# Design and Implementation of an Automated Management Information System for the Iowa Department of Transportation

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ABSTRACT

Recently transit systems of all sizes have begun to explore the variety of small-scale computer uses for assisting management. The process of design and implementation of a computerized management information system (MIS) for the Iowa Department of Transportation and five Iowa transit properties is traced. The automated system chosen consists of an NCR supermicrocomputer and Tower hardware coupled with the UNIFY data-base management system and other software. The project consisted of two phases. Focusing on research and design, Phase 1 included needs analysis conducted on site, review of institutional relationships and capabilities, assessment of available hardware and software, evaluation of telecommunications needs, and development of a Request for Proposal (RFP) to procure hardware and software. Phase 2, centered around the implementation and evaluation portion of the project, included distribution of the RFP, evaluation of bids and the procurement process, development of the chosen software, preparation of training materials, and development of a computerization impact analysis. The variety and scope of issues relevant to the development and choice of a particular computerized MIS are presented. Among the major factors affecting choice were the functions to be performed on the computer, the relationship to both local and state computer resources, the amount of employee experience with computers, the desired level of telecommunications between local and state users, and the actual software and hardware needed to satisfy the MIS needs. The entire process of design through implementation was complex and involved, and the results should prove insightful to state transportation officials and transit managers.

The management information requirements of transit properties involve large volumes of data. Once the data have been collected, they are combined with other data, summarized, and manipulated in a variety of ways. Utilization of computers for managing these data has been recognized as both efficient and productive. The change from manual to computerized data processing is a complex process that must be thoroughly planned. The transition to a computerized management information system (MIS) centers around several interrelated elements: the actual users, creators, and flows of information; the information needs as viewed by the transit professionals who will be using the system; and the desired modes of computer operation.

The design and implementation of a microcomputer-based MIS for the Iowa Department of Transportation (DOT) and five Iowa transit properties are examined here. The project was executed in two phases, the first phase concentrating on background research and design. Information was gathered using on-site visits and interviews with key transit personnel. From this information, institutional relationships were examined, and individual experience using computers was reviewed. Next an assessment was made of the readily available hardware and software suitable to meet the transit management informational needs as defined and ranked by priority by the Project Team. The Project Team consisted of state and local officials and a private consultant. Telecommunications requirements were also evaluated, and hardware and software specifications were developed in order to prepare a Request for Proposal (RFP) for prospective hardware and software vendors.

The second phase of the project centered around implementation and evaluation issues. The RFP was finalized for bid and purchase of hardware, software, and related materials. Then the RFPs were evaluated by using an assigned point system, followed by procurement of NCR Tower hardware, the UNIFY data-base management system (DBMS), and other software. The software was then adapted to serve the functional requirements identified in Phase 1. Following system installation, a variety of training aids were developed for the Iowa DOT and transit property personnel. The final step was to establish a method for evaluating the operational differences resulting from computerized data processing.

## PHASE 1

### Needs Analysis

An on-site needs analysis was conducted at transit systems in five of Iowa's major cities and the Public Transit Division of the Iowa DOT concerning priority

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tasks to be computerized. Other issues such as communications and procedures related to the municipal mainframe, financial, payroll, and personnel systems were examined. Basic implementation capabilities for an information system, including such items as organization, skills, resources, policies, and procedures, were determined. The Project Team assessed the information flow at each location (i.e., the data users and data creators).

In addition to individual interviews at each site, two group interviews were conducted to help determine and document user requirements. Participants at each site were encouraged to consider appointing a key staff person who would have the primary responsibility for each respective automated information system. Potential users at each transit site were contacted to provide existing and desired data elements and to gain an understanding of the short-term and long-term labor requirements involved in the implementation and maintenance of the information systems. The interest among the transit administrators in automating the various activities was determined. Based on these considerations, a ranking of functional priorities for computerization for each site was determined. These site priorities and a projectwide summary are shown in Table 1.

