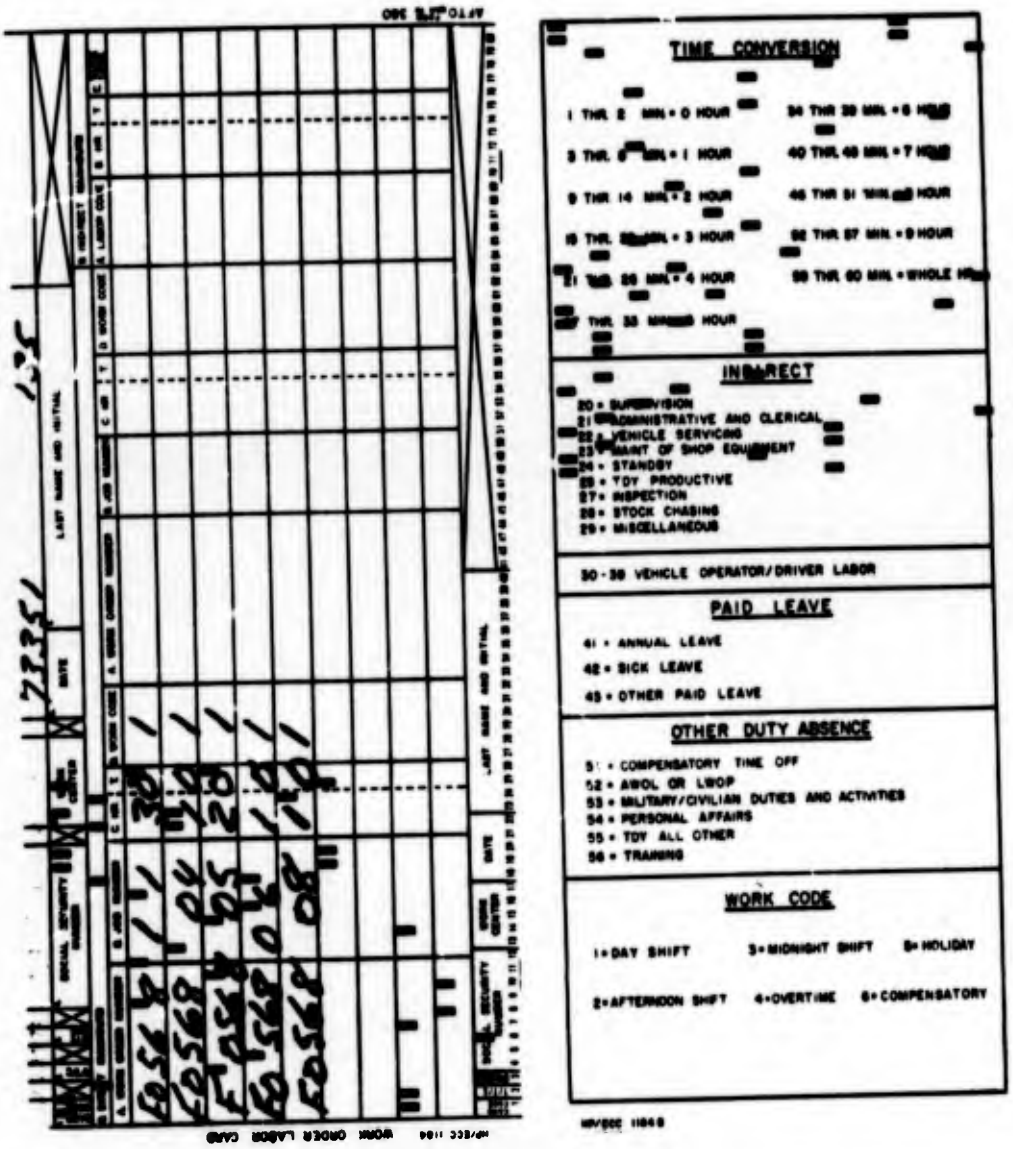


Figure 9. Work Order Labor Card (AFTO Form 380)

SECTION V

POSSIBLE LONG TERM IMPROVEMENTS TO VIMS

DISCUSSION

As indicated in Section I, the imminence of AFOLDS (Air Force On Line Data System) has helped to stimulate an interest in examining the relative merits of restructuring VIMS to operate in an on-line, interactive mode. Consequently, a part of this study was directed toward addressing the on-line issue.

The approach taken was to postulate a terminal located at specific control points within the maintenance system, and to develop scenarios as a means of exploring how some of the transactions now being performed at those points might be accomplished in an interactive mode.

In developing the scenarios, a terminal was assumed to be located at workload control and in R&A. A terminal could also be reasonably postulated in the Materiel Control area for use in such activities as parts research and ordering, inventory control, cost accounting, and transactional reporting to VIMS of parts availability, issuance and cost. However, lacking both time and an adequate understanding of the details of the supply and cost accounting functions of Materiel Control, no attempt was made to develop a scenario for this area.

The nature of the postulated terminals was assumed to be an alphanumeric CRT with keyboard, and attendant printer for necessary hard copy. Actual selection and specification of appropriate terminal equipment would follow a detailed requirements analysis. However, the CRT is considered a good first guess because of the speed with which it can present large amounts of data for viewing and because of the large number of inexpensive CRT's now on the market.

