ATTACHMENT TO THE BOARD REPORT

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Long Range EDP Planning Project
Final Report

September, 1980

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&
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September 19, 1980

Mr. Robert Pentek
Southern California Rapid Transit District
425 South Main Street
Los Angeles, California 90013

Dear Mr. Pentek:

We are pleased to submit our Final Report on the District's Long-range EDP Planning Project. This report reflects the comments and suggestions received after your review of the draft copy. Submission of this and the preceding reports is intended to satisfy the objectives of the study and completes our work specified in our proposal.

Since publication of our draft report and updating of our final version, IBM has made certain equipment announcements which will affect the specific configuration recommendations made herein. While these equipment announcements affect the cash requirements timing and configuration of our recommendations, they basically serve to reinforce their economic justification over the long-run due to the new equipment's price/performance improvements.

The recent equipment announcements affecting our recommendations include the following:

- Substitution of the IBM 3033N series for the IBM 3032 computer.

- Substitution of the IBM 4341 Model Group 2 for the IBM 3031 computer.

After considering several alternatives, we believe the optimum equipment configuration for SCRTD to be as follows:

- IBM 3033N (8 megabyte), or equivalent compatible equipment, serving as primary host processor

- IBM 4341 Model Group 2 (4 megabyte), or equivalent compatible equipment, serving as backup and overload processor

- Each of the above with switchable IBM 3705, or equivalent compatible equipment, communication controllers.

The above configuration replaces the immediate need for two minicomputer data collection/communication computers and the IBM 3032 host processor described in our report. It should also provide sufficient capacity to obviate the need for the IBM 3031 computer anticipated in the fourth year of the master plan.

In our original planning estimates, we anticipated a $2.8 million equipment expenditure in the first year (for the two minicomputers and IBM 3032) and a $1.2 million expenditure in the fourth year (for the IBM 3031); a total of $4.0 million to meet the District's processing requirements over the next five years. This expenditure was to cover the cost of the central processors, related peripherals, communications controllers and minicomputer front end processors. This estimate excluded costs of proprietary systems software, facility requirements, lines, modems, multiplexors and terminals which the District expects to separately budget with each computer application's implementation.

We believe that this $4.0 million estimate is still viable; however, because of the recent vendor announcements, we recommend

that the revised configuration be acquired in the first year, thereby increasing initial outlays by $1.2 million over original plan and decreasing outlays in the fourth year by a corresponding $1.2 million.

The advantages of this revised recommendation includes the following:

- Reduction in conversion effort and costs associated with CTA's VMS since the two property's hardware configurations would be more compatible.
- Utilization of currently supported equipment having improved price/performance ratios.
- Easier systems development because all processing would be performed on one computer with backed up on functionally similar equipment.
- Availability of full inquiry capability for users during primary processor downtime periods.
- Greater availability of both internal and external technical personnel trained in main frame programming techniques.

The disadvantages of this revised recommendation include the following:

- Cost of the IBM 3033/IBM 4331/IBM 3705 configuration is $300,000 to $400,000 more than the cost of two minicomputers and an IBM 3032.
- All the equipment costs under the revised recommendation would be incurred in the first year rather than spread over four years.

- The District would have excess computing capacity until the planned computer applications were implemented during the five year period.

* * *

It has been a particularly rewarding experience for us to participate with District personnel throughout the course of this study. We wish to thank all who gave of their time and effort; especially, we wish to express our appreciation to Messrs. Pentek, Scatchard and Black who found time in their busy schedules to consult with us frequently during the study.

If you have further questions or comments, please feel free to contact David Schultz at 977-3661 or Larry Arnold at 977-3660.

Very truly yours,

Arthur Young & Company

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I. MANAGEMENT SUMMARY

I. MANAGEMENT SUMMARY

This report represents the proposed Long Range EDP Plan for the Southern California Rapid Transit District (SCRTD). The plan encompasses application development practices, system design concepts, personnel and equipment requirements, facility guidelines and operating philosophy for electronic data processing at the District over the next five years, based on the situation at SCRTD as it appears today. Events whose impact cannot be accurately forecasted, such as the development of mass transit, could alter this situation and have a profound impact upon data processing requirements and planning. Provision for such events has not been included in this plan.

This report is the last of three produced during the course of this project. The initial report (Interim Report) described the basic information requirements of the District as determined by District personnel assigned to this project. The second report (Preliminary Report) described and ranked potential computer applications which could be implemented to meet the information needs identified in the initial report. The Preliminary Report also proposed computer equipment alternatives and an operating philosophy for the MIS Department.

The remainder of this section describes the organization of the present Final Report and summarizes our recommendations.

A. REPORT ORGANIZATION

The purpose of this Final Report is to provide the District, in as concise a form as possible, an operating guide for computer applications development and systems operation over the next five years. This report presents in Section II a data processing operational plan describing the District's EDP goals and objectives, applications development priorities,

five year planning horizon. This document concludes with appendices containing overviews of these five computer applications. Each appendix summarizes the basic design concepts to be followed.

B. SUMMARY OF RECOMMENDATIONS

Based on the needs analysis descriptions prepared by District personnel, and our independent analysis and discussions with representatives of District management, we conclude the following:

1. Applications Development

The District should target no more than five applications areas for development or enhancement over the next five years. These areas should consist of:

- Vehicle Maintenance/Materials Management
- Payroll
- Planning and Scheduling
- Purchasing and Accounts Payable
- Human Resources (HRMIS)

2. MIS Department

There should be formal recognition of the fact that the MIS Department will probably not be able to undertake internally major systems development projects, at least for the next few years, due to problems in attracting and retaining qualified personnel. This situation may change in the long term as a result of procedural and technical strengthening of the department which we have recommended. However, for the short-term, major systems development projects, such as those described above,

should be undertaken by outside contractors under the direction of the appropriate user departments with technical input from the MIS Department.

3. Equipment Requirements

The District should immediately acquire an IBM-compatible computer, approximately equivalent to an IBM 3032, to serve as its primary mainframe. Dual minicomputer front-end processors should be installed to provide redundant (backup) data collection capability for the vehicle maintenance/materials management and payroll systems. The presently installed Univac 1106 computer should be used for "stand-alone" on-line applications to avoid fragmentation of data bases and to concentrate the need for Univac training in a smaller number of SCRTD personnel. Potential uses of the Univac computer include CCIS, planning and scheduling (RUCUS) and time sharing (e.g., do-it-yourself reports by users). If applications development proceeds as planned, the District will probably have to add computing capacity equivalent to an IBM 3031 computer to provide additional needed processing power during the five year period.

The District should carefully evaluate the relative advantages of leasing this computing equipment as opposed to purchase. Capability and relative cost of performance for computing equipment is changing so fast in today's market that purchased equipment may well become seriously obsolete before its cost is fully amortized.

This equipment plan represents the "fall back" strategy discussed in our Preliminary Report. The rationale for the District's rejection of our recommended Univac solution is discussed later in this report.

4. System Software Requirements

System support software such as operating system and data base management software must be selected for both the host computers and the front-end minicomputers. In order to minimize conversion problems when VMS is installed in-house, the host computer operating system should be OS/VS2. Selection of a host computer data management system can wait until preliminary designs are completed for some of the major data bases. Selection of software for the minicomputers depends upon the equipment chosen.

5. Facilities

The District should consider remodeling the present MIS Department area to convert its office space to an expanded computer room and data center, subject to computer space requirements. MIS Department personnel should be moved to nearby quarters in the same building.

6. Estimated Costs

The following cost estimates are provided for general planning purposes only. These estimates are expressed in CY1980 dollars and do not include provision for inflation:

Incremental Cost Estimate Over Next Five Years (In Millions)

Equipment		
IBM 3032	$2.5*	
Minicomputers	.3*	
IBM 3031	1.2*	
		$4.0
Facility Expansion		(UNK)
Software Design and Development		3.7
Other		1.0
TOTAL - FIVE YEARS		$8.7

The above estimate excludes the $2.0 million annual operational budget of the MIS Department.

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* Estimate based on equivalent purchase price; leasing should be considered for protection against equipment obsolescence.

II. DATA PROCESSING OPERATIONAL PLAN

II. DATA PROCESSING OPERATIONAL PLAN

This section describes the recommended plan to be followed for undertaking applications development and deploying resources over the next five years.

A. DATA PROCESSING GOALS AND OBJECTIVES

The foundation of our proposed EDP plan rests on the assumed goal of the District to utilize its EDP resources to maximize cost savings and/or reductions, and to improve service to patrons, with emphasis on the needs of the major operating departments (i.e., transportation and maintenance). With this in mind, we have examined the results of the District's data processing activities over the past two years, and have concluded that future planning should be based on acceptance of the following principles and objectives:

1. Targeted Systems Development Activities

Although the District has attempted in the past to identify its EDP priorities, lack of qualified personnel resources, personnel turnover, interjected projects outside the agreed upon priorities, and diversion of resources to keep old information systems running have contributed to a diffusion of efforts and slower systems development than expected. Accordingly, the proposed operating plan specifies five targeted areas to be developed over the next five years. We urge the District to concentrate its limited resources on these five key areas until they are completely implemented before moving on to other major development activities.

2. Limited Internal Systems Development

Most major computer applications in the District over the past two years were developed by outside contractors or were the result of acquired applications software. These projects include payroll, CCIS, automated dispatch, automated vehicle monitoring and vehicle maintenance, among others. The MIS Department has not been successful in attracting or retaining sufficient qualified personnel to take on large-scale projects. Accordingly, for the near term, the proposed plan provides for formalizing a role for the MIS Department and defining its organization to accommodate monitoring of, rather than active involvement in, large-scale systems development projects. In the longer term, beyond the scope of this plan, recommendations we have with respect to procedural and organizational changes in the MIS Department may place it in a position to assume more development responsibility internally.

3. More Integration of Information Systems

District personnel consistently articulate the need for better management information, which often necessitates the sharing of data between information systems. Further, requirements at the operational level virtually mandate the integration of computer applications. For example, the vehicle maintenance area requires dispatch data for road-call reporting; payroll requires run assignments from scheduling to verify that only one operator is paid for a given run; and, the purchasing function requires purchase requirements information from materials management (and materials management requires on-order and expected delivery dates

from purchasing). Accordingly, the proposed plan reflects the need for information sharing in its computer configuration requirements.

4. Retention of Large Mainframe, Single Vendor Policy

With the exception of some stand-alone, minicomputer applications which would be expensive to alter even if it were desirable, the District has been relying on one mainframe computer and one equipment vendor for the majority of its computer capacity. Continuation of this one vendor policy is important, in our opinion, in order to:

- Simplify integration of information among computer applications
- Minimize equipment reliability problems and computer backup requirements by restricting essential processing, to the extent possible, to one type of computer, rather than performing parts of processing on two incompatible machines
- Minimize EDP training and personnel requirements.

5. Computer Redundancy (Backup) in Critical Areas

Ideally, contingency provisions should be made to meet the processing requirements of all users should the primary computer become inoperative. Such redundancy, however, can be prohibitively expensive requiring, in the District's case, the availability of two sets of compatible mainframe computers and their associated peripheral equipment. Consequently, the equipment plans described herein are predicated on the more cost/effective option of providing computer redundancy for critical on-line applications only, and then only for

those applications' data collection activities. The designated critical applications are payroll and vehicle maintenance/materials management (VMS/MMS).

6. Preeminence of VMS/MMS in Computer Selection Decision

The District is presently pilot testing a version of Chicago Transit Authority's (CTA) VMS on the MCAUTO computer service bureau with the intent of going District-wide as soon as possible. Because any VMS must eventually integrate with many other information systems; because it is such a major consumer of computer resources; because it would be expensive to convert or replace; and because the service bureau costs would be prohibitively high when the system is extended District-wide, there is a need to give prime consideration to VMS/MMS requirements in making the computer selection decision.

B. KEY FACTORS INFLUENCING THE DISTRICT'S EDP PLAN

The principles/objectives cited above guided the development of the recommended Long Range EDP Plan. We believe that the details of the plan follow directly from these principles and objectives. Three other factors, however, materially guided the plan's development and are discussed below:

1. The Future of CCIS will Materially Affect Equipment Requirements and Costs

CCIS provides automated routing for District customers requesting such information from SCRTD. The system was converted and modified for the District's Univac 1106 computer by an outside contractor and is currently being pilot tested. The system's future will be decided

shortly after completion of an independent evaluation of its utility and cost/effectiveness.

If CCIS is expanded District-wide, provisions will have to be made for expanded processing capability. We estimate that, at a minimum, supporting CCIS will require the entire processing capacity of the District's Univac 1106. If this is to be the case, we recommend that the Univac 1106 be dedicated to CCIS without automated backup provision (utilize present Thomas Guide manual system for backup), and that all other computer applications be transferred to the new, proposed mainframe computer. If CCIS is not extended District-wide, we recommend that the present Univac computer be dedicated to scheduling and planning and for user timesharing applications which can be isolated from the District's main data bases.

2. The Use of Univac vs. IBM Computers Depends on the District's Position on VMS/MMS

Our Preliminary Report recommended that the District retain the one vendor mainframe policy and that a Univac 1100/84 computer be installed to supplement the presently installed Univac 1106 computer. This recommendation was predicated on the fact that the District already has an investment in computer applications designed to run on Univac equipment, that such an arrangement maximized backup, and that it fit with the present training of MIS Department personnel.

Mainly, however, this recommendation was predicated on the adoption of a consortium involving SCRTD, MTA (Houston) and Univac. The consortium was to be formed to custom develop an integrated vehicle maintenance/

materials management system which could operate more effeciently than CTA's VMS, and which could provide both properties with required capabilities that are absent from CTA's design. A tentative understanding was reached between the parties to the consortium subject to the approval of each organization's management and Board. In return for the computer upgrade by SCRTD, Univac was to furnish computer programming; MTA was to furnish the materials management system; and both properties would split the cost of systems design.

Subsequent to reaching this tentative agreement, we understand SCRTD management declined participation in the consortium development because of the following factors:

- Relative cost of the Univac computer
- Relative risks associated with custom development, and belief that the CTA system could either be enhanced by SCRTD or by acquiring future CTA enhancements
- SCRTD's dissatisfaction with Univac's performance relative to equipment downtime and maintenance support.