## Existing Relationships and Capabilities

The individual and group interviews and discussions just described served to identify the relationships that existed between each city's transit, finance, and data processing departments and their respective information management activities. All of the source data forms completed by data creators and the reports produced for the data users for each of the transit systems were collected and analyzed with respect to who completes the forms, who uses them, how often they are completed, what information is included, what additional reports are produced from the data, and what purpose is served by the form or report. This information was tabulated in summary form (1) for each of the five transit sites and the information was confirmed with site staff.

Certain conclusions were drawn for all of the transit sites as a result of the determination of information flows. Some level of data--either detailed or summary--is transferred between each functional department and nearly every other department. Reports prepared by departmental supervisors often require information from several of the other departments. Once prepared, these reports are then often used by other functional departments in the preparation of their own reports. In four of the five cities, the municipally operated mainframe computer was used to assist the transit property in processing and analyzing primarily financial data. This interrelationship qualified the low prioritization for administrative and financial functions noted earlier.

Information was also obtained that provided a basis for assessing the transit system's capability to use a microcomputer or minicomputer from an operational and personnel standpoint. These assessments were based on three factors--the computer experience levels of the site staff, the overall organizational effectiveness of the staff, and the attitude of the staff toward the prospects for computerization of the present manual processes. The latter two factors were subjective observations. Computer experience was determined by interviewing staff on site and included previous experience with any of the following: word processing software, DBMS software, spreadsheet software, accounting software, graphics software, programming in a computer language, computer courses or seminars, end-user turnkey applications, or other special-purpose software packages. Such experience was classified by the hardware used--either microcomputer system or terminal to a larger minicomputer or mainframe.

Three of the five sites had little or no staff computer experience and only one site had any programming or development experience among the staff. The DOT staff capabilities, outside of the Data Processing Department, included some development with off-the-shelf microcomputer software.

The lack of computer experience among site staff indicated that both the hardware and the software procured had to be designed for ease of use and ease of development by the end user, in spite of the scope and complexity of data-processing tasks among the management functions of each site. All the sites exhibited high levels of staff cooperation, overall management organization, and interest in the automation effort. The consultant concluded that the staffs at all sites, with appropriate training, would be able to use the menu-driven applications.

## Assessment of Computerized Systems

An assessment of the state of the art of computerized systems for small to medium-sized transit systems was conducted on the basis of available information. This assessment included consideration of software, hardware, and software-hardware combinations as described in the following paragraphs.

### Software

An evaluation was made of software alternatives and recommendations were developed for implementation based on this evaluation. The software alternatives explored included existing transit-specific applications and general business accounting applications. The usefulness, necessity, and potential integration of these programs with a commercial microprocessor-based DBMS were determined. The aim was to select software that would allow for future modifications by the users and for expandability. Site requirements

**TABLE 1 Computerization Priorities by Site**

| | Dubuque | Waterloo | Davenport | Sioux City | Cedar Rapids | Total Score[a] | Project Priorities in Rank Order of Importance |
|---|---|---|---|---|---|---|---|
| Maintenance | 3 | 2 | 1 | 1 | 1 | 8 | 1 |
| Materials and equipment management | 4 | 3 | 2 | 2 | 2 | 13 | 2 |
| Performance monitoring and evaluation | 2 | 4 | 3 | 3 | 3 | 15 | 3 |
| Operations | 1 | 5 | 4 | 4 | 4 | 18 | 4 |
| Administration and finance | 5 | 1 | 5 | 5 | 5 | 21 | 5 |

[a]Lowest total score indicates highest priority, projectwide. The grouping of needs follows the categorization scheme employed in Figure 1 of the report by McOwen and Collura *(1,p.13)*.

called for multiuser expandability at each site while also permitting use in a single-user environment. Evaluation criteria included more than 60 features and considerations, as follows:

1. Transit applications;
2. General business applications for transit systems;
3. Degree of user friendliness;
4. Cost for purchase;
5. Documentation;
6. Integration and interaction between programs;
7. Need for user training and availability of trainers, cost;
8. Warranties and service (maintenance availability);
9. Communications programs;
10. Security data;
11. Back-up data system;
12. User policies and responsibility;
13. Flexibility;
14. Availability;
15. Capacity limits;
16. Upgrades;
17. Other limitations;
18. Interfacing needs;
19. Speed of program operations;
20. Reliability;
21. Ownership of software (control and licensing);
22. List of current transit or small business users or both; and
23. Program language or languages.