SCENARIOS

Presented below are four scenarios that were developed for workload control and R&A. The current, manual procedures for the transactions depicted in the scenarios are detailed in the baseline description in Section II. For ease of comparison, the transaction codes used in the scenarios are the same as their manual counterparts.

The display images are formatted to be contained on a screen with a capacity of 27 80-character lines, which is the capacity of the Delta Data Terminals located in MITRE's Data Handling Applications Center. The sample printouts were generated on a GE Terminet printer associated with the Delta Data CRT.

In the present vehicle maintenance system, a work order is used as the primary means of authorizing and subsequently reporting what maintenance is performed on a vehicle. Hence the generation, updating and eventual close-out of work orders are key transactions in the system. The three scenarios for workload control illustrate how these work order transactions might be done interactively. For reference, Figure 10 shows a copy of the Work Order (AFTO Form 383) as it is currently used.

Work Order Initiation Scenario

1. AFTO Form 37X and vehicle Serv-O-Plate for an incoming vehicle are brought to workload control for initiation of a work order.

2. A controller at the CRT sends an interrupt requesting service from VIMS.

3. VIMS asks the controller to enter a transaction code.

4. The controller enters "FZ" meaning "open a work order" (see Figure 11).

5. VIMS requests the vehicle registration number and the controller enters it.

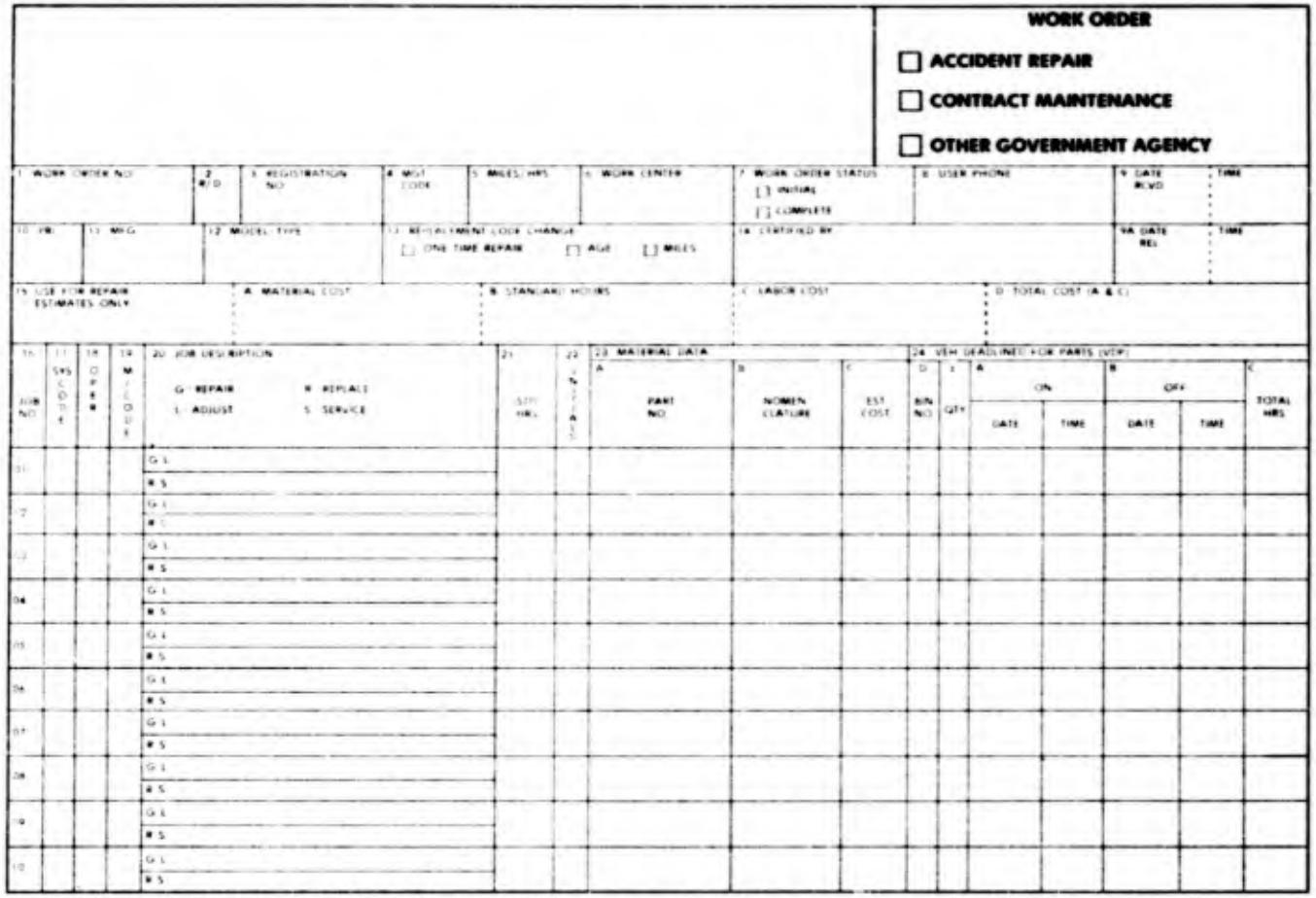
6. VIMS displays a work order form with some items already completed (see Figure 12).

   a. VIMS assigns the work order number from an internal work order register.

   b. Using data from the vehicle master file, VIMS enters the R/D code, Registration Number, Management Code, Model/Type, Manufacturer, and the One-Time Repair Limit.

   c. Using system data, VIMS supplies the date and time of arrival of the vehicle.

   d. Checking against the current date, if the vehicle has exceeded its life expectancy in years, VIMS will place an X in the Age entry under Replacement Code Change.