In contemplation of this possible eventuality, our Preliminary Report specified a contingency plan based on adoption of the CTA system. The equipment recommendation in our present report represents our understanding of the District's policy decision regarding the consortium project, and therefore activates the "fall back" equipment recommendations stated in the Preliminary Report (with some minor modifications). These equipment recommendations are discussed later in this report.

3. The VMS Acquired from the Chicago Transit Authority Requires Substantial Enhancement

Adoption of the VMS acquired from CTA will require some system design and computer program changes to fit into the equipment plans discussed in this report. These relatively minor technical changes, which are intended to provide a measure of system redundancy, will be overshadowed by what we believe to be extensive enhancements required to support substantial improvement in the District's vehicle maintenance operation. Such enhancements can be added modularly over time within the context of a well planned system upgrade program. We recommend that such enhancements be considered an essential and integral part of the VMS/MMS implementation program and be planned concurrent with the pilot testing of VMS at Division 3.

C. APPLICATIONS DEVELOPMENT PRIORITIES

We recommend that the District target the areas described below for systems development over the next five years. The rationale for their prioritization and a description of other potential computer applications are discussed in the Preliminary Report.

1. Vehicle Maintenance/Materials Management

- Minicomputer data collection "front-end"
- Stock status and reorder point determination
- Materials requirements planning
- Preventive and scheduled repair planning

- Work order generation and tracking
- Warranty and claims processing
- Component history
- "Rebuild" shop records management
- Non-revenue vehicle and equipment processing
- Inventory valuation
- Repair kit control
- Consumables reporting
- Coach history

2. Payroll

- Operator data collection and scheduling system interface (timeroll)
- Maintenance system interface
- Administrative payroll processing
- Processing of retirement, insurance and voluntary deductions

3. Planning and Scheduling

- RUCUS
- Transportation scheduling (run assignments and roll-out sheets)
- Integration with other computer applications

4. Accounts Payable and Purchasing

- Check writing
- Disbursements control and account aging
- Vendor analysis
- Purchase requirements
- Purchase order generation
- Integration with financial system

5. Human Resources Management Information System

- Personnel record maintenance (complaints, commendations, accidents, work history)
- Applicant flow
- Position control
- Personnel evaluation
- EEO/OSHA reporting
- Training records and skills matrix
- Labor relations and fact finding support

An overview of these high priority computer applications is presented in Appendices A-E of this report.

D. MIS DEPARTMENT ORGANIZATION AND STAFFING PLAN

As discussed previously, the District's MIS Department has limited capability to undertake major systems development projects. Consequently, we recommend that the following changes be made in the Department's role, responsibilities and organization:

1. Departmental Functions

We recommend that the MIS Department be charged with the following mission:

- Development of standards for systems design, systems development, telecommunications and data bases (e.g., data base naming conventions and structuring)
- Technical monitoring and quality assurance of contractor-developed systems

- Maintenance, where possible, of in-house and externally developed computer applications software

- Design and development of small systems projects, perhaps those requiring less than six man-months of effort

- Gain, over the long-term, the technical confidence necessary to assume greater development responsibilities in-house.

2. Responsibilities With Respect To Major Systems Development Projects

We recommend that the user departments take primary responsibility for project direction and justification of large scale systems development projects using the MIS Department as a technical resource in monitoring the contractor's work, and in helping to evaluate and justify such projects to District management. Each major systems development project should have a designated District Project Director from the user department supported by MIS Department senior technical personnel. The Project Director should maintain a close working relationship with the contractor and remain intimately acquainted with project status and major decision points. A project steering committee composed of two to five District representatives from affected departments should be appointed to provide input throughout the project.

3. MIS Department Organization and Staffing

In April 1980 this emerging role for the MIS Department was discussed with key District personnel. Based on those discussions and on his own initiative, the Director of the MIS Department implemented many of the

proposed organizational and staffing changes required to accommodate the Department's evolving role. Specifically, the organizational and staffing changes entail:

- Elimination of two layers of management, with a more direct reporting relationship established between the MIS Director and his Supervising Analysts

- Elimination of planned technical positions not required by the recommended Departmental mission and responsibilities

- Evolution away from separate systems analysts and programmer functions to, instead, more versatile and less specialized programmer-analyst positions

- Addition of a quality control and standards function.

An example of a Departmental organization chart reflecting these proposed changes is presented as Exhibit I, following this page.

Presently, the MIS Department has approximately 73 authorized positions. We believe that the Department should remain at or below its present staffing level, assuming adoption of its recommended role, although the staff mix may change over time.

E. EQUIPMENT PLAN

Several alternative equipment plans were considered and discussed with District management. Keeping with the objectives and principles discussed earlier in this report, we tied the equipment plans to the decision regarding vehicle maintenance/ materials management.

RECOMMENDED FUNCTIONAL ORGANIZATION
MIS DEPARTMENT

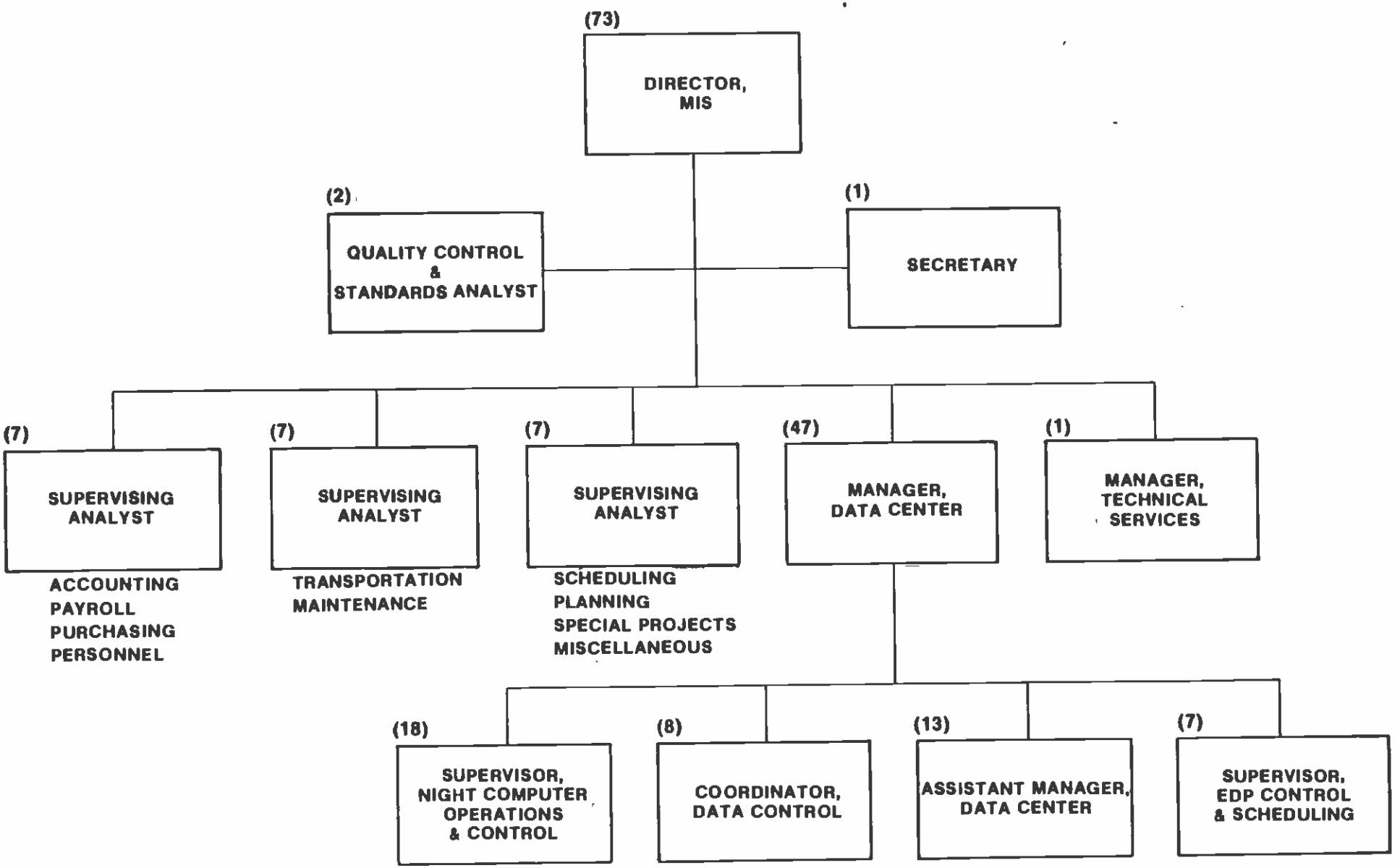


EXHIBIT I

Our Preliminary Report indicated that the preferred alternative involved custom development of a VMS/MMS through formation of a consortium including MTA (Houston), Univac, and SCRTD, with the acquisition of a Univac 1100/84 computer to serve as the District's primary mainframe. (This recommendation was amended slightly based on a meeting in Houston with the consortium principals; namely, to acquire a Univac 1100/82 now, then field upgrade to the 1100/84 model later when the additional processing power was needed.)

If SCRTD chose not to proceed with the VMS custom development/consortium project, we suggested a "fall back" position using IBM (or IBM-compatible) equipment. Based on our understanding, District policy is to decline involvement in the consortium and proceed with CTA's Vehicle Maintenance System. Accordingly, we considered three IBM oriented alternatives:

- Option 1

  Acquire two IBM 4341 comuters to run VMS; keep the presently installed Univac 1106 computer.

- Option 2

  Acquire an IBM 3032 computer; arrange for telecommunications backup on essential data collection services with a service bureau; keep the presently installed Univac 1106 computer; install an IBM 3031 as a second processor when needed (about the fourth year of the plan) and disengage from the service bureau at that time.

- Option 3

  Acquire an IBM 3032 computer and two identical minicomputers; keep the presently installed Univac 1106 computer; install an IBM 3031 as a second processor when needed (about the fourth year of the plan).

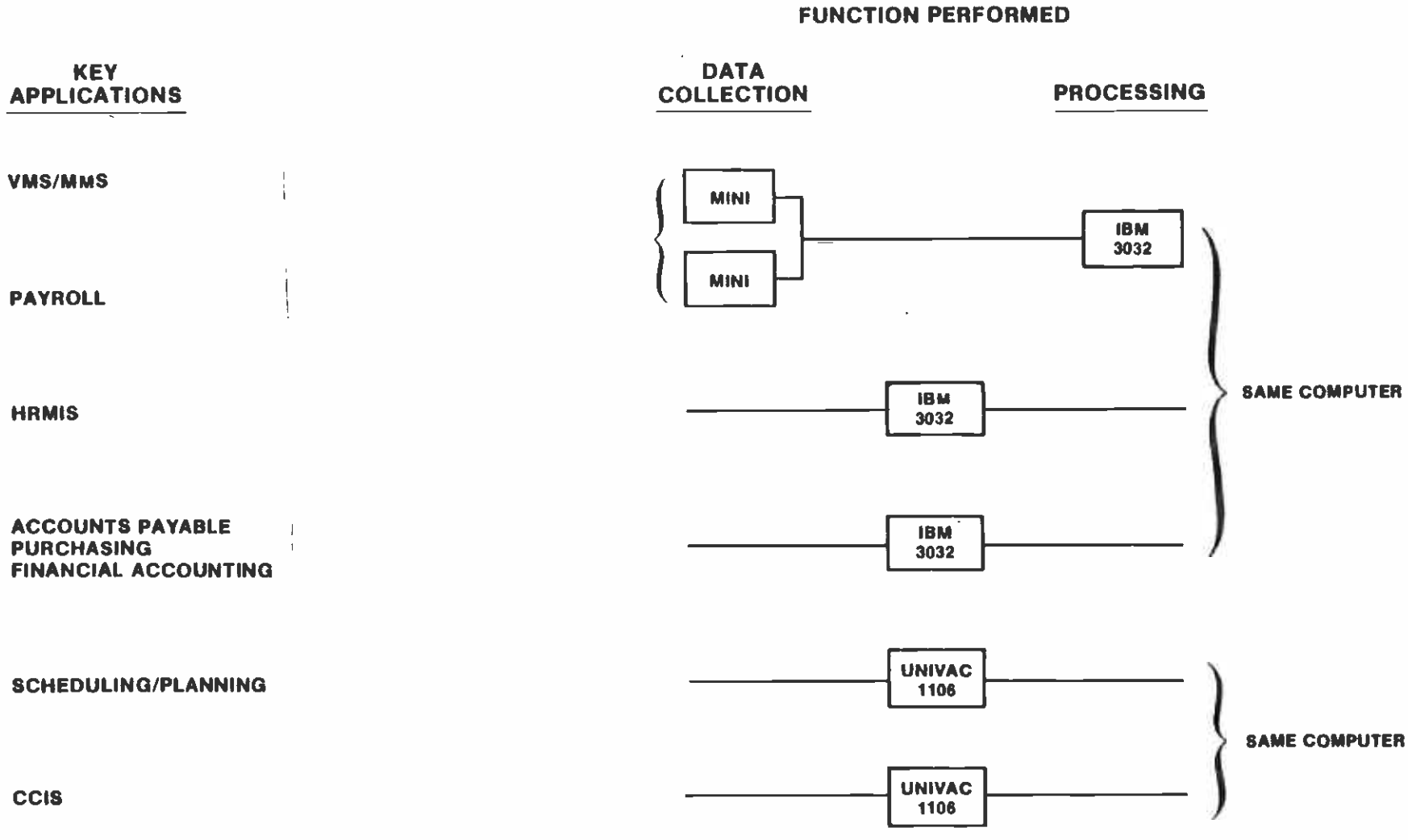
Option 1 was rejected because it provided support for VMS/MMS only and violated the objectives and principles discussed earlier regarding single vendor mainframes capable of handling the District's requirements.

Option 2 provided a large IBM mainframe consistent with the long-range processing requirements of the District but provided limited redundancy by employing a computer service bureau. This option was rejected due to its lack of long-range cost/effectiveness and due to the limitations on control provided by using a service bureau for backup.

Option 3 is recommended for adoption by the District. It provides for the immediate acquisition of an IBM 3032 computer for installation within eight months. The VMS operating at MCAUTO would be then transferred intact to this computer thereby eliminating the service bureau costs associated with MCAUTO as soon as possible. Additionally, two identical minicomputers would be installed by Month 6. The data collection logic in VMS would then be transferred to the minicomputers by Month 12. This would provide backup for data collection (and some limited inquiry capability) in case the single mainframe were to fail. At Month 12, VMS would be extended to all divisions. The minicomputers (one would backup the other) would be programmed to handle all data collection for VMS/MMS and for the transportation timeroll system. An IBM 3031 computer would be installed by Year 4 of the plan, assuming systems development proceeds as planned and processing estimates are confirmed at that time. The Univac 1106 computer would be used for essentially "stand alone" applications such as CCIS, and planning and scheduling. The IBM 1401 would be eliminated and its functions performed on the IBM 3032.