Additional software considerations in the preliminary evaluation of candidate DBMS software were as follows:

1. Data retrieval requirements,
2. Data update requirements,
3. Security requirements,
4. Recovery capabilities,
5. Ease of use by nonprogrammers,
6. Format convertability,
7. Program and data independence,
8. Cost,
9. Operating effectiveness (response time),
10. Operating efficiency [central processing unit (CPU) and disk access speeds],
11. Documentation,
12. Vendor support (user questions and maintenance),
13. Expandability,
14. Size of data base and type of indexing,
15. Training requirements, and
16. Communications support.

More specific features of the candidate DBMS were as follows:

1. Data manipulation language employed,
2. Data types allowed,
3. Screen format design,
4. Number of indexing keys per file,
5. Help screens,
6. Conditional processing of commands,
7. User-defined messages,
8. Entry of parameter values from terminal,
9. Maximum file size,
10. Maximum record size,
11. Maximum field size,
12. Maximum records per file,
13. Maximum fields per data base,
14. Minimum random access memory (RAM) requirements,
15. Data entry options (automatic range checking, automatic repeat, display only, calculated fields, verification, default entries, password protection for any field, logical operation, skip field),
16. Maximum files per output mask,
17. Maximum files per input mask,
18. Maximum pages per screen mask,
19. Custom menu program creation with predefined commands for interactive use,
20. Global file operations,
21. Data-base file merging with word processing,
22. Multiuser and networking capabilities, and
23. Interfacing and telecommunications.

All five transit systems needed to provide computer work stations to several functional departments. Standardization of the software packages, operating systems, applications programs, data elements, and attribute-record-file structures among the five transit sites was an important evaluation objective. Options that allowed the selection of the data elements and report formats most useful to each work site were provided.

## Hardware

An assessment was made of appropriate hardware so as to provide for the optimal design specification, selection, and performance of the hardware systems and peripherals. The software specifications and needs analysis determined the hardware requirements.

The reliability and usability of the alternative hardware packages were determined by contacting other users with similar hardware configurations. Hardware was considered only if it did not require new, specially qualified staff for its operation. All hardware considered supported industry-standard operating systems, which in turn supported industry-standard programming languages.

Evaluation criteria for hardware are as follows:

1. System standards that will meet the three operating modes (stand-alone, terminal, and network);
2. Degree of user friendliness;
3. Cost for lease or purchase or both of
   a. Memory and
   b. Peripheral options;
4. Need for user training and availability of trainers, cost;
5. Warranties and service;
6. Communication systems;
7. User policies and responsibilities;
8. Availability;
9. Capacity limits;
10. Need for remote terminals or separate work stations;
11. Speed of system;
12. Reliability;
13. Usability by staff;
14. Expandability;
15. Operating system or systems;
16. Upgradeability;
17. List of similar system users;
18. Language capabilities; and
19. Work-station characteristics (e.g., physical dimensions, electrical requirements, temperature, humidity control).

Criteria for selection and evaluation of candidate hardware components and packages are as follows:

1. Detailed specifications for CPU main memory requirements,
2. CPU speed,
3. Size of data path,
4. Secondary hard disk storage requirements and tape backup,

5. Terminal requirements,
6. Keyboard requirements,
7. Communication ports,
8. Communication modems,
9. Printers and related peripherals and adjuncts,
10. Expandability from single-user to multiuser capability without changing software, and
11. Upgradeability of system's main and secondary memories.