WORK ORDER

☐ ACCIDENT REPAIR

☐ CONTRACT MAINTENANCE

☐ OTHER GOVERNMENT AGENCY

1 WORK ORDER NO	2 M/D	3 REGISTRATION NO	4 MGT CODE	5 MILES/HRS	6 WORK CENTER	7 WORK ORDER STATUS [ ] INITIAL [ ] COMPLETE	8 USER PHONE	9 DATE RCVD	TIME
10 YR	11 MFG	12 MODEL TYPE	13 REPLACEMENT CODE CHANGE [ ] ONE TIME REPAIR [ ] AGE [ ] MILES			14 CERTIFIED BY		9A DATE REL	TIME
15 USE FOR REPAIR ESTIMATES ONLY		A MATERIAL COST		B STANDARD HOURS		C LABOR COST		D TOTAL COST (A & C)	

16 JOB NO	17 SYS CODE	18 OPR	19 MAL CODE	20 JOB DESCRIPTION (G: REPAIR, R: REPLACE, A: ADJUST, S: SERVICE)	21 SITE NBR	22 NALA	23 MATERIAL DATA A PART NO	B NOMEN CLATURE	C EST COST	D BIN NO	E QTY	24 VEH DEADLINED FOR PARTS (VDP) A ON DATE	A ON TIME	B OFF DATE	B OFF TIME	C TOTAL HRS
01				G #S												
02				G #S												
03				G #S												
04				G #S												
05				G #S												
06				G #S												
07				G #S												
08				G #S												
09				G #S												
10				G #S												

AFTO FORM OCT 70 383

Figure 10. VEHICLE AND EQUIPMENT WORK ORDER

PREVIOUS EDITION WILL BE USED

```
ENTER TRANSACTION CODE
FZ
ENTER VEHICLE REGISTRATION NUMBER
07L00457
```

Figure 11. Operator/Computer Dialog for Work Order Initiation

```
WORK ORDER NO (43044)  P/U(3)  REQ NO (S/L00457)  DATE RCVD(74093)  TIME(0730)
MGT CODE(5102)  MODEL/TYPE(SEDAN)  SPEC(4-DR)        DATE RELEASED(      )  TIME(      )
REPLACEMENT CODE CHANGE:  ONE-TIME REPAIR ( )        AGE( )      MILES( )

PRI(  )    MILES(          )     USER PHONE(          )

                                  O=REPAIR    R=REPLACE                    MATRL   STD
  JOB  SYS                 WORK   JOB        L=ADJUST    S=SERVICE         COST    HRS
 ----- ---- ---- -------  ------------------------------------------------ -----  -----
( )01  (36) (X) (17220) (S/OIL CHANGE/          DUE:APR13/SCH:APR13)      (  2)  ( 0.5)
( )02  (37) (X) (17220) (S/OIL FILTER CHANGE/   DUE:APR13/SCH:APR13)      (  4)  ( 0.3)
( )03  (38) (  ) (17220) (S/LUBRICATION/        DUE:APR13/SCH:APR13)      (  1)  ( 0.5)
( )04D (16) (  ) (17231) (R/FRONT SHOCKS/ 12567853212/  PIN 102  )        ( 16)  ( 1.0)
( )05D (04) (  ) (17231) (R/CLUTCH FAN HUB/ 5567432335?/ PIN 102 )        ( 18)  ( 1.5)
( )06  (   ) (  ) (      ) (                                             )  (   )  (   )
( )07  (   ) (  ) (      ) (                                             )  (   )  (   )
( )08  (   ) (  ) (      ) (                                             )  (   )  (   )
( )09  (   ) (  ) (      ) (                                             )  (   )  (   )
( )10  (   ) (  ) (      ) (                                             )  (   )  (   )
( )PAGE 2

                                  REPAIR ESTIMATES:      LABOR COST($  17)
                                                      INDIRECT COST(   10)
                                                      MATERIAL COST(   41)
                                                      EST TOTAL COST($  68)
          (ONE-TIME REPAIR LIMIT = $345 )

  WORK CTR(17220) AVAIL HRS =( 56.0)   HRS THIS TRANS =( 2.3)   BAL =( 53.7)
  WORK CTR(17231) AVAIL HRS =( 64.0)   HRS THIS TRANS =( 4.4)   BAL =( 59.6)
```

Figure 12. Work Order Form - Initial Display When Opening

e. If there is scheduled maintenance due or overdue for this vehicle, those job entries are filled in by VIMS. The system code for each job is supplied, the job description is given (including the due date for the particular job and the scheduled date, if any), the estimated cost for materials is given and the standard hours are supplied. The work center to which the job will be assigned is shown as well.