A graphical representation of this plan is shown in Exhibit II following this page.

RECOMMENDED COMPUTER CONFIGURATION



NOTES:

1. CONFIGURATION: (2) MINICOMPUTERS; (1) IBM 3032 WITH IBM 3031 ADDED IN YEAR 4; (1) UNIVAC 1106 (PRESENTLY INSTALLED)
2. IF THE UNIVAC 1106 IS USED FOR DISTRICTWIDE CCIS, PLANNING AND SCHEDULING COULD BE PERFORMED ON THE BACKUP MINICOMPUTER
3. THE MINICOMPUTERS SHOULD BE IBM-COMPATIBLE TYPES AS WELL (E.G., PRIME, IBM) TO SIMPLIFY THE USE OF PRESENT COMPUTER PROGRAMS

EXHIBIT II

F. SYSTEM SOFTWARE ACQUISITION

System support software such as operating system and data base management software must be selected for both the host computers and the front-end minicomputers. In order to minimize conversion problems when VMS is installed in-house, the host computer operating system should be OS/VS2. Selection of a host computer data management system, to fill the need on the IBM-compatible computer which is satisfied by DMS/1100 on the Univac 1106, can wait until preliminary designs are completed for some of the major data bases. Selection of operating system and data base management software for the minicomputers depends upon the equipment chosen, and the defined requirements for VMS front-end and timeroll data collection processing.

G. FACILITY GUIDELINES

We recommend that the District consider remodelling the present MIS Department area to convert its office space to an expanded computer room and data center. Such remodelling should be undertaken only after confirming the space requirements of the selected computers (e.g., IBM 3031, IBM 3032, two minicomputers and Univac 1106) with their respective vendors. Electrical, air conditioning, storage space and security should be upgraded as well.

MIS Department employees should be moved to nearby quarters in the same building, preferably on the same floor. Planning standards should be adopted which will permit more conference room and work space per employee.

H. ESTIMATED COSTS

The following cost estimates are provided for general planning purposes only. These estimates are expressed in CY1980 dollars and do not include provision for inflation:

Incremental Cost Estimate
Over Next Five Years
(In Millions)

Equipment:		
IBM 3032	$2.5*	
Minicomputers	.3*	
IBM 3031	1.2*	
		$4.0
Facility Expansion		(UNK)
Software Design and Development		3.7
Other		1.0
TOTAL - FIVE YEARS		$8.7

The above estimate excludes the $2.0 milion annual operational budget of the MIS Department for personnel, equipment maintenance, etc., which should continue at or below its present level (except for normal salary increases and a sharp increase in equipment maintenance expense) over the next five years. Consequently, considering annual operational costs of the MIS department and the incremental systems development and capital expenditures discussed above, the District could expect a $18.0 to $20.0 million expenditure on data processing over the next five years. This compares favorably with the estimated $18.0 to $20.0 million expenditure over the next five years forecasted for operating the MIS Department and continuing on the MCAUTO service bureau with a fully implemented VMS/MMS system. This latter alternative does not provide the benefits of the development projects presented in the long-range plan, however.

* Equivalent purchase price: leasing should be considered.

III. IMPLEMENTATION PLAN

III. IMPLEMENTATION PLAN

A. OVERALL PLAN AND FUNDING REQUIREMENTS

The overall systems development plan and estimated funding requirements are presented in Exhibit III. Since the current projected five year cost of VMS operation at MCAUTO is $8 to $10 million, and the MIS Department five year budget is $10 million, their combined total of $18 to $20 million is approximately equivalent to the estimated cost of $18.7 million for the complete five year data processing plan presented in this report. Thus it is estimated that since the total costs are approximately equal, the projects presented in the plan can be funded out of the savings in VMS processing costs which result from running VMS in-house on a District owned computer.

B. SUMMARY OF ACTIONS REQUIRED IMMEDIATELY

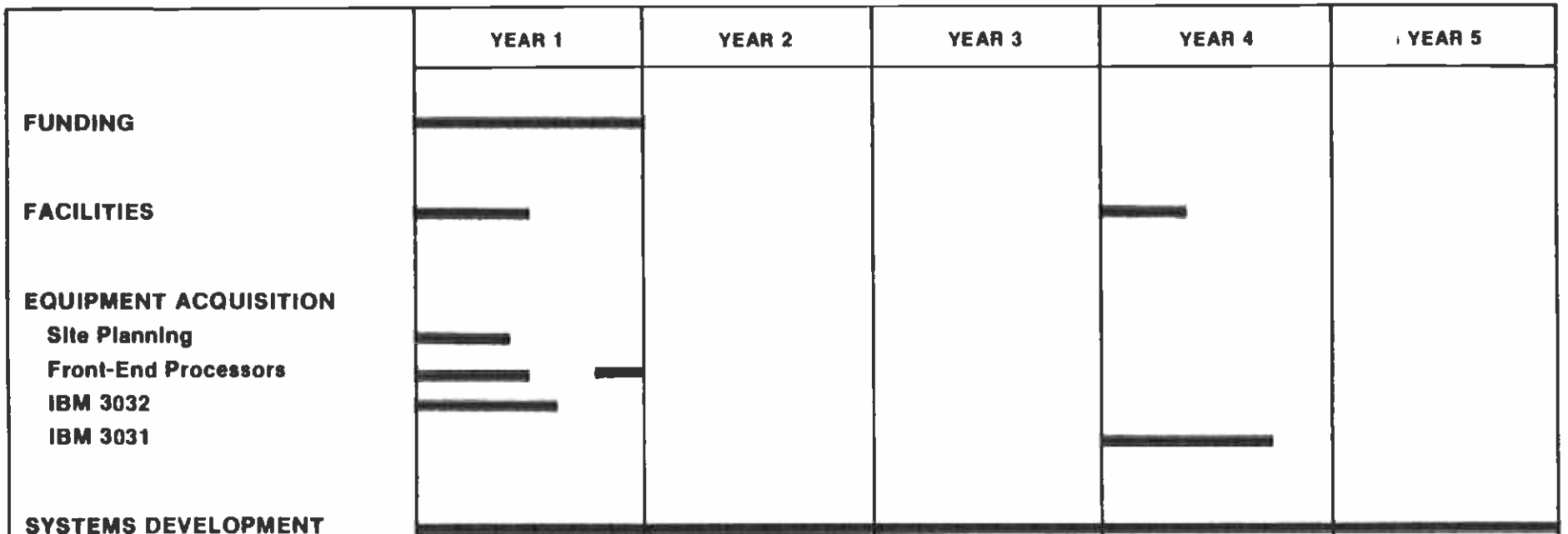
The major events occurring in each of the development projects are discussed in the next section. Certain of these events require immediate action by SCRTD. These include:

- Funding. Grant funds for VMS operation will become available upon completion of the pilot. Mass transit funding may also be available if MIS provides project control processing to mass transit development

- Equipment selection and order placement. Orders for both an IBM-compatible main computer, approximately equivalent to an IBM 3032, and minicomputer front-end processors should be placed as soon as possible to ensure on-schedule delivery. The main computer and the first minicomputer should be installed in Month 8

- Requirements definition and design of the enhanced VMS/MMS. The minicomputer front-end must be in

OVERALL PLAN AND ESTIMATED FUNDING REQUIREMENTS



FUNDING REQUIREMENTS[1]	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
Facility	UNK	UNK	UNK	UNK	UNK	UNK
Equipment	$2.8M			$1.2M		$ 4.0M
Systems Development	0.4M	0.9M	0.8M	0.8M	0.8M	3.7M
Other	0	0.3M	0.3M	0.2M	0.2M	1.0M
MIS Department[2]	2.0M	2.0M	2.0M	2.0M	2.0M	10.0M
TOTAL	$5.2M	$3.2M	$3.1M	$4.2M	$3.0M	$18.7M[3]

[1]THESE ESTIMATES DO NOT INCLUDE PROVISION FOR INFLATION.

[2]ALREADY BUDGETED.

[3]ADDING INFLATION, FACILITY COSTS, AND CONTINGENCY PROVISION, THIS FIVE YEAR TOTAL COST COULD BE BETWEEN $20 AND $25 MILLION.

EXHIBIT III

place for backup protection before VMS operation can be extended District-wide in Month 12

- Operation of VMS in pilot test mode in Division 3 and/or other selected divisions through the end of Month 12

- Requirements definition and design of an operator timeroll system. Installation shold be complete and system in use by Month 18.

C. SYSTEM DEVELOPMENT IMPLEMENTATION PLANS

1. Overview

Exhibit IV, following this page, displays the phasing of the five development projects we recommend SCRTD pursue over the next five years. Note that since VMS/MMS is a large effort and the first priority, it has been broken down into its major components. Phase I includes requirements definition and conceptual design of the entire VMS/MMS system, design and implementation of the "front-end" processors for data collection and backup, completion of the VMS pilot, and installation of VMS on an in-house IBM-compatible computer. Phase II includes stock status and reorder point determination, materials requirements planning, preventive and scheduled repair planning, work order generation and tracking, warranty and claims processing, and component history. Phase III completes VMS/MMS, as currently envisioned, with "rebuild" shop records management, non-revenue vehicle and equipment maintenance, inventory valuation, repair kit control, consumables reporting, and coach history.

SYSTEMS DEVELOPMENT OVERVIEW

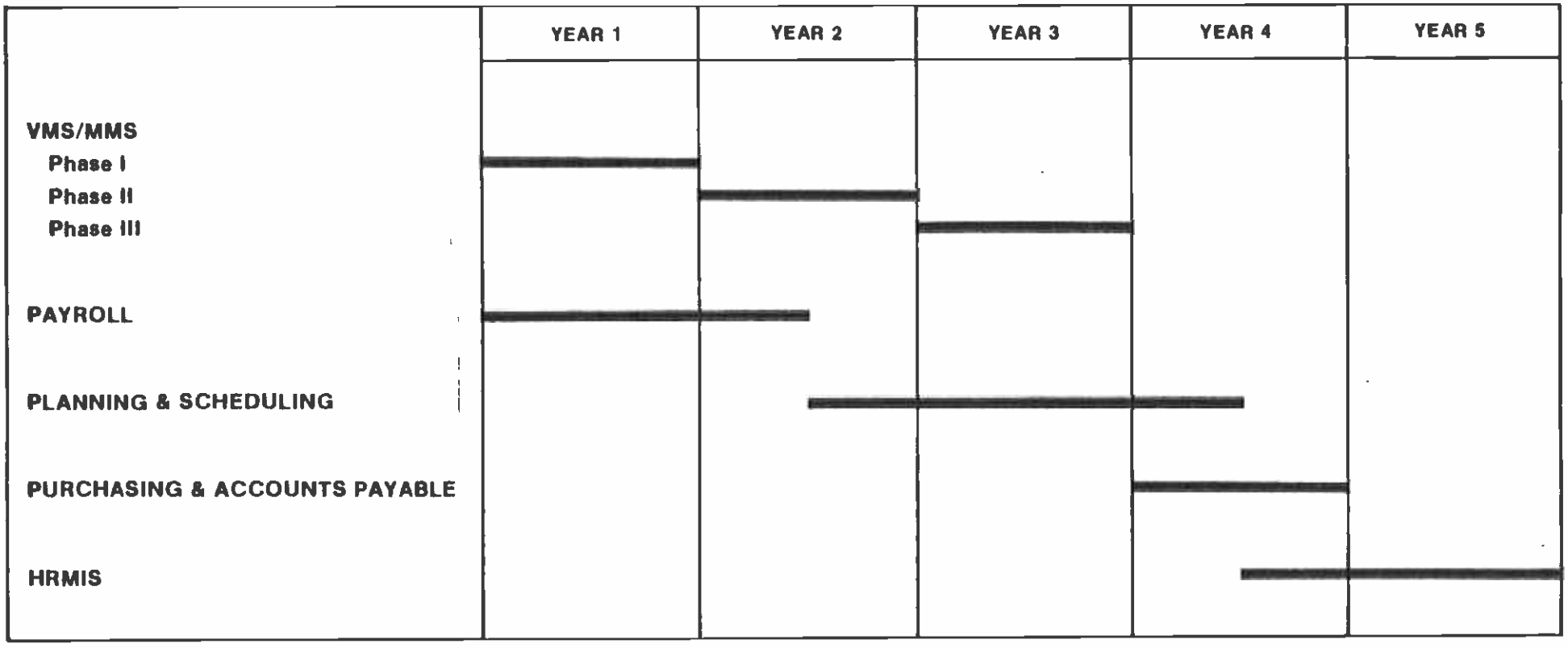


EXHIBIT IV

2. Implementation Plans

Exhibit V presents the major events for each of the five development projects arranged in project order. Imminent activities are displayed in greater detail than those occurring later in the five year period. Three other categories of events have been added: Facilities Preparation, Host Computer Acquisition and Front-end Computer Acquisition. These categories provide a reminder of the independent activities required in support of the individual development projects.

Exhibit VI presents the events of Exhibit V in time sequence. With each is listed the sequence numbers of the principal events on which it is dependent. Projects which are largely independent are listed in priority order.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT

1. Facilities Preparation

1.1 Move personnel currently located adjacent to computer room.

1.2 Expand computer room to accommodate new main computer and front-end processors.

1.3 Prepare facility for second IBM-compatible computer.

2. Acquire IBM-compatible Computers

2.1 Select IBM-compatible host computer. We recommend an IBM 3032 processor or a compatible machine, possible from another manufacturer, of equivalent capacity. In order to minimize the effort required for installing VMS, the operating system should be OS/VS2.

2.2 Order host computer.

2.3 Install host computer.

2.4 Select data management software. A data base management system for use on the IBM-compatible computer must be selected. In addition, a generalized data dictionary for controlling definition and location of all SCRTD's data should be selected.