## Hardware and Software Combinations

The best combinations of hardware and software for this application were formulated and presented by the consultant. The trade-offs involving cost, capabilities, and ease of use of the software-hardware combinations were discussed and a consensus was established.

A primary consideration in evaluating the combinations was that they be easy to use. The recommended combinations provide for nontechnical, logical-level views and access and powerful high-level system commands that are well documented and capable of being learned by individuals without any knowledge of computer programming languages. Although the initial design and structure of such a DBMS is critical and does require professional assistance, once the users have become familiar with the systems they should be able to modify the data-base structure and generate new reports by following the manuals and procedures provided.

## Communications Needs and Requirements

The choice of the software and hardware should be viewed in terms of their compatibility in a coordinated system. Not only must the computer work well at an individual site, it also must be able to "communicate" easily with the other sites.

The requirements of the Public Transit Division of the Iowa DOT for communications capabilities between its computers and the sites' computers and among the site computers was determined by the consultant.

Four of the transit sites exchange information with their respective municipally controlled mainframes or minicomputers. All five of the transit sites, including Waterloo, exchange much data with the Iowa DOT. In order to streamline the exchange of information and reduce the time and expense involved with manual information exchange, which usually involves multiple copying of information (data entry), there are advantages to establishing means of electronic exchange of data among the respective information systems (computers) of the transit sites, the city's mainframe, and the Public Transit Division of the Iowa DOT.

In addition, the division's responsibility for distributing state and federal transit funds to local sites and monitoring publicly funded projects gives the division added interest in accessing data produced at the transit sites.

The Public Transit Division will utilize the same equipment and software as the local transit sites. With a telecommunications link, the division can receive data automatically from the various transit systems. These data have had to be manually entered at the division in the past and are used for performance monitoring by the state and for UMTA Section 15 reporting. Although most of the data to be transmitted to the division will be aggregated or summary data, it will also be possible to transmit detailed data if needed. The ability of the division to receive data promptly from the sites will provide for improved project management and financial planning.

The other important function of the communications link among the transit sites and with the division is to share data and programs. Software modules that are developed by the state or one of the local sites can be shared by transmitting the source code (programs) to any interested site for its own use. The ability of one transit site to obtain a computer program from another site that has developed a particular program to solve a similar problem is an important telecommunications feature. Examples could include the development of a data base for storing and retrieving information about ticket, pass, coupon, or token sales and use or a program to analyze accident data. By sending these programs from one computer to another electronically, any site can take advantage of the efforts of the other sites to solve common management information needs without having to start from scratch or type in the program by hand.

Communications between computers for file transfer or for terminal emulation are achieved with the appropriate hardware and software. Telecommunications also provides the advantage of allowing access by the local sites to the DOT's statewide information network. An integrated system between the state DOT and the transit properties facilitates all types of information exchange.

## System Design and Specifications

Given the trade-offs among capabilities and functions of available hardware and software, it was decided that the greatest consideration should be given to those proposals that came closest to providing all of the components specified and were best suited to meeting the needs of the project. The elements identified as a necessary part of the Request for Proposal (RFP) were the following:

1. Special consideration should be given to software that is proposed in combination with the accompanying hardware, and vice versa.
2. All software and hardware must be available for demonstration and testing, and vendors should make available software and hardware for benchmark tests if requested. Vendors may also offer their own benchmark programs and data for testing, if desired.
3. Software must be designed for multiple-user environments with comprehensive concurrency control features that allow multiple users to read and update data concurrently without overwriting updates or other loss of integrity. Lock tables (at least at the record level) or timestamping are acceptable methods. If locking methods are used, deadlock detection and response should be provided.
4. Comprehensive documentation will be required with accepted software and hardware, and telephone support for end users must be available for software and hardware.
5. Proposers should submit technical information with proposals, including users' manuals for all proposed hardware and software in sufficient detail so as to allow for close examination of the products. If requested, users' manuals may be returned for proposals that are not accepted.
6. Proposals may be considered for only a portion of the nonprimary hardware and software requested in the RFP, including individual hardware or software components. However, special consideration should be given to those proposals that come closest to meeting all of the hardware and software requirements specified. Any hardware or software components proposed must be demonstrably compatible with the major hardware and software components selected.