f. If there is delayed maintenance on this vehicle that can now be done, these job entries are also filled in by VIMS. A 'D' is appended to the job number to indicate delayed maintenance. The system code and work center for each job is shown, a job description is given (including part number and bin location of parts in the case of maintenance delayed for parts), the estimated cost of parts is given, and the standard hours that were estimated when the job was deferred are also displayed.

g. For each job entered, VIMS uses an internal algorithm to convert the standard hours to an estimation of direct and indirect labor costs (see Appendix II). These costs, together with the material costs given for each job, are accumulated and running totals are displayed by VIMS as job entries are filled in.

h. For each work center listed, VIMS computes and displays the current number of available manhours (see Appendix I for discussion of manhour availability calculations). As jobs are entered on the work order, VIMS applies an algorithm to the standard hour estimates for the jobs, to compute the number of manhours that should be allotted for job completion. The cumulative total of manhours committed by the work order is displayed, and a new tentative balance of available hours is shown.

7. The controller enters Priority, Miles/Hours, and User Phone.

8. VIMS checks the Miles/Hours figure, and if the vehicle has exceeded its life expectancy in miles, VIMS will place an X in the Miles entry under Replacement Code Change.

9. If the controller wishes to cancel any jobs that have been tentatively assigned, be may do so by entering a K next to the job number. VIMS will remove the job, close up the gap and adjust the cumulative cost estimates and available hours display.

10. The controller enters jobs to be done as noted on the 37X. For each job, he gives the system code, work center, job description, estimated material cost and standard hours. As the jobs are entered, VIMS updates the cumulative cost estimate and tentative commitment of available manhours. If the cost estimate exceeds the one-time repair limit, VIMS will place an X in the One-Time Repair entry under Replacement Code Change.

11. If more than ten jobs are to be entered, the controller calls up a second page either by placing an X in the PAGE 2 entry or by use of a function key. The job itemization portion of the display will be overlaid with a form for jobs 11-20, and the controller continues to enter jobs.

12. When all jobs are entered, the controller signals by function key that the work order is complete and should be cut as shown. VIMS does the following:

    a. If the total estimated cost exceeds the one-time repair limit, VIMS temporarily suspends the transaction and asks the controller if he wishes to continue. The controller must obtain special authorization before further maintenance can be performed on this vehicle. If authorization is obtained, the controller gives the override signal to VIMS, the One-Time Repair entry under Replacement Code Change is erased and processing continues.

    b. VIMS updates the internal record of available manhours for all affected work centers.

    c. VIMS checks the vehicle historical file to look for possible repetitive maintenance. If any is apparent the repetitive jobs are flagged with a double asterisk.

    d. VIMS creates an entry in the Open Work Order file and updates other files as required. If any of the jobs were previously deferred, VIMS will remove them from the delayed maintenance file (the current procedure requires a Work Order Status Card to be processed in order to remove jobs from the delayed maintenance file).

    e. Two copies of the work order are printed (the shop copy is printed without the standard hours).

Add Job To Work Order

1. When the shop discovers additional work to be done on a vehicle, the mechanic or his supervisor returns to workload control with the additional work noted on the shop copy of the work order.

2. The controller at a CRT requests service from VIMS, enters the transaction code signifying job(s) to be added to a work order, and gives the work order number.

3. VIMS retrieves and displays the open work order as it currently exists in the file. The cumulative cost estimates are shown as they were last left. The work center available manhours are recomputed to reflect changes due to elapsed time, and the number of hours committed by this transaction is set to zero.

4. The controller enters additional jobs, giving the system code, work center, job description, material cost and standard hours.

5. As each job is entered the total cost estimate is automatically updated. The cumulative total of manhours tentatively committed by the add-on jobs is computed and shown, and the tentative balance of available manhours is displayed.

6. When all add-on jobs have been entered, the controller signals that he is done. VIMS will do the following:

   a. If the one-time repair limit is exceeded, VIMS handles this in the same way as described under Work Order Initiation.

   b. The internal records of available manhours are updated for all affected work centers.

   c. The vehicle historical file is checked to see if the add-on work appears to be repetitive maintenance, and flags any such jobs with a double asterisk.

   d. The appropriate files including the Open Work Order file are updated.

   e. New copies of the updated work order may be printed, or the old copies may be updated by hand.

Work Order Close Scenario

1. When work on a vehicle is completed, the shop copy of the work order is returned to workload control. Quality control insures that necessary inspections are completed and the user is notified that the vehicle is ready.

2. The controller at the CRT signals for service from VIMS.

3. VIMS asks the controller to enter a transaction code, and the controller enters "WZ", meaning "close a work order" (see Figure 13).

4. VIMS asks for the work order number and the controller enters it.

5. VIMS locates the corresponding entry in the Open Work Order file, and displays the work order as shown in Figure 14. Using system data VIMS fills in the date and time for release of the vehicle.

6. The controller reviews the displayed jobs and, using the shop copy of the work order as reference, enters on the display the disposition of each job as follows (see Figure 15):

   a. For each job completed, the controller enters a "P" in front of the job number. VIMS will consider the job completed, close it out, and post it to the vehicle historical file.

   b. If a job that was entered on the open work order proved to be unnecessary and was not done, an "N" is entered before the job number (e.g., job Ø8 in Figure 15).

   c. If an add-on job appears on the shop copy of the work order but does not appear on the display, the job can be added to the displayed list at this time, and the disposition can be entered (e.g., job Ø9 in Figure 15).

   d. If a job is to be deferred, the appropriate maintenance code (A through M) is entered before that job number (e.g., job Ø7 in Figure 15). VIMS will create an entry for this vehicle and job in the delayed maintenance file.