2.5 Install data management software. Training of the MIS staff in its use also begins at this time.

2.6 Select second IBM-compatible computer. Since the acquisition of the second IBM-compatible host occurs several years later, evaluation of requirements with respect to what is available in the market should be done again. Although it currently appears that an IBM 3031, or equivalent, will be an appropriate choice, SCRTD's understanding of the computing capacity it requires may change.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT (Cont'd)

2.7 Install second IBM-compatible computer.

3. Acquire Front-end Computers

3.1 Select front-end processor. Selection of a minicomputer to provide data collection processing and backup for VMS/MMS and timeroll should be based on the specific processing requirements for those applications.

3.2 Order front-end processors.

3.3 Select system software for front-end processor. An appropriate operating system, and possibly a data base management system, will have to be selected for use on the front-end processor.

3.4 Install first front-end processor.

3.5 Install second front-end processor.

4. Vehicle Maintenance and Material Management System (VMS/MMS)

4.1 Gross requirements definition for VMS/MMS. These requirements must be defined in sufficient detail so that the VMS/MMS front-end processing requirements are identified and an overall VMS/MMS preliminary system design can be prepared.

4.2 VMS/MMS preliminary system design.

4.3 VMS/MMS front-end detail design. This design addresses only the portion of the system which resides in the front-end processors, and that portion in the host which interfaces directly with the front-end.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT (Cont'd)

4.4 Implement VMS/MMS front-end. This includes program design, programming and checkout.

4.5 Pilot test VMS at Division 3. This entails operating the present VMS system at Division 3 and/or some other selected site.

4.6 Convert VMS to the SCRTD environment. Some, probably minimal, conversion of job streams and control statements will be required to move the current VMS from MCAUTO to SCRTD's own IBM-compatible computer.

4.7 Modify VMS to interface with front-end. Since the proposed front-end data collection processor is not a part of the current VMS design, some modifications to VMS will have to be made.

4.8 Install VMS with front-end processor.

4.9 Pilot VMS with front-end processor.

4.10 Expand VMS service District-wide.

5. Payroll

5.1 Define gross requirements for timeroll processing. This definition need go only so far as necessary to determine the impact upon selection of the front-end hardware and system software.

5.2 Complete definition of timeroll requirements.

5.3 Conceptual design of timeroll processing. If it appears that acquisition of a timeroll software package is feasible, this task will be concerned with defining those modifications to the package required for SCRTD.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT (Cont'd)

5.4 Detail design of timeroll processor.

5.5 Implementation of timeroll processor. This activity includes program design, programming and testing.

5.6 Revise current payroll system to interface with timeroll.

5.7 Define requirements for Payroll/Personnel data base. This task defines the information needed by a fully developed payroll system, by the Human Resources System (HRMIS), as well as by other applications to be developed by SCRTD. (These other uses of Payroll/Personnel information were outlined in the Preliminary Report.)

5.8 Payroll/Personnel preliminary data base design.

5.9 Convert payroll system to execute on IBM-compatible host. The necessity for converting the payroll system to the IBM-compatible computer will be determined as a result of the Payroll/Personnel preliminary data base design. Although it may prove feasible to leave payroll on the Univac 1106, it is probable that the need for information sharing with other applications and capacity limitations of the Univac machine will force its conversion.

5.10 Implement complete gross-to-net payroll functions. This activity includes requirements definitions, design, and implementation.

6. Planning and Scheduling

6.1 Define requirements for Schedules data base. Consideration should be given to all the users of schedule related information throughout the District, but special attention should be given to coordination of working versions and released versions of the basic operating schedule, definition of operator-piece-of-work representation, and a common bus stop file.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT (Cont'd)

6.2 Conceptual design of the Schedules data base.

6.3 Detail design of operator-piece-of-work portion of Schedules data base.

6.4 Detail design of remainder of Schedules data base.

6.5 Implementation of Ridership and Schedule adherence application, enhancements to Mini-Scheduler, enhancements to RUCUS, and schedule reporting and related applications. This activity includes requirements definition, design, and implementation on the IBM-compatible computer.

7. Purchasing and Accounts Payable

7.1 Requirements definition for Purchasing and Accounts Payable system.

7.2 Survey of available purchasing and accounts payable systems. It is probable that several suitable purchasing and accounts payable systems can be found in the commercial software package market or among other transit properties. If a suitable system already developed is not found, however, a custom development project will have to be pursued.

7.3 Selection of purchasing and accounts payable software package.

7.4 Specification of modifications required for purchasing and accounts payable package. The selected package will probably require some modification in order to make it fully satisfy SCRTD's requirements.

7.5 Installation of purchasing and accounts payable system. This activity includes design and implementation of modifications required.

PRINCIPAL DEVELOPMENT EVENTS BY PROJECT (Cont'd)

8. Human Resources Management Information System (HRMIS)

8.1 Contract with Information Sciences (InSci) for their Human Resources System, installation assistance, and maintenance support. This and the following recommendations with respect to HRMIS are contained in Alternative 1 of Arthur Young's 1979 HRMIS study.

8.2 Specify required modifications to the InSci system to meet SCRTD's requirements.

8.3 Design and implement modifications to InSci system. This activity includes design and programming required for interface with the payroll system.

8.4 Design employee update/turnaround forms.

8.5 Install customized InSci system on IBM-compatible computer.

8.6 Build the employee data base from existing files and other sources.

PRINCIPAL DEVELOPMENT EVENTS IN TIME SEQUENCE

Sequence Number		Event	Dependencies (Sequence Number)
1	2.1	Select IBM-compatible computer	
2	2.2	Order IBM-compatible computer	1
3	1.1	Move MIS personnel	
4	1.2	Expand computer room	3
5	4.1	Gross VMS/MMS requirements	
6	4.2	VMS/MMS preliminary design	5
7	5.1	Gross timeroll requirements	
8	3.1	Select front-end processor	6, 7
9	3.2	Order front-end processors	8
10	3.3	Select front-end system software	6, 7, 8
11	4.3	VMS/MMS front-end detail design	6, 8, 10
12	5.2	Complete timeroll requirements	7
13	4.4	Complete VMS/MMS requirements	5
14	3.4	Install front-end processor	9
15	4.5	Implement VMS/MMS front-end	11, 14
16	4.6	Pilot test VMS	
17	2.3	Install IBM-compatible computer	2, 4
18	4.7	Convert VMS to SCRTD computer	17
19	4.8	Modify VMS for front-end	11, 18
20	4.9	Install VMS on SCRTD computer	17, 18, 19
21	4.10	Pilot VMS with front-end	20
22	3.5	Install second front-end processor	9
23	4.11	Expand VMS District-wide	21, 22
24	6.1	Schedules data base requirements	
25	6.2	Schedules data base conceptual design	24
26	5.3	Timeroll conceptual design	12
27	2.4	Select data management software	13, 25, 26
28	6.3	Detail design: operator-piece-of-work	25
29	5.4	Timeroll detail design	26

PRINCIPAL DEVELOPMENT EVENTS IN TIME SEQUENCE (Cont'd)

Sequence Number		Event	Dependencies (Sequence Number)
30	5.5	Timeroll implementation	29
31	5.6	Payroll/timeroll interface	30
32	4.12	Implement VMS/MMS Phase II	13, 23
33	6.4	Schedules data base detail design	25
34	5.7	Payroll/Personnel D.B. requirements	
35	5.8	Payroll/Personnel D.B. preliminary design	34
36	2.5	Install data management software	27
37	6.5	Implement scheduling applications	33
38	5.9	Convert payroll system	
39	5.10	Implement gross-to-net	38
40	4.13	Implement VMS/MMS Phase III	32
41	7.1	Accounts payable requirements	
42	7.2	Survey accounts payable packages	41
43	7.3	Select accounts payable system	42
44	7.4	Specify accounts payable modifications	43
45	7.5	Install accounts payable system	44
46	8.1	Contract with InSci	
47	8.2	Specify InSci modifications	46
48	2.6	Select second IBM-compatible computer	
49	1.3	Prepare facility for second computer	48
50	8.3	Implement InSci modifications	47
51	2.7	Install second computer	48, 49
52	8.4	Design employee forms	47
53	8.5	Install InSci system	50, 52
54	8.6	Build employee data base	53

APPENDICES

OVERVIEW OF VEHICLE MAINTENANCE/MATERIALS MANAGEMENT SYSTEM

SCRTD has established the following goals and objectives for the maintenance and material systems:

- Goal
  - Provide a sufficient quantity of mechanically reliable coaches to meet revenue service demands.
  - Provide a tool for managing and controlling the District's inventories.
- Objectives
  - Move from a reactive maintenance mode to a preventive mode.
  - Reduce the current load of paperwork associated with repairing and maintaining coaches.
  - Develop an analytical system to assist in the performance and management of maintenance functions and activities to improve data recording and timeliness.
  - Establish a vehicle maintenance system which will
    - Be coach and exception oriented.
    - Provide flexible and ready-access to the system's base of data allowing detailed special reports for analytical purposes.
    - Provide the ability to track repairs to specific coaches or campaigns across multiple coaches.
    - Provide the ability to forecast and schedule work based on vehicle mileages, hours, or days.
    - Allow people to manage the Maintenance Department through the use of various management-oriented reports.

- •• Provide information in a real time mode via CRTs and printers.
- •• Accept data and transactions from other systems as well as from CRTs.

- Move from the current manual inventory control system to an automated system utilizing current District computer hardware.
- Establish a data base that allows for the flexible inquiry and receipt of information needed for analytical reports.
- Provide the ability to track the purchase, receipt and disbursement of supplies from a Central Stores area as well as from division areas.
- Allow for the automatic reordering of stock inventory as well as the ordering of non-stock items.
- Provide the capability for handling multiple types of inventory items including spare parts, equipment and stationery or office supplies.
- Provide design flexibility to facilitate meeting changing needs and requirements.
- Provide the capability for meeting the stocking and reporting needs of the VMS.

Flexibility has been provided in the Conceptual Design overview to facilitate ready adoption of the system to potential changes in the maintenance or materials areas which will result from the use of the system over a period of time. In addition to planned significant increases in the number of buses within the fleet, SCRTD may shift to other modes of providing transit services such as fixed rail or light rail or some combination of light rail and bus service. Both of these changes will impact the reporting capabilities of the VMS/MMS system placing additional demands upon the system.

VMS/MMS CHARACTERISTICS/PHILOSOPHIES

To critically evaluate the VMS/MMS potential for success in meeting SCRTD's requirements it is necessary to understand the underlying concepts and philosophies upon which the VMS is based. Those concepts and philosophies are provided as an overview of the structure and interrelationships existing within the proposed system. In addition, we have provided definition of components which are considered necessary for the successful and proper operation of the VMS/MMS.

The VMS/MMS has been designed to meet the reporting requirements of multiple levels of individuals with differing requirements for detail information. To facilitate the process four types of reports are included within this system:

- Exception reports identify those coaches or situations which are outside limits established by appropriate personnel through parameters. These reports then serve to highlight specific problems allowing management to focus attention on exceptions to the norm, not details.

- Information reports provide general supporting information concerning coaches and maintenance activities within SCRTD. These reports provide more details on certain activities allowing the opportunity to perform in-depth research on specific topics. These reports support the general "need to know" requirements associated with transit maintenance activities.

- Scheduling reports define those maintenance activities that can be reliably predicted based on the passage of time or miles driven. As such, these reports are predictive in nature, identifying future maintenance activities and their expected completion date. The timely and conscientious use of these reports will move SCRTD from its current reactive

mode of maintenance to a planned or preventive mode, that is, repair after failure versus component change-out. This process can occur over a period of time by using the information obtained from these reports.

- Workload summary reports or performance indicator reports identify in quantitative terms the maintenance activities that have occurred in a given time period. They show the backlog of activities at the beginning of the period and the progress against that backlog. These reports provide the capability to monitor progress against both scheduled and unscheduled maintenance activities allowing management to focus its attention on those areas not meeting their performance goals.

In addition to providing four types of reports the system will report work that has been completed and work yet to be done for each coach. The majority of the information included in the VMS relates to these two categories or to the progress of an activity from one category to another. Consequently, two major files exist within the VMS, the closed repair order file and the open repair order file. These two files, in addition to several supporting files, comprise the data base to be maintained within the system.

In order to maximize the utilization of the data within the VMS, the system is oriented toward providing easy access to key activity data by superintendents, supervisors, and mechanics. This accessibility is accomplished by use of computer terminals (CRTs), located in key maintenance activity centers such as Running Repairs, Inspection, etc. Hardcopy printer capabilities will exist on selected CRTs to allow the printing and displaying of information when the need arises. Information necessary to immediately influence current maintenance activities will be available via CRT. Other reporting requirements will be met through regularly scheduled printed reports, reports

printed only on request, or reports specially designed and prepared for meeting unique on-time study needs.

The success of the system is dependent upon two key factors: the validity, accuracy and timeliness of data contained in the system and the complete understanding of the system by maintenance personnel. To facilitate this understanding, definitions and use of common terms or nomenclature is required throughout both districts. The commonality of terms will cover all aspects of the maintenance operations from data input collection forms or documents to information displayed on reports. The key data collection forms such as the repair order and the road-call form will have a similar structure and use the same basic terms and codes. Consequently, the same forms, policies, and procedures must be used in each facility. This will provide a common base of understanding throughout the District's maintenance personnel to facilitate the consistent and accurate reporting of the information necessary for the VMS. Common nomenclature or terms will be defined during the Detail Design/Implementation phase.

Coach mileage is the key utilization indicator to be used throughout the entire VMS. Mileage forms the basis for scheduling component replacement, inspections and other preventive maintenance type work. It is currently anticipated that coach mileage will be collected daily as part of the servicing operation.

Inspections will be scheduled and performed based on the actual miles travelled by the vehicle, supplied by a daily mileage reading from the service island. Inspections will be based on these actual miles projected for a two to five day interval which will allow sufficient time to schedule the coaches in. Specific inspection mile intervals will be

specified through the use of parameters submitted by the facility. This approach provides flexibility and allows each facility to provide the inspection intervals most appropriate for their particular condition and maintenance environment.

At SCRTD consumable dispensing and recording is currently done on a manual basis. We understand that an automated consumable dispensing and data collection system will be installed on each service island in the future. Consequently, that system will need to interface with the VMS to provide the amount of consumables, fuel, oil, and coolant, supplied to each bus.

It is currently anticipated that the service and cleaning operator will be required to enter the vehicle number and the hubometer reading with the automated system providing data on the amount and type of consumables dispensed to each vehicle. SCRTD is currently using an Automatic Vehicle Identification (AVI) system that reads and transmits coach number to particular stations. SCRTD wants to maintain the option for using this feature in the recording of vehicle numbers on the service island.