7. All software should be menu-driven and include help screen features.
8. Combinations should be required for the following primary components:
   a. Central processing system [including all main and secondary memory and input-output (I/O) ports],
   b. Operating system, and
   c. Relational DBMS.

There should be no exceptions to this requirement.
9. Proposed prices should be itemized for all hardware and software components.
10. All proposals should include a list of end users who currently use the proposed components and combinations and who may be contacted for references.

With these elements in mind, the RFP was finalized.

## PHASE 2

### RFPs

In August 1984 the Iowa DOT sent out the RFP (2). After much review, it was decided that a multiuser computer system capable of supporting multiple work stations would be required. The on-site analysis process and experience with other transit systems with similar characteristics precluded the use of a single-user personal computer at any of the sites. Multiple-user requirements narrowed the scope of available hardware and software considerably. The range of potential uses that the Iowa DOT computer should be capable of handling was as follows:

- Electronic spreadsheet
- General ledger
- Financial and statistical reporting
- Accounts receivable
- Accounts payable
- Cash management
- Passenger and revenue accounting
- Payroll, personnel, and labor distribution
- Timeroll
- Maintenance scheduling and management
- Materials management (inventory/consumables) and valuation
- Purchasing and receiving
- Claims and safety
- Responsibility and project accounting
- Construction project management
- Scheduling, estimating, and accounting
  - Financial forecasting
  - Budget development
  - Performance measurement systems
  - Section 15 reporting
  - Grant reporting
  - State and local agency funding report
- Cost-allocation plans
- Fund accounting
- Grant accounting
- Cash receipts and disbursements system
- Budget preparation and budgetary accounting
- Purchasing and encumbrance accounting systems
- Fixed-assets accounting
- Revenue and tax administration
- Cost-accounting systems
- General audits
- Attachment P "Single Auditing"
- Section 15 reports
- Section 5 level of effort and maintenance of effort
- State and local reports
- Bond indenture reports
- Pension plan audits
- Transfer of data files and program files among and between proposed work stations and IBM 4331 (operating under DOS/VSE) and or IBM 3081 (operating under OS/MVS) over existing DOT communications network
- Electronic mail
- Human resources management
  - Personnel planning
  - Training
  - Performance evaluation
  - Wage and salary administration
  - Fringe-benefit planning
  - Pension plans
  - Affirmative Action, Equal Employment Opportunity, Minority Business Enterprise
- Route analysis systems
- Internal control evaluations
- Internal audit functions
  - Organization
  - Computer methods
  - Staff training
  - Audit programs
- Revenue estimation and forecast
- Tax sales or depreciation
- Financial feasibility studies
- Funding alternative studies
- Nonfinancial feasibility studies
- Vehicle scheduling
- Customer information
- Ridership sampling
- Run cutting
- Schedule writing
- Extraboard and run picks
- Accident and safety reports
- Word processing
- Work rules impact
- Impact of service and fare changes
- Life-cycle cost data
- Warranty data (vehicles)
- Demand-responsive dispatching data
  - Client file
  - Origin-destination file
  - Vehicle use
  - Consuming-client data
  - Billing and rates
- Invoice preparation
- Market research data (surveys)
- Graphics
- Special-purpose examinations
- Contract auditing
  - Construction costs
  - Professional services
  - Transit vehicles
- Performance audits
  - Efficiency and economy review
  - Program results evaluation
  - Performance measurement systems

The hardware and software specifications set out the mandatory and supplementary requirements for the information systems. The complete list of requirements was quite extensive, and it included many of the features just described. Some selected paragraphs from the RFP that other properties should consider when undergoing a microcomputer purchase are as follows:

> The hardware components should be a multitasking, multiuser general purpose central processing microcomputer system including a floppy-disk system (one drive) or equivalent for program loading, cartridge streamer tape or equivalent (for disk backup), a printer buffer (not required if spooling-despooling software is proposed).
>
> The software DBMS should be based on the

> relational model as opposed to network or hierarchical models in order to provide for the most flexibility to the user with the least requirements for predetermined, more rigid design of file relationships. Nested comparison joins, selects, and projects should be available. Ad hoc queries should be available and capable of use by end users without programming experience. Nonprocedural queries are preferred and queries should be powerful and comprehensive.