ENTER TRANSACTION CODE
07
ENTER WORK ORDER NUMBER
4364

Figure 13. Operator/Computer Dialog for Work Order Close

```
WORK ORDER NO (4364)  P/D(3)  REG NO (o/L00457)  DATE RCVD(74093)  TIME(0730)
MGT CODE(B102)  MODEL/TYPE(SDN) MFG(AMC)      DATE RELEASED(74093)  TIME(1545)
REPLACEMENT CODE CHANGE:  ONE-TIME REPAIR ( )      AGE( )      MILES( )

PRI( G)     MILES( 04938)     USER PHONE(271-9657)

  JOB   SYS        WORK   JOB              G=REPAIR   R=REPLACE          MATRL  STD
  NO.   CODE OPER  CENTR  DESCRIPTION      L=ADJUST   S=SERVICE          COST   HRS
 -----  ---- ----  -----  ---------------------------------------------  -----  ------
( )01   (36) (X)  (17220) (S/OIL CHANGE/              DUE:APR18/SCH:APR18)  (  2) ( 0.5)
( )02   (37) (X)  (17220) (S/OIL FILTER CHANGE/DUE:APR18/SCH:APR18)        (  4) ( 0.3)
( )03   (38) ( )  (17220) (S/LUBRICATION/            DUE:APR18/SCH:APR18)  (  1) ( 0.5)
( )04D  (16) ( )  (17231) (R/FRONT SHOCKS/ 12567853212/  BIN 102  )        ( 16) ( 1.0)
( )05D  (04) ( )  (17231) (R/CLUTCH FAN HUB/ 5567432356/ BIN 102 )        ( 18) ( 1.5)
( )06   (13) ( )  (17231) (L/ADJUST BRAKES--LOW PEDAL                )     (    ) ( 0.5)
( )07   (07) ( )  (17231) (R/REPLACE MUFFLER AND TAILPIPE            )     ( 35) ( 1.5)
( )08   (04) ( )  (17231) (R/REPLACE UPPER RADIATOR HOSE             )     (  3) ( 0.4)
( )09   (  ) ( )  (     ) (                                          )     (    ) (    )
( )10   (  ) ( )  (     ) (                                          )     (    ) (    )
( )PAGE 2
```


Figure 14. Work Order At Start of Close Transaction

```
WORK ORDER NO (4364)  R/D(3)  REG NO (67L00457)  DATE RCVD(74093)  TIME(0730)
AGT CODE(B102)  MODEL/TYPE(SDN) MFG(AMC)     DATE RELEASED(74093)  TIME(1545)
REPLACEMENT CODE CHANGE:  ONE-TIME REPAIR ( )      AGE( )      MILES( )

PRI( G)    MILES( 64936)    USER PHONE(271-9657)

                                G=REPAIR   R=REPLACE                    MATRL  STD
  JOB  SYS        WORK   JOB    L=ADJUST   S=SERVICE                    COST   HRS
 ----- ---- ---- -----  ------------------------------------------      -----  -----
(P)01  (36) (X) (17220) (S/OIL CHANGE/          DUE:APR18/SCH:APR18)   (  2) ( 0.5)
(P)02  (37) (X) (17220) (S/OIL FILTER CHANGE/DUE:APR18/SCH:APR18)      (  4) ( 0.3)
(P)03  (38) ( ) (17220) (S/LUBRICATION/         DUE:APR18/SCH:APR18)   (  1) ( 0.5)
(P)04D (16) ( ) (17231) (R/FRONT SHOCKS/ 12567853212/  BIN 102  )      ( 16) ( 1.0)
(P)05D (04) ( ) (17231) (R/CLUTCH FAN HUB/ 55674323356/ BIN 102 )      ( 18) ( 1.5)
(P)06  (13) ( ) (17231) (L/ADJUST BRAKES—LOW PEDAL                )    (   ) ( 0.5)
(P)06  (13) ( ) (17231) (R/REPLACE MUFFLER AND TAILPIPE           )    ( 35) ( 1.5)
(C)07  (07) ( ) (17231) (R/REPLACE UPPER RADIATOR HOSE            )    (  3) ( 0.4)
(N)08  (04) ( ) (17231) (R/NEW FAN BELT                           )    (  2) ( 0.2)
( )10  (  ) ( ) (     ) (                                                (   ) (    )
( )PAGE 2
```

Figure 15. Work Order At Completion of Close Transaction

e. When the disposition of all jobs has been noted, the controller signals that the close-out is complete. VIMS makes the appropriate file entries and modifications. If any of the jobs are being deferred for parts, a form will be printed to be used by Materiel Control in keeping track of parts as they arrive (see Figure 16).

Manhour Reporting Scenario

This scenario assumes a CRT terminal in Reports and Analysis (R&A), and describes how the CRT might be used to replace the key-punching of daily input for manhour reporting.