The Unitshop will function in a vendor relationship to the Inventory or Material Control department, by receiving requests for specific component rebuilds. Specific requirements to rebuild components or parts will be generated by the inventory control system. It is desirable to have a material requirements planning (MRP) document identify standard items to be replaced on rebuilt components. This would be generated by the inventory control system and would identify those parts needed whenever that major component is removed from a vehicle. For example, when an engine is issued from the storeroom to Maintenance an MRP list would be generated, identifying those parts

that are always replaced with an engine rebuild and which could be included in a kit for the Unitshop. This MRP list would then be used by Inventory Control to state the parts for use by Unitshop for that particular rebuild operation.

A key concept within the VMS is that preventive maintenance activities can and should be scheduled in advance. To successfully accomplish this goal it is necessary to schedule maintenance activities and to monitor progress against the accomplishment of those activities. This facilitates moving the District from a reactive mode of maintenance to a preventive or scheduled mode of maintenance. Because this cannot be accomplished immediately due to existing backlogs of work, the system is designed to provide flexibility by allowing SCRTD to move at a reasonable pace to a preventive mode of maintenance for its vehicles. Consequently, emphasis will be given to the scheduling of maintenance activities.

Schedules will be produced on a periodic basis identifying specific vehicles and the maintenance activities required on each vehicle. Supervisors must have the responsibility and authority to select and assign specific coaches and maintenance activities to meet that schedule.

Shop loading will be performed for preventive maintenance activities in gross terms on a percent of available resources basis. In this way, a given percent of available manpower resources are scheduled for preventive work. Over time, this percentage is expected to grow to approximately a 70/30 relationship with 70% of the maintenance resources being spent on preventive maintenance activities and 30% being spent on reactive maintenance activities, such as dealing with driver defects and road-calls.

The coach backlog file or open repair order file is updated as work is scheduled. This will facilitate the review and identification of work for each coach as the coach enters a maintenance functional area. This provides the maintenance supervisor with the ability to identify work that has been scheduled for a coach which is currently in the shop on an unscheduled repair resulting from either a driver defect or a road-call, and, therefore, provides the ability to accomplish both tasks at the same time. The system will allow the supervisor to maximize his resources by eliminating part of the normal set up and tear down time required with certain activities.

The scheduling system allows for unscheduled activities by scheduling work requirements and not labor hours. In the future if labor standards are developed the system could support scheduling on a labor hour basis.

Preventive maintenance forecasts and schedules will be based on vehicle miles. Miles will be used in conjunction with standardized component lives by subfleet established by SCRTD to determine those maintenance activities that are required and the miles at which they are to occur. This further implies that as major components are changed, their life miles are recorded and tracked to aid future scheduling and forecasting of preventive work.

The closed repair order file will be the primary source of information for special studies and inquiries. Due to the wide variety of possible combinations and future information needs it is impractical to try to develop specific reports during the Conceptual Design Phase. However, selected reports will be developed during the Detailed Designed Phase and, consequently, a report writer capability should be provided

allowing SCRTD personnel the flexibility to identify and generate specific reports for meeting unique informational requirements. This report writer capability would allow SCRTD to establish one-time study reports as well as on-going reports that can be generated on a scheduled or request basis. In this way the flexibility of the system would be greatly increased while minimizing the on-going costs.

Both driver defect and road-call forms are sources of work requirements and will be functioning as work orders for the recording of maintenance activities. Those items that are not completed become work requirements. A work order inspection form, road-call, or driver defect is considered open until all maintenance activities included are closed or completed. In those instances where a driver defects or road-call is not cleared within 24 hours of its initiation, it automatically moves to the open work order file, becoming part of the outstanding work on that coach. The system will monitor and report uncleared defects as opposed to driver defect reports. In those instances where multiple defects appear on one report or where a defect is reported on subsequent days, only individual defects are tallied and reported.

This system has the capability for identifying and tracking warranty items. This tracking capability is provided through the use of coach warranty I.D.'s. It is designed to track individual components on a warranty basis and, therefore, capability must exist within the VMS/MMS for identifying specific warranty components and for their tracking. At the present time, most properties are tracking warranty items on a vehicle basis with key items flagged as warranty items. The system included in the conceptual system overview would allow for the identification of warranty-type items by comparing information from a fixed asset file to the closed repair order file on a

periodic basis. Those items and/or repairs that have been completed during the period on coaches under warranty would be flagged, placed on a report and sent to a warranty processing claims group who would then evaluate, in detail, the particular warranty status of the items and/or repairs conducted during the period. In addition to this capability, this system has the capability to track and/or flag specific repair types within a given sub-fleet, identifying what is commonly called a "fleet defect" when a certain percentage of the fleet has the same component failure or repair required.

The prime objective of the MMS is to provide a sufficient quantity of spare parts for meeting the Maintenance Department's needs in maintaining a reliable and operational fleet. A secondary goal is to provide the capability to identify and maintain an adequate supply of inventory items to meet other departments' consumption requirements. Consequently, the MMS must be flexible enough to handle both maintenance and non-maintenance items. An overriding philosophy within the inventory system is that of providing both accurate information about the quantity of items on-hand and used as well as the costs associated with various classes of inventory.

The strong interface and support requirements of the VMS place some additional burdens upon the MMS. It is desirable that the MMS support multiple classes of on-hand inventories, such as available and committed to PM activities, as well as two types of inventory issues or usages: preventive maintenance or failure. Within SCRTD numerous vehicle components or parts are remanufactured within the Unit Rebuild Shop. The Unit Shop needs to be treated as a vendor of the MMS producing parts to stock levels determined by the system. It is desirable, therefore, to maintain two classes of inventory: new and rebuilt, and track them throughout the system. This may be most

effectively accomplished through the use of a suffix on the part number indicating new or rebuilt.

In addition to requiring the tracking of new and rebuilt parts the VMS, as a result of UMTA reporting requirements, also must track certain parts or components by serial number. This will require that the MMS maintain information concerning which specific parts (by serial number) it currently has on hand and to whom they are issued (vehicle, location, etc.).

The VMS system will be performing scheduled maintenance and can provide scheduled parts requirements for several periods in advance. The MMS needs to make use of this information from a Materials Requirements Planning (MRP) viewpoint and base future stock levels, EOQs and EOPs upon the information. Additionally, it is desirable to base the EOQs and EOPs on two components: fixed demand via MRP requirements and variable demand based upon failure or unplanned usage, thus the requirement for two classes of issues: PM and failure. With the implementation of planned coding conventions on the VMS repair order this usage information may be available via the repair order number and a system data transfer.

Within SCRTD multiple vendors are supplying parts for use on the various vehicles. The parts are frequently ordered under the original equipment manufacturer number. Maintenance manuals frequently refer to a "part" by the manufacturer part number. Within the transit industry there is a great deal of duplication and interchangeability among manufacturers but not part numbers. It is therefore desirable to establish a standard part number scheme and cross reference all parts to this scheme. In order to standardize the reference to parts and avoid the confusion created by duplicate part numbers from two or more vendors, the

following part numbering system should be implemented for the MMS. A sequence number will be incorporated into a group numbering structure. In addition, an expansion prefix digit will precede each inventory item number. Inventory items will be assigned numbers using the following scheme:

9	A 9 9 9 9	9 9 9 9 9
Prefix	Group Identifier	Sequence Number

Prefix - Expansion digit to indicate medium for part usage. Following is an example of how this digit could be used:

0 = Bus Parts
1 = Stationery
2 = Non-Revenue Vehicle Parts
3 = Equipment

Group Identifier - This identifier represents the group number as in engines, suspension, etc.

Sequence Number - This group will be assigned to an appropriate group, commencing with the first item in the group. Each consecutive item will be sequenced in increments of 10. Existing items that do not have group identifiers will be assigned appropriate groups and given sequence numbers.

In addition to the above characteristics and philosophies the MMS embodies the following characteristics or capabilities:

- Maintain a uniform and comprehensive item master file including records for all components, tools, parts and supplies used by SCRTD.

- Maintain on-hand and on-order balances for each storeroom and in total.

- Upon receipt of purchased material, generate data to update purchase order status files.

- Maintain cross-reference of SCRTD and manufacturer part numbers including any superseded manufacturer part numbers.

- Maintain historical usage data by fleet on each inventory item as well as projected usage based on maintenance schedules.

- Project stockouts for those items whose lead time requirements are not covered by material on-hand and on-order.

- Control transfers of inventory between locations by recording both quantity sent and quantity received for each transfer.

- Report any stock-outs and any inventory balances below reorder points. Include only information such as supplying vendor, price and unit of measure.

- Maintain perpetual inventory listing for financial accounting purposes.

- Provide capability to revalue inventory at year-end.

- Maintain error suspense file to insure invalid transactions are corrected and processed.

- Calculate the standard cost of parts issued to maintenance repair orders for maintenance cost reporting purposes.

- Provide ability to perform cycle counting, and physical inventory counting including inventory adjustment capability.

- Provide lists of obsolete or slow-moving inventory as well as reports of inventory adjustments.

- Provide capability to establish and maintain kit file structures for various maintenance jobs and perform material requirements planning activities.

SYSTEM CONTROLS

An increased awareness of the need for accurate and timely processing of data will be required within the District as a result of the implementation of the VMS. Specifically, this means that greater attention will be required to ensure that data is entered to the system in a timely and accurate manner. The system should be designed to validate data entered and screen out and produce error reports on those items not passing predefined edit rules. Those transactions not passing the edit rules will be placed in a suspense file and will have to be corrected and removed from that suspense file in order to become part of the normal processing of data. It will be the responsibility of specific individuals within each facility to correct any errors and to re-enter corrected data to the system to ensure the availability of data for meeting future reporting requirements. The information provided through the VMS/MMS will only be as good as the data that is collected. Consequently, a great deal of emphasis will need to be placed on the definition of and adherence to data collection and data entry procedures. The successful operation of the system will require an on-going training program for maintenance personnel, including comprehensive training for new employees.

To enhance the accuracy of the data entered into the system, extensive utilization will be made of CRT function keys during the data entry process. The use of function keys will greatly reduce the amount of data that an employee will have to enter each time he addresses the CRT. By providing specific

information, such as the bus number, and using a function key, the computer, based on the terminal location will identify specific activities and complete the balance of the transactions leaving the employee free to go about his or her other responsibilities.

Another overriding philosophy of the system is the existence of audit trails such that transactions can be traced from their entry into the system to the report or document upon which they are presented. To accomplish this, transactions may be batched and processed as groups, depending upon the particular application and the appropriateness of using such controls. In those cases where batches are used, batch balances and control totals will be required. An example of this would be the use of batch balances and control totals on the entry of consumables information.

Another important element of system control involves the logging of all transactions as they enter the system. The transaction log should be saved daily and kept for approximately seven days before it is destroyed. This would provide the needed transactions to be used in restart/recovery procedures as required. Restart/recovery procedures deal with the steps data processing follows in restoring a particular system or file so that file and report data are complete. Key elements in the restart/recovery procedures are transactions logs and backup or file copies from previous processing periods. By using file copies and transaction logs, it is possible to rebuild a file that has been destroyed due to some accident.

The development and maintenance of control totals are of key importance to the success of the system. In many cases, it

will be appropriate to maintain run controls on certain files. An example may be the employee history file.

In addition to the controls identified previously, controls associated with access to the system itself can be provided through the use of terminal I.D.s, hardwired terminals, or some other type of hardware protocol which causes the terminal to identify itself to the computer.

Through the use of terminal I.D.s it is possible to prevent certain terminals from accessing certain modules, subsystems, programs and/or data. It is possible to utilize passwords to prevent specific employees from accessing certain systems, programs and/or data. It is also possible to employ combinations of these two controls to allow an individual access to a program or a system but not to have update or change capabilities on specific information. That is, an employee may be given permission to read the workorder file or the repair order file, but he does not have permission to make changes or updates to it.

CONCEPTUAL SYSTEM FLOW

The VMS/MMS system is centered on two key files: the closed work order file, which identifies work that has been completed on a given coach and the work requirements of open work order file which identifies work yet to be completed on each coach. Principal input includes: road-calls, service and cleaning information, inspections, and repair orders. Repair items remain open in the open work order file until such time as they are placed on a repair order through the interaction of the supervisor. When work is completed through the regular repair function, it moves from the open work order file to the closed work order file.

Various interfaces exist between VMS/MMS and other SCRTD systems. The payroll system interface provides information on the labor expenses associated with each repair order accumulated through the clocking on and off of jobs by maintenance personnel. Other systems provide information necessary for the proper operation of the VMS/MMS such as parts received and entered to the MMS, vehicle requirements by transportation scheduling, etc. These various interfaces are crucial to the success of labor and parts utilization reporting as well as the total VMS/MMS system.

SYSTEM INTERFACE REQUIREMENTS

The Vehicle Maintenance/Materials Management System is an integral part of the total information system at SCRTD. As such, this system must integrate with a number of existing systems or information areas. This integration will occur at two different levels, manual and automated. In both cases, data or information will be passing in two directions from the VMS/MMS to other informational areas and from other informational areas to the VMS/MMS. The major portion of the information interfaces are currently manual. The development of an automated or semi-automated VMS/MMS will allow portions of this interface or information exchange to occur in an automated manner. This will allow SCRTD to utilize and take full advantage of the benefits of entering data at a single point while providing the information to multiple areas. This will eliminate some of the redundant data entry typical of manual information systems.

The majority of the information systems currently interfacing with the VMS/MMS are manually based. Consequently, the requirements for VMS/MMS system interfaces are relatively limited from an automated viewpoint. Two areas currently require or support automated interfaces while the remaining

areas will continue to interface at the manual level. The major area that the VMS/MMS must interface with are as follows:

The maintenance management system must interface with users outside of the VMS/MMS confines since it is designed to handle non-vehicle related inventory items as well as vehicle related items. Within this context, it must be able to interface with other user departments to track the issue, and return of items within the District. In addition to other user departments, the MMS must interface with receiving as well as purchasing. In the receiving area, it must receive information relative to the timing and receipt of goods. The MMS will interface to Purchasing providing purchase requests for various items maintained within the inventory area. The purchasing system interface must also provide data back to the MMS concerning the outstanding POs and their current status.