The vendor selection criteria included the following:

> The evaluation of the submitted proposals will be made by an evaluation committee. The evaluation of qualified proposals will include, but not be limited to, the following items: features and capabilities of DBMS and other software; benchmark performance of such activities as disk I/O, terminal I/O, and CPU intensive processing; optional features provided and the extent to which they are provided; the amount and type of disk storage provided; overall performance of such items as ease of operation to communicate with the host computer, suitability of software, integration of components, additional software included; availability of service site, service turnaround time, and service rates; net cost to the Iowa DOT; a review of the proposed software and a comparison of applications features and compatibility with other proposed software; features and capabilities of hardware components.

## Evaluation of the RFPs

A section of the RFP was devoted to an explanation of the proposed evaluation process. Evaluations, performed by an evaluation committee composed of Iowa DOT representatives and the consultant, were based on a scoring system. Fifteen components were assessed a maximum point value and were awarded on a continuum from zero to the indicated maximum in each of the categories. It should be noted that a weighting factor, up to the maximum number of points possible, was awarded to each criterion on the basis of the judgment of the evaluation committee about that particular aspect of the proposal. The point system was also used to determine the cost-effectiveness of acquiring optional items.

Table 2 shows the evaluation categories and their assigned points. Five different vendors responded to the RFP; one vendor offered three options. The total cost per unit ranged from a low of $17,000 to a high of $73,000. The evaluation committee, after thoroughly reviewing all the proposals, found two that were acceptable according to the defined criteria. These two were then subjected to a comprehensive evaluation. The NCR Tower computer coupled with UNIFY DBMS software was chosen as most suitable for Iowa's needs. The Iowa DOT procured the computers according to state procurement policies.

## Training Aids

A variety of training aids was employed in order to assist transit managers and staff in using the information system. These training aids included on-line help screens and comments integrated into the software, written documentation in the form of an 11-page end-user guide and a 14-page guide for technical resource persons, both of which appear in the project final report (3). In addition to these training aids, telephone consulting and support were also provided to users during the initial implementation of the systems.

**TABLE 2 Evaluation Categories**

| Category | Points |
|---|---|
| Proposal organization and completeness | Max. 30 |
| Benchmark performance | Max. 200 |
| Command completeness | 10 |
| Compile time | 10 |
| Disk write throughput | 20 |
| Floating point | 20 |
| Multiuser disk performance | 60 |
| Multiuser CPU performance (sorting) | 40 |
| System RAM test | 10 |
| CPU scheduling (context switching) | 20 |
| DBMS software features | Max. 40 |
| Microprocessor features | Max. 110 |
| Coprocessors used | 20 |
| Caching features | 10 |
| Floating point support | 15 |
| Time for single-track positioning | 5 |
| Time for average-track positioning | 5 |
| Rotational latency | 5 |
| Transfer rate | 5 |
| Maximum number of users | 15 |
| Maximum RAM | 15 |
| Maximum hard disk capacity | 15 |
| Terminal features | Max. 15 |
| Printer features | Max. 15 |
| Financial software features | Max. 15 |
| Source code availability | 5 |
| Source of support | 5 |
| Spreadsheet software features | Max. 20 |
| Main system resident in RAM | 10 |
| Number of cells | 10 |
| Word processing software features | Max. 25 |
| Operating system features | Max. 20 |
| Programming languages supported | 10 |
| Utilities provided | 10 |
| Maintenance and service terms | Max. 200 |
| One phone number for hardware and software problems | 20 |
| Toll-free line for support | 30 |
| Telephone response time | 20 |
| Service response time | 60 |
| Same day | 60 |
| Within 24 hr | 40 |
| Within 48 hr | 20 |
| Over 48 hr | 0 |
| Original Equipment Manufacturer service (versus third party) | 20 |
| Telephone diagnostics availability | 25 |
| Length and terms of guarantees and warranties | 25 |
| Options available (at additional cost) | Max. 40 |
| Extras (at no additional cost) | Max. 40 |
| Communications | Max. 20 |
| Installation | Max. 10 |
| Total maximum points | 800 |