1. Work Order Labor Cards (AFTO Form 380) are collected and turned in to R&A daily for inputting to VIMS.

2. The terminal operator in R&A calls for service from VIMS.

3. VIMS asks for identification of transaction.

4. The operator responds with GZNALL, meaning:

   G - Manhour reporting

   Z - Initial input

   N - Site code

   All - Batch entry for designated site. VIMS will pop up names from the employee master list one at a time. If ALL not given, operator will enter name, SSAN and work center himself.

5. VIMS presents the first name from the list of accountable employees at the designated site. VIMS supplies the SSAN and work center, and presents a form to be filled in by the operator (see Figure 17).

6. If the operator has no data for the employee shown, he may use a function key to cause VIMS to go on to the next entry on the list.

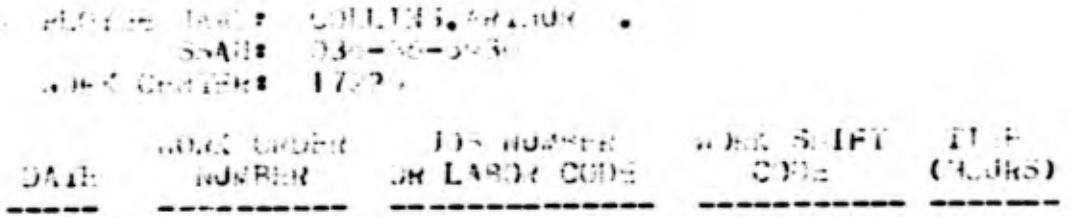
7. The operator fills in the form for each employee, job by job (see Figure 18). If the entry in a column is the same as the previous entry for that item (e.g., same date, same work order number) a function key can be used to cause the item to be repeated.

DELAYED MAINTENANCE PARTS LOG

WORK ORDER NO (4364) R/D(3) REG NO (67L00457) PRI(G) DATE(74093)
MGT CODE(B102) MODEL/TYPE(SDN) MFG(AMC) USER PHONE(271-9657)

WORK CENTER	JOB DESCRIPTION G=REPAIR L=ADJUST	R=REPLACE S=SERVICE	BIN NO.	PART NUMBER	MATL COST
(17231)	(R/REPLACE MUFFLER AND TAILPIPE	)	( )	( )	(35)

Figure 16. Delayed Maintenance Parts Log



DATE	WORK ORDER NUMBER	JOB NUMBER OR LABOR CODE	WORK SHIFT CODE	ELAPSED (HOURS)

Figure 17. Manhour Reporting Form - Initial Display

EMPLOYEE NAME: COLLINS, ARTHUR A.
SSAN: 038-36-6930
WORK CENTER: 17220

DATE	WORK CENTER NUMBER	JOB NUMBER OR LABOR CODE	WORK SHIFT CODE	TIME (HOURS)
74092	F7160	01	1	3.5
74092	87129	02	1	4.5
74092	F7101	05	4	0.5
74092	F7101	08	4	1.0
74092	F7101	09	4	2.5

Figure 18. Manhour Reporting Form - Completed Entry

8. When all jobs are entered for the designated employee, the operator signals this fact to VIMS by entering a special character or with a function key. VIMS clears the form and pops the next name from the list.

9. This process continues until VIMS has been through the entire employee list. After entries have been made for the last employee, VIMS performs a number of validity checks on the data. VIMS checks to see if at least eight hours of regular time have been reported by each employee, and verifies that all work order and job numbers reported are legitimate. If no errors are found, an employee's time is accepted as reported. For those records that failed the validity checking VIMS creates an error file, and prints an error listing showing the data as it was reported and flagging all detected errors.

10. The operator determines the nature of the listed errors and makes the appropriate annotations on the error list. When the errors have been resolved, the operator returns to the terminal and calls up a manhour correction program from VIMS. This program will assist the operator in stepping through the manhour reporting error file to make necessary corrections. The corrected entries will be subjected to the same validity checking, and if no further errors are found they will be removed from the error file and accepted as valid input by VIMS.

The scenarios presented above are not to be taken as a design recommendation. They were developed and presented as a means of illustrating some of the potential advantages of an on-line VIMS capability.

ADVANTAGES TO ON-LINE

The addition of an on-line, interactive capability to VIMS appears to offer a number of advantages, many of which are illustrated in the foregoing scenarios. These advantages include:

a. Improved currency of operational data. In the present batch reporting system, reports that reflect the 'current' operational status are in fact at least a day or two behind because of normal delays in collecting and inputting operational data, and in distributing updated reports back to users. In an on-line system these delays would be

largely eliminated, allowing daily operations management decisions to be made based on actual, current status.

b. Improved accuracy of data. Software editing and validation procedures during data input can help to insure the accuracy of data. Since more of the data is entered at the point of origin, retranscription of data is reduced, which reduces the opportunity for transcription errors. The legibility problem with work orders because of poor carbons, poor embossing of serv-o-plates or sloppy handwriting would be eliminated.

c. Simplification of transactions. The work order open transaction is a good example. This procedure could be greatly simplified with on-line support, by reducing the number of cross references to various listings, reducing the amount of information to be copied over to the form, automatic calculation of estimated costs and manhours and automatic checking for repetitive maintenance.

d. Reduction in data handling and transcriptions. As mentioned above, the use of terminals close to the point of origin of data can reduce the quantity of data that must be transcribed and subsequently keypunched. This not only reduces the opportunity for transcription error, but also frees R&A from some routine data preparation and leaves them more time for analysis.

e. More direct computer assistance.