Operations must interface with the VMS/MMS providing data relative to road-calls, operating hours, the sign-in and sign-out or dispatching of vehicles, scheduled miles and driver defect reports. Information is transmitted between the VMS/MMS and the operations area concerning the need for particular vehicles on the a.m. and p.m. peak as well as the particular coaches being assigned to daily runs.

The fixed asset system has a need for interfacing to the VMS/MMS system concerning the equipment that is maintained within the system. At the present time, it is desirable that certain fixed asset information be maintained outside of the VMS system. Such information would be maintained within the fixed asset system which would also provide the capability for performing the basic depreciation calculations, etc. An interface would be required between the two systems to provide basic vehicle and/or equipment information. Depending upon the

resolution of the question concerning equipment number linkages, additional information may be maintained within the fixed asset system and appropriate interfaces required.

An interface is required with the accounting system where financial data would be transmitted between the financial systems and various systems within the VMS/MMS area. Appropriate financial data concerning inventory as well as inventory usage would be maintained within the financial area. Payroll information as well as information concerning closed and open work orders and any amount of materials and labor applied to each area would be maintained within the financial data base. The financial data would also be used in the reconciliation of certain areas such as payroll data, consumable data and material parts usage.

All VMS interface requirements currently specified by SCRTD exist at the manual level. There is, however, a requirement for information exchange between the two areas. At this time, we believe, this exchange will be best handled by reports generated by the VMS and a few minor input documents generated by the accounting area. We have reviewed the accounting reporting requirements for Section 15 and believe these requirements should be satisfied by the accounting system. Maintenance information reporting requirements for Section 15 will be met by planned VMS and associated systems reports. The major areas that the VMS system must interface with at the automated level are as follows:

- The major interface of the payroll system deals with employee attendance and hourly labor rates by individuals. An interface must exist to provide current information to the VMS system so that maintenance supervisors can determine which mechanics are present and/or absent.

- The labor rate interface can occur on a periodic basis, such as monthly or quarterly and only specific individuals need to be updated as changes occur.

OVERVIEW OF PAYROLL SYSTEM

SYSTEMS OVERVIEW

The Payroll application is a key system at SCRTD because it affects every one of the 7,500 District employees and because it must be processed in regular bi-weekly cycles on a tight time schedule. This application captures labor source records, processes daily time records for the pay period, produces paychecks and associated reports, and passes labor distribution detail to the finance system. The application processing functions are comprised of four components: (1) data capture, (2) timekeeping processing and validation, (3) paycheck preparation and reporting, and (4) labor distribution.

Primary source inputs to the Payroll System consist of the master personnel roster of District employees, and the labor hours and work assignments for each. Methods of data capture and processing are customized to particular subgroup characteristics of the work force. Vehicle operators comprise by far the largest segment of the total employees, and most of them have pre-defined work assignments. This makes it feasible to forecast their work activity and execute the timekeeping function using exception reporting techniques. Major work assignment changes occur three times per year, but lesser changes occur weekly and daily, necessitating frequent updating to the personnel work assignment data bases.

The second largest employee componenet consists of maintenance personnel and labor detail for this group, and is captured by the Vehicle Maintenance System (VMS). A timekeeping subsystem within the VMS records daily labor hours distributed to vehicle work orders and activity classes. Since this work is not pre-defined in any way, it is necessary to use positive

reporting for maintenance labor records. At the conclusion of the pay period, the labor detail of the VMS is summarized to gross hours and passed to the payroll calculation routine. Labor capture for the remaining hourly and salaried employees is via timecards at the end of each pay period.

After validation and summarization steps are completed for the input data, the payroll calculation subsystem calculates gross-to-net pay and prepares paychecks as well as a variety of reports. In addition, the subsystem performs labor distribution to appropriate accounts for interface with the finance system.

SYSTEM CHARACTERISTICS AND PHILOSOPHIES

The effectiveness, timeliness and accuracy of the Payroll System will be affected to a significant degree by the design and operational characteristics of its data capture and processing subsystems. The nature of the labor data capture requirements vary substantially among the major groups of District employees. Accordingly, different processing techniques are applied for operators, mechanics, and salaried plus other hourly employees.

For coach operators, a front-end data capture and timekeeping subsystem is required to capture, validate, report and summarize labor data for subsequent payroll and labor distribution processing. The fundamental concept underlying this subsystem is that scheduled work activity for most operators can be forecast from their bid data; thus only changes to the forecasted work activity need to be entered and on-line exception processing techniques are used for that purpose. However, the size of the District's operator work force and the volume of

changes which regularly occur would necessitate a relatively high volume of exception procesing. The volume of exceptions can be reduced by further automating the subordinate bids and daily extra-board markup so that a larger proportion of the daily scheduled activity is pre-specified and the exception cases are correspondingly reduced.

Labor data for the mechanics work force is captured by a subsystem of the VMS. Positive entry is required for these personnel since there is no pre-assigned or pre-defined work activity. The VMS collects labor hours by work order and maintenance activity class. Data entry is from clock in and out readings via either automated badge reading equipment or on-line processing. The data capture system collects the labor hours by work orders, vehicle numbers and activity codes for the VMS, the summarizes the employee gross hours earned for payroll and labor distribution processing.

Labor data capture and entry for the remaining District employees is more straightforward. This last group of about 1,200 employees are office and clerical, non-contract management and professional personnel. Data input is via timecards which are batch entered for payroll and labor distribution processing.

Each of the three labor data capture and processing subsystems described above requires a unique design and processing logic to minimize personnel effort, provide timely and accurate information, and maintain effective administrative controls and audit trails. The operator timekeeping system must be closely integrated with the transportation dispatch control process and with the scheduled work assignments and operator bids. The maintenance timekeeping system is a necessary subset of the VMS and must accumulate labor expenditures accurately against vehicles in the District's fleet. All labor data capture activities depend on the Personnel Management System for the current status of employees.

OPERATOR SIGN-UP FOR WORK ASSIGNMENTS

For vehicle operators, the major elements of the payroll data capture and timekeeping function revolve around matching work assignments with the individual operators who perform the respective assignments. The operator sign-up process provides that link. The process is executed via division and system-wide shakeups, vacation bids, weekly bidding, and daily extra-board markup.

Shakeups occur three times per year, two of which are conducted at the division level and one is system-wide. All operators participate and select either regular work assignments, relief work assignments or extra-board assignments. Since regular and relief work assignments have stable, predictable patterns, they can be forecast and timekeeping can be performed by exception-only adjustments. Exception entries are necessary for variations from scheduled work time, sickness, vacation substitution, and unanticipated days off or disruption to the normal cycle. Exception entries also are required for all extra-board duties. On-line timekeeping for this level of exceptions would only involve about one-fifth to one-quarter of the operators; as much as 80% of the operator workforce timekeeping would be performed automatically by the system.

Further improvements to automating operator timekeeping could be made. Weekly bids are conducted at SCRTD to cover open assignments arising from vacations, resignations, retirements, etc. The weekly bids update and extend the number of pre-defined work assignments, making it possible to handle additional operators by exception timekeeping. This leaves only extra-board operators who must have daily entry of assignments because their work is not predefined. Each day the extra-board personnel are rotated and the next day's work for each operator is

assigned. If the extra-board markup process were performed via on-line processing, then the next day's extra-board assignments could be automatically entered into the timekeeping system on a daily dynamic basis. This would enable virtually all of the operator personnel to be covered with predefined work activities. Then the level of exception entry would be limited to no-shows, missouts, sickness, accidents, supplemental service, breakdowns, etc. The volume of exceptions in that case is estimated to involve only about five to ten percent of the operators.

The three levels of sign-up automation (shakeup, weekly, and extra-board) could be implemented in successive stages or simultaneously. It is also feasible to implement them incrementally division-by-division (with the exception of the system-wide shakeup). Since the shakeup process is probably the easiest to automate and covers the largest complement of work assignments, it is reasonable to give it priority attention.

An interactive bidding subsystem to manage the operator sign-up should greatly reduce the time and cost of the operator bidding process and avoid many of the errors which occur frequently in manual bidding methods. The logic of the system is simple. At the start of the sign-up, an initialization process generates the seniority list and sets up the seniority order and a temporary file for the bids. The available work runs are posted for review by the operators. Following their scrutiny of the possible work assignments, each operator selects several choices and indicates his order of preference for each. The operators' multiple choices are entered into a proxy file which is then scanned and automatically applied in seniority sequence. The operators are processed in order by displaying their choices

and showing the open run matches which are still available. When a chosen work run is open, the operator's badge number is entered to assign that operator to the run. The run is the removed from the available list. The next operator on the seniority list and the last operator signed up is displayed on the video screen. Any time a bid is entered, its seniority position is confirmed, and if not in proper sequence, a warning message is displayed and supervisory approval is requested.

To reduce the likelihood that all bid choices will have been previously allocated, the choices can be registered in daily cycles. At the conclusion of processing, the remaining available work assignments are listed and posted for the next group of operators. The second group then makes their proxy choices and the process is repeated, ending with a new list of remaining work assignments for the next day's bidding. This stepwise bidding method reduces the number of redundant bid choices which may no longer be available and speeds the processing as well.

Sign-up procedures may be invalidated for various reasons following a given operator action. Therefore, the system permits removal of all bids past that point (saving a significant portion of the sign-up), and restart bidding for the remaining operators.

At the end of the bid, the program scans the file and flags any runs not taken or operators not signed up. Several reports are printed upon completion of the sign-up:

- Alphabetic list of operators and their run assignments.
- Seniority list of operators and their run assignments.
- Seven-day work schedule by line.

The system includes update capabilities so that changes to the sign-up can be entered to reflect changes in the personnel file (retirement, new employees, and sick leave, etc.)

ON-LINE OPERATOR EXCEPTION TIMEKEEPING

To complement the operator sign-up subsystem, an on-line exception timekeeping system processes operator time records, performs edit checks and daily audits, summarizes daily-to-gross hours for the payroll calculation subsystem, and generates a number of reports for accounting and transportation management. On-line processing will significantly limit manual effort, enable validation checks simultaneous with data entry, and improve consistency of timekeeping calculation in compliance with the labor agreement.

The operator timekeeping system uses three basic sources of information to generate time records for operators:

Work Assignment File - which contains all of the time detail for work assignments scheduled to be operated each day of the pay period. This information is captured for each operator shakeup period from the scheduling system. Modifications to the schedule records can be made via video display terminals to account for changes in regular runs, relief runs, extra-board slots, or any other special work assignments. The schedule records include regular paytime and its elements (platform, report time, travel, pull-in, etc.), and overtime (overtime premium, spread premium, shift premium). In case of two (or three) piece runs, it shows each piece with its time details, as well as start and end clock times.

Personnel File - which contains operator personnel data, as well as bid information, vacation selection, and floating holiday or birthday if appropriate. This file also has on-line update capabilities.

Daily Work Exceptions - variations in scheduled work assignments, as well as assignments for the extra-board operators are registered by the dispatcher on his daily dispatcher sheets.

Based upon the operator sign-up results, the timekeeping system generates the forecasted work activity of each operator for the next week or for the entire pay period. The system automatically scans vacations, floating holidays and birthdays to reflect the future work activity by day. Results are then reported to show operator personnel rosters and their assigned work each day, work assignments by order of pull-out and the associated operator each day, and supplemental daily summaries of operators on vacation, days off, holiday, etc.

The reports serve as markup sheets for division dispatchers to record exceptions and assignment changes, deletions or additions. The markup sheets then become the source documents which reflect actual operator and work activity, and are used for updating time records by on-line processing with the timekeeping system.

Exceptions are entered by updating work run details or operator assignments on a video terminal. The system automatically calculates hours earned and time guarantees in accordance with the labor agreement. Status codes are used to minimize data entry requirements yet describe all activities for operator personnel. Sufficient detail is carried in the time records to satisfy Section 15 operator wage reporting as well as internal management requirements.

Because changes occur frequently to both the roster of operator personnel and the work assignments, the system includes inquiry and update capabilities for maintaining these files.

Each day, upon completion of the prior day's exception entries, a daily audit is executed to check against errors such as runs unassigned, operators without work assignments, runs with duplicate operators assigned, and variations between scheduled and actual work assignment hours. A series of audit and error reports are produced for checking and resolution. Corrections are made via on-line terminals.

At period end, the system transmits the operator time records to the gross-to-net subsystem and produces several reports for the current period and year to date. In addition to the gross hours file transmitted for payroll calculation, a history file is created showing daily time records by operator for permanent archiving.

Reports available from the system include an operator payhours register documenting the payroll input, labor utilization summaries, daily operators recap by division and system, labor distribution detail for Section 15 Form 321 reporting to UMTA, and allocation of operator hours (and costs if desired) to routes and services. Attendance reports for operators may also be obtrained at user option.

Time records are protected by a security system which permits only certain personnel to access the timekeeping records or to initiate any modifications to them. Security levels control who may activate a terminal, who may access the time record update programs, and who is permitted to enter any modifications. Daily backup procedures and a detailed transaction log allow for automatic recapture of data or restart.

SYSTEM CONTROLS

Security and data integrity are critical concerns in the Payroll System application because it is the source for disbursement of large sums of money and because it contains confidential information. Strict access controls, system and terminal passwords, valid user interrogation, transaction logging of all entries and modifications, complete audit trail, and backup/recovery procedures are incorporated to assure security and confidentiality.

Authorities for personnel record changes (additions, deletions, modifications) are controlled by limiting them to selected terminals and password identification codes. The codes are re-defined frequently. All changes are registered on a transaction log for review and validation.

The operator's timekeeping subsystem also requires a password before system access is permitted and restricts file modifications to approved user codes and/or designated video terminals. All transactions are logged and reported for independent review and verification. Each day an audit check is processed which reports all variations between scheduled and actual work and identifies unassigned as well as duplicated work and operators.

Backup and restart procedures are an integral part of the system procedures. Daily backup of the timekeeping transactions protect against system failures and massive loss of data files. In the event of a data loss, restart can be initiated with the most recent backup file to minimize recovery effort. A history file is generated for future recall of employee hours earned detail should it be necessary.

OVERVIEW OF PLANNING AND SCHEDULING

OVERVIEW AND PHILOSOPHY

The role played by Planning and Scheduling is one that impacts virtually every other function of a transit property: here the public demand for transit service is matched with the district's financial, manpower, and equipment resources. Small improvements in the quality of the planning and scheduling process can result in large reductions in costs, better quality service, or both. Conversely, seemingly small inefficiencies in the process can produce inordinate cost increases or service that is less than it could be or is poorly matched to the demand. If used properly, data processing can improve the quality of the planning and scheduling process by improving the management of the large volumes of data required for those tasks and by easing some of the more complex decisions that must be made.