## Computerization Impact Analysis

A before-and-after case study was developed by the consultant and carried out with the assistance of local and state officials. The evaluation goal was to illustrate the potential for benefits, costs, savings, successes, and failures accruing from computerization.

Before the impacts of computerization were assessed, the procedural elements of the manual reporting process were examined. These elements included the time needed to complete the reports and the use of data in more than one report. The scope of the "before" evaluation was narrowed to the Cedar Rapids system, which has completely manual data processing and analysis. This focused on the property that would show the most pronounced impact from computerization.

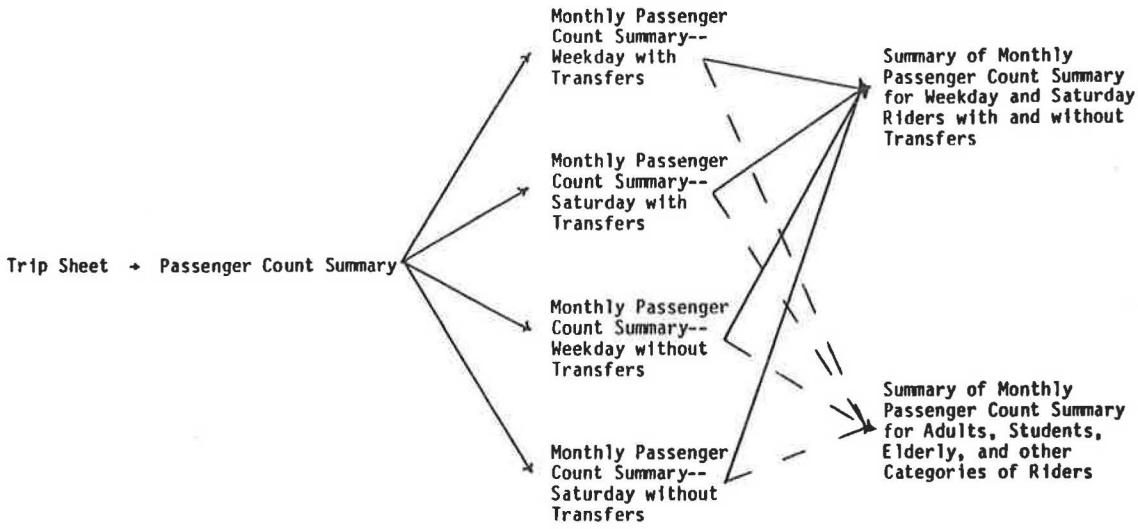


FIGURE 1 Cedar Rapids performance and operations reports.

The forms and reports prepared by Cedar Rapids personnel were collected by the consultant in order to trace the transition process from the base forms to the final reports. Figure 1 shows the data path for some selected performance and operations reports. A number of people utilize the data from these forms for completing these different reports. Extensive arithmetic manipulation is needed to produce the data shown.

To track the time spent on report preparation, a series of time logs was developed. The completed time logs showed that report preparation times varied from a low of 29 min to a high of 13 hr and 40 min. The variations, resulting from the complexity of the individual reports, were representative of the types of data collected and manipulated on the other properties.