   (1) The computer can be of assistance in a number of ways during data input. As shown in the work order initiation scenario and the manhour reporting scenario, it can reduce the amount of data to be entered by supplying data from internal files, can perform dynamic calculations, and can perform immediate error checking on input data.

   (2) Extensions to the current VIMS functions could provide R&A with a set of software tools for analyzing data contained in VIMS files, and for generation of special reports. Computer assistance could also be given to materiel control to aid in parts research, ordering and cost accounting.

SECTION VI

CONCLUSIONS

1. VIMS provides a great deal of data that is necessary and useful for effective vehicle maintenance management.

2. Like any such system, its success is quite dependent on the training and motivation of participants. Lack of training and/or failure to follow procedures carefully can degrade the system quickly. Reduced usefulness and credibility of system data has a further detrimental effect on motivation of participants.

3. The system could be improved by implementing several near term changes, without any major restructing of VIMS.

   a. The confusing formats of a number of the VIMS reports is felt to be a major weakness, and one that could be remedied rather quickly.

   b. The output capability could be extended to provide more support to R&A, in the form of additional summaries, a month-to-date summary capability and computer generated charts or graphs.

   c. The codes used to identify the vehicle subsystems being repaired could be expanded to be more definitive.

   d. The alphabetic prefix to the work order number could be eliminated.

   e. The Work Order Labor Card could be redesigned to make it easier to use.

4. The effectiveness of the system could be significantly improved and extended by restructuring VIMS to operate in an on-line mode. The anticipated advantages include improvement in timeliness and accuracy of data, simplification of transactions, reduction in data handling and more direct computer assistance in data input, data analysis and report preparation.

APPENDIX I

MANHOUR AVAILABILITY

The Work Order Initiation scenario shows VIMS maintaining an internal tally of available manhours for each work center. Following is a discussion of how VIMS might perform this function:

For a given work center, the remaining direct labor manhours in a shift is found by

$$M_t = (N_p)(H_r)(K_1) \qquad (1)$$

where

N_p = number of personnel assigned to shift

H_r = number of hours remaining in shift

K_1 = reduction factor

At the beginning of the shift VIMS is informed of the number of personnel available (N_p), including fractions if it is known that an individual will be available for only a portion of a shift. Any changes in the number of available personnel during the day (e.g., sickness, injury, special duty) are reported to VIMS as they occur.

The time remaining in the shift (H_r) can be determined by VIMS by reading an internal clock. The reduction factor (K_1) accounts for the time spent in the category called Indirect Productive, that is, time spent on the job but not in direct labor (e.g., stock chasing, maintenance of shop equipment, inspection, standby, etc.).

Both Direct Labor and Indirect Productive time are reported daily on the Work Order Labor Cards. Thus the reduction factor for each work center could be computed from cumulative historical data by

$$K_1 = \frac{\text{Direct Labor Hours}}{\text{Direct Labor Hours + Indirect Productive Hours}}$$

When a job is assigned, the number of manhours to allot to the job is found by

$$H_j = (H_e)(K_2) \qquad (2)$$

where

H_e = flat rate standard hours estimate

K_2 = estimation error factor

The estimated number of direct labor manhours (H_e) is determined in accordance with the Commercial Flat Rate manual or from inspector estimate.

The estimation error factor (K_2) accounts for the fact that there is normally a discrepancy between the estimated and actual time to complete a job. K_2 can be calculated from historical data from each work center, using standard hour estimates from work orders and actual hours expended as reported on labor cards. K_2 is calculated by

$$K_2 = \frac{\text{Actual Hours Expended}}{\text{Flat Rate Standard Hour Estimates}}$$

The number of manhours of work assigned but not yet completed at any given time is given by

$$M_r = M_s - M_c \qquad (3)$$

where

M_s = sum of allotted times for all jobs assigned

M_c = number of manhours of work already accomplished against the assigned jobs

M_s in (3) above is simply $\sum H_j$. At any given time during the shift, M_c can be estimated by

$$M_c = (N_p)(T_e)(K_1) \qquad (4)$$

where

T_e = number of hours of elapsed time since start of shift.

Lacking actual data on the rate of progress of work through the shop, the best guess is that jobs are being completed at the predicted rate, requiring exactly the amount of time that was allotted when they were assigned. Thus (3) above becomes

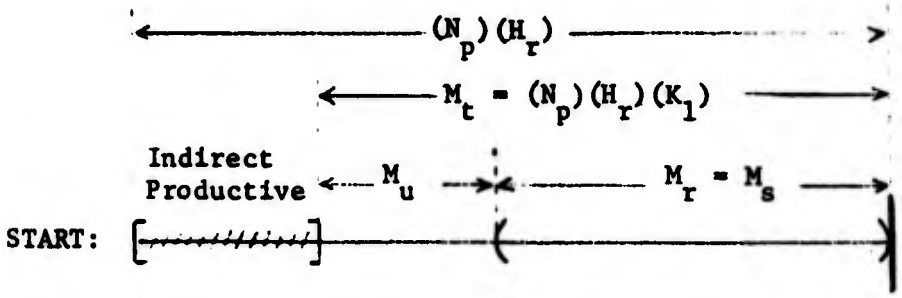
$$M_r = \sum H_j - (N_p)(T_e)(K_1) \qquad (5)$$

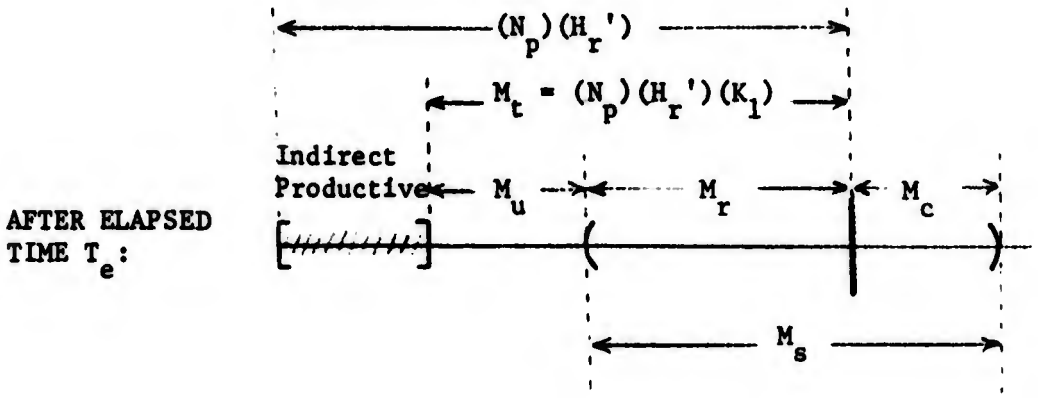
and the number of available but uncommitted direct labor manhours becomes

$$M_u = M_t - M_r \qquad (6)$$

This is the quantity that would be computed and displayed at the time a work order was being opened (see Work Order Initiation scenario), to replace the manhour availability status board that is currently used.

The quantities discussed above may be illustrated as follows:





As the shift progresses, M_r can be refined as follows to reflect the actual rate of job completion:

As discussed before, the quantity M_c in (4) gives the estimated number of completed manhours of work after an elapsed time T_e. As work orders are completed and closed out, the sum of their H_j's can be accumulated and compared to M_c. If the sum of the allotted times for the now-completed jobs ($\sum H_{jc}$) exceeds M_c, then the shop is turning out work at a faster rate than estimated, and more time should be available for scheduling. This can be reflected in the calculations by using $\sum H_{jc}$ in place of M_c in equation (3), so that

$$\text{if} \quad \sum H_{jc} > M_c$$

$$\text{then} \quad M_r = M_s - \sum H_{jc}$$

$$\text{or} \quad M_r = \sum H_j - \sum H_{jc} \qquad (7)$$

However, if $\sum H_{jc} \leq M_c$, use equation (5) to calculate M_r, since lacking specific information on rate of job completion, this is still the best guess.

The backlog, if any, to be carried over and reflected in the scheduling for the next shift can be accounted for as follows:

Assume that job reporting on Work Order Labor Cards is done at the end of each shift by R&A as described in the manhour reporting scenario.

At the end of the shift the backlog of work to be carried over into the next shift can be found by summing the H_j's for all work orders that are still open and active, and subtracting the sum of actual labor hours expended against those work orders as reported on the labor time cards. Let

$\sum H_{jo}$ = sum of H_j's for work orders still open at end of shift

and $\sum H_{joc}$ = actual labor hours expended against work orders still open

These quantities represent initial values for the next shift for M_s and M_c respectively. From equation (3), the initial value for M_r becomes

$$M_{ri} = M_{si} - M_{ci}$$

$$\text{or} \quad M_{ri} = \Sigma H_{jo} - \Sigma H_{joc} \qquad (8)$$

This calculation can be made automatically by VIMS after R&A has entered data from the labor time cards at the end of the shift.

APPENDIX II

COST ESTIMATING

In the work order initiation scenario, as jobs are entered on the work order the material costs and standard hours are entered. The scenario shows VIMS keeping a running tally of the estimated repair costs (see Figure 12). The manner in which these costs are computed is explained as follow:

Labor Cost - A nominal hourly wage of $4.00/hour is assumed. The estimated labor cost for a job is the product of the hourly wage and the estimated time, adjusted by an estimation error factor (K_2) intended to bring the time closer to actual (see Appendix I for definition and discussion of K_2).

$$\text{Direct Labor Cost} = (H_e)(K_2)(\text{Hourly wage})$$

$$= (H_e)(1.1)(\$4.00)$$

$$= \$4.40(H_e)$$

Indirect Cost - The Indirect to Direct Manhour Ratio is used to determine the indirect cost from the direct labor cost. The ratio would be determined for each work center using historical data for the work center. It is an Air Force goal that Indirect Productive hours not exceed 60% of Direct Productive hours. The scenario assumes that this goal is met, so that

$$\text{Indirect Costs} = (.60)(\text{Direct Labor Cost})$$

Material Cost - This is a cumulative figure, which is simply the sum of the material costs entered on the work order for all of the individual jobs (note that when scheduled maintenance and delayed maintenance jobs are placed on the work order the material cost and standard time are supplied automatically).