The interdependent areas related to planning and scheduling are: 1) Ridership and Performance Monitoring, 2) Planning, 3) Scheduling, 4) Runcutting, 5) Operator Bidding, 6) Extra-Board Management and Operator Paytime Data Capture (Timeroll), and 7) Operational Reports. Although this section discusses only 1, 3, 4, and 7, each of these functions requires data from the one before it, and all of them depend upon the results of Scheduling and/or Runcutting. Moreover, each is labor intensive and requires considerable skill, judgement and experience. Efforts to automate these functions have achieved some success, both at SCRTD and elsewhere, but the major lesson to be learned from such efforts is that the judgement of the skilled scheduler, runcutter, planner, or dispatcher cannot be replaced. Rather, the aim of a data processing plan should be to augment and supplement these skills with the fast, accurate and tireless support that a computer can provide.

Computing is inherently very fast and very accurate, and the new generation of hardware is also inherently quite reliable. Yet, it does not necessarily follow that a data processing system will make the planning or scheduling process faster, more accurate or more effective. Both the speed and the acuracy can be completely negated if time consuming and error prone manual steps are interposed between various computerized steps. And the effectiveness of a computer system can be negated if the computer system is inflexible, or poorly matched to the job. These considerations imply that, in the present application, most of the system must consist of on-line interactive programs. The only alternative, batch systems, are inadequate both in the way they present data to the user, and in the way data is gathered from the user. Batch systems rely on reports as the main interface to the user. Reports, where useful, can be produced from interactive systems, but reliance on paper wastes time -- particularly when several documents must be used together or when documents are misplaced -- and is susceptible to the many mistakes that people make when juggling large amounts of data. Data flow from the user to the system is at least as critical: the chained nature of the various functions considered here means that there is no true end user of data; each step uses data from the previous step and simultaneously generates data for the next. Thus, in a batch stystem, the results of each step must be manualy recorded and entered into the system for use by the next step. That produces the very interweaving of computerized and manual steps that negates both the speed and the accuracy of computerized systems.

In addition to managing large volumes of data used in scheduling, computers can also supplement human decision making when a good decision requires the examination of a large number of alternatives (e.g., in the case of vehicle or driver assign-

ment). Runcutting decisions are already largely done by the SCRTD RUCUS package, and SCRTD is now experimenting with the SAGE Mini-Scheduler Package which, among other capabilities, applies the power of the computer to the vehicle assignment problem.

GENERAL DATA BASE CONSIDERATIONS

The data bases to be considered below have in common the (potential) need to be accessed and updated very frequently (at least daily), the need to be accessible to multiple applications simultaneously, and in many cases, the need for updates to be reflected immediately in all subsequent accesses. These needs place certain constraints on the data base design and on the data management programs. First, the data must be on-line. Second, each data item must functionally reside in only one location in the data base (i.e., either it must physically reside in only one location in the data base, or the data management programs must automatically update all copies of the item whenever one copy is updated). Otherwise the data processing system can generate confusion when different processes have differing values for an item because all copies of that item were not updated. Third, data must be available to multiple users unless it is actively being updated (and inadvertant update must be avoided). And finally, data that is needed by data hungry routines such as RUCUS and the Mini-Scheduler vehicle assignment routines must be available very quickly; otherwise these programs run too slowly to be useful in an interactive environment.

All but the last of these requirements are familiar to anyone that has considered the problems of Data Base Management Systems (DBMS) , and all but the last have been solved by any

number of general purpose DBMS packages available on the market. In the cases where high volume fast access is not required, a DBMS may be useful. But data that supports interactive decision algorithms requires carefully designed special purpose data bases and maintenance systems. These will be considered in the appropriate sections below.

RIDERSHIP AND PERFORMANCE MONITORING

Adjustments to service require that timely and accurate measurement of ridership and schedule adherence be available to planners and schedulers. Recent trends of ridership growth and rapidly changing patterns of transit usage create a need both for more data and for a shorter cycle of data availability. Also, a scarcity of equipment and manpower (which will continue for the forseeable future) makes accurate allocation of service even more crucial; service in excess of demand (and policy minimums where applicable) must be moved to cover excess demand as quickly as possible.

The need for accurate and timely ridership data is also related to the ability of schedulers to reschedule lines; only so many lines can be rescheduled each sign-up (and with manual methods that number is relatively small). Data for lines that cannot be rescheduled may serve to set priorities for the next sign-up, but is otherwise of historical interest at best. However, the Mini-Scheduler based scheduling system is expected to be in production use in 1981 and will enable schedulers to reschedule many more lines in a given sign-up. The concomitant need for ridership data will grow apace.

Current data gathering methods are manual, although experimental APC and AVM systems are in progress. Data reduc-

tion and analysis is automated in a batch system that produces the various reports which are stored until needed. The result is that the planner or scheduler in need of a report for a particular line must sift through a closet full of reports to find the appropriate one(s), and often that data is nine months to a year old.

A major goal of the five year plan must be the automatic collection of ridership and schedule adherence data. This may be accomplished by either or both of the current experimental projects (AVM and APC). But if these systems are not satisfactory, other systems must be tried. A property as complex as SCRTD cannot be satisfactority monitored by checkers riding buses pen-in-hand.

Until some form of automated data gathering system can come on-line, SCRTD will have to rely on the current manual method. But because automated data will almost certainly be available in the next five years, the Ridership and Schedule Adherence (RSA) system must be designed to handle the much larger volume of data that will then be available. Similarly, although the RSA data base need not at first be on-line, the longer range goal should allow for interactive use by the scheduling system, so it should be designed accordingly.

The data base should consist of a set of files (one for each check) organized by line, service, date and time of check. Two main systems must access the data: the data maintenance and entry system, and the analysis/report system. The first of these contains three subsystems: 1) An on-line catalog of data that allows easy determination of what data is available and how old it is, 2) a data entry system (which may be a batch entry of keypunch data even though online data entry on formatted screens

would provide better control over the process), and 3) an edit checking and correction system to screen out the errors that inevitably arise in the transcription of data. The Analysis and Report system consists of an on-line report request module (with menu driven report requests and a facility for determining the availability of data at the time the request is made), and a background batch mode report module that processes the report requests and spools them to the printer.

The purpose of the catalog is not only to track complete checks, but also to track checks from the time they are initiated. So the catalog should indicate the status of a check (i.e., "complete", "in data entry phase", "in data gathering phase", or "scheduled but not begun"). With such a catalog, planners and schedulers can know what data will soon be available as well as what complete data is currently available. Thus they can request checks if need be. Finally, because the catalog is organized by date, it can be used periodically to identify old data and move it to off-line data storage.

SCHEDULING

Scheduling is responsible for building the individual trips that make up the schedule, for assigning the vehicles so that every trip is serviced, and for maintaining the schedules data base (called the BOS) in its various stages of development -- from new schedules in the process of construction or modification, to the complete schedule that is being bid by the operators, to be schedule that is in current operation on the street. The volume of data involved in this process lead SCRTD to be one of the first properties to begin to automate the data base and maintenance procedures. Unfortunately, the system was begun just prior to IBM's announcement of the 360 series, and so

it is based on an IBM 1401 unit record system. This system, though cumbersome, is marvelously flexible -- too much so in fact. Because much of the record is designed only to be sorted and printed, never parsed, there are very few constraints on the data within a record. The schedulers have taken advantage of this lack of constraint to include data and data formats that cannot be deciphered by any practical automatic process. This, and other aspects of the BOS, has frustrated much of the scope of the original RUCUS project, has caused difficulties for the CCIS project, is currently causing difficulties for the Mini-Scheduler project, and, if not corrected, will eventually impact the AVM and APC projects.

1. The Scheduling Data Base

The Mini-Scheduler, in addition to its computational routines for trip building and vehicle assignments, is a scheduling data base system. It does not now encompass the full range of complexity found in the SCRTD schedules, but it can be modified to do so. A joint SCRTD/SAGE design team has recently decided to make the necessary modifications so that the BOS will be replaced by the on-line Mini-Scheduler data base. That data base will contain subsets for currently operating schedules, schedules in the bidding process, schedules under revision, and speculative planning schedules. Each of these subsets will be a complete, independent and internally consistent data base which includes special service such as school/holiday, race/non-race, and Bowl/non-Bowl.

All updating of the data base will be via the Mini-Scheduler. However other applications will have read-only access via a set of data access subroutines that

will be responsible for the traffic control functions necessary in a multi-user system. During the transition phase, the Mini-Scheduler must be capable of outputting a BOS-like file which, with some manual input, can drive the runcutting and reporting functions that now depend on the BOS file.

2. Trip Generation and Vehicle Assignment

These functions, which are primarily manual at present, will be extensively supplemented by the Mini-Scheduler as it is phased into production. But modifications are needed to the Mini-Scheduler to handle what has become known as the "multiple pointer" problem, namely that a block may exist in several versions -- a basic set of trips together with special trips for school, racetrack or Hollywood Bowl service which are run according to need. This presents problems for the data base design as well as for the vehicle scheduling procedures. Solutions for these problems are now in the design phase.

A further goal of the five year plan is to provide an automated, or computer aided interface to patronage data. Mini-Scheduler trip generation routines are powerful and flexible but the parameters must be chosen by the scheduler and entered manually. Some of these, e.g., headways, could be derived semi-automatically from patronage data. Thus some effort should be devoted to designing such a capability.

RUNCUTTING

The runcutters, given the bus runs as determined by scheduling, must produce the daily run cuts (according to

the type of service applicable for the day) that conform to union rules, and combine them into weekly work-runs suitable for bidding. This is an art, not a science, because the work-runs must not only be near minimal cost, but also the mix of work-runs must be of acceptable quality. If a unique minimum cost runcut were possible it may well involve a mix of work-runs that is unacceptable to the drivers.

At present, runcutting is done in a batch mode by a much-modified version of RUCUS. The interface between runcutting and previous and subsequent steps is manual. Input is a manually coded and keypunched subset of the BOS file that includes only the relief points of the bus-runs. Output is a listing of work-runs that is manually marked up, then recorded, keypunched, and eventually becomes the Work-Run Master File. That file feeds the bidding and extra-board operations. The goal of the five year plan is to automate the interfaces and to make runcutting interactive.

Automation of the data flow to and from RUCUS is important because RUCUS is in the critical path of the scheduling process. The days taken by manual coding and keypunching could otherwise be spent improving the schedules or runcuts. Moreover, errors creep into the data during the manual processes; time wasted finding and correcting them can be substantial. Details of the interface with the Mini-Scheduler cannot be determined until modifications to the data base are complete. Details of the interface to the bidding and extra-board process must await redesign of those systems (see Appendix B).

Conversion of RUCUS from batch to interactive is an important long range goal. A great deal of effort has been expended to fine-tune the runcutting logic to match SCRTD's needs; the result is that good runcuts can be obtained if time is available for several iterations. However, turnarounds are slow, hence, in practice, the runcuts are seldom as good as they could be. An interactive system would allow the runcutter to try more possibilities and thus produce better runcuts. More important though, the current RUCUS logic is hard-coded and thus inflexible. Any substantial change in the labor contract that must be satisfied or the character of the bus runs that must be cut could degrade the ability of the present logic to produce good cuts. Moreover, this degradation could go unnoticed if it results from a gradual change in the way bus runs are formed (which might happen as the Mini-Scheduler is phased in). The long range solution is to replace the hard-coded logic with flexible direction from run cutters in an interactive environment.

OPERATIONAL REPORTS

Nearly all of the reports produced in the planning and scheduling process, whether for internal use or for bidding or operations, are obtained by sorting and listing various subsets of the unit-record BOS or Work-Run Master File. These methods require minimal programming effort, but unduly restrict the data base structures they use. During the transition phases of the Mini-Scheduler and runcutting projects, the BOS and Work-Run Master File must be maintained or produced by the new system. But at an early date, new report programs must be written that access the new data bases. To that end, SCRTD should review the usage and format of all current reports that rely on the BOS or

the Work-Run Master File. Those reports that are distributed outside the department, pariculary those that receive large distribution, must be changed with caution; nonetheless, some changes may be beneficial. Those used within the department may well benefit from extensive changes inasmuch as their initial design was heavily influenced by 1401 technology and attitudes.

Report distribution methods should also be reviewed. At present all reports, even those distributed from the divisions, are printed on the Univac or 1401 printer, then turned over to the print shop for duplication. This process has become a bottleneck which has shortened the time that scheduling can devote to schedule revision and runcutting. Also, the massive effort required to distribute reports sometimes discourages revisions that could otherwise have been made. One potential solution is to place RJE stations with printers at each division and print reports such as paddles and supervisors summaries locally at each division. If this were done, the opportunity would exist to print these reports daily so that schedule adjustments could take effect the day after they were complete.

BUS STOP FILE

SCRTD at present lacks a common nomenclature for bus stops. The system is or will be dealt with at a bus stop level for various applications -- planning, CCIS, AVM, APC and Stops & Zones among them. Thus, SCRTD should design a bus stop file that consolidates stop information in one place if only to unify the various applications. But more importantly, in the long run such a file will open up the possibility of computer graphics. So much of the essential character of a transit system is geographical that many of the most useful potential management tools will rely on graphic representations of the system. AVM

is but one example, others include; automated generation of route maps for public timetables, identification of "near miss" transfer points where lines may miss by a block or so, and an automated interface to geographic planning data such as demographic data and transit network models (e.g., TRANPLAN or UTPS).

The record for each stop should contain the stop location, both on a X-Y grid that is sufficiently detailed to distinguish one side of the street from the other, and by street name. The record should also specify the Mini-Scheduler and/or RUCUS mode number when applicable, and other information such as the lines that use the stop, the presence of a shelter, or radio sign post.

Because many of the potential applications of such a file will require rapid and frequent access to the data, careful consideration must be given to the data base design. A simple sequential file may suffice for the present applications, but if too much reliance is placed on simple file structure, future data intensive applications will be impractical.

OVERVIEW OF PURCHASING AND ACCOUNTS PAYABLE SYSTEM

The following goals and objectives have been established for the proposed Purchasing and Accounts Payable system:

- Goals
  - Cost savings through increased fiscal control.
  - Improved vendor relations.
  - Reduction of clerical labor necessary to support current system.

- Objectives
  - Control issuance of accounts payable payments by matching invoices with purchase orders.
  - Accurately record disbursements in general ledger.
  - Reduce the amount of time currently required to produce payables checks.
  - Take greater advantage of payment discounts.
  - Provide more accurate budget control by disbursing accounts payable financial data on a timely basis.
  - Report expenditures by department, project or grant.
  - Development of internal management reports necessary to support the accounts payable function.
  - Produce all required external reports from routinely collected and stored accounts payable data.

- Provide accounts payable management reporting on a more timely basis by improving input-output turnaround time.
- Produce purchase orders automatically and create an automated open purchase order file for invoice validation and matching purposes.
- Produce reports which facilitate the reporting of inventory status (i.e., quantity on order, quantity received, etc.)
- Integrate accounts payable and purchasing data with the financial and inventory data bases.
- Create a valid vendor file for matching and editing purposes.
- Accumulate and produce historical vendor accounts payable data on a regular basis.

The overall goal is to install new accounts payable and purchasing applications that will provide better control over payment to suppliers, allow the District to improve its cash and discount position, and provide for economical and efficient internal processing. To achieve these goals, there is the need to improve both the manual and automated components of the accounts payable and purchasing processes.

This overview concentrates on the automated components and manual control features of the new system. In addition, emphasis is placed on the interfaces among system components and informational and data flows.

PURCHASING AND ACCOUNTS PAYABLE CHARACTERISTICS/PHILOSOPHIES

Data flows into the purchasing and accounts payable system from two independent sources:

- Accounts payable in the form of invoices, adjustments and manual checks, and

- Purchasing in the form of purchase requisitions, vendor changes and receipt of goods.

As a result of these two independent data flows, two data processing files are created. These are the accounts payable transaction (accounts payable subledger) and open purchase order files. Due to their independent sources, each file can verify the validity of data stored in the other file and act as an additional control prior to the generation of accounts payable checks. The system automatically matches approved invoices with open purchase orders to verify quantity, unit price, total price, vendor, and other key data prior to printing accounts payable checks.

Creation of an accounts payable check then triggers creation of a historical transaction record. Currently, SCRTD is not able to accurately maintain and access historical vendor records. Thus, vendor and accounts payable analysis is becoming more and more difficult. In response to this requirement, the system utilizes a vendor file. This file is used to store and retrieve historical data about all vendors. Thus, once checks are generated by the system, the vendor file is updated to reflect all transactions.

The vendor file also serves another important purpose, it is the repository for the approved vendor list. Vendor data can be added or changed on this file. Maintenance of the approved vendor list is the responsibility of the purchasing department. All vendors in the vendor file are considered approved vendors unless otherwise indicated within the vendor's record. Hence, the vendor file serves as a key control utilized by the accounts

payable and purchasing system. By matching and editing purchase requisition data against the vendor file, prior to entering the order into the open purchase order file and generating the purchase order, the system helps ensure that only valid suppliers are entered into the system.

Provisions have also been made for vendors or suppliers where no purchase orders exist. Examples of these payables might include attorney or audit fees. Manual checks might also be required in the case of other non-standard accounts payable. In all cases that require the generation of manual checks, information will be entered into the vendor file, thus maintaining the accuracy of all vendor historical data.

The initial input to the system, in most cases, will be a purchase requisition. Purchase requisitions would fall into one of two categories:

- Purchase from a new vendor and
- Purchase from an already approved vendor.

If the purchase is requested from a new vendor then appropriate level authorities must be present to validate and enter the vendor information into the vendor file. Once the vendor is established on the vendor file, the purchase requisition initiates the generation of a purchase order and the entering of the order into the open purchase order file.

If the purchase is requested from an existing vendor, the information is entered into the system and screened against the vendor file for vendor name, address, etc., to ensure the accuracy of the data. If there is a match, the data is entered into the open purchase order file and a purchase order is generated. Otherwise, the requisition is not entered into the

system and is returned to the requestor for appropriate authorizations and/or error corrections.

When invoices are received, they are entered into the system through the accounts payable function. To produce the accounts payable checks, the accounts payable transaction file is matched against the open purchase order file. Checks are then produced for every match due this cycle and historical vendor data in the vendor file is updated. When there are records in either file, with no matches, this information is included on an exception report.

Partial shipments are also included in the open purchase order file by an indication of partial receipt of merchandise within the originally established open purchase order record. When invoices are received for partial payment, the invoice is entered the same way as with full payment. However, partial payment does not eliminate data from the accounts payable transaction file or open purchase order file. Partial payment does update the vendor's historical record in the vendor data file.

The system provides accounts payable and purchasing reports in the following areas:

- Accounts Payable Subledger
  - Checks
  - Check register
  - Exception reporting
- Accounts Payable Reporting
  - Vendor Listing
  - Vendor summary

- Cash requirements
- IRS reporting

- Accounts Payable Expense Distribution

  - Expense distribution report

- Purchase Orders

  - Purchase orders
  - Purchase order analysis

CONCEPTUAL SYSTEM FLOW

The accounts payable and purchasing system is centered around three key files. These are the accounts payable transaction file, which acts as an automated accounts payable subsidiary ledger; the open purchase order file; the vendor data file, which retains all vendor historical data and the approved vendor list.

Data input to the system flows from two main functional sources, accounts payable and purchasing, through the established control points and into its respective files. Once the data are entered into the open purchase order file and the accounts payable transaction file, a matching process takes place. When a match between an invoice and open purchase order occurs, accounts payable checks are generated and the vendor data file is updated.

In addition, this matching process triggers the information flow from the accounts payable system into SCRTD's other related computerized systems. Thus, the accounts payable and purchasing system must be compatible with these other systems if they are to rely on the data generated by accounts payable and purchasing.

SYSTEM INTERFACE REQUIREMENTS

The accounts payable and purchasing system utilizes the accounts payable data base and interfaces with the inventory and financial data bases. The open purchase order file is an integral part of both the accounts payable and purchasing system and the inventory data base. Supplies and parts on order and merchandise received data are used by the inventory data base and open purchase orders are matched with invoices in the accounts payable data base.

From the accounts payable and purchasing system, key financial data is generated. These data include disbursements and expense distributions that are used by SCRTD's general ledger application.

OVERVIEW OF HUMAN RESOURCES MANAGEMENT INFORMATION SYSTEM

The following goals and objectives for the Human Resources Management Information System (HRMIS) have been established by SCRTD:

- Goals
  - Improved service through more efficient employee resource utilization.
  - Reductions in clerical functions and costs required to support the human resources management function.

- Objectives
  - Development of an integrated Employee Data Base capable of interfacing with the District's other data bases (integration of compatible data).
  - Capturing and entering employee data at a single source, thus eliminating duplicate activities.
  - Reporting employee data in support of labor contract negotiation including costs of benefits and other contract elements.
  - Reduction of substantial clerical labor required in preparation of contract negotiation.
  - Utilization of computer processing resources to adjust and recompute alternative labor cotracts while negotiations are in progress, thus providing a more secure bargaining position.
  - Production of the reports necessary to support the administration of SCRTD's benefits and pension programs.
  - Production of SCRTD's mandated (required by law) and internally required reports and management information.

- Improvement of accuracy in reported data by utilizing computer processing resources and reduction in manual support.

- Improved support to SCRTD's personnel administration areas and functions including safety, training, and applicant flow.

- Generation of data for labor analysis and forecasting the District's manpower requirements.

- Reduction of clerical support as a result of interface with other data bases.

- Identification of salient personnel selection criteria to enhance employee recruitment and evaluation.

- Elimination of duplicate data being stored on the computer system and subsequent reduction of required computer storage space.

- Better response to ad hoc inquiries.

- Centralization of employee data within the Employee Data Base.

This overview highlights the most important features of the system. Emphasis is placed on conceptualization of key system components, interfaces and informational flow. In addition, functional reporting requirements are shown. HRMIS is designed to provide maximum information about employees, benefits, and other areas of interest at minimum cost. Effective use of the system will aid SCRTD management in defining and solving business problems and help in meeting future plans and goals.

HRMIS CHARACTERISTICS/PHILOSOPHIES

The system is divided into the following five functional areas:

- Labor Relations
- Benefits and Pension Administration

- Mandated and Internal Reporting
- Personnel Record Management
- Employment and Labor Planning

Each functional area draws on and is dependent upon the data stored in the Employee Data Base. The amount of information required about each employee necessitates a large file for SCRTD employees. Most of the detail for this data base is furnished by direct input, however, the Employee Data Base also draws on data from the Schedules and Accident data bases.

The Employee Data Base contains a record for each employee in the system. Included are personal information; control information such as location, employment and job data; salary information; employee chronological employment history; formal education and training course data; and prior work history. Employee records are maintained for all active part-time and inactive employees.

In addition to the Employee Data Base the system utilizies the Applicant Data Base and Parameter Tables. The Applicant Data Base is made up of general information about all employment applicants. This data base allows the District to track and monitor the career progress of all successful applicants. Consequently, this will permit analysis and evaluation of employee selection criteria and will aid in the recruitment of new employees to the District.

The Parameter Tables are a series of tables contained in a single file. Each table contains static data that does not change as employee records are routinely updated. The Parameter Tables file is made up of data tables and editing tables. The editing tables are used to screen employee transactions and data prior to updating employee records. The editing tables include the:

- Edit Table
- Error Message Table
- Transaction Code Table
- Company Table

The data tables include the:

- Location Table
- Job Table
- Salary Grade Table
- Life Insurance Table
- Travel Accident Table
- Additional Benefits Table
- Skill Vocabulary Table

HRMIS uses the data tables to provide standard data for individual employee records that would otherwise have to be entered for each employee. For example, if inquiry was made about an employee's current job, the following data might be required:

- Job title
- FLSA code
- EEO compliance code
- Job points
- Evaluation date

A table entry containing this information for each job in the organization would eliminate the need of entering this data for each employee. By merely entering the key code, all of the above data could be obtained from the appropriate data table. Consequently, efficiency in hardware utilization is maintained while providing users with a high service standard.

Maximum flexibility and cost effectiveness in meeting SCRTD's unique HRMIS requirements is achieved by the system. For example, information retrieval can be accomplished either through batch or on-line processing modes. Priorities can be established for ad hoc and routine inquiries, thus, resulting in the most appropriate response for the situation.

Accuracy and validity of employee data input to the system is assured by standardized input procedures and extensive editing of input transactions and data. When errors in data entry occur, the data will not be applied to employee records until it has been corrected. In addition, control totals are generated that allow reconciliation of data input with data output.

SYSTEM CONTROLS

An important control in the system is the Run Control Sheet. The Run Control Sheet is submitted every time HRMIS is run. This sheet provides the user with several control features and processing options. For example, the user can specify that only invalid records be printed so that errors can be easily located. If the Run Control Sheet is not submitted, or if errors are found on the sheet, the processing run will terminate immediately. Hence, all data that has been entered to be processed in the current cycle, will automatically be rejected by the system and will not have any affect on the Employee Data Base.

The system automatically produces control and maintenance reports. These reports should be used by supervisory personnel to review for irregularities and unique conditions on a regular basis. The most important of these reports and their description are listed below:

- Control Totals Report

The control totals that are generated by the system are shown on the Control Totals Report. Some of the totals that appear on this report are:

- Master records read
- Master records created
- Master records deleted

- Parameter Tables Directories

These directories reproduce each table that is found in HRMIS. The last change date for each table directory indicates the date of the latest update. Furthermore, those items that have been changed since the last update are marked with an asterisk. Thus allowing the user to easily audit the updating of tables.

- Employee Data Element Entry Audit

This report provides a card image of all data element entries that were used as input to the current processing cycle. Along with the card image, an error number and message are generated. The error numbers are those which have been specified in the Edit Table for data entries that are invalid. The error message comes from the Error Message Table.

One entry may create more than one error number and message if more than one element within the entry was invalid. Thus, eliminating the reprocessing of invalid data.

- Total Employee Report

  This report represents a matrix account of all employee records in the Employee Data Base. It includes not only those records that are active, but those which are inactive as well. In addition, the Total Employee Report shows the updated status of the Employee Data Base after all processing has occurred during the processing cycle.

Finally, another important control feature of the HRMIS is security control. By using user and/or terminal identification codes, restrictions can be placed on the direct access capabilities of users. For example, some employees may be given the ability to update and change employee records in the Employee Data Base via on-line access. (Typically, this would include only responsible individuals from within the Human Resource Management Function.) Whereas, HRMIS users from outside of the Personnel function can be given on-line read only capability. Thus, preventing misuse and accidental changes to important employee records.

CONCEPTUAL SYSTEM FLOW

The heart of the HRMIS is the Employee Data Base. Information about each employee is located there and all HRMIS reporting stems from this data base. Reporting is either to be initiated by users on an ad hoc basis or occurs on a regular basis with each processing cycle, depending upon the need and type of information. For example, maintenance and control reports are generaged automatically by the system with each processing cycle. Whereas, during union contract negotiations, on-line access would normally be required by the Labor Relations Department to respond quickly and accurately to various proposals.

Data is entered into the system by the use of one of several input forms. These forms include:

- Parameter Table Data Entry Form
- Data Collection Form
- New Hire Form
- General Purpose Form

These forms utilize standard character conventions and coding structures. Illegal or incorrect entries are detected by the edit programs and require correction and resubmission prior to acceptance by the system. Since error correction represents a duplication of effort that is time consuming and costly, care must be taken in the preparation of input documents.

Personnel Record Management has overall responsibility for maintaining and updating the Employee Data Base. Consequently, it is their responsibility to review all input, prepare control totals and verify the correctness of reports prior to distribution.

In addition, Personnel Record Management and Benefits and Pension Administration are responsible for updating and maintaining the Parameter Tables that they control. Thus, appropriate supervisory personnel for both areas should review control and maintenance reports on a regular basis.

SYSTEM INTERFACE REQUIREMENTS

In addition to utilizing data from the Employee and Applicants Data Bases, the HRMIS also utilizes data from other data bases, which include:

- Schedules Data Base
- Accidents Data Base
- Maintenance Data Base
- Cost Data Base
- Payroll Data Base

HRMIS uses data from other data bases in two ways. (1) Data from other data bases updates the Employee Data Base directly, as is the case with the Schedules and Accidents Data Bases; and, (2) the reporting modules call upon the other data bases to meet various reporting requirements as is the case with the Maintenance, Cost and Payroll Data Bases.