The "after" study was designed to assess MIS implementation effects. The topics addressed are ease of microcomputer use, difference in adaptability by site, the success of the training program, and the time needed to prepare reports. To perform this study, a small data base was established and incorporated within the overall information system. Users enter a variety of data via the usual menus and screens, such as the amount of time required to use the system and any difficulty experienced. Management can then query these evaluation files in order to summarize and evaluate these data.

## SUMMARY AND CONCLUSIONS

The process of designing and implementing an MIS for small and medium-sized transit properties in Iowa has been described. This process yielded a number of findings that should prove interesting to other transportation officials.

The findings are as follows:

- Transit MIS needs fall into five functional areas: maintenance, materials and equipment management, performance monitoring and evaluation, operations management, and administration and finance. A multitasking, multiuser computer system was required to meet these needs.
- In many cities a municipally operated mainframe computer is used to assist the city bus operator in processing and analyzing primarily financial data; in these instances, administration and finance may be of less importance as compared with the other four functional areas.
- At most local transit sites, employees have little or no experience with microcomputers.
- Telecommunications between a state DOT and local transit sites is technically feasible.
- The software components needed to satisfy local and state MIS needs include a relational database manager (DBMS), a multitasking operating system, a financial package, an electronic spreadsheet, and word processing, graphics, and telecommunications software. The approximate costs of off-the-shelf software per site range between $5,000 and $10,000, depending on the number of components required, discount rates, and other factors.
- The cost of developing and customizing this software for a particular site will vary with the site characteristics and requirements.
- Appropriate MIS hardware components include a multitasking, multiuser CPU, printers, modems, display screens and keyboards, tapes for disk backup, hard disk systems, and other minor peripherals. The approximate costs per site for hardware range between $20,000 and $40,000, depending on the quality of the CPU and peripherals, memory requirements, number of work stations (terminals), discount rates, and other factors.
- The RFP process was suitable for the acquisition of the appropriate hardware and software combinations.

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# Management Recruitment in the Transit Industry

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ABSTRACT

Recruitment of talented transit managers has been identified as a critical problem for the industry. A description is offered of the scope of the problem as reported by transit agencies. It is sought to determine whether the problem is more acute for particular types of transit agencies or is more accurately viewed as an industrywide problem not linked to factors such as agency size or organizational structure. An overview of the recruitment problem as reported by a sample of 207 transit agencies is presented first. The analysis includes identification of those management areas for which recruitment is a particular problem, a listing of the possible reasons for recruitment difficulties, and a summary of steps taken to resolve recruiting problems. Next addressed is whether the problem of attracting new managerial talent to the industry is related to particular characteristics of some agencies or is more generally an industrywide problem. The agency characteristics included in this analysis are size, degree of change, organizational complexity, and institutional setting. The findings of the study establish that no particular type of agency is more likely to experience recruitment problems. This contradicts the expectation that larger, organizationally complex agencies would be more attractive. Thus, recruitment difficulties either are products of local, particularistic factors irrespective of size and complexity or reflect a problem for transit as an industry.

In a 1973 study of managers in the transit industry, transit was accurately described as an "up-from-the-ranks" industry (1). Management personnel were drawn largely from within the industry, and individuals frequently moved up from nonmanagement positions. However, current trends suggest that this is less true in the mid-1980s. The increasing specialization of management functions, changes in services offered, and the institutional changes resulting from the process of governmentalization have required many agencies to recruit management personnel from outside traditional manpower pools. The resulting problem for the industry was described in the proceedings of the Transportation Research Board's 1982 Conference on the Future Directions of Urban Public Transportation (2,p.7):

> A long-term fundamental problem has been that new blood cannot be attracted into a declining industry. Only in the last decade has it been possible to attract some new managers as a result of modest growth that has occurred, and now these benefits are threatened by loss of revenues from all levels and by changing federal policy.

Thus, the recruitment problem may be seen as partly a product of the perception that transit is an industry in decline. It would be expected, therefore, that agencies reporting decreases in the numbers of vehicles operated, work force, or numbers of management personnel (or all three) would report greater